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FOREWORD

Presented number of Silesian University of Technology. Scientific Papers. Organization and Management Series. Presented papers contain result of researches conducted by various universities. The number consists of 41 papers.

The papers presented in the number concentrate on many topics connected with organization and management. There are in the number papers about innovation management, AI usage in management, human resource management, startups, logistics, information management, energy management, corporate social responsibility, the impact of COVID-19 pandemic on management, service management, public management, smart cities, leadership and project management.

*Bożena Skotnicka-Zasadzień
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PROTECTING INNOVATION AS AN INSTRUMENT OF ORGANIZATIONAL RESILIENCE

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Purpose: The purpose of this article is to answer the question of whether innovations that are an instrument for the resilience of an organization can be protected by the organization from their use by others, and if so, based on what regulations.

Design/methodology/approach: The considerations of the following article are based on the literature on the subject and the case law of common and administrative courts. These materials were subjected to critical analysis.

Findings: The analysis carried out leads to the conclusion that innovations that are products can be the subject of exclusive rights, while innovations that constitute a production process can, moreover, be the subject of a patent as an invention. Regardless of this, innovations including non-productive processes and marketing and organizational methods can be protected under the provisions of the law against unfair competition.

Practical implications: The introduction of innovations by organizations raises the need to protect them from exploitation by other organizations, especially competing entrepreneurs. The article discusses the legal regulations that can be the basis for such protection, creating a framework for their practical use.

Originality/value: The issue of qualification of innovations from the point of view of intellectual property law has already been the subject of research in the Polish literature. The article is partly polemical in character with regard to the presented results of these studies, and, moreover, complements them with regard to the regulation of combating unfair competition. The addressees of this research are, in particular, entrepreneurs who use innovations in their activities.

Keywords: innovation, organizational resilience, intellectual property, know-how, intellectual property courts.

1. Introduction

Resilience is the ability of a system or society exposed to threats to adapt to a new situation by resisting or making changes to maintain an acceptable level of functioning (United Nations, 2007). As K. Sienkiewicz-Małyjurek points out, resilience is considered a trait of individuals,

organizations and communities that allows them to cope with threats. It can be a driver of entrepreneurship in crisis situations. Entrepreneurship, in turn, as the ability to use resources in the right way and at the right place and time, builds resilience to future threats, even in the event of failure (Sienkiewicz-Małyjurek, 2020). One of the instruments that allow organizations to resist threats arising in the environment in which they operate is to undertake innovative activities. New models of implementation of innovation processes determined by changing conditions are gaining importance (Woźniak, 2024). A correlate of the innovative activities undertaken by organizations is the need to ensure their protection from the enticements of other organizations competing in a given environment. Consequently, the analysis of this issue becomes important from the point of view of an organization wishing to protect the innovations it uses. The purpose of this article is - using the method of critical analysis - to answer the question of whether, and if so, on the basis of which regulations and in what proceedings an organization can seek legal protection against such actions, and in particular, whether a particular innovation can be protected as an object of exclusive rights, or only under the regulation of combating unfair competition?

2. Qualification of innovations as the subject of exclusive rights

It is difficult to find a clear definition of innovation in the literature. Among the reasons for this are the short tradition of conducting research on the understanding and perception of this concept, as well as the consideration of this problem from many points of view. In equal measure, the lack of previous interest and the failure to attach significant importance to innovation have resulted in the failure to form a unified definition. Authors embrace the concept with both broad and narrow meanings. The broad meaning already allows a small change as an innovation, as it is enough for it to be something improved, slightly modified. On the other hand, in the narrow sense, innovation is a fundamental change that serves to revolutionize a specific area (Żero, 2018). For the purposes of further consideration, it can be assumed that an innovation can be considered a product, service or process (including business) that is new or existing and has been improved (Taylor, 2017).

On the other hand, the legal definition of innovation is found in Article 7(6) of the Act of September 11, 2019 Public Procurement Law (consolidated text, Journal of Laws of 2024, item 1320), according to which the term should be understood as the implementation of a new or significantly improved product, service or process, including, *inter alia*, production processes, construction or design, a new marketing method or a new organizational method in business activities, work organization or external relations. One should also cite the definition of innovative activity contained in Article 2(1)(3) of the Act of May 30, 2008 on Certain Forms of Support for Innovative Activity (consolidated text, Journal of Laws of 2022, item 2474),

which, in the legislator's view, is an activity consisting in the development of a new technology and launching on its basis the production of new or significantly improved goods, processes or services.

In this context, the question arises whether an innovation is a new product, process or service, regardless of whether it follows the application of a new technology? However, a positive answer to this question in light of the above definitions may lead to surprising results. In the case of certain categories of entrepreneurs (e.g., publishers of books, magazines or phonograms), the essence of the activity is the introduction of new products to the market on a permanent basis. This would mean that such entrepreneurs should be considered innovative *per se*. Such a qualification does not seem right. Rather, the assessment of such entrepreneurs in terms of their innovativeness should be made through the prism of their introduction of new product categories (e.g. e-books, audiobooks), rather than specific books, magazine issues or phonograph albums.

Before analyzing the possible qualification of innovations as one of the intangible goods, it is necessary to pay attention to the governing principle of *numerus clausus* of rights on intangible goods. This principle implies that it is not possible to create new subjective rights of an absolute nature other than by statutory means, in particular, by means of a legal act or a court ruling (Kurosz, 2021; Dybowski, 2003). Therefore, in order to protect innovation, it is necessary to qualify it as one of the subjects of exclusive rights stipulated by the legislator.

3. Qualification of innovations as the subject of exclusive rights

First of all, it should be pointed out that Article 1(1) of the Act of February 4, 1994 on Copyright and Related Rights (consolidated text, Journal of Laws 2022, item 2509, hereinafter referred to as CRRA) allows works embodied in innovative products to qualify as works. In order for this to occur, the innovative good must be produced based on a design fixed in a tangible medium (*corpus mechanicum*), in particular in the original product itself, and thus constitute an original or copy of the work. For it should be remembered that the work is not the innovative product *per se*, but the work of which it is a carrier. Among the works enumerated by way of example in Article 1(2) of PrAut, which pretend to be works, the work of industrial design (Article 1(2)(5) of CRRA) deserves special attention. The form of a product, due to its new and unique design, may therefore be qualified as a work, and the product itself may constitute an innovation in the above sense (Szewc, 2014).

On the other hand, it should be pointed out that Article 1(2¹) of CRRA explicitly excludes procedures and methods, among others, from copyright protection. It is emphasized that, on the one hand, they are a part of reality, inherent in it, although they have not been noticed so far for various reasons, and thus cannot be considered the result of creative activity,

and, on the other hand, that granting property rights to such intangible goods would mean their monopolization and the impossibility of free access to them by others (Ferenc-Szydełko, 2021). As a result, not only innovations in the form of services, but also production processes, construction or design, as well as new marketing methods or new organizational methods in business, should be excluded from the possibility of qualifying as an object of author's protection.

At this point, a distinction must be made between the innovative process or method as a potential subject of exclusive rights and its description. The innovative process/method itself, like its description, has an intangible form, with the difference that the description of a given process/method may be fixed on a tangible medium. While the innovative process/method itself *per se* cannot be the subject of copyright in light of Article 1(2¹) of CRRA, as is clear from this provision, its description can already be qualified as a work within the meaning of Article 1(1) of CRRA. The fact that a description of a process/method as a work of literary character (Article 1(2)(1) of CRRA) meets the prerequisites for qualifying it as a work should not pose any major difficulties. Only that the object of protection as a work will then not be the process/method embodied in that description, but the description itself. In other words, the copyright monopoly will cover the use in any field of exploitation (Article 50 of CRRA) of the description of the process/method, but not their own. This means that while a particular description of a process/method will be protected as a work, the use of a particular process or method will be permitted.

In principle, it is also impossible to exclude the possibility of qualifying as an object of related rights the artistic performance (Article 85 of CRRA), phonogram (Article 94(1) of CRRA), videogram (Article 94(2) of CRRA), broadcast of a program (Article 97(1) of CRRA), and press publication (Article 99⁷(1) of CRRA) contained in an innovative product. Finally, it should be pointed out that it is possible to qualify an innovative product as a database within the meaning of Article 2(1)(1) of the Act of July 27, 2001 on the Protection of Databases (consolidated text, Journal of Laws of 2021, item 386; hereinafter referred to as PDA), and consequently be covered by *sui generis* right.

Turning to the assessment of the possibility of protecting innovations under the Act of June 30, 2000 Industrial Property Law (consolidated text, Journal of Laws of 2023, item 1170; hereinafter referred to as IPL), it should be pointed out that it is possible to qualify an innovative good as an invention (art. 24 of IPL), including a biotechnological invention (Article 93¹(1) of IPL), utility model (Article 94(1) of IPL), industrial design (Article 102(1) of IPL) or integrated circuit topography (Article 196(1) of IPL). While in the case of utility models, industrial designs and integrated circuit topographies the protection of innovations refers only to innovative creations, in the case of inventions it is broader. This is because it covers not only the product, but also the method of manufacturing products (Article 27 of IPL). This means that not only innovative products, but also production processes can be protected as inventions. In the latter case, not only the innovative process itself is covered by the patent, but also the products created

using it (Article 64(1) of IPL). It should be added that the protection of innovations that are products as community designs under the provisions of Council Regulation (EC) No. 6/2002 of December 12, 2002 on Community designs (Official Journal of the EU L 2002 No. 3, p. 1) also comes into play.

On the other hand, it should be emphasized that Article 28(1)(3) of IPL, which, based on Article 100(1) of IPL, is appropriately applicable to utility models, excludes the possibility of qualifying as an invention, as well as a utility model, schemes, rules and methods for carrying out thought processes, playing games or conducting business. The lack of technical nature of such solutions is cited as justification for this exclusion (Demendecki et al., 2015; Kostański, 2010). The sphere of technology does not go beyond the domain of natural sciences, while its subject is the use of inanimate or animate matter. Thus, the sphere of technology does not include solutions whose objects are ideas of an abstract-thought nature, including organizational ideas, as they solve intellectual or organizational problems (Kondrat, 2021), and such include marketing or organizational methods in business, organizing work or external relations. The enumeration contained in Article 28(1)(3) of IPL - like the enumeration contained in Article 1(2¹) of CRRA - explicitly mentions methods of carrying out thought processes, and consequently it should be considered that marketing or organizational methods in business activities, organizing work or external relations are excluded from industrial property protection due to their non-technical but organizational nature.

On the other hand, the possibility of protecting an innovation as a trademark should be excluded, as a general rule. This is because a trademark is a sign that makes it possible to distinguish the goods of one enterprise from those of another enterprise, and in particular a word, including a name, a drawing, a letter, a number, a color, a spatial form, including the shape of the goods or packaging, as well as a sound (Article 120 of IPL), so it can be neither a good, nor a service, nor a process/method. An exception will be the possibility to protect as a trademark an innovative product due to its shape or the shape of its packaging, since, as mentioned earlier, the shape of the goods themselves or their packaging can constitute a trademark. The assessment as to the inadmissibility of protection of an innovation as a trademark also applies to the European Union trademark within the meaning of Article 4 of Regulation (EU) 2017/1001 of the European Parliament and of the Council of 14 June 2017 on the European Union trademark (consolidated text, Official Journal of the EU L No. 154, p. 1).

As is the case with trademarks, contrary to the position expressed in the literature (Szewc, 2014), the possibility of protecting innovations as geographical indications in a broad sense should be rejected. This is because in this case, the object of protection is the designation, not the goods, services or process/method. Therefore, regardless of what we are dealing with is a geographical indication within the meaning of Article 174(1) of IPL, or a protected designation of origin or protected geographical indication within the meaning of Article 46(1) and (2), respectively, of Regulation (EU) 2024/1143 of the European Parliament and of the Council of April 11, 2024 on geographical indications for wine, spirits and agricultural products

and traditional specialties guaranteed and quality terms used optionally for agricultural products, amending Regulations (EU) No. 1308/2013, (EU) 2019/787 and (EU) 2019/1753 and repealing Regulation (EU) No. 1151/2012 (Official Journal of the EU L of 2024, p. 1143; hereinafter Regulation (EU) No. 2024/1143), the object of protection is the use of a specific name (designation) for specific products, not products *per se*.

On the other hand, for slightly different reasons, contrary to the position expressed in the literature (Szewc, 2014), there will be no basis for protecting innovative products as traditional specialties guaranteed within the meaning of Article 53(1) and (2) of Regulation (EU) No. 2024/1143. For first, as is the case with trademarks and geographical indications, the object of protection in this case is the name, not the good, service or process/method. Secondly, a good bearing a name protected as a traditional specialty guaranteed must be "traditional". This means historically documented use of the name by producers in a given community for a period of time allowing transmission between generations. This period must be at least 30 years (Article 2(3) of Regulation (EU) No. 2024/1143). By its very nature, therefore, a good designated as a traditional specialty guaranteed is a negation of an innovative product, which should be characterized by novelty.

Finally, the qualification of an innovative agricultural product that is a plant variety as a protected variety under the provisions of the Act of June 26, 2003 on the Legal Protection of Plant Varieties (consolidated text, Journal of Laws of 2021, item 213; hereinafter LPPVA) may come into play. The condition for qualifying a variety as a protected variety is that the variety is either bred or discovered and derived by the breeder of the variety (Article 1(1) in conjunction with Article 2(1)(4) of LPPVA).

In conclusion, it should be pointed out that the current legal regulations creating subjective rights provide, in principle, the possibility to protect innovative products as objects of exclusive rights. This may include protection of works or objects of related rights incorporated in these products, as well as databases. They can also be protected as inventions, utility models, industrial designs, community designs and integrated circuit topographies (the arrangement of the individual elements of an integrated circuit contained therein), as well as plant varieties. Protection of innovations that are processes as subjects of subject rights is limited only to production processes patentable as inventions. Outside of protection as subjects of exclusive rights are therefore services, non-productive processes, and marketing or organizational methods in business, labor organization or external relations.

4. Protection of innovations outside the system of exclusive rights

When looking for protection of innovations that constitute non-productive processes and organizational methods in business activities, labor organization or external relations, the first point to be made is the possibility of qualifying them as a rationalization project. Indeed, according to Article 7(2) of IPL, any exploitable solution that is not a patentable invention, utility model, industrial design or integrated circuit topography can be considered a rationalization project. This means that non-productive processes, particularly those involving construction or design, as well as organizational methods in business, organizing labor or external relations, could qualify as a technical (in the case of construction or design processes) or non-technical (in the case of organizational methods), organizational solution to the specific problem of achieving certain strategic and operational goals of the organization in specific circumstances. However, the condition for recognizing such a process or method as a rationalization project is that the entrepreneur recognizes this type of solution as a rationalization project in the rationalization regulations adopted by the entrepreneur (Article 7(2) *in principio* in conjunction with Article 7(3) of IPL). As it follows from the above, the possibility of qualifying a given process or method as a rationalization project applies only to such organizations that have the attribute of an entrepreneur and, moreover, have adopted regulations for rationalization (Article 7(1) of IPL). It should be noted, however, that the model adopted by the legislator for the protection of rationalization projects is different from other industrial property rights, which have been formed as subjective rights of an absolute nature. Consequently, an entrepreneur whose employee has created a rationalization project in the form of a specific process or organizational method is not entitled to the protection belonging to civil subjective rights of an absolute nature. (Judgment of the Provincial Administrative Court in Wrocław of January 12, 2010, I SA/Wr 1602/09, LEX No. 559606; Skubisz, 2012; Żelechowski, 2021).

Therefore, further consideration should be given to the possibility of protecting innovation on the basis of tort liability regulated by the Act of April 16, 1993 on Combating Unfair Competition (consolidated text, Journal of Laws 2022, item 1233; hereinafter referred to as the CUCA). Pursuant to Article 3(1) of CUCA, an act of unfair competition is an act contrary to law or morality, if it threatens or infringes the interest of another entrepreneur or customer. It is assumed that an action should also be understood as an omission, i.e. a situation in which the entity committing a tort as defined in the CUCA should behave in a certain way in order not to commit an act of unfair competition (Nowińska, Szczepanowska-Kozłowska, 2022; Michalak, 2013).

The provision of paragraph 1 of Article 3 of CUCA defines the act of unfair competition in a general way, while paragraph 2 of this article lists by way of example certain acts, further typified in Articles 5-17 of CUCA, which should be interpreted in such a way that the general

definition and the provisions detailing the act of unfair competition remain in the following relations: the acts listed in the Act do not form a closed catalog, an act not listed in Articles 5-17 of CUCA, as long as it meets the prerequisites defined in Article 3(1) of CUCA (the so-called supplementary function); the requirements set forth in the definition of Article 3(1) of CUCA apply to acts listed in Articles 5-17 of CUCA, and the general clause has a corrective function with respect to specific provisions. When a given state of facts, formally, meets the prerequisites of Articles 5-17 of CUCA, but in reality the action does not exhibit any of the elements of Article 3(1) of CUCA (e.g., unlawfulness, contrary to good morals), it is not possible to recognize it as an act of unfair competition.

In the protective context of innovation under consideration, two stipulated acts of unfair competition are noteworthy, i.e. infringement of a business secret by disclosing, using or acquiring someone else's information that constitutes a business secret (Article 11(1) of CUCA) and copying a product by means of which its external form is copied by technical means of reproduction (Article 13(1) of CUCA).

Processes, including production, construction or construction processes, marketing or organizational methods in business, organizing work or external relations can qualify as specific know-how. This term includes both know-how that is generally known (so-called open know-how) and that which is confidential in nature (so-called secret, confidential know-how). The basis for this protection of the latter is to be found in the regulation of Article 11(2) of CUCA, which indicates that an enterprise secret is understood to be not only technical or technological information, but also organizational information of an enterprise or other information having economic value, which as a whole or in a particular juxtaposition and collection of its elements is not generally known to persons normally dealing with this type of information or is not readily available to such persons, provided that the person authorized to use or dispose of the information has taken, with due diligence, actions to keep it confidential. Business secrets protected by Article 11(2) of CUCA can therefore be divided into technical information and organizational information.

The first category includes technological information, confidential (technical) know-how, recipes, rationalization projects, technical solutions even if they do not meet the premise of inventive step required by the provisions of IPL (Kępiński, Szwaja, 2024). Production, construction or construction processes should be qualified as such. The categories of organizational information of an enterprise that can be qualified as business secrets in the literature include methods of quality control of goods and services, methods of marketing, or methods of labor organization (Kępiński, Szwaja, 2024), as well as principles of cooperation between individual departments of an enterprise (Nowińska, Szczepanowska-Kozłowska, 2022). Thus, marketing or organizational methods in business, labor organization or external relations can be classified as such. At the same time, it should be remembered that due to the scope of application of the CUCA, only marketing or organizational methods used in the enterprise, and not in other organizations, can be covered by this protection.

The prerequisite for including the information in question as a business secret is that it is confidential and covered by the entrepreneur's activities aimed at maintaining this confidentiality, as well as its economic value (Kępiński, Szwaja, 2024; Nowińska, Szczepanowska-Kozłowska 2022). Therefore, there may be difficulties in protecting as a business secret organizational methods in external relations. On the other hand, it is not necessary for such information to be usable in another enterprise (Kępiński, Szwaja, 2024), i.e. a given marketing or organizational method, due to its specificity, may not be usable in other enterprises.

In turn, Article 13(1) of CUCA may provide a basis for protecting innovative products from so-called slavish imitation. It consists in copying the external form of a product by technical means of reproduction. The condition for qualifying such copying of a product as a stipulated act of unfair competition is the danger of misleading customers as to the identity of the manufacturer or innovative product. At the same time, it does not constitute an act of unfair competition to imitate the functional features of a product, in particular, the construction, design and form that ensure its usefulness. If the imitation of the functional features of a finished product requires taking into account its distinctive form, which may mislead customers as to the identity of the manufacturer or product, the imitator is obliged to mark the product accordingly (Article 13(2) of CUCA). Thus, this protection does not cover situations of imitation of a product that do not lead to a danger of misleading customers as to the identity of the manufacturer or innovative product, but involve copying an innovative product in order to parasitize its reputation. Protection against so-called parasitic imitation of a product constituting an untyped act of unfair competition should therefore be sought in the general clause of the act of unfair competition (Article 3(1) of CUCA).

The situation will be similar in the case of innovative services. An action consisting in offering innovative services by a competing entrepreneur, taking advantage of the reputation that characterizes such innovative services, may be qualified as contrary to morality and, moreover, as threatening or infringing the interest of the entrepreneur who was the first to offer such innovative services. It may constitute an unspecified act of unfair competition, the protection of which will take place on the basis of the general clause contained in Article 3(1) of CUCA, using its supplementary function.

5. Claims for infringement of innovation rights

The catalog of claims to which an entrepreneur whose exclusive rights to innovations have been infringed or who has been harmed by an act of unfair competition is entitled, regardless of the basis for the claims asserted, includes a claim for cessation of infringement (Art. 79(1)(1) CRRA, Art. 11(1)(1) of PDA, Article 287(1) of IPL, Article 36a(1)(1) of LPPVA) or

unauthorized acts (Article 18(1)(1) of CUCA) and to remedy the consequences of the infringement (Article 79(1)(2) of CRRA, Article 11(1)(2) of PDA, Article 36a(1)(2) of LPPVA) or unauthorized acts (Article 18(1)(2) of CUCA). Where the infringement of author's economic rights or related rights, *sui generis* right to a database, industrial property right or exclusive right to a plant variety is of an innocent nature, the court may order the person who has infringed author's economic rights, related rights, *sui generis* right to a database, industrial property right or exclusive right to a plant variety, at his request and with the consent of the right holder, to pay an appropriate sum of money to the right holder, if the abandonment of the infringement or the removal of the consequences of the infringement would be disproportionately severe for the infringer (Art. 79(3) of CRRA, Article 11(3) of PDA, Article 287(3) of IPL, Article 36a(3) of LPPVA).

In addition, the holder of exclusive rights and an entrepreneur affected by an act of unfair competition may demand surrender of wrongfully obtained benefits (Article 79(1)(4) of CRRA, Article 11(1)(4) of PDA, Article 287(1) of IPL, Article 36a(1)(4) of LPPVA, Article 18(1)(5) of CUCA), except that in the case of an act of unfair competition, surrender of wrongfully obtained benefits should be made under general rules. They may also demand reparation of the damage caused to the right holder under general rules (Article 79(1)(3a) of CRRA, Article 11(1)(3a) of PDA, Article 287(1)(1) of IPL, Article 36a(1)(3a) of LPPVA, Article 18(1)(4) of CUCA), i.e., the rules set forth in the Civil Code Act of April 23, 1964 (consolidated text, Journal of Laws of 2024, item 1061). Due to difficulties in determining the causal link between the action of the infringer or the perpetrator of the act of unfair competition and the damage, as well as the amount of the damage itself, the holder of exclusive rights or the entrepreneur affected by the act of unfair competition may seek lump-sum damages as an alternative to compensation under general rules. The holder of author's economic rights, related rights and *sui generis* right to a database under, respectively, Article 79(1)(3b) of CRRA, Article 79(1)(3b) in conjunction with Article 101 of CRRA and Article 11(1)(3b) of PDA may claim lump-sum damages in the form of a sum of money equal to twice the relevant remuneration which, at the time of claiming it, would have been due for granting the holder permission to use the work, the subject of related rights or the database. In turn, the holder of industrial property rights under Article 287(1)(2) of IPL may claim lump-sum damages in the form of a sum of money equivalent to the license fee or other appropriate remuneration which, at the time of claiming them, would be due as a result of the holder granting permission to use the invention, utility model, industrial or community design or integrated circuit topography. A breeder entitled under an exclusive right to a plant variety pursuant to Article 36a(1)(3b) of LPPVA may claim lump-sum damages in the form of a sum of money in the amount corresponding to the license fee which, at the time of claiming it, would have been due by virtue of the granting of a license by the breeder, and in the case of a culpable infringement in the amount corresponding to a multiple of that remuneration, but no more than three times its value. On the other hand, in the case of an act of unfair competition involving infringement of

a business secret, the holder may demand, instead of compensation, reparation of damages by payment of a sum of money in an amount corresponding to the remuneration that would be due at the time of claiming it by virtue of the holder's granting of permission to use information constituting a business secret (Article 18(5) of CUCA). In addition, an entrepreneur affected by an act of unfair competition in a situation where the commission of the act of unfair competition was of a culpable nature may demand an award of an appropriate sum of money for a specific social purpose related to the promotion of Polish culture or the protection of national heritage. (Art. 18(1)(6) of CUCA) This claim has no equivalent in CRRA, PDA, IPL or LPPVA.

Irrespective of the above claims, the holder of author's economic rights, related rights, *sui generis* right to a database or exclusive right to a plant variety, or an entrepreneur affected by an act of unfair competition, may demand one or multiple announcements of a statement of appropriate content and form (Article 79(2) of CRRA, Article 11(2) of PDA, Article 36a(2) of LPPVA, Article 18(1)(3) of CUCA). However, while in the case of infringement of intellectual property rights, only the dissemination of the statement in the press may be demanded, in the case of an act of unfair competition, the statement may be demanded in any manner not excluding the press and the Internet.

In addition, both the holder of exclusive rights and the entrepreneur affected by the act of unfair competition may request that part or all of the court decision issued in the case under consideration be made public, in the manner and to the extent specified by the court (Article 79(2) of CRRA, Article 11(2) of PDA, Article 287(2) of IPL, Article 36a(2) of LPPVA, Article 18(5) of CUCA). However, the condition for granting such a request in the case of committing an act of unfair competition involving the violation of a business secret is to justify it by the circumstances of committing the act of unfair competition, in particular, the manner in which the act was committed, the value of the information to which the act referred, the effect of the act and the likelihood of committing the act of unfair competition in the future, and in the case where the defendant is a natural person - if, in addition, this is not opposed by the defendant's legitimate interest, in particular, consideration of the protection of his personal rights. However, the manner and extent of public disclosure of the verdict or the contents of the verdict may not lead to disclosure of business secrets (Article 18(3) of CUCA).

Pursuant to Article 79(4) of CRRA, Article 11(4) of PDA, Article 286 of IPL or Article 36a(4) of LPPVA, the court, in deciding on the infringement of the right, may, at the request of the right holder, rule on the unlawfully produced objects (products, seed or harvested material) and the means and materials used in their production, in particular, may rule on their withdrawal from the market, award to the right holder against the compensation due (the sum of money awarded) or destruction. When ruling, the court shall take into account the gravity of the violation and the interests of third parties. The said means and materials are presumed to be the property of the person who violated intellectual property rights (Article 79(5) of CRRA, Article 11(5) of PDA, Article 36a(5) of LPPVA). In turn, pursuant to Article 18(2) of CUCA, the court, at the request of the right holder, may also adjudicate products, their packaging,

advertising materials and other objects directly related to the commission of the act of unfair competition. In particular, the court may order their destruction or credit for damages.

6. Investigating claims for infringement of innovation rights

As of July 1, 2020, by virtue of the Regulation of the Minister of Justice of June 29, 2020, on transferring to certain district courts the cognizance of intellectual property cases from the jurisdiction of other district courts (consolidated text, Journal of Laws of 2022, item 1398), intellectual property divisions were separated in the structure of the district courts of Gdańsk, Katowice, Lublin, Poznań and Warsaw. Thanks to this procedure and the entrusting of the adjudication of appeals against the decisions of these district courts to the Courts of Appeals in Poznań and Warsaw, a structure of specialized courts (hereinafter referred to as intellectual property courts) for the adjudication of intellectual property cases was created (Kurosz, 2021).

The concept of an intellectual property case is defined in the introduction to the Act of November 17, 1964. - Code of Civil Procedure (consolidated text, Journal of Laws of 2023, item 1550, as amended; hereinafter referred to as the CPC) by virtue of the Act of February 13, 2020 amending the Act - Code of Civil Procedure and certain other acts (Journal of Laws of 2020, item 288), Article 479⁸⁹ of CPC. Intellectual property cases, according to Article 479⁸⁹ § 1 of CPC, include cases for the protection of copyright and related rights, for the protection of industrial property rights, and for the protection of other rights on intangible property such as the *sui generis* right to a database or the exclusive right to a plant variety. They therefore include cases for infringement of exclusive rights to innovative products, or, in the case of an invention, innovative production processes. In light of Article 479⁸⁹ § 2(1) of CPC, intellectual property cases are also cases for the suppression of unfair competition. As a result, intellectual property cases also include cases for acts of unfair competition committed with respect to innovative products, services, and processes and methods.

Classification of the above innovation cases as intellectual property cases entails not only subjecting them to the jurisdiction of intellectual property courts, but more importantly, recognizing them within the framework of separate proceedings in intellectual property cases covered by the regulation of Article 479⁸⁹-479¹²⁹ of CPC. As a result, an entrepreneur whose exclusive rights to an innovation have been infringed or who has been harmed by an act of unfair competition committed with respect to his innovation will be able to take advantage of special legal institutions specific only to intellectual property proceedings that facilitate his claims, in particular for compensation and the release of unjustly obtained benefits, known as ancillary measures.

Ancillary measures include three institutions provided for by the provisions of intellectual property proceedings, i.e., securing a measure of evidence (Articles 479⁹⁶-479¹⁰⁵ of CPC), disclosure or issuance of a measure of evidence (Articles 479¹⁰⁶-479¹¹¹ of CPC), and summons for information (Articles 479¹¹²-479¹²¹ of CPC). While in the case of securing a measure of evidence, the right holder will be able to use this institution both to derive his claims from the laws regulating intellectual property rights and the CUCA, in the case of disclosure or issuance of a measure of evidence and a summons for information, the application of these institutions is limited, as follows respectively from Article 479¹⁰⁶ *in principio* of CPC and Article 479¹¹³ § 1 of CPC - only to cases of infringement of exclusive rights referred to in Article 479⁸⁹ § 1 of CPC, with, therefore, is not possible in cases of acts of unfair competition (so the Court of Appeals in Warsaw in the decisions of November 20, 2020, ref. no. VII AGz 497/20, not published, of December 15, 2021, ref. no. VII AGz 498/21, not published, of January 28, 2022, ref. no. VII AGz 613/21, not published, and of September 6, 2024, ref. no. VII AGz 483/24, , not published; differently, the Court of Appeals in Poznań in decisions of April 5, 2022, I AGz 5/22, not published; of August 2, 2023, I AGz 54/23, LEX no. 3622487 and of March 18, 2024, I AGz 240/23, not published).

In addition, it should be noted that an entrepreneur whose exclusive rights to an innovation have been infringed or who has been harmed by an act of unfair competition committed with respect to his innovation can use the institution of claim security (Articles 730-757 of CPC), which allows him, in particular, to interrupt the state of exploitation of his innovation by a market competitor. This procedural institution in intellectual property cases is characterized by certain peculiarities as a consequence of the changes made by the Act of March 9, 2023 amending the Act - Code of Civil Procedure and certain other acts (Journal of Laws of 2023, item 614) relating to securing non-monetary claims (Gołaszewska, 2023). It is expressed in the departure in these cases from the principle of *ex parte* proceedings, which is the rule, to a hybrid model with adversarial proceedings dominating and exceptions in favor of *ex parte* proceedings (Antoniuk, 2023).

7. Concluding remarks

The considerations carried out lead to several conclusions. First, it is possible to protect innovations as the subject of exclusive rights, i.e. works or objects of related rights, databases, inventions, utility models, industrial designs, community designs, topographies of integrated circuits and plant varieties. However, this possibility applies only to innovations that are products. Thus, it does not allow for the protection as the subject of exclusive rights of innovations that are services, processes or methods, with the exception of production processes, which may be patentable as inventions. Second, it also excludes the possibility of protecting

innovations as marks or geographical indications in the broad sense. Third, it is possible to qualify processes or methods as a rationalization project, provided that such a process or method is recognized as a rationalization project by the entrepreneur in the rationalization regulations adopted by him.

Fourthly, and finally, innovations in the form of products may be protected against copying as an act of unfair competition as stipulated in Article 13(1) of CUCA, while innovations that are processes or methods constituting business secrets may be protected against disclosure as an act of unfair competition as stipulated in Article 11(1) of CUCA. Protection of innovations in the form of services, on the other hand, can be sought, at most, in the general clause of the act of unfair competition (Article 3(1) of CUCA), using its complementary function as a untyped act of unfair competition.

An entrepreneur whose exclusive rights to an innovation have been infringed or who has been harmed by an act of unfair competition carried out in relation to his innovation is entitled to a wide range of claims provided for in the laws regulating exclusive rights and the CUCA. These claims will be pursued in separate intellectual property proceedings before specialized intellectual property courts, which is intended by the legislator to increase the quality of judgments rendered in intellectual property cases. Within the framework of these proceedings, the entrepreneur will be able to take advantage of special procedural institutions to support his claims, especially monetary ones, the so-called auxiliary measures.

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USE OF CHATGPT-4 TO SET THE PROJECT'S RESERVE BUDGET

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Purpose: To present the results of a study on the potential of ChatGPT-4 (GPT-4) in determining the reserve budget of a project, based on its financial risk assessment performed using the Monte Carlo (MC) simulation method.

Design/methodology/approach: To determine the potential of GPT-4 in determining the size of a project's reserve budget, in Phase 1 of the research this budget was determined using data on the selected project, the knowledge of the authors of the publication, the MC method, and a Microsoft Excel spreadsheet tool. In phase 2 of the study, the reserve budget was determined using the same data, the MC method and GPT-4. The results obtained were subjected to comparative analysis and discussion.

Findings: GPT-4 correctly assessed the financial risk of the project using MC simulation in 83.33% of the experiments (50 out of 60), and on this basis determined the reserve budget and explained the significance of the results obtained.

Research limitations/implications: The undertaken problem of assessing the financial risk of projects relates only to exceeding their budget, which is a relatively easier issue than the question of not achieving the expected financial results. Therefore, it would be interesting for further research to see how GPT-4 deals with the assessment of the risk of not achieving financial outcomes, carried out using MC.

Practical implications: GPT-4 can be considered as a decision-support tool for the size of a project's reserve budget. Given the misinterpretation of data in 10 experiments (16.66% of the study sample), caution and a critical look at the results of GPT-4 calculations and their verification should be recommended.

Social implications: As part of the training of project managers, it is worth convincing them to use AI in project risk assessment, as this influences more rational decision-making.

Originality/value: Conducting experiments with GPT-4, including its testing and validation, to ascertain whether it can provide information to support decision-making about the size of a project's reserve budget.

Keywords: project financial risk assessment, reserve budget, Monte Carlo, ChatGPT-4.

Category of the paper: Research paper, Case study.

1. Introduction

Project implementation is constantly accompanied by risk. This is due to their specific nature, which is largely defined by uncertainty determined by unpredictable events or conditions, defined as parameters that can affect the achievement of project objectives. It is emphasised that the precise definition of these parameters is a real challenge (Borgonovo, 2016; Baraldi et al., 2009; Aven, Nøkland, 2010).

In considering project risk, the way in which uncertainty is understood is important and is discussed (Flage, 2014). In general, it can be assumed that uncertainty determines the level of risk, but in order to assess it, uncertainty needs to be expressed by a specific measure. Among the many measures, probability is considered the most widely used (Aven, 2016). Concepts of project risk quantification based on this measure mostly assume a probabilistic description of the uncertainty of specific parameters. This is the basis for the use of Monte Carlo (MC) simulation, which is one of the rather precise probabilistic-statistical methods of risk assessment.

MC is not a new method and its origins and development should be linked primarily to N.C. Metropolis, E. Fermi, J. von Neumann, S.M. Ulam and A. Turkevich (Metropolis, 1987). Although the benefits of its use in risk assessment and advances in information technology have made MC increasingly popular, it can be argued that even today its use in business practice is low (Ryan P.A., Ryan G.P., 2002, Wiśniewski, 2004; Wieteska, 2021). This is thought to be mainly due to a lack of skills to carry it out, a lack of understanding, a sense of discomfort or reluctance to use advanced statistical methods (Avlijas, 2019). For this reason, there are increasing hopes for the use of artificial intelligence (AI) for project risk assessment (Avlijas, 2019; Taboada et al., 2023). Thus, the Project Management Institute (PMI) (PMI. AI @ Work, 2019), in presenting considerations relating to the needs and possibilities of using AI in the seven main domains of project management effectiveness, points precisely to uncertainty and risk. The expectations of AI relating to project risk assessment are also confirmed by the results of a survey of 81 experts (Fridgeirsson et al., 2021), and academic publications emphasise that AI is desirable especially because of the complexity of projects and its relationship to uncertainty and risk (Dao et al., 2016; Floricel et al., 2016; Padalkar, Gopinath, 2016; Dunović et al., 2014; Qazi et al., 2016). AI is believed to be able to process large datasets quickly and accurately, supporting more informed decision-making, and can learn and make adjustments based on new data, enabling more accurate, up-to-date risk assessments, using various methods such as Machine Learning (ML) (Zhang, 2020), Neural Networks (NN) (Yegnanarayana, 2005), Natural Language Processing (NLP) (Chowdhury, 2023) or fuzzy logic (FL) commonly using expert systems (Król-Smetak, Zajac, 2012), among others. It is worth noting that the AI methods indicated have been used to develop a number of models relating to various aspects of project risk. For example, using ML, models have been developed to manage the risk of

construction projects by case-based reasoning (Poh et al., 2018), to predict task risk in software projects (Choetkiertikul et al., 2015), or to predict the stability of construction projects (Fourie et al., 2018). Using NN, a system for predicting project outcomes based on critical success factors was developed, which classifies risk levels based on the experience of project managers (Costantino et al., 2015). Using NLP, a model for safety risk management and accident prediction in construction projects was developed (Di Giuda et al., 2020), and using FL, solutions for digitised risk management of construction projects were presented (Xu, Lin, 2016). The potential of hybrid AI methods for risk assessment of construction projects has also been indicated (Afzal et al., 2021).

Thus, it can be concluded that there is a steadily growing interest in the use of AI for project risk assessment. However, a systematic review of the literature (Taboada et al., 2023) shows that this does not apply to the assessment of their financial risk, although it is very important, especially in the planning and implementation phases of a project.

The financial risk of projects refers to two main issues.

The first issue relates to the failure to achieve the expected financial results from the project. The results of the financial risk assessment in this case should inform decisions on whether to proceed with the project or whether to introduce measures to reduce the risk or whether to wait for market conditions to change or whether to reject the project. Here, the possibilities of using AI for some elements related to financial risk assessment are presented, mainly relating to cash flow forecasting (Cheng et al., 2015; Cheng et al., 2020) or the development of project implementation scenarios (Hajdasz, 2014). However, AI-based solutions that make a holistic assessment of the risk of not achieving the expected financial outcomes have not been presented.

The second issue concerns project budget overruns. The assessment of financial risk in this case supports decision-making on the size of the managerial reserve. This reserve, referred to in practice as a reserve budget, is one of the basic tools of project risk management. The reserve budget is the amount of money that should be designated to cover costs resulting from the occurrence of changes in uncertain project parameters. Due to the dynamics of changes in these parameters, the setting of a reserve budget is now recommended, among others, in project management standards (A Guide to the Project Management, 2019; Dałkowski et al., 2009). It is emphasised that the size of the reserve budget should depend on the degree of uncertainty in the parameters of the project in question. This means, in the decision-making process concerning this size, an assessment of the financial risk of the project should be taken into account (the higher the risk, the higher the budget should be).

This publication focuses on the issue of budget overruns. Based on the interviews and the literature review, it was assumed that managers are interested in using the results of the risk assessment in deciding on the size of the reserve budget. At the same time, it was noted that, due to the problems identified earlier relating to MC, it is usually not applied in practice and the managerial reserve is assumed to be 10% of the base project budget (Trocki, 2015).

Such a solution can be considered problematic, as in the case of low risk it leads to an unjustified freezing of financial capital (which is important especially in projects with a high base budget), and in the case of high risk it reduces the ability to respond to emerging risks or opportunities.

The current capabilities of AI make it worthwhile to use it to assess the financial risk of MC projects, to support decision-making on the size of the reserve budget. At the same time, there is a realisation that it would be most beneficial to add AI to personalised decision support systems, allowing them to become even more effective. Among other things, AI could help automate the collection and analysis of uncertain parameters for MC, as well as perform the necessary calculations, thus reducing the time needed for decision-making. However, it should be noted that such a solution is costly. Other AI-based solutions, such as the popular ChatGPT (GPT-4 - OpenAI), which is not costly to use, offer new opportunities for a wide range of businesses. However, the question must be asked - will ChatGPT do the calculations well and obtain reliable information?

The authors of the publication assumed the hypothesis that ChatGPT-4 can correctly assess the financial risk of a project on the basis of MC simulations and, on this basis, determine the reserve budget. In order to verify it, a study was carried out, the purpose, the course of research, as well as the data and methods used, are presented in the next section of the publication.

2. Purpose, course of research, data and methods

The purpose of the research was to determine the potential of GPT-4 in determining the reserve budget of a project, based on its financial risk assessment made using MC.

To achieve this purpose, experiments were conducted with ChatGPT-4 (GPT-4). These included checking the way the calculations were made and the results obtained, to make sure it could work as expected and provide information to support decision-making on the size of the project's reserve budget.

Experiments were conducted on a selected investment project planned by a certain company. The base budget for this project is PLN 1,000,000.00. In the course of a management workshop at this enterprise, the 7 most significant uncertain parameters (6 threats and 1 opportunity) affecting the achievement of the project objectives were identified. For these parameters, the probabilities and consequences of their occurrence were determined.

The experiments were conducted in two phases. In Phase I, a reserve budget was determined based on data received from the company, the knowledge of the authors of the publication, the MC method, and a Microsoft Excel spreadsheet tool. In phase II, the reserve budget was determined on the basis of data obtained from the company, the knowledge of the authors of the publication, the MC method, and the GPT-4 tool. The results obtained were subjected to comparative analysis and discussion.

3. Findings

It was assumed that on the basis of the data received - the identified parameters (6 threats and 1 opportunity), the probabilities and consequences of their occurrence, with the help of the MC method, the project reserve budget should be determined for the three selected confidence levels, i.e. 0.5, 0.8 and 0.9. It was assumed that 10,000 iterations should be carried out within the MC framework.

3.1. Conducting MC using Excel

As previously mentioned, MC is not a new method, and its formal basis has been presented in many papers (e.g. Jäckel, 2002; Mitrenga, 2014), hence a theoretical description of it is omitted in this publication, focusing on practical application.

In Phase I of the research, an Excel model (Table 1) was prepared to carry out the MC. The first column in this table contains the identified parameters, the second the probability of their occurrence and the third the effect of their occurrence. For each parameter, the expected value of the effect was calculated by multiplying the probability and the effect. The sum of the expected values of the effect of each parameter determined the expected value of the effect of their occurrence on the achievement of the project objectives. This value was 64,500.00 PLN. The fifth column introduced the formula =LOS(), which acted as a pseudo-random number generator, for each parameter. The cell with this formula returned a value between 0 and 1 right-open, meaning that a value of 0 could occur and a value of 1 would never be generated as a result of the formula. The sixth column contained the logical function =IF(), which checked whether the value from the previous column was less than the probability. If it was, the value from column three was rewritten to column six. The sum of the effects for each parameter gave the effect value for one iteration, i.e. for one scenario in MC.

Table 1.
Excel model to run MC

Parameter	Probability	Effect, PLN	Expected value of effect, PLN	Pseudorandom number generator, - "LOS()	The value of the effect in the iteration, - "IF()", PLN
1	2	3	4	5	6
Danger no 1	0.10	200,000.00	20,000.00	0.0820	200,000.00
Danger no 2	0.01	300,000.00	3,000.00	0.7396	
Danger no 3	0.10	50,000.00	5,000.00	0.0976	50,000.00
Danger no 4	0.50	10,000.00	5,000.00	0.9735	
Danger no 5	0.20	20,000.00	4,000.00	0.5276	
Danger no 6	0.30	100,000.00	30,000.00	0.0159	100,000.00
Chance no. 1	0.05	-50,000.00	-2,500.00	0.4906	
Σ			64,500.00		350,000.00

Source: own elaboration.

10,000 iterations were carried out, i.e. 10,000 possible scenarios of changes in the development of the project parameters were obtained, defined by the result being the value of the sum of the consequences of their occurrence. Subsequently, a statistical analysis of the obtained results was carried out (44, 45, 46), based on risk assessment indicators, which include: expected value (μ), standard deviation (σ), coefficient of variation (cv). Thus, for the analysed project, the expected value of the reserve budget is 64,469.70 PLN, the standard deviation is 83,869.02 PLN and the coefficient of variation is 1.30.

Then, in order to determine the expected value of the reserve budget for the adopted confidence levels, the cumulative distribution of the normal distribution was plotted (Figure 1). The values corresponding to the adopted confidence levels are indicated on the distribution. The first, equal to 0.5 (the median of the distribution), determines the expected value of the reserve budget, which (as indicated above) is $\mu = 64,469.70$ PLN. This is a value that secures the project with 50% certainty that costs arising from changes in project parameters will be covered. The second and third confidence levels indicate reserve budget values with 80% certainty, at 137,500.00 PLN and 90% certainty, at 172,500.00 PLN.

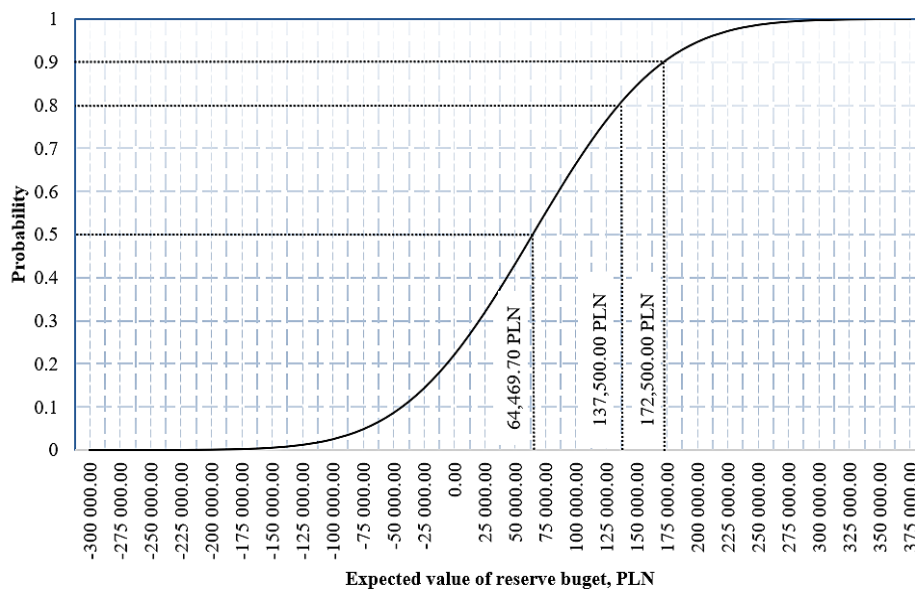


Figure 1. Cumulative distribution of the normal distribution of the value of the project reserve budget.

Source: own elaboration.

3.2. Performance of MC by GPT-4

In Phase II of the study, for the determination of the reserve budget using GPT-4, the following command was formulated:

"From now on, act as a business analyst in investment projects. You will be instructed to assess the risk of the investment project using the Monte Carlo method. The total expenditure for the implementation of the investment project is PLN 1,000,000. Using the Monte Carlo method (only 10,000 calculation cycles), calculate:

1. *Expected value of the project reserve budget.*
2. *Standard deviation of the project reserve budget.*

3. *Variability index of the project reserve budget.*

Then:

4. *Draw the distribution function of the normal risk distribution (cumulative Gaussian plot).*

On this basis, determine the value of the reserve budget for the investment for the confidence levels: 0.5, 0.8 and 0.9.

Draw conclusions about the level of risk of the investment project.

Below is data on the possibility of occurrence of risk factors for the implementation of the investment:

Risk factor probability, effect, PLN

Danger #1: 0.10 200000.00

Danger #2: 0.01 300000.00

Danger #3: 0.10 50000.00

Danger #4: 0.50 10000.00

Danger #5: 0.20 20000.00

Danger #6: 0.30 100000.00

Chance No. 1: 0.05 -50000.00"

In response to the given command, GPT-4 calculated the expected values of the reserve budget, standard deviation and coefficient of variation, as well as the expected values of the reserve budget for confidence levels 0.5, 0.8, 0.9. He also presented his interpretation of the obtained results of the financial risk assessment. The command was asked 30 times to check the repeatability of the calculation results. The obtained results of the calculations are presented in Table 2. During the execution of the experiments, it was noticed that Chat 4 times made calculations using the percentiles of the distribution of simulated incremental costs resulting from possible risks in the project, rather than on the basis of the cumulative distribution of the normal distribution, and that the results of 2 experiments differed significantly from the others. The results of these calculations are referred to in Section 4.

Table 2.

Expected values of reserve budget, standard deviation and coefficient of variation indicated by GPT-4

Index	Expected value of budget	Standard deviation of budget	Risk variability index	The value of the reserve budget for the investment project for the confidence level			Distribution function of the normal distribution
				0.5	0.8	0.9	
	PLN	PLN		PLN			
Experiment 1	65.728	84.566	1.287	65.728	136.901	174.105	yes
Experiment 2	64.856	83.304	1.284	64.856	134.966	171.614	yes
Experiment 3	63.862	82.265	1.288	63.862	133.098	169.289	yes
Experiment 4	64.578	83.562	1.294	64.578	134.905	171.667	yes
Experiment 5	64.571	82.889	1.284	64.571	134.332	170.797	yes
Experiment 6	64.619	84.187	1.303	64.619	135.473	172.509	yes
Experiment 7	64.309	82.806	1.288	64.309	134.001	170.430	yes
Experiment 8	65.827	85.751	1.303	20.00	110.00	200.00	no
Experiment 9	64.887	83.584	1.288	64.887	135.233	172.004	yes
Experiment 10	64.432	83.73349	1.300	20.00	110.00	200.00	no

Cont. table 2.

Experiment 11	64.309	82.806	1.288	64.309	134.001	170.430	yes
Experiment 12	1 063.978	83.320	0.078	20.00	110.00	200.00	no
Experiment 13	1 064.309	82.806	0.078	1064.309	70.000	106.000	no
Experiment 14	64.856	83.304	1.284	64.856	134.966	171.614	yes
Experiment 15	64.619	84.187	1.303	64.619	135.473	172.509	yes
Experiment 16	64.715	83.012	1.283	20.00	110.00	200.00	no
Experiment 17	64.856	83.304	1.284	64.856	134.966	171.614	yes
Experiment 18	65.126	85.346	1.310	65.126	136.955	174.501	yes
Experiment 19	65.423	85.236	1.303	65.423	137.160	174.658	yes
Experiment 20	64.733	83.716	1.293	64.733	135.190	172.019	yes
Experiment 21	64.619	84.187	1.303	64.619	135.473	172.509	yes
Experiment 22	65.622	84.187	1.283	20.00	110.00	200.00	no
Experiment 23	65.728	84.567	1.287	65.728	136.901	174.105	yes
Experiment 24	64.619	84.187	1.303	64.619	135.473	172.509	yes
Experiment 25	64.856	83.304	1.284	64.856	134.966	171.614	yes
Experiment 26	64.503	83.768	1.299	64.503	135.004	171.856	yes
Experiment 27	65.728	84.567	1.287	65.728	136.901	174.105	yes
Experiment 28	64.620	83.482	1.292	64.620	126.962	158.131	yes
Experiment 29	64.619	84.187	1.303	64.619	135.473	172.509	yes
Experiment 30	64.419	83.644	1.298	64.419	134.815	171.613	yes

Source: own elaboration.

4. Analysis of results and discussion

A comparative analysis of the results obtained using the knowledge of the authors of the publication and the Excel and GPT-4 software was carried out in relation to the compliance of the indicators of the project financial risk assessment, i.e. the expected value of the reserve budget (μ), standard deviation (σ), coefficient of variation (cv), and the value of the project reserve budget (μ) at the confidence levels of 0.5, 0.8 and 0.9.

The value of μ calculated in Phase I of the study, using the model in Microsoft Excel spreadsheet, was 64,469.70 PLN. In Phase II, the results of the calculations performed by GPT-4 on μ varied from experiment to experiment, oscillating between PLN 63,862.00 and PLN 1,064,309.00 (Table 2). However, it is worth noting the values of μ indicated by GPT-4 in Experiments 12 and 13, which differ markedly from the values of μ in the other experiments. The results of these two experiments were assumed to be incorrect and should therefore not be considered for further inference. Excluding experiments 12 and 13, the results of the calculations performed by GPT-4 in 28 experiments oscillate between 63,862.00 PLN and 65,728.00 PLN (Table 2). Taking into account the specificity of MC, in which randomisation (random selection) of the magnitude of uncertain parameters plays an important role, it can be concluded that the results obtained in phases I. and II. are consistent. This allows us to conclude that the results of the calculations performed by GPT-4 are reliable in 28 out of 30 experiments.

The value of σ calculated in Phase I. was 83,869.02. In Phase II, the calculation results for μ vary from experiment to experiment, oscillating between 82,265.00 PLN and 85,346.00 PLN. It can therefore be concluded that the results obtained in phases I. and II. are relatively consistent.

The value of cv calculated in Phase I. was 1.30. In Phase II. the results of cv calculations vary from experiment to experiment, oscillating between 1.28 and 1.31. It can therefore be concluded that the results obtained in Phases I. and II. are relatively consistent.

The value of the project reserve budget at the confidence levels 0.5, 0.8 and 0.9 in Phase I. of the study was 64,469.70 PLN, 137,500.00 PLN, 172,500.00 PLN, respectively.

In phase II. the values of the reserve budget are quite different. After elimination of experiments 12 and 13, at the 0.5 confidence level μ are in the range from 20,000.00 PLN to 65,728.00 PLN, at the 0.8 confidence level - in the range from 110,000.00 PLN to 136,901.00 PLN, at the 0.9 confidence level - in the range from 158,131.00 PLN to 200,000.00 PLN.

The analysis of the calculations carried out by GPT-4 allows us to conclude that in the case of 24 experiments (1, 2, 3, 4, 5, 6, 7, 9, 11, 14, 15, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30), in accordance with the order, the normal distribution distributor was used in the calculations (Figure 2). The results obtained from these 24 experiments at a confidence level of 0.5 are the same as for the calculation of the previously indicated μ values, which is due to the properties of the normal distribution. It can therefore be concluded that these results are consistent with the results of Phase I, and that the calculations carried out by GPT-4 are correct.

In the case of 4 experiments (8, 10, 16, 22), the calculations were realised on the basis of the percentiles of the distribution of simulated incremental costs (Figure 3). The obtained results of these 4 experiments are consistent, but definitely differ from the results of the 24 experiments indicated above.

As part of the discussion of the results obtained, it is worth addressing the research question posed: can GPT-4 correctly assess the financial risk of a project using MC simulations and, on this basis, determine the reserve budget?

On the basis of a comparative analysis of the 30 results obtained, it can be concluded that in 24 experiments (80% of the study sample), GPT-4 correctly and as instructed, carried out the MC, as well as calculated the risk assessment indicators and determined the value of the project reserve budget for the adopted confidence levels. Furthermore, it correctly interpreted the results obtained. The fact that there are discrepancies in the results (in these experiments and in relation to the calculations in the Microsoft Excel model) has to do with the nature of the MC simulation. It is primarily about the generation of pseudo-random numbers to simulate the values of unpredictable design parameters. Changes in the so-called random seed (the starting point of the sequence of pseudo-random numbers) can lead to different sets of simulation results even with identical parameters, as well as the number of iterations. At this point, it is worth emphasising that a sufficiently large number of iterations must be carried out, preferably calculated from a suitable formula (Wodarski, 2009).

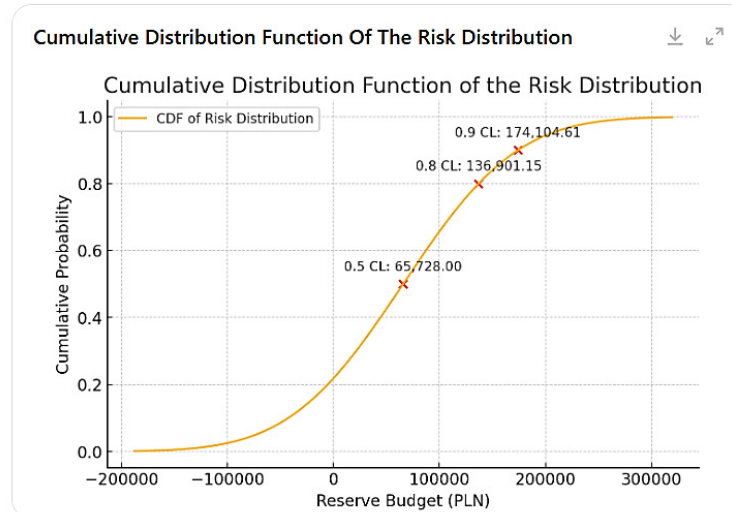
ChatGPT 4 ▾



Based on the Monte Carlo simulation of 10,000 cycles for the investment project, we have the following results:

1. **Expected Value of the Project Reserve Budget:** PLN 65,728.00
2. **Standard Deviation of the Project Reserve Budget:** PLN 84,566.72
3. **Variability Index of the Project Reserve Budget:** 1.29

Next, I'll plot the cumulative distribution function (CDF) of the risk distribution to find the values of the reserve budget at different confidence levels (0.5, 0.8, and 0.9). This will also provide visual insights into the risk spread of the project. [-]



The Cumulative Distribution Function (CDF) plot for the risk distribution of the investment project gives us the following reserve budget values at different confidence levels:

- **50% Confidence Level:** PLN 65,728.00
- **80% Confidence Level:** PLN 136,901.15
- **90% Confidence Level:** PLN 174,104.61

Conclusions about the Level of Risk of the Investment Project:

- The **expected reserve budget** of PLN 65,728 represents the typical amount you might expect to need beyond the planned expenditure due to risk factors.
- The **variability index** of 1.29 indicates a high degree of uncertainty relative to the expected value. This high variability index suggests that the risk distribution is quite spread out, indicating substantial unpredictability in potential additional costs.
- Reserve budgets for higher confidence levels are significantly greater than the expected value, indicating that if the project requires a higher assurance against overrunning costs, substantially more reserve budget is necessary.
- The large difference between the reserve budgets at the 50% and 90% confidence levels (over PLN 100,000) emphasizes the potential volatility and unpredictability associated with the project's risks.

Considering these factors, the investment project carries a high level of financial risk. Depending on the risk appetite and the criticality of sticking to the budget for stakeholders, adequate precautions and possibly a higher reserve budget allocation might be recommended to mitigate potential overruns and ensure project feasibility. [-]

Figure 2. Results of GPT-4 calculations based on the distributions of the normal distribution, for selected - 1 experiment.

Source: GPT-4.

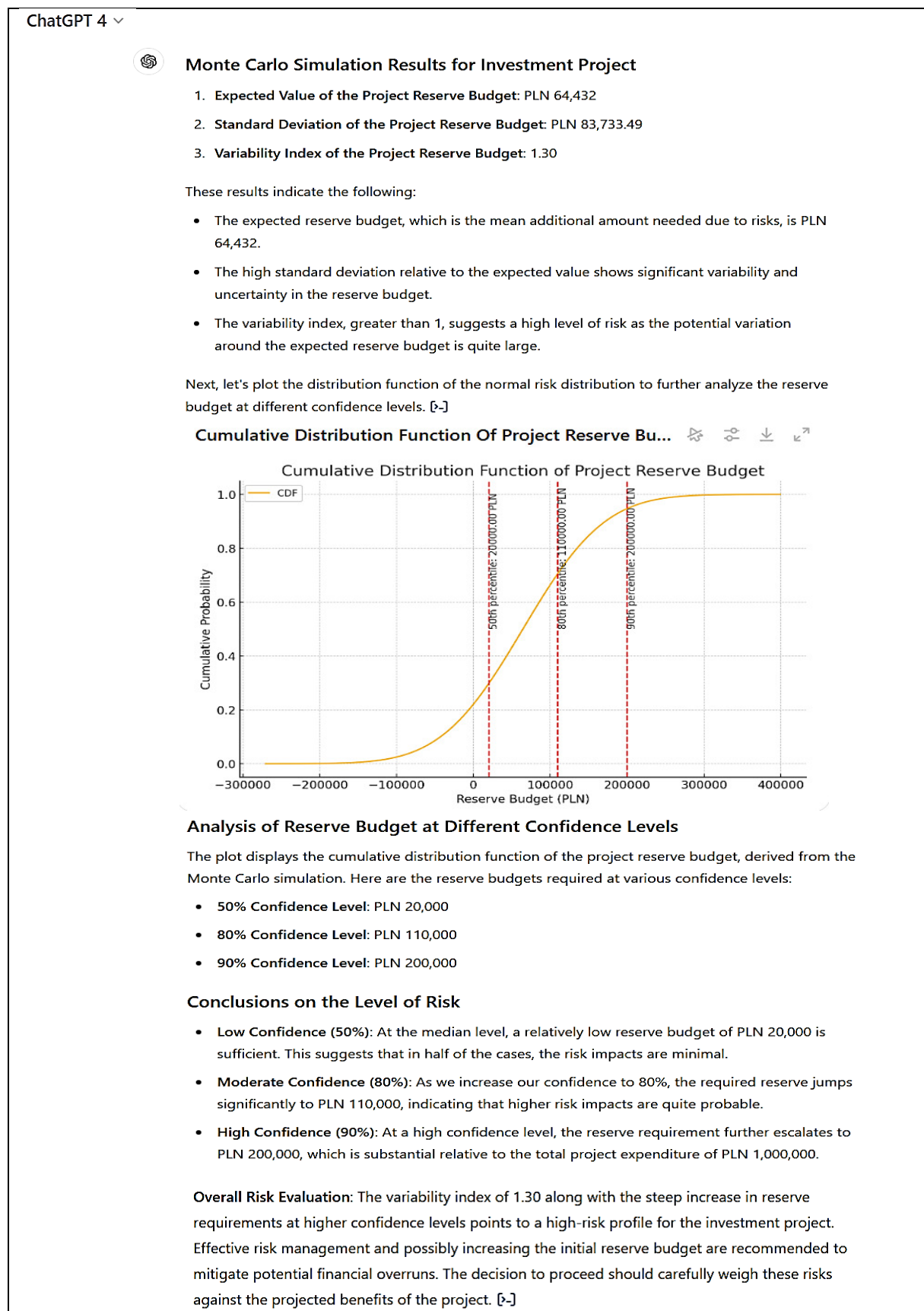


Figure 3. Results of GPT-4 calculations based on percentiles, for selected - 10 experiment

Source: GPT-4.

It is worth noting the methodological differences in the performance of MC by GPT-4. Calculations in 4 experiments (13.33% of the study sample), which were performed on the basis of percentiles, resulted in significant differences in results with respect to calculations based on the cumulative distribution of the normal distribution. It is also important to note the miscalculations in 2 experiments (6.66% of the study sample).

To clarify whether such a situation would recur and, if so, what was the source of the problem, a further 30 experiments were run with GPT-4, on the same input data and with the same command, adding only that it should make calculations 'solely' based on the cumulative distribution of the normal distribution.

In the 32nd experiment, GPT-4 again miscalculated μ . It was therefore asked a question aimed at explaining the source of the error. It turned out that it was an incorrect interpretation of the data and the addition of the value of the basic project budget to the reserve budget. It is worth noting that in the course of the conversation GPT-4 stated: *"You are correct, my error in interpreting the data may indeed have caused confusion in understanding the results. I apologise for the mistake"*. He then made the correct calculations.

In the 34th experiment, GPT-4 re-determined the reserve budget for different confidence levels (0.5, 0.8 and 0.9) using the percentiles of the distribution of simulated incremental costs resulting from possible risks in the project. He was then asked the question *"Why, despite being explicitly instructed that the reserve budgets were to be determined on the basis of the distribution of the normal distribution, were percentiles used?"*. GPT-4 replied: *"You are correct that values from the normal distribution distributions were to be used. The explanation is due to my interpretive error in the data analysis process. In the Monte Carlo simulation that generated the results of the distribution of incremental costs, I actually applied the percentiles directly on the simulation results and not on the fitted normal distribution. I apologise for this misunderstanding. I will now correct this by using the values from the normal distribution function (CDF) for the specified confidence levels."* He then made the correct calculations.

In a further 26 experiments, GP-4 made 24 correct calculations and correctly interpreted the results, while in 2 it again added the value of the project's base budget to the reserve budget. This means that GPT-4 does not learn from its mistakes or experiences, which is not a unique finding (ChatGPT is generally not taught from current data).

To summarise the analysis of the results and discussion, based on the 60 experiments carried out, it can be concluded that the accepted research hypothesis has been confirmed to a very high degree. Therefore, it can be assumed that ChatGPT-4 is able to assess the financial risk of a project using MC simulations and, based on this, determine the reserve budget, but the authors of the publication recommend caution and verification of its calculations. It is important to look at how the results are obtained.

5. Conclusions

The results of the calculations presented in this publication allow us to conclude that GPT-4 has correctly assessed the financial risk of the project using MC simulations in 83.33% of the experiments (in 50 out of 60), and has determined the reserve budget on this basis. Furthermore, it adequately explained the significance of the results obtained. This means that the research hypothesis set out in the introduction has been largely confirmed. GPT-4 can therefore be recommended for use in practice, but given the misinterpretation of data in 10 experiments (16.66% of the study sample), caution and a critical look at the GPT-4 calculation results and their verification should be recommended.

Based on the results of the experiments, it is assumed that, in practice, GPT-4 can be a tool to support decision-making about the size of a project's reserve budget, but taking into account the recommendations indicated. The authors of the publication believe that GPT-4 has potential in this regard and is an alternative to managers performing MC based on their own knowledge, or to more sophisticated AI tools, such as those added to decision support systems. With regard to the considerations in the publication regarding, on the one hand, managers' lack of MC skills and, on the other hand, the adoption of a reserve budget of 10% of a project's base budget without assessing its risks, it is worth emphasising that GPT-4 addresses these problems and can contribute to more informed, rational decision-making. This does not change the fact that GPT is worth developing further. In addition, managers should be made aware of the need to develop their competencies in financial risk assessment and MC, which are necessary to interpret and verify the results given by GPT-4. Furthermore, it should be standard practice in the training of project managers to convince them to use AI in project risk assessment, as this influences more rational decision-making.

It is worth emphasising that the problem of assessing the financial risk of projects addressed in the publication relates only to exceeding their budget, which is a relatively easier issue than the question of not achieving the expected financial effects. For this reason, it would be interesting to see how GPT-4 deals with the assessment of the risk of not achieving financial outcomes, carried out using MC simulations. This sets a further direction for research, the results of which may be of relevance for supporting managerial decisions about the implementation of projects, especially those of a strategic nature requiring significant financial expenditure.

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IDENTIFICATION AND ANALYSIS OF DISRUPTIONS IN THE MATERIAL FLOW TO PRODUCTION PROCESS

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Purpose: The aim of this article is to introduce the concept of investigating disturbances in the flow of materials for production and to select methods that can be used to identify, measure and evaluate disturbances that occur in the material logistics of companies.

Design/methodology/approach: This paper proposes a self-developed methodology for identifying, measuring and analysing disruptions in material flows to the production process based on cause-and-effect analysis.

Findings: The result of the research undertaken in this article is to present the application of the developed methodology for the identification and analysis of disruptions in the material logistics of a paint and plastering compound company.

Practical implications: The developed methodology provides a versatile tool for identifying and analysing disruptions to material flows in the production process and can be applied to manufacturing companies in various industries.

Originality/value: This article contains the results of the measurement and analysis of disruptions occurring in the material flows of a company specialising in the production of paints and plastering compounds, for which an in-house methodology based on cause-effect analysis was proposed. This resulted in the identification of disruptions in material flows, but also in the identification of the source of their occurrence and where they manifest themselves in the value-added chain.

Keywords: material flows, disruptions, production process.

Category of the paper: Research paper, Case study.

1. Introduction

Materials logistics is the branch of science that deals with the management of the flow of materials within a company. Its main objective is to optimise and improve the way materials are moved, stored and used by a company. Within material logistics, the identification and analysis of disruptions in material flows plays a key role, as it allows the effective elimination of problems and the improvement of the efficiency of production processes. Maintaining

a competitive edge in the face of a turbulent reality requires continuous improvement and the monitoring and reduction of events that cause deviations in the planned process flow.

Any delays in the execution of production orders in the construction chemicals industry, can postpone the progress of the schedule of construction investments for which the products were intended. Identifying material flow disruptions involves identifying, detecting and analysing any problems or events that may disrupt the continuity and efficiency of procurement and production processes. These can include delays in material deliveries, difficulties in inventory control, breakdowns of machinery and equipment, errors in production planning and many others. This article demonstrates the various methods and tools that can be applied in the identification of material flow disruptions and presents a three-step proposed methodology for identifying and searching for the sources of a company's problems.

The aim of the research carried out was to identify disruptions in the material logistics of a company producing paints and plastering compounds. A methodology for the identification and analysis of disruptions was proposed for such a research subject and the results of the research carried out in the selected production enterprise were presented. In relation to the selected objective, the events discussed in the literature that cause deviations were familiarised with in logistic processes and analysed methods of searching for their sources. The effectiveness of the presented methodology for identification and analysis of disturbances was compared with other methods available in the literature.

2. Literature background

In the face of today's challenges, it is essential to look for bottlenecks in the production process and minimise them. Organisations, especially industrial companies, are looking to save money and discover the potential of activities that could add more value to the company. Focusing on their internal processes, they first analyse material, information and financial flows (Makysova et al., 2024; Bulej et al., 2011; Bhamu, Singh Sangwan, 2014). In business practice, production and logistics companies have to solve a number of problems. Among the most common are (Hou et al., 2017; Islam, Huda, 2019): transport (choice of transport mode, choice of transport type, etc.), allocation (optimisation and distribution of products, distribution warehouses, optimisation of capacity utilisation, material handling), allocation (allocation of workers and machines), priorities (in orders, services), optimisation of loading operations and optimal use of resources.

Thus, when analysing the problems arising in the material logistics of an enterprise, it is necessary to take into account that the material flows used in the production of finished goods extend far beyond the framework of the production enterprise and involve a number of previous links in the supply chain (Bendkowski, Radziejowska, 2011). And the elimination of deviations

can be carried out through the disposition of orders, material or technical parameters of operations, without changing the planned quantities. Another variant of activities that regulate the flow and aim to bring the expected volume into line with the achieved volume is the correction of accepted standards. Correction of the conditions of production process implementation is the most radical action aimed at changing the operational algorithm of production planning. Disturbances in such a complex production-logistics system are identified both at the input to the system and in the material flows in the system, as well as at the output from the system (Kramarz, 2012).

Disruptions to material flows are rarely discussed in the logistics literature. Most discussion in this area relates to the definition of risk in logistics processes (Kovacs, Tatham, 2009). Tang (2006) considers supply chain risk management (SCRM) as a collection of all types of events that can cause unplanned changes in the system, ranging from intra-organisational operational factors to random factors such as disasters, terrorism, etc. Similarly, other authors specialising in supply chain risk management consider a wide range of potential disruptions as sources of risk, but note that all such events require an extraordinary commitment of company resources (cf. Christopher, Peck, 2004). Dynamism, coupled with market volatility, continues to expose supply chains to disruptive events. The origins of these disruptions can be attributed not only to the complex, multi-tiered, and global nature of many supply chain configurations (Christopher, Peck, 2004; Jüttner, Maklan, 2011; Sheffi, Rice, 2005) but also to their inherent interconnectivity (Knemeyer et al., 2009; Bakshi, Kleindorfer, 2009). Consequently, supply chain disruptions are unavoidable occurrences, presenting a significant contemporary challenge regarding how organizations and their supply chains can recuperate while maintaining sustained performance outcomes (Ponomarov, Holcomb, 2009). This necessitates an enhancement in their ability to manage disruptions, thereby fostering and developing a resilient supply chain. Over the past decade, the resilience of organizations and their supply chains has garnered substantial interest from both practitioners and scholars (for a comprehensive review, see Tukamuhabwa et al., 2015). This heightened interest is driven by the profound impacts that disruptions can have at the firm level and beyond, affecting both short-term and long-term operational and financial performance (Hendricks, Singhal, 2005).

Taking into account all areas of the logistics process operation, failures can be divided into those that occur in the zone:

- procurement – resulting from collaboration with suppliers; related to delays, lack of communication, quantitative and qualitative errors in deliveries, volatility of material prices,
- production – due to lack of knowledge of process bottlenecks, lack of tools for planning and monitoring the production process, machine breakdowns, poor definition of customer needs or poor organisation of workstations,

- distribution – due to lack of adequate information on actual demand from points of sale, faulty forecasting methods, variability of demand, seasonality and trends, and market potential,
- transport – resulting from transport equipment failures, accidents, shortages of vehicles and drivers, inadequate means of transport, but also from transport system failures in the context of intra-company transport,
- warehousing – caused by poor organisation of warehouse space – lack of clearly separated zones for receiving storage and picking, lack of classification of materials, poor labelling of storage areas, shortage or excess of materials,
- supporting processes.

It should be noted, however, that each of these factors affects the business differently and not all of them will be recognised in every organisation. This list is not a closed set of issues, but rather outlines the areas around which they may fluctuate. They can all lead to a deterioration in customer service - delays in order fulfilment, damage to the company's image, loss of customers and weakened liquidity.

The problem of disturbance analysis is a multi-stage one and includes the identification of: the place where the disturbing factor appears (production line, workplace, supplier), the element that is the source of the disturbance (employee, means of transport, machine), the disturbance (difficulty in the functioning of the process: lack of employees, equipment, breakdowns, lack of materials, lack of information), deviations (as a consequence of disturbances), losses (related to the appearance of the deviation - extension of the production cycle, excessive stocks). On the other hand, disruptive factors are any unexpected events that have a disruptive effect on the system, causing a change in the state of the system in directions far from the state of equilibrium or the purpose of the activity (Kramarz, 2012).

3. Methodology

The activities of an enterprise are irrevocably linked to the constant cooperation, interactions and interactions between subsystems, departments and employees inside the organisation, but also with neighbouring links in the supply chain and stakeholders outside the system. The multiplicity of these interactions can provoke the emergence of conflicts, disrupt the smooth running of a given process and even go deeper, paralysing a wider range of processes carried out in active cells within the organisation. The most sensible way to counteract disruption is to eliminate the events that caused it. The different types of disruption and their most common causes have been recognised in the previous section, but their full identification for the unit under study, is a more complex process. In order to thrive in the current environment of intense market competition, companies need to be mindful of the increasing demands of

customers to respond efficiently to their needs by delivering products according to the three principles of the '9W' logistics concept – at the right time, quality and price. In order to achieve the highest level of compliance with the above postulates, a company must first ensure the continuity and regularity of all processes directly and indirectly related to production. It was found that the efficiency of the core business of the studied organisation is affected by disruptions from the area of material logistics, which, by accumulating from the early stages of the procurement process, delay the delivery of products to final customers. It was decided to identify disruptions and wastage in the procurement and production processes of the selected enterprise, and to analyse the sources of their generation. A research procedure consisting of the following action plan was proposed:

1. Identification and quantification of disturbances – quantitative expression of the occurrence of disturbances

To ensure the best possible objectivity, reliability and completeness of the picture of the company's internal situation, it is suggested that data on disruptions be collected using social research techniques - employee interviews and surveys. Employees' views on disruptions and problems are important for building a culture of trust. Employees tend to have more information about daily operations and processes, so creating a space for dialogue and openness to their comments and suggestions improves understanding of the underlying problems that hinder their work and that of the plant as a whole.

A disruption measurement sheet was prepared for research purposes. The information contained in it should be selected on the basis of interviews (open questionnaire) with employees of sensitive departments of the organisation, such as logistics, procurement and production, and the so-called checklist containing a list of potential disruptions developed on the basis of literature research. It is only on this basis that a list of problems specific to the organisation and processes studied can appear in the interference measurement sheet. In the next step, the individual disturbances are subjected to an assessment of their frequency of occurrence in order to prioritise them later. The quantification of the studied phenomena is carried out by the employees, based on a five-point Likert scale, where 1 means very rare occurrence of a given obstacle - once a quarter and less often, 2 means occasional occurrence - once every two months, 3 means occasional occurrence - once a month, 4 means frequent occurrence - once every two weeks, and 5 means very frequent occurrence of a given obstacle - at least once a week. A model of the interference measurement sheet with examples of problems selected by employees is shown in Table 1.

Table 1.
Disturbance measurement card

Disturbance measurement card					
Process:	flow of materials for the production of paints and plasters				
Disturbances	Frequency of occurrence				
	Very rarely				Very often
Production equipment failure	1	2	3	4	5
Long-term/multiple retooling of the production device	1	2	3	4	5
Customer's withdrawal from the ordered goods	1	2	3	4	5
Change in the quantity/type of goods ordered by the customer	1	2	3	4	5
Overproduction	1	2	3	4	5
Production line stoppages	1	2	3	4	5
Lack of raw material for production	1	2	3	4	5
Incorrect placing of an order with the raw material supplier	1	2	3	4	5
Overflow of storage spaces for raw materials	1	2	3	4	5
Delay in the delivery of raw material	1	2	3	4	5

Source: own elaboration.

It should be noted, however, that the interview-based Disturbance Measurement Card reveals difficulties directly faced by employees, which may only indirectly contribute to the main problems reported by the organisation or its customers. Furthermore, they may interact, accumulate or have common causes.

2. Analysis of disturbances sources – Disturbance tree diagram

However, at the root of the diagnosed problems may lie non-obvious factors that are not apparent in the daily activities of the workplace and are overshadowed by their acute effects. Based on the 5WHY method, which helps to find the sources of waste by tracking down answers by successively asking the question "why" (Stoller, 2015), a fault tree diagram (Figure 1) was created, which shows the avalanche effect of the occurrence of a fault in a particular link of the process chain. This approach makes it possible to get to the source of the faults listed in the disturbance measurement diagram. At the top of the diagram is the effect of the partial failure – the main problem faced by the company, and the subsequent rows detail the intermediate events that led to its creation.

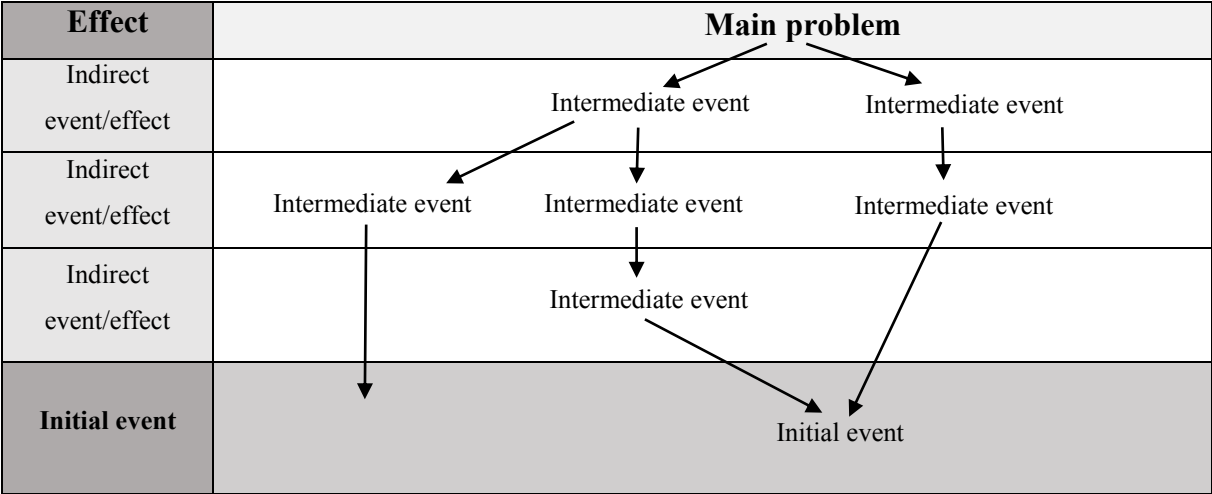


Figure 1. Disturbance tree diagram.

Source: own elaboration.

Having drawn up the above diagram, it can often be observed that the occurrence of a disturbance in one area/stage affects the deterioration of the situation in the following areas/stages, and that a given disturbance may have a multifaceted background.

3. Positioning the disruption in the value-added chain – Big Picture analysis

Value Stream Mapping (VSM, or Big Picture Analysis) has been suggested as a way to identify where the disruptions are occurring. This approach illustrates the flow of the entire process - from the supplier, through the manufacturing company, to the delivery of the product to the customer - and the associated information flows. On the big picture map, you can see where the problems diagnosed in the previous stage of analysis occurred, as well as activities that did not add value to the final product. It also helps to understand the relationships between different parts of the process and how they affect the flow of value. The map thus created is the starting point for identifying and eliminating activities, participants and objects that are responsible for process defects that do not add value, and for reducing the duration of those that remain essential (Dohn, 2004). This helps teams to understand exactly where to focus corrective actions.

4. Results

The research was carried out in a company belonging to the construction chemicals industry, which includes companies with similar needs - producing products for use in the wider construction market, where customers include individual customers as well as builders' merchants, wholesalers or renovation and construction companies. The selected company is a brand specialising in the production of facade and interior materials, in particular paints and

plasters. Due to the diversity and complexity of the production processes in the company, the scope of the study was limited to the paint range. Production follows a similar sequence and is based on the same machinery for both paints, plasters and primers. Production starts according to the safety stock level set for each product, which is influenced by the demand forecast, the level of unfilled customer orders and the level of stock. The production of paints and other coatings consists of a series of repetitive operations based on batch processes. The operations performed in these processes are mainly mechanical in nature. In general, the production of waterborne paints involves dispersing and mixing bulk materials, including pigments and fillers, with an aqueous solution of additives.

The stability of the raw materials and the maintenance of the main supplier are of great importance for the reproducible quality and uniformity of the finished product. This is particularly important for the raw materials that form the basis of plaster products, where the slightest change in the source of the aggregate will alter the properties of the finished product. Due to the lack of natural sources of raw materials for the production of building materials in Poland, the company is forced to import some materials from abroad, including Italy, Germany and China. An analysis of the complaints of the customers of the interviewed company showed that most of the complaints addressed to the company were related to the failure to meet deadlines – delays in delivery. Deadlines are often not met. In addition, the company's employees pointed out the problem of overcrowded storage space for finished goods and the need to send surplus goods to a warehouse in Jaworzno up to twice a week. With the help of the interference measurement card, it was found that the most common errors hindering the employees' daily tasks were as follows:

- production equipment breakdowns, which occur on average once every two months,
- the hassle of retooling production machinery, which workers face every working week,
- overproduction, with quantities that cannot be used in the local warehouse,
- downtime on the production line - on average once every two weeks,
- delays in the delivery of raw materials, which occur on average once every two weeks.

These are priority issues for the company to focus on. However, as mentioned earlier, this survey is only a prelude to further analysis of the problems - it outlines the overall situation in the company. A fault tree diagram (Figure 2) was used to identify the source of the faults listed in the disturbance measurement sheet.

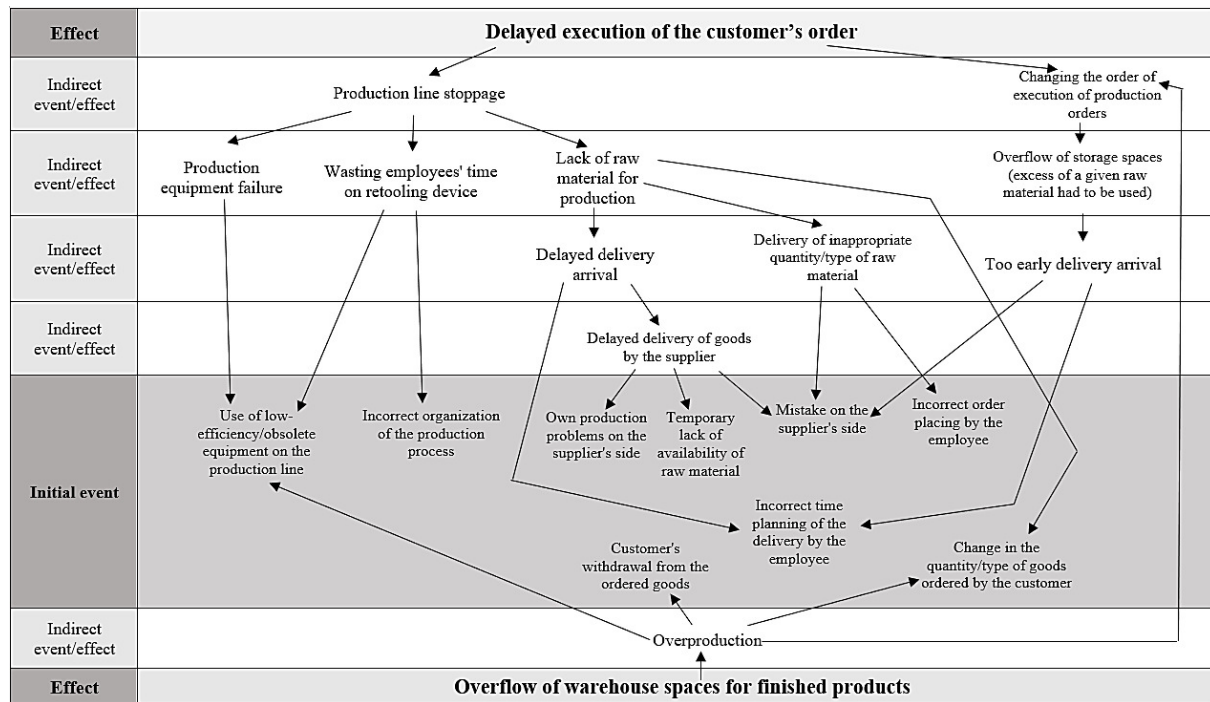


Figure 2. Disturbance tree diagram.

Source: own elaboration.

This method revealed the complex nature of the main problems. The two main dimensions of the sources can be traced back to supply logistics - most often inadequate quantity, type and timing of delivery - and production logistics, where efficiency and effectiveness are affected by the machinery used and the organisation of the production process. Errors made by employees at the stage of planning material requirements and placing orders with suppliers can result in production stoppages due to a lack of raw materials, which means wastage in the form of waiting times (for raw materials) and unused potential of employees or overflowing storage areas for materials. Changing the order of the production schedule in order to reduce stock levels avoids downtime, but often results in overproduction - unplanned production of products for which there is no demand at the time, while the customer waits for an outstanding order. On the other hand, the inconvenience of machine changeovers equates to wasted movement, transport and time within the changeover station.

Some of the sources of disruption are random and beyond the company's control - accidents, suppliers' own problems, customers' changing purchasing decisions. However, these are not analysed further because the company is unable to develop effective safeguards against them. It was found that placing the identified sources on the company's value stream map (Figure 3) would provide the most complete understanding of which areas, positions, equipment or stakeholders should be targeted for adjustments, corrective actions and improvements. In determining the times of individual operations in the production cycle, the average times for changeovers and transport of raw materials to dissolvers and mixers were also taken into account. The illustration of disruptions from suppliers and supply logistics shows that their occurrence affects the continuous flow of the remaining phases of the cycle. Dispersing and

mixing equipment are involved in the rearmament activities. Raw materials are picked up, measured, delivered to the machines and filled into drums, all done manually by employees (except for pigment dosing, where a three-step dispenser is used, allowing precise dosing of the colour). Sources of disruption in the procurement subsystem are also found outside the organisation. Findings from employee interviews show that disruptions in the flow of information about the progress of orders to suppliers are a common situation. Some suppliers are more likely to experience delays in meeting commitments due to their own production problems or the distance between them and the organisation concerned.

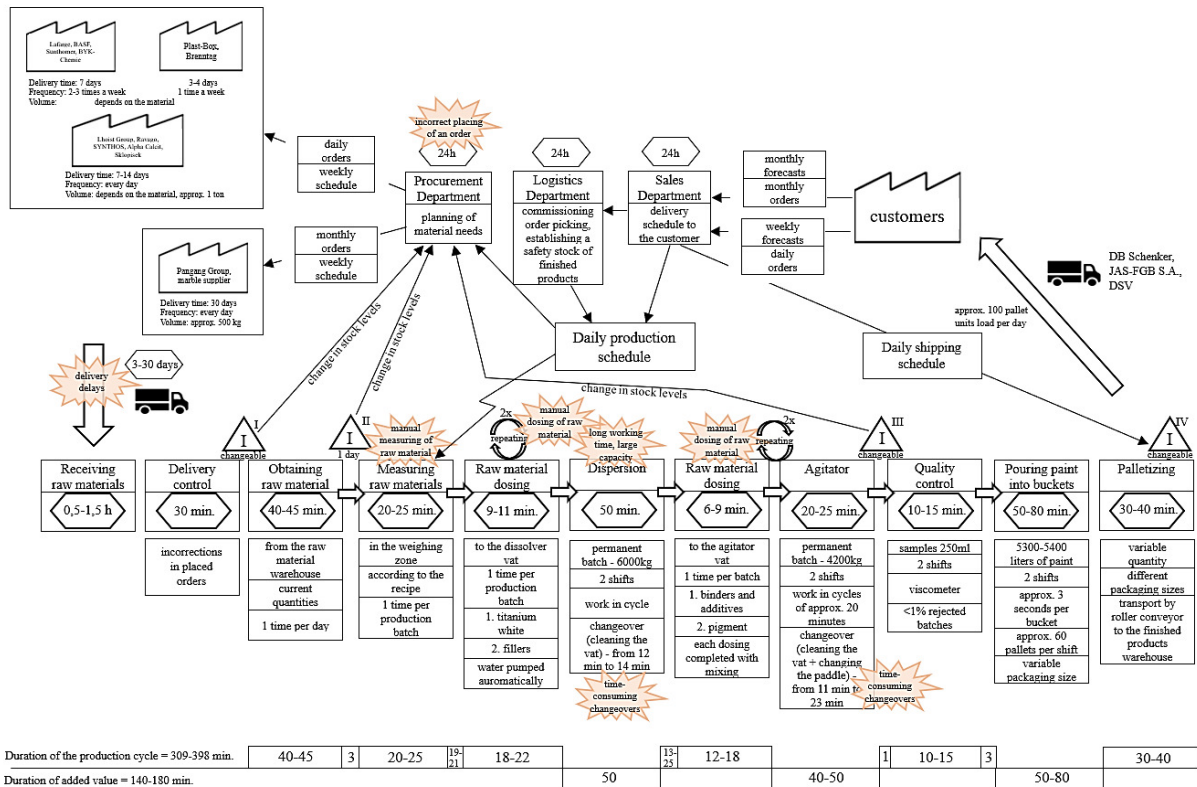


Figure 3. Big Picture map of the current state of material logistics flows in the selected company.

Source: own elaboration.

The map shown is a starting point for mapping the desired condition. Eliminating or correcting faults at the locations marked on the map will go a long way towards eliminating production line downtime and reducing customer service time.

It has been possible to tailor solutions and repair methods to the problems identified. A specific tool to reduce changeover times is SMED (Single Minute Exchange of Die), and it was decided to use it to redesign the production process flow. A supplier scoring exercise was carried out to verify which links at the top of the supply chain were responsible for delivery delays. In addition, the use of elements of the Poka Yoke philosophy in the ordering module of the ERP information system creates opportunities to eliminate human error at this stage of the material flow. The methods were chosen thanks to a careful analysis and localisation of disturbances in the company's process flow.

5. Discussion

Little research has been devoted to the consideration of effective methods for identifying problems in material flows and their causes. In the logistics literature, flow disturbances are usually discussed in the context of their impact on process continuity and considerations of their underlying causes. Little work has focused on identifying universal methods for identifying waste in processes and its causes. This is an area that requires further research and the development of specialised tools to effectively identify and understand the sources of disruptions.

Disturbances are events that cause deviations from the planned flow of materials. Disturbances can affect the quality, productivity and efficiency of processes, so their identification is critical for optimal system performance. The identification and analysis of disturbances is an integral part of process investigation and is critical to evaluating process performance and identifying areas for improvement.

In the work of S. Fox (1982) the idea of a procedure for the process of identifying disturbances appears, including:

- identifying the disturbances that affect the selected production process,
- definition of the frequency and probability of occurrence of the disturbance,
- comparative analysis of the impact of the disturbance on the process.

In their deliberations, the authors used a similar roadmap to draw up a list of priority disruptions for the company. However, at the stage of defining the disruptions, it was enriched with a questionnaire that made it possible to express precisely and quantitatively the problems directly encountered by the organisation's employees. However, it does not provide a full probabilistic analysis of the problems defined, but only a subjective expression of the frequency of occurrence of the irregularities listed.

Among the studies with topics that coincide with the objectives of this paper, one can find a multi-stage, cause-and-effect approach to the study of disruptions. Kramarz (2013) suggests that this analysis should start with the identification of irregularities in the material flow and then identify the relationship between the identified problem and its impact on the process. This research should eventually lead to the identification of the place where the disturbance occurs and the factor, the resource that causes it, which creates the conditions for assessing the total losses caused by its occurrence. This methodology was also used by the authors of this paper, where the cause-effect analysis, based on the 5WHY method, was visualised in the form of a fault tree diagram. Kramarz and Kmiecik (2017), on the other hand, presented the cause-effect relationship of the disruptions that occurred in the form of a disruption measurement sheet for each job (Table 2).

Table 2.
Disturbance measurement card

Date	Disruption	Reason descriptively	Entity responsible	The effect descriptively	Scoring of disturbances	
					financial	organizational
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Source: Kramarz, Kmiecik, 2017.

Marecki and Pawlewski (2011), faced with the stochastic reality that surrounds the company, propose the use of problem solving techniques as a contrast to the analytical approach to problem solving that was the domain of the last century. Like the authors, Marecki and Pawlewski (2011) and Lis (1982) point to the crucial role of employees in identifying and investigating the causes of disturbances, as they have the most complete knowledge of the obstacle that has occurred.

As part of an effective system to support the detection of disturbances, they specify two groups of tools (Marecki, Pawlewski, 2011):

- theoretical, within which they list SPC (Statistical Process Control), FMEA (Failure Mode and Effects Analysis), QFD (Quality Function Deployment), Fish Diagram,
- creative: TRIZ (Theory of Inventive Problem Solving), USIT (Unified Structural Inventive Thinking), 5WHY, which partly overlap with tools attributed to the Lean Management philosophy.

The appropriateness of using the 5 WHY method for the problems encountered in paint production is confirmed by the areas of application suggested by the authors, which include "[analysing] deficiencies in process execution, [analysing] the causes of complaints".

In the past, however, tools based on a complex, multi-level analysis of the causes of the problem have already been developed. The exemplary USIT method, adopted in Japan in 1999 and based on the six-box system, is one way of creatively solving technological problems. It assumes that the diagnosis begins with the input of the problem from the user, who can be identified as an employee of the company. The problem should then be correctly defined, placed in the structure of the system in question and the target state defined, as is the case with the Big Picture Maps (VSM) used by the author.

The usefulness of the FMEA analysis cited by the authors is also recognised in the study by Kramarz and Kmiecik (2017), as another of the methods for clearly presenting the cause-and-effect relationships of the disruptions that have occurred. The authors emphasise the multifunctionality of the tool, which can be used both for projects aimed at validating newly manufactured products and for processes already implemented in the company. In the future, the FMEA tool could be used to evaluate the effectiveness of the preventive or corrective actions proposed by the author in relation to the defects that have occurred, by analysing their risk before and after the improvements.

A tool often used in research to analyse the causes of failure is the Ishikawa diagram. It can provide a graphical classification of the causes of a problem, in the dimension of five "M" (factors that can affect a problem) – man, machine, method, material, meter – as a cause-and-effect diagram. The summary of the analysis allows you to identify the main existing and potential sources of disturbance that have affected the outcome of the process under study.

Grabowska (2020), on the other hand, suggests using the A3 report to search for the root causes of previously diagnosed disturbances. This tool is characterised by its versatility, so it can be used for many purposes - solving predetermined problems, identifying those responsible for carrying out an activity, improving the effectiveness of organisational and employee learning, supporting continuous improvement within the company. The A3 report has a concrete structure that helps to understand and present the problem. It consists of sections such as a description of the problem, an analysis of the causes, objectives to be achieved and proposals for corrective action. However, the report itself is not an independent tool for investigating the causes of the problem, but relies on the methods already discussed - usually using one of the cause-effect analysis tools (Grabowska, 2020).

In the literature (Czabak-Górska, Kucińska-Landwójtowicz, 2015) one can also find an approach that uses statistical process control (SPC) – control cards – as a tool for detecting disturbances. When analysing control charts, it is important to identify the causes of all change signals in the processes under study, but this tool alone does not provide an answer to the question of where the problems originate. It only allows you to identify the occurrence of random errors, most of which are due to incorrect measurements. It can only provide a basis for finding their causes.

The methodology proposed by the authors can be applied to any area of the company's operations and is a universal tool for analysing the disruption of any process. Thanks to this approach, it is possible to act at the source of the problem, before it occurs, and prevent the generation of costs associated with the removal of the resulting "fires", often associated with the disruption of the continuity of plant operations. On the other hand, the proposed solutions to problems in the flow of materials into production itself depend on the nature of the problem and the industry/company in which it occurs. The research methodology adopted was an attempt to move away from methods based on intuition and guesswork, towards methods based on reliable information and practical knowledge from employees who were in direct contact with the problems that arose. The introduction of this methodology was aimed at increasing precision and objectivity in identifying problems and physically locating their causes in the value chain.

6. Conclusions

Disturbances are a common part of material flow. There are many factors that can cause disruptions in the flow channel. In order to formulate appropriate measures to mitigate the disruptions themselves and their negative effects, companies need to choose a methodology for their comprehensive analysis and evaluation.

Many types of disruptions to material flows have been identified in the literature, such as delays in the delivery of raw materials, errors in ordering, breakdowns in production equipment, imperfect design of the production process or problems with transport handling. Most of these fall into the category of organisation and management and are related to the most sensitive link in the whole process - the human factor and the system they design. In order to deal effectively with disruptions, it is essential to understand them, analyse their causes and how they arise.

The methodology proposed by the authors is based on existing, proven tools. It is based on a review of the literature on the material logistics of supply chain management and an analysis of the practices of various companies. The first step is to identify the main sources of disruptions in material flows. The second step is to analyse the location of these disturbances and their impact on the production process. This allows us to get to the root of the problems, to improve the factors that have disrupted daily operations, to give employees a voice, and to easily identify and locate problems in the company's material flow process.

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APPLICATION OF RESEARCH FINDINGS IN MANAGEMENT SCIENCE AND PRACTICE: EXPERIMENTATION AND SIMULATION

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Purpose: The paper aims to explore how research results can be effectively implemented in management science and practice, focusing on experimentation and simulation methods. The study seeks to address the gap in knowledge transfer between theoretical research and practical management applications, and to identify key methodologies that contribute to this process.

Design/methodology/approach: This research adopts a narrative and methodological approach, combining qualitative and quantitative methods. It emphasizes experimentation and simulation as core techniques for transferring research results into management practice. The paper explores theoretical foundations, presents case studies, and evaluates the effectiveness of these methodologies in practical settings. Additionally, it discusses the utility of models and theories in shaping management solutions.

Findings: The research reveals that both experimentation and simulation methods provide robust tools for understanding and addressing complex management challenges. These methods allow for controlled testing and prediction of outcomes, offering valuable insights into organizational behavior and decision-making processes. The study also highlights that the practical application of these methods requires careful adaptation to specific organizational contexts.

Research limitations/implications: Limitations include the difficulty of applying experimental methods in real-world settings, which may not fully capture all the variables present in actual organizational environments. Future research should focus on refining simulation models to enhance their accuracy and applicability across different industries and scenarios.

Practical implications: The findings suggest that the integration of experimentation and simulation into management practices can enhance decision-making, increase efficiency in strategy implementation, and improve overall organizational performance. These methods provide a structured approach to testing hypotheses and forecasting the potential outcomes of managerial decisions.

Social implications: The research has implications for improving the transparency and accountability of management practices. By utilizing experimentation and simulation, organizations can better predict and mitigate social risks associated with business decisions, leading to more socially responsible and sustainable management practices.

Originality/value: The paper contributes to the field of management science by offering a comprehensive framework for implementing research findings through experimentation and simulation. It provides valuable insights for both academics and practitioners seeking to bridge the gap between theory and practice in management.

Keywords: experimentation, simulation, management science, organizational research, decision-making.

Category of the paper: Research Paper, Case Study.

1. Introduction

The limited applicability of research results to management science and practice most often refers to the problem of knowledge transfer. This is because it can be assumed that at least part of the practical knowledge of organisational management is derived from scientific knowledge. Hence, important for practice are the translation and diffusion of research results, which are only possible if a properly conducted research process is based on appropriately selected research methods, among them the narrative approach, with a special focus on organisational discourse (Gabryś, 2016).

In scientific research, an experiment is used to: explore, to make comparisons, to explain, to provide evidence and to test the validity of evidence. Furthermore, it provides the possibility of generalisation, which in this case depends on the extent to which the operationalisations of the constructs are true to the constructs themselves (Highhouse, 2009).

Simulation is the approximate reproduction of a phenomenon or the behaviour of an object by means of a model of it. It is a procedure in which random numbers are generated according to probability. They are assumed to be associated with a source of uncertainty, such as, for example, capital expenditure sales revenue or company operating costs. The data associated with the input variables are analysed to determine the outcomes that are likely to be the output variable and the risk attributed to it (Pawlak, 2012).

The research procedure outlined has certain implications. Its universal nature also gives it many advantages. It can be adapted to both simple and sophisticated research methods, to build and test theories, to model variation and process models, to cross-sectoral and longitudinal studies, quantitative or qualitative, laboratory, simulation, archival or other observation methods (Pawlak, 2012).

The paper highlights the importance of narrative framing and the use of experimental and simulation methods in social science research processes.

2. Narrative in organisational research processes

The importance of effective research methodologies in management science, particularly those that bridge theory and practice, has been widely recognized. Experimentation and simulation are crucial methods for testing hypotheses and evaluating the impact of strategies in various organizational settings. Recent studies have expanded on these methods, emphasizing the pragmatic application of research in areas such as green logistics, sustainability, and digital transformation. For instance, Dźwigoł (2018) highlights contemporary research processes in management, while Dźwigoł and Trzeciak (2023) focus on the pragmatic methodologies that align with the implementation of research findings in real-world practices. Further, Dźwigoł et al. (2021) explore the organizational mechanisms for implementing green logistics, showcasing how simulation models can predict outcomes in strategic management. The role of environmental regulations, renewable energy, and innovation in fostering sustainable growth is also discussed by Dźwigoł et al. (2023a, 2023b). These studies demonstrate the utility of simulation in forecasting economic outcomes and enhancing decision-making processes, thereby reinforcing the relevance of experimentation and simulation in management science. Furthermore, Kharazishvili et al. (2020, 2021), Kharazishvili and Kwilinski (2022), Kwilinski (2019a, 2019b), and Kwilinski et al. (2022a, 2022b, 2023a, 2023b, 2023c, 2023d) contribute to understanding the integration of technological advancements and sustainability in management practices, further validating the use of simulation models to address complex organizational problems. These research efforts underscore the value of simulation and experimentation as tools for transferring theoretical insights into practical applications in management science.

According to B.J. Gabryś (2016) understanding the process by which research can contribute to theoretical as well as practical knowledge is one of the fundamental challenges facing proponents of management science.

The process of generating theoretical knowledge, not only in narrative terms, should allow for the clarification of key research questions, namely whether the aim of the research is to find answers to questions that concern (Gabryś, 2016):

- a description of an explanation or prediction of future events that are occurring or may occur in the organisation,
- the relevance of the research questions considered in terms of their formulation, evaluation or resulting action,
- verifying the extent to which the researcher carries out his or her activities from the point of view of an external observer, or an internal participant in events fully involved in the processes under investigation.

Stakeholder advisory science involves processes of describing, explaining or predicting phenomena in an organisation. It is based on the main principles of social science research, according to which the researcher, when seeking information, is located outside the social

system, i.e. the organisation. The researcher analyses the processes taking place in the organisation using the activity of the internal participants of the organisation. He or she completely controls and manages all elements of the research process. Typically, research processes are based on the work of a group involving internal and external stakeholders. This type of research is strongly correlated with the needs of these stakeholders, so the extent of its widespread use is less than, for example, observation methods (Gabryś, 2016).

By shaping a policy of evaluating phenomena for the needs of management practitioners, the shape of policies, programmes or models for solving practical problems is normatively determined. These activities provide an indication of research-based knowledge about the conditions for achieving efficiency as well as the possibility of success when other solutions are applied. The implementation of research usually has the character of an external review as the only way to access a lot of research without the emotional involvement of the researcher (Gabryś, 2016).

All stages, i.e. problem formulation, research design, problem solving, should take into account the multi-study nature of the research conducted. In the case of participatory research, taking into account suggested solutions for specific organisations, a highly accurate diagnosis of the organisation's problem leads to a specific solution, unique in other conditions and for another organisation (Gabryś, 2016).

According to H. Putman (1962) logical positivism or logical empiricism indicates the difficulty of considering the social sciences as objective, rational and cumulative primarily due to language, culture, social norms, ideology, mental models, or selective perceptions of reality.

Science is an intensive social process that is created by people, and therefore the above elements (separately or together) demarcate in some way the process of its creation - also in management science (Gabryś, 2016).

Social science research should emerge from strong assumptions of critical realism (especially at the philosophy of science stage). B.J. Gabryś (2016) indicates that they should be based on the following assumptions:

- there is a real world (consisting of material or mental products), but its individual perception and understanding is limited,
- facts, observations or data are grounded in a particular theory from which they derive,
- every methodological approach has a certain value - its effectiveness always lies in its skilful application in the study of a specific phenomenon,
- recognising the holistic problems of reality obliges the use of many different, as well as often differing, perspectives,
- the models that appear to be best suited to solving organisational problems will develop most rapidly, which in turn will increase the body of knowledge about the processes or phenomena in question.

It is important, as part of conducting research, to distinguish precisely between theory and research model. In the social sciences, model testing is used for this purpose (observation or theory testing is not) (McKelvey, 2002).

Models are a partial reflection of the map of cognition created by theory. They contain a set of instruments and assumptions used in the process of implementing scientific methods of observation and analysis (Gabryś, 2016).

There are two basic models in the social sciences: the variation model and the process model. Each of them starts from different epistemological assumptions, hypotheses and tools in terms of the theories and research phenomena represented. The fundamental difference between these models is in the questions they address: what is the cause and effect of the issues under investigation? and how did the issues emerge, develop and end in a particular place and time? It is worth noting that there are few studies of the narrative model compared to the vast number of studies of the variation model (Gabryś, 2016).

According to B.J. Gabryś and M. Bartnicki (2010) in definitional terms, a narrative is a spoken or written collection of interconnected events that are arranged into a story defined by those describing these events. A narrative, in most cases, is arranged around a specific order, most often around a linear order, i.e.: it has a beginning, middle stages and an ending (Gabryś, 2016). Participants regard narrative as an important part of the process of making sense of experienced organisational reality (Czarniawska, 1998).

Like the most commonly used variation model approach, the process model provides the basis for generalisation claims - however, based on quite different criteria. The narrative approach of the process model does not preclude the use of quantitative methods. On the onehand, it allows the use of any method that enables the researcher to approximate the sense of the changes taking place and the processes of development of the phenomena. On the other hand, it imposes many restrictions on the researcher, which are related to the type of data used or the nature of the models that can be applied. The process approach assumes that explanatory capacities emerge only in relation to a level of generality - not to individual cases (it is the generalising processes located in narratives, particularly in process modelling, constitute the different character of the process approach) (Gabryś, 2016).

The variation model may also rely to some extent on evoked stories, narratives or discourse, but these have the character of mini-narratives, which only reinforce the understanding of causal processes and provide an understanding of the links between individual variables. A narrative approach explains changes in terms of a sequence of events, a certain order or stage in the process in which they occurred. The thread of a given narrative, in the narrative approach, is a factor that allows generalisation (Gabryś, 2016).

The main problems and issues that the researcher must grapple with before undertaking research in terms of a process model using narrative and discourse include (Gabryś, 2016):

- at the stage of formulating the research process: meaning of the process, theories of the process, point of view, research method, observation method, source of change, study sample (unit), sample size (unit) and the design of the research process,
- in the measurement and data analysis stages of the research process: process concepts, events (cases), case selection, event measurement, event identification, process development.

The narrative approach enables the researcher to look at the process of change taking place in an organisation as a kind of argumentative game, i.e. an organisational discourse, in which individual narratives create a new line of understanding of events in the organisation (Gabryś, 2016).

In organisations, multiple paths or approaches can be followed in terms of narrative analysis. The historical approach is one of the most established paths, highlighting the temporal dimension of events and the way in which stories become part of an organisation's present or future plans. It is important to emphasise here that the stories that are told and the narratives that are constructed legitimise the decisions that are made and indicate the elements that are relevant to the researcher making the story (Gabryś, 2016).

3. Experimental method in the research process

There are many different scientific methods in management science, including those of a universal nature. This fact makes the choice of research methodology not an easy task. This is because, before deciding on its choice, it is necessary for the researcher to know the philosophical assumptions on which his scientific achievements are to be based and to understand why a particular type of research methodology is suitable for the implementation of a strictly defined scientific study (Creswell, 2009; Bryman, 2008).

In the social sciences, it has become accepted to identify three groups of research methodologies, i.e.: quantitative research, qualitative research, mixed methods (methodological triangulation). Among quantitative research, the most popular is the survey, and among qualitative research, the experiment. Despite their popularity, however, quantitative methods are criticised (Zou et al., 2014; Creswell, 2009), e.g. for their lack of objectivity, the differences between the actual behaviour of the respondents and the declarations contained in the answers given, their isolation from the real world, or their emphasis on standardised testing (Grix, 2004; Bryman, 2008). In addition to the choice of research method, it is equally important to design the research process, which should build the ground for optimisation (Davis et al., 2013):

- generalisation of results in relevant populations,
- realism in the way the environment in which the variables were observed was perceived,
- precision in the measurement of variables.

In the management sciences, the methods of experimentation, simulation or observation, due to their many advantages, should be and are successfully used as a method of conducting research and solving scientific problems (Stańczyk-Hugiet, 2014, 2016).

A scientific experiment is understood to be a repetitive cognitive procedure that involves a researcher intentionally changing a selected factor (independent variable), while controlling others (dependent variables), performed to determine, or to elicit, the effects of the change made (Stachak, 2006). It allows for factual knowledge and provides information on whether manipulating the selected variable affects the results obtained and in what way. It is particularly applicable when analysing repeated phenomena, under at least partly the same conditions. According to some methodological researchers, an experiment is a special case of observation, but differs from observation in having a more carefully developed research design, a more complex structure and the use of a more varied and broader set of research tools, which supports its inclusion among scientific methods (Pilch, Bauman, 2010).

The main objective of the experiment is to detect causal relationships between two variables/phenomena, which provides the possibility of defining causal laws (Podgorski, 2007). In order to construct such laws, it is useful to refer to the logical canons of J.S. Mill, from which practical methods of inference are derived, i.e. (Pytkowski, 1985): the method of congruence, the method of difference, the method of congruence and difference, the method of concomitant changes and the method of residuals. These methods are models for experimental research, but the greatest importance is attributed to the difference method, on which experiments in the social sciences, economics and humanities are based (Stańczyk-Hugiet, 2016).

As universal principles of scientific experimentation, one can point to (Pieter, 1967):

- the separation of the phenomenon, structure or process under analysis from secondary influences,
- defining the variables of the phenomenon under study and establishing the conditions to be actively integrated by the experimenter,
- bringing about a change in a discrete phenomenon, structure or process,
- determining the nature and extent of the induced active change - the dependent variables.

Research conducted using an experiment is too often not used in management science. Examples include research that sought to determine whether BSC increases efficiency in the strategy implementation process (Strohecker, 2007), research using a quasi-experiment using longitudinal data that was analysed in these banking organisations (Davis, Albright, 2004), or research with students playing the role of managers (de Figueiredo J., de Figueiredo R.J., 2016; Oladunynjoye, Onyeaso, 2007).

There are many different types of experiments, e.g. in marketing research there are experiments with one independent variable, i.e. quasi-experiments, real experiments and experiments with a series of measurements, and experiments with multiple independent variables, i.e.: random experiments and statistical experiments. In addition to the different types

of experiments, each experiment is also conducted under specific conditions, hence we can distinguish between: natural experiment and artificial/laboratory experiment. Considering the extent of control of the experimental situation on the part of the researcher and the way in which the results are measured, we can point to: laboratory experiment, field experiment and natural experiment (Stańczyk-Hugiet, 2016).

An essential component of an experiment is observation. The result of scientific observation is scientific observation - a description of phenomena, which is why it is referred to as the primary method of empirical cognition. It differs from simple perception in that it is intentional and continuous. Therefore, it can be considered as a research method when it takes into account all stages of research activity - from problem definition to research report and answering research questions. Observation allows, among other things: to collect specific data, to set hypotheses, to verify and select the collected research material. In summary, observation is characterised by being purposeful, planned, systematic, objective, measuring and recording individual activities and facts, a precise description of the process of a given reality and the absence of interference of the researcher in the process being analysed (Stańczyk-Hugiet, 2016).

The way to achieve the above objectives is to design the experiment properly, i.e. in such a way that it is characterised by a high degree of internal validity and the data obtained allow the theory or hypothesis to be tested (Croson, 2005).

Among the more important principles that make up the procedure for carrying out the experiment are:

- manipulating at most one independent variable at a time,
- continuous monitoring of the phenomenon,
- minimising the impact of independent variables that distort the measurement of the dependent variable,
- measuring the dependent variable. In turn, the following can be mentioned as elements of an experimental study: the object of study, the variables, the instrumentation, the experimental design, the procedure and the statistical analysis (Stańczyk-Hugiet, 2016).

The universal procedure for conducting a scientific study by experimentation consists of the following steps (Stańczyk-Hugiet, 2016):

- identification of the research problem, as a result of which the researcher can focus on a much narrower area and investigate it accordingly,
- formulating a research hypothesis that is consistently tested and deducing consequences,
- the design of the study, which is related to sample selection, identification of variables, control of non-experimental variables, conduct of pilot studies and development of the study schedule,

- the conduct of the experiment, which is related to the manipulation of a variable that affects the experimental group and the control of the experiment, which allows the prediction of events that may occur under the conditions of the experiment and thus makes it possible to neutralise their effect on the other factors,
- data collection and coding, which becomes particularly important in quantitative research (experiments are more often quantitative than qualitative), due to the very large amount of data to be measured,
- application of statistical tests,
- the analysis and formulation of conclusions which conclude the scientific study, and in which it is important to compare the results from the experiment with those obtained in a control group or other experimental group, and the statistical presentation of the results obtained.

4. Simulation method in the research process

In Simulation is regarded as a method that uses computer software to model 'real world' processes, events, systems and operations (Law, Kelton, 1991). It can be considered as a variation of an experiment, where we assume that a model can be manipulated to obtain specific information. The models should have some characteristics of the real world, while the data for them should be longitudinal (Stańczyk-Hugiet, 2014). Furthermore, a simulation model requires the precise definition of all assumptions, relationships between variables, ways of transforming numerical values and it is based on a specific theory. The simulation method is used when it is practically impossible to analyse behavioural changes directly on a real object or when such studies are more costly (Gilbert, Troitzsch, 2005). Three groups of simulation objectives can be distinguished:

- predictive, aims to identify qualitative and/or quantitative features of the performance of the system under analysis for given circumstances,
- identification, aims to identify qualitative and/or quantitative principles or laws of operation of the system under analysis,
- rationalisation, aims to identify the conditions of operation of the system under analysis, at which the qualitative and/or quantitative characteristics of the system meet the indicated conditions of rationality.

Simulation as a research method is mainly used to simulate the effects in decision-making, e.g. in the area of strategic management, with regard to the production process, as well as in other areas of management (Dźwigoł, 2018).

Simulation methods allow solutions to be tested in a controlled environment, primarily on the basis of historical or fictional data. Types of simulation can be identified as (Dooley, 2002):

- discrete-event simulations in which events are triggered in a probabilistic and sequential manner,
- system dynamics models in which differential equations define the key system and interaction variables,
- agent-based models, where agents undertake behaviour according to specific rules, between which there is interaction.

The procedure for preparing and running the simulation is as follows (Law, 2007):

- formulation of the actual problem,
- collection of actual data,
- construction and verification of a computer model,
- carrying out pilot simulations,
- model validation,
- designing a simulation,
- carrying out simulations,
- analysis of input and output data,
- presentation of results.

A particular variation of simulation methods is computer simulation, which is supported by reasons such as:

- too costly or too dangerous to investigate a real phenomenon,
- too long to wait for the test result,
- the non-existence of the research object - its design stage.

The key elements of the computer modelling and simulation process are the real object, the experimental system, the model of the object under study and the computer with software. Computer simulations are based on mathematical models, but they reflect the researcher's knowledge of the operation and structure of the modelled system and the phenomena occurring in it (Stańczyk-Hugiet, 2016).

An important method in the group of simulation methods is agent-based simulation, in which the focus is on an agent acting according to a specific logic, while the behaviour of the whole system results from the integration of the agents with the environment and with each other. B. Heath, R. Hill and E. Ciarallo (2009) give four stages of agent simulation, i.e.:

- formulation of the problem and objectives of the simulation,
- building a conceptual model,
- translating the conceptual model into a formal model,
- carrying out simulations and analysing the results.

5. Conclusion

The study highlights the vital role of experimentation and simulation methods in advancing management science by providing structured frameworks to analyze, predict, and validate organizational processes. While these methods offer numerous advantages, including versatility and the ability to model complex systems (Gilbert, Troitzsch, 2005), they also come with challenges such as the need for substantial computational resources and the intricacies of model validation (Stańczyk-Hugiet, 2016). Despite these limitations, experimentation allows for precise control and replication of phenomena, generating actionable insights for organizations (Stachak, 2006). A well-rounded theoretical framework should not only describe but also explain the occurrence of phenomena, incorporating both stakeholder involvement and narrative approaches to provide deeper organizational insights (Gabryś, 2016; Whetten, 1989). As such, this research reinforces the importance of combining both theoretical and practical perspectives to address the complexities of modern management challenges.

Future research should focus on refining simulation models to enhance their precision and applicability across diverse industries, especially in the context of environmental sustainability and digital transformation. As demonstrated by recent studies, integrating simulation and experimentation in fields like green logistics, energy efficiency, and sustainable development has proven beneficial (Dźwigoł, 2018; Dźwigoł, Trzeciak, 2023; Dźwigoł et al., 2021). However, there is a need for more extensive research into the intersection of artificial intelligence and simulation methods to improve decision-making processes in management (Kharazishvili, Kwilinski, 2022). Moreover, further investigation into the spillover effects of green finance and urbanization on sustainable development could offer new insights into the role of digitalization in achieving these goals (Kwilinski et al., 2023a, 2023b, 2023c). By advancing these research areas, management science can continue to evolve toward more innovative, data-driven solutions that are critical in navigating the complexities of modern organizations.

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RESEARCH PROBLEM FORMULATION IN MANAGEMENT SCIENCE

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Purpose: The purpose of this paper is to explore the formulation of research problems in management science, highlighting the importance of a structured research methodology and its connection to both theory and practice. The paper seeks to bridge the gap between scientific research and business practice in the discipline of management.

Design/methodology/approach: The paper is based on an extensive literature review and theoretical analysis of the development of management science. The methodological approach includes examining historical methods in management research, analyzing their evolution, and proposing a model for structuring the research process. The paper emphasizes methodological triangulation and the relevance of both qualitative and quantitative methods.

Findings: The analysis reveals that management science has evolved significantly, from industrial efficiency to modern paradigms that include flexibility, sustainability, and innovation. The formulation of research problems in management science is driven by both theoretical inquiry and practical application, requiring a balance of qualitative and quantitative methods. The paper identifies the importance of methodological pluralism and the necessity of bridging theory with practice in modern management research.

Research limitations/implications: The research primarily focuses on the theoretical development of management science and does not include empirical testing. Future research should aim to test the proposed models and frameworks in practical settings to validate their applicability and effectiveness.

Practical implications: The paper offers insights into how businesses can benefit from structured research methodologies in management science, providing a guide for managers to apply academic research to real-world business problems. It encourages businesses to adopt flexible and innovative management practices, supported by rigorous research methods.

Social implications: The research highlights the importance of sustainable and responsible business practices, suggesting that management science can contribute to societal well-being by promoting practices that balance economic success with environmental and social responsibility.

Originality/value: This paper contributes to the ongoing discussion of research methodologies in management science by proposing a model that integrates theoretical and practical perspectives. It is valuable for researchers and practitioners looking to enhance their

understanding of the evolving nature of management science and the formulation of research problems.

Keywords: management science, research problem formulation, methodological triangulation, theoretical-practical integration, business research.

Category of the paper: theoretical paper, review.

1. Introduction

The goal of management science is to continuously develop or create new methods and research techniques. Management has been a part of human life since the beginning of civilization, and in practice, it is employed daily by individuals in various ways. Methodology refers to a structured set of approaches, rules, and principles for completing tasks. However, it is essential to consider the unique aspects of management science methodology. Some literature highlights the idea that management sciences suffer from a lack of methodological development, partly due to the anti-methodological stance of some of its leading schools of thought (Kozmiński, Oblój, 1989).

Theoretical sciences focus on understanding the natural and social world without considering how the research findings will be applied. In contrast, practical research is geared toward solving or explaining real-world problems or phenomena. As a result, the practical and theoretical dimensions must complement each other (Dźwigoł, 2018).

In management sciences, however, experimental research is not the primary method used. Instead, internal relevance depends on aligning with a suitable theoretical framework, employing deductive reasoning, or analyzing variable relationships that provide robust support for the findings. Additionally, internal validity enhances the value of theoretical triangulation, as the multifaceted study of a phenomenon helps to identify the most persuasive interpretation (Dźwigoł, 2018).

In recent years, similar issues have been explored in the context of sustainable development, as researchers have focused on aligning management practices with sustainability goals. This growing trend highlights the need to incorporate environmental, social, and governance (ESG) factors into management science, ensuring that research not only supports business efficiency but also contributes to the broader goal of sustainable development. Studies suggest that integrating sustainability into management methodologies fosters long-term business viability and resilience (Dźwigoł et al., 2021, 2023a, 2023b; Kwilinski et al., 2022, 2023c). Furthermore, the rapid digitalization of businesses has significantly impacted management practices, with digital tools and technologies reshaping the way organizations approach decision-making, resource allocation, and stakeholder engagement. Digital transformation, in combination with sustainability efforts, allows companies to innovate while maintaining their commitment to responsible and sustainable practices (Kwilinski, 2019a, 2019b; Kwilinski

et al., 2022, 2023a, 2023b, 2023d). This reflects the ongoing shift in management science toward more holistic approaches that encompass both economic and societal impacts (Dźwigoł, Trzeciak, 2023; Kharazishvili et al., 2020, 2021; Kharazishvili, Kwilinski, 2022; Krieger et al., 2023).

The formulation of the research problem and the search for a solution are largely driven by the adopted research objective. According to J. Niemczyk (2016), these may be goals that refer to an unrestrained desire to learn about the world, however, more often they are strictly determined by the persons or institutions ordering a solution to a scientific problem. The commercialisation of science has meant that the utilitarianism of the proposed solutions, the timing of the research, the success of the promotion process or the desire to use funds that are earmarked for the development of science effectively inhibit ambitious, risky, long-term and multifaceted projects - from this point of view, the area of interest of researchers may be the result of compromises between their own ambitions and the expectations of the environment (Lakatos, 1995).

To accurately formulate a research problem in management science, several fundamental questions need to be addressed (Dźwigoł, 2018):

- What research methods are appropriate for the research process in management sciences?
- Is methodological triangulation essential for conducting research?
- Should qualitative methods in research be complemented by case studies?
- Is it necessary to validate the methods, procedures, or models developed in practice to ensure the credibility of the research?
- Does the pilot study play a guiding role in the research process?
- Is it important to create specific models, procedures, tools, or approaches for the research process?

To provide adequate answers to these questions, relevant research needed to be conducted with the primary goal of developing a model, procedure, tool, or approach for selecting methods and outlining the process for conducting research in management science and practice.

This paper outlines the approach to formulating research problems and establishing the assumptions for the research process in management science. It highlights the growing connection between scientific research and business practice, emphasizing that modern management still requires strict adherence to methodological rigor in the research process.

2. Developments in management science

Management science emerged in its original form at the end of the 19th century. It is associated with the classical school of management, namely the American engineer F. Taylor. Management in classical terms was called industrial direction. The industrial approach assumed that man was merely an accessory to machines and equipment. Contributions to the management sciences at this time were mainly made by Le Chatelier, H. Gantt, H. Emerson, the marriage of F.B. and L.M. Gilbreth and K. Adamiecki. The main areas of activity of the above-mentioned people included, above all, the issue of increasing labour productivity. Among others, the following methods were developed:

- A 'time and motion study' method to measure and standardise work.
- A cyclogram method to film a worker's working movements in order to better match machines and equipment to the worker.
- Organised activity cycle stages method - aims to identify those activities through which employee performance is increased.
- The scheduling method allowed a comparison between the planned and actual workflow.

We can call these methods management by hierarchy.

Initially, management methods (19th century) were only applied by experts through their own tools of analysis and action when specific problems or phenomena occurred at all levels of the organisation. The myth of a machine dominated all other activities continued to be present. As a result, organisations sought to function as 'mega-machines' in which humans are just one of the wheels of the mechanism (Chauvet, 1997).

The next stage in the development of management methods is the taking of an administrative direction and the inclusion of bureaucracy theory (1920s). This was followed by the approach of the behavioural school in management (1940s), which focused, among other things, on the aspect of motivating employees. It emphasised the human aspect as a more important element than the material factor (machinery and equipment). During this period, management methods and techniques such as:

- methods of work enrichment,
- motivation methods and techniques based on needs classification,
- management methods by delegation,
- methods using autonomous groups.

Management methods based on operational research were also emerging, and mathematical decision-making methods were the result.

Another element of the development of methods about management is the 1960s-70s, when a radical change took place and organisations discovered the benefits and power of participatory methods.

In the 1980s-90s, many interesting methods and techniques were provided by the academic field of strategic management, resulting in methods such as:

- portfolio methods,
- scenario methods.

Modern companies need to be able to adapt flexibly to an economy marked by uncertainty and continuous dynamic changes (Zieniewicz, 2007). Several key concepts related to management in the global economy can be identified, including (Nogalski, Rutka, 2007):

- sustainability and sustainable enterprise,
- responsible business partnerships,
- flexibility and adaptability in organizational behavior and structures,
- intellectual capital and knowledge,
- entrepreneurship.

In today's business management, the focus should be on not only improving productivity but also increasing the overall value of the enterprise (Gerring, 2017; Mooi et al., 2018). Enhancing an enterprise's value largely depends on its ability to collaborate sustainably with its environment and implement flexible changes in its organizational culture, supported by IT technology. The use of IT enables companies to maintain sustainability while swiftly adapting to environmental changes and various internal processes (Dźwigoł, 2018).

The ongoing changes in the business environment call for the creation of new rules, principles, and management systems (O'Leary, Hunt, 2016; Petrova, 2018). The complexity of modern organizations and their external relationships requires employees to have advanced organizational knowledge and multidisciplinary skills. In this context, both the survival and growth of an enterprise depend on (Nogalski, Rutka, 2007):

- the ability to anticipate and stay ahead of change,
- focusing on core operational processes,
- adapting current management methods to new implementation conditions,
- effectively managing ongoing and implemented changes,
- fostering positive employee attitudes and behaviors,
- concentrating on building efficient processes.

As a result, management science in the 21st century has adopted a new paradigm centered on the ability to manage constant change. Change is now recognized as the only consistent process in the modern economic landscape (Sloan, Quan-Haase, 2017; Singleton, Straits, 2017). This new paradigm emphasizes (Nogalski, Rutka, 2007):

- teamwork,
- continuous learning,
- project implementation based on prior experience,
- effective communication,
- integration and cooperation,

- partnerships with customers and suppliers,
- agility and innovation.

Building the enterprise of the future based on the management science paradigm in the 21st century therefore requires, among other things (Malara, 2006):

- restructuring of the governance structure,
- restructuring the rules on information gathering,
- more efficient use of resources.

In modern companies, moreover, the organisational structure is changing, moving away from bureaucratic and hierarchical forms and the business processes themselves are taking place in so-called inter-organisational networks. Of particular importance in this context are concepts which build so-called intelligent organisations, virtual organisations, organic organisations (e.g. with a network or cluster structure), relational organisations (Czakoń, 2007). In order to build an organisation based on the above concepts, it is necessary to develop the organisation's resource of knowledge. The correct management of knowledge will therefore determine the achievement of a competitive advantage (Dźwigoł, 2018).

3. New trends in management and research methodology

In the literature, there are additional claims pointing to the weak methodological foundation of management sciences, along with the emphasis on the need for skillful acquisition of knowledge, methods, and techniques from other scientific disciplines (Krzyżanowski, 1999). It is also argued that it is not necessary to create and develop methods exclusive to management sciences, but rather to pursue a transdisciplinary integration of sciences, avoiding excessive specialization (Dźwigoł, 2018).

However, the assertion that the methodological state of management sciences is weak is somewhat overstated. It should be acknowledged that management science employs both methods unique to the field and those borrowed from other disciplines. Borrowed methods are typically used to study organization and management, while proprietary methods are designed to shape the organization and its management system. Examples of methods used in the study of organization and management include:

- survey methods (derived from sociology),
- observational methods (from natural sciences),
- ethnological methods (from anthropology),
- para-experimental methods (from natural and social sciences),
- documentary methods (from social and historical sciences).

The application of management methods and the classification of management as a scientific discipline are frequently subject to critical scrutiny. This is often due to the rapid emergence and application of new management methods, which are sometimes adopted as trends or marketed as concepts, with their effectiveness often questioned by researchers.

In contemporary management, there is an increasing focus on the quality of the thinking process, as it directly influences the accuracy and quality of decisions made. The difference between contemporary and traditional approaches is substantial. The traditional approach to management, particularly in research, revolves around answering questions such as:

- Which elements of the organization or process are not functioning properly?
- Which elements are considered inadequate?
- What are the causes of these issues?

This traditional approach does not always yield satisfactory results and may not necessarily lead to improvements. In contrast, the contemporary approach seeks to expand knowledge of problem situations through the development of new rules, procedures, and tools (Ares, Varela, 2018a, 2018b). For example, the Positive Organizational Scholarship (POS) perspective can be applied. Using POS, one would start by asking, "Why are some employees ineffective?" and follow up with questions such as:

- Why is this happening?
- What are the underlying causes of this issue?

The application of POS leads to insights on what actions need to be taken to achieve the desired outcomes, such as improving performance and striving for excellence.

In modern management science, methodological fundamentalism, which rigidly defined scientific methods according to neopositivist models from the natural sciences, has been largely abandoned (Hempoliński, 1992). The literature frequently stresses the need to use a wide range of methods concurrently to both understand and shape organizations (Dźwigół, 2018).

4. Science and practice

There is a strong connection between science and practice, as scientific research is frequently driven by real-world problems or phenomena. This connection highlights the interaction between scientific inquiry and practical human activity, where research can be categorized into:

- theoretical (basic) sciences,
- practical (applied, developmental) sciences.

The primary goal of management science is to support the practical aspects of economic and social life by (Lichtarski, 2007):

- offering models for effective organizational and management solutions,
- providing methods for implementing these models.

As research becomes more integrated with business practice (Kozłmiński, 2000), it is crucial that management research addresses both theoretical and practical perspectives. Although management sciences are typically considered applied or practical, theoretical research remains essential for the growth of any scientific discipline (Kuciński, 2009). Additionally, the relationship between management science and business practice is both reciprocal and complex (Gabara, 1989). For this reason, management sciences can be seen as the "medicine of organizations," addressing the "health and diseases of organizations" while simultaneously focusing on "the art of prevention and treatment" (Kozłmiński, 2000; Zimniewicz, 2005).

Management sciences have evolved alongside the economy, adapting to its changes and complexity. The discipline emerged as a practical response to economic and social needs, and as these conditions grow increasingly complex, the necessity for practical scientific approaches becomes more pronounced. Consequently, management science is often crucial for driving competitiveness in the modern business landscape (Dźwigoł, 2018).

However, one of the primary challenges of management science is the transient nature of its conclusions. This instability stems from several factors (Jokiel, 2006):

- the variables studied are subject to change over time due to various factors, such as legal, environmental, and social conditions,
- the research subjects (e.g., companies) are diverse and complex,
- qualitative factors, which are difficult to measure, must be considered,
- the methods used are evaluated differently by theoreticians and practitioners depending on historical context,
- challenges with verifying research results,
- the normative character of management science,
- claims are often only verified when research findings are applied in practice.

Despite these challenges, the collaboration between science and practice must remain strategic for effective management in 21st-century enterprises. Several aspects of the relationship between science and practice can be identified:

- Theory and practice are inseparable. "Theory fundamentally arises from practical needs. Practice raises questions for theory, and theory in turn requires practice to implement its findings" (Pytkowski, 1981).
- There is a fundamental mismatch between the goals of science and practice. Science seeks objective truths, while practice prioritizes effective algorithms and solutions for problem-solving (Mazur, 1970).
- When companies present low-impact problems to the scientific community, it can dilute the scientific inquiry, reducing the credibility and authority of the proposed solutions.

- A significant delay often occurs between identifying a problem, analyzing it, finding a solution, and implementing it, which affects both the effectiveness and evaluability of the solution.
- The concepts and solutions developed in management science are not universally applicable; research results often apply only to specific cases.

5. Methodological approach

Methodological evaluation of research can be conducted across three dimensions (Shrivastava, 1987): a) Conceptual adequacy, which ensures that the study is appropriately embedded within the relevant theoretical framework for the discipline. This involves confirming that the correct knowledge is applied to define the research problems and that suitable methods are chosen to address them. b) Methodological rigour, relating to the research design and method, which evaluates whether the research process achieves the intended outcomes. c) Empirical validation, which assesses whether the collected data confirms and supports the proposed solutions, descriptions, and relationships between concepts.

In economic sciences, there is often tension between the rigour of research—understood as the formal strictness of models and assumptions—and its relevance to the audience (Blaug, 2009). Based on this, three types of theories can be distinguished:

1. Highly rigorous,
2. Moderately rigorous,
3. Low in rigour.

Highly rigorous theories, such as general equilibrium theory, rely on a few fundamental laws expressed through mathematical equations, enabling the explanation of various economic laws and deviations. However, their weakness lies in their detachment from reality, as they lack empirical evidence and are not aligned with real-world economic practices (Blaug, 2009).

Moderately rigorous theories, exemplified by game theory, use mathematical models to simulate interactions between multiple players in decision-making scenarios. Yet, in practice, people rarely engage in the kind of complex thinking predicted by game theory, leading to deviations from theoretical predictions (Blaug, 2009).

Low-rigour theories, though less formally structured, are still used in management sciences to make decisions or explain phenomena. Therefore, the absence of rigour does not necessarily reduce the relevance of a theory in management research (Czakoń, 2016).

Quantitative research seeks to test hypothesized relationships between variables. Three areas are key in evaluating the methodological rigour of such research:

1. Theories related to phenomena.
2. Measures that explain these phenomena.
3. The reality being analyzed.

This allows the development of models of social processes, incorporating theoretical causal relationships, operational measures to evaluate variable relationships, and theories describing these relationships (Boyd et al., 2005). Methodological rigour applies individually to each area and to the coherence between them. Consistency defines the logic of hypothesis testing, while reliability refers to the ability of the research to produce comparable results (Czakon, 2016).

Intrinsic relevance focuses on establishing causal relationships, which applies to studies analyzing the causes of phenomena. Causality involves three requirements (Scandura, Williams, 2000):

- Covariance in the statistical relationships.
- Temporal sequencing to prove that cause precedes effect.
- Rejection of alternative explanations.

Construct validity refers to how well an operationalization measures the intended concept (Cook & Campbell, 1979). Complex issues require a construct to describe the phenomenon, although direct observation of constructs is rare. Therefore, to test theoretical propositions, it is necessary to use measures that allow for quantitative description of constructs, known as operationalization (Czakon, 2016). A rigorous approach to constructs requires that the measures assess all relevant characteristics. The most effective way to assess construct validity is through the multi-trait multi-method (MTMM) matrix (Campbell, Fiske, 1959). There are at least ten different procedures for MTMM analysis, sometimes leading to conflicting results (Bagozzi et al., 1991). Currently, factor analysis is preferred for its ability to determine overall fit, discriminant and convergent validity, and clarify variance (Czakon, 2016).

External validity refers to the generalizability of results across time, space, and participants. It evaluates whether relationships between variables observed in one setting can be applied elsewhere. External validity highlights the background variables that influence empirical findings (Calder et al., 1982) and provides insights for management researchers and practitioners on the likelihood of obtaining similar results in other contexts (Lynch, 1999). Though external validity is rarely discussed in management science methodology, it is crucial for the practical applicability of research findings. However, the generalizability of results depends not only on external validity but also on the combined influence of relevance and reliability (Czakon, 2016).

Reliability pertains to the reproducibility of results, focusing on the accuracy of data before hypotheses are tested. Various types of reliability are mentioned in the literature, based on factors like time, research subjects, and the tools used (Czakon, 2016). The demand for reproducibility drives the need for reliable tests, which also raises costs and introduces risks that can undermine reproducibility. The most widely used tool for assessing reliability is Cronbach's alpha (Cronbach, 1951).

Interpretive research, evaluated by its adherence to methodological standards, is based on four assumptions (Corbin, Strauss, 1990):

- Data collection and analysis are interdependent processes.
- The core unit of analysis is the concept, not the data itself.
- Concepts are categorized and interrelated, forming a comprehensive picture of the phenomenon.
- The research process is guided by theory, focusing on specific individuals in specific contexts.

Despite the distinct criteria of qualitative research, there is a tendency in management sciences to adopt criteria from quantitative approaches. Relevance is considered in two ways (Leitch et al., 2010): as an outcome and as a process. Relevance as an outcome focuses on the narrative, including aspects like description, interpretation, theory, generalizability, and evaluation (Maxwell, 1992). Relevance as a process refers to validating research procedures, emphasizing ethics, researcher quality, and substantive content (Leitch et al., 2010).

6. Grading of scientific problems

The priority of the researcher according to K. Popper (Niemczyk, 2016), also in management science, should be the search for new knowledge. In turn, other researchers are associated with its falsification (Niemczyk, 2016).

Management science is a relatively young scientific discipline. For this reason, according to J. Niemczyk (2016), one can risk the observation that in principle the level of mature theory has not yet been reached. The relationship of management with the social sciences (including the humanities) or the mathematical sciences is still questionable - this poses a problem with defining problems in the management sciences and, in particular, with adopting a particular research perspective. This feature, from the researcher's point of view, of the management sciences is not necessarily a weakness. It can also represent an opportunity to make discoveries on the scale of important systematisations, a chance to build coherent and holistic paradigms, or an opportunity to remove inconsistencies at the level of local and strongly contextual laws (Niemczyk, 2016).

The research problem, in the management sciences, may be located in the area of ontology, epistemology, methodology or axiology specific for each of the fields or scientific disciplines included in the Polish classification. Research in the area of ontology of science is typical basic research, which is not easy to enclose in an inductive-hypothetical system. They are extremely difficult, however, they may have a very real and wide impact on the development of a scientific discipline or field. Epistemology, on the other hand, is the part of knowledge that makes it possible not only to name, but also, to a large extent, to understand the world - research in this

area is primarily basic research. It should be noted that from the level of epistemology it is much closer to management practice than from the level of ontology. Methodology is classical foundational knowledge, which is a specific area of knowledge. The management sciences use a variety of scientific methods, however, they still lack methods specific to it - perhaps in many cases this aspect raises the question of the identity of these sciences. Axiology, on the other hand, defines solutions not only for all specific sciences, but also as a component of each specific science. The dilemma related to the notion of value (Niemczyk, 2016) becomes important. According to W. Tatarkiewicz (Niemczyk, 2016), the notion of value is defined in different ways and for this reason frequent misunderstandings arise both among philosophers and representatives of the sciences applying the term. The concept of value can be seen as (Niemczyk, 2016): axiological subjectivism (things do not have value by themselves, it is people who give them value), axiological relativism (things have value, but not by themselves, only in relation to other things or entities), axiological variability (value is both subjectively relative and changeable), axiological scepticism (values that are an expression of desires or needs are nothing certain) (Niemczyk, 2016).

It is worth considering locating, or looking for, a problem from the level of detailed management sub-disciplines. From this perspective, one has a so-called cube to choose from, which includes at the strategic level: strategic management and entrepreneurship, at the operational level: knowledge and information management, process management, quality management, management decision support, organisational behaviour and innovation management, at the functional level: logistics management, human resource management, production and technology management, marketing management, corporate financial management and service management and intangible asset management (Cyfert et al., 2014). According to J. Niemczyk (2016), this cube can be treated as a morphological one, which increases the possibilities for creating new directions in management science. Another way of searching for research problems may be to build new knowledge in management by locating its general framework in the theory of management science and using it to explain problems at the level of management sub-disciplines. The opposite direction is also possible, i.e. specific knowledge from a sub-discipline can be used to introduce generalisations appropriate to the management sciences as a whole. A way to build knowledge in this convention is to transfer solutions between the subdisciplines of management science, or to create new subdisciplines in the form of separate sets (Niemczyk, 2016).

The full structure of the sciences should also be considered. In this arrangement, any sub-discipline of the management sciences can be placed at the lowest level, above them the management sciences above the management sciences, and above them the economic sciences (management with economics, finance and commodity studies are part of them). In turn, the economic sciences are part of the social sciences, and above them are placed solutions specific to the philosophy of sciences. In this form, it is possible to try to verify the appropriateness of specific solutions to build general knowledge, or, based on general

knowledge, to build solutions to problems arising in specific disciplines. An example would be any scientific problem referring to praxeological anatomies of efficient action, i.e. specialisation or diversification, efficiency or economy, resource reserves or work without reserves, etc. Given a change of perspective, one will obtain a variety of ways of transforming knowledge from the general level to the level of, for example, a sub-discipline (Niemczyk, 2016).

Due to methodological rigour, variants of knowledge construction at the interface of different sciences and areas are possible, hypothetically also new, formally hitherto non-existent areas of scientific knowledge. In summary, the presented ways of identifying scientific problems by locating them in different scientific structures can also prove effective in the precise identification of reference points (Niemczyk, 2016).

The scientific process requires, firstly, the finding or search for a scientific problem, secondly, the creation of a solution to that problem and its scientific justification. According to T.S. Kuhn (1968), the history of sciences is a history of accidental discoveries and expanding knowledge, not a constant accumulation of knowledge made possible by precise data and increasingly extensive theories. According to K. Popper (1977) the progress of science does not come from the fact that more and more perceptual experiences are accumulated over time (Dźwigoł, 2018).

An identified research gap can be a source of scientific problems. Its filling is a motivator to undertake scientific research work. It should be emphasised that most science methodologists focus on defining the research method in such a way that a priori it guarantees the reliability of the solution (Niemczyk, 2016). Finding a research problem from the perspective of the researcher or the potential impact on the development of science is not a simple task. The whole work of a scientist boils down to the search for certainty as to the credibility of a given research problem (for this purpose one can use such activities as: inventory of knowledge available in scientific publications, participation in conferences, etc.) (Stańczyk-Hugiet, 2014). The result of the above activities is the formulation of a research question and, if possible, also a research hypothesis in the form of a conjecture - this is the phase of the researcher's work that provides an opportunity to undertake appropriate research to justify the hypothesis or research question posed. The question for the researcher is whether to accept the principle that one should always formulate a hypothesis, or whether to look for a form of evidence for the questions or hypotheses posed. As a rule, as a result of a review of the literature or management practice, the formulation of hypotheses does not meet the requirement of credibility (for this reason, they are often trivial, safe and formulated in such a way as to favour evidence carried out by quantitative methods). Thus, it is useful to formulate research questions particularly for questions that address open-ended problems, exploring completely new areas or building new theories (Niemczyk, 2016).

The phenomenological approach, on the other hand, describes reality without assumptions (as it is) and the research problem is constructed in a different way than in the method of questioning theories - abstracting from conventions, theories, paradigms. The advantages of this approach are the discovery of a completely new phenomenon, relationship or event. It is possible to see what might be missed when looking through the prism of a rigid set of ontological and often even methodological assumptions (Niemczyk, 2016).

According to J. Niemczyk (2016) among the detailed methods of finding management-specific problems will be the methods of heuristic thinking (Delphi method, cross tables, brainstorming, etc.). The researcher's intuition should also not be overlooked as a good source of research problems.

In management, compared to other sciences, outstanding discoveries are hard to come by. However, this does not mean finding solutions to trivial problems. What is important is that the problems are:

- 1) new, with a global dimension,
- 2) resulting in a significantly important impact on the development of both the practice and theory of the discipline of management science,
- 3) difficult and even fraught with the risk of failure,
- 4) scientific (Niemczyk, 2016).

Novel problems absolutely provide new knowledge that fills a significant research gap. They can include: problems interpreted as novel in the context of the novelty of the research, new approaches in the different phases of the problem-solving process, the use of new problem-solving methods, or new research procedures. As M. Kostera states, "if the interests of researchers are only aligned with existing ways of scientific cognition, they may become one of the main obstacles to the acquisition and expansion of knowledge" (Kostera, 1996).

Citations can also be unreliable due to the fact that journals are often subject to a market game of supply and demand (Niemczyk, 2016). It should be borne in mind that the more applications a researcher's solution finds, in learning about, understanding and explaining the objects of interest of a particular subdiscipline of management science, management science itself, economic sciences and social sciences, the greater the impact it will have on the development of science (Niemczyk, 2016).

It is worth citing here the determinants of D.C. Feldman (2004) regarding well-developed scientific papers that are directed at enriching scientific theory in management. These include (Feldman, 2004):

- the non-trivial scope of the research question,
- a literature review covering the most relevant publications and including citations from scientific articles over the last 5 years,
- maintaining a balance in the research between redundancy and exclusivity of the variables analysed,
- precise and concise definition of the relevant paper constructs,

- the unambiguous nature of both the dependent and independent variables and the consistency of the hypotheses presented, etc.,
- locating research in a specific research perspective,
- visible definition of boundaries in the research argument carried out,
- clear presentation what you want to present in the theory you are building,
- discovering new knowledge, pointing out new directions or new insights into existing solutions,
- relating the theoretical proposals put forward in the paper to the real world (possibility of empirical testing) (Dźwigoł, 2018).

7. Conclusion and future research prospects

Upon analyzing the above findings, it is evident that management science, along with its associated methods, plays a crucial role in supporting business practices. It should guide managers and supervisors by offering normative frameworks that facilitate effective and efficient organizational operations. Management science must be viewed as a normative discipline, aiming to develop rules that enhance the functionality of enterprises. The research outcomes from management science should, therefore, find direct practical application. Failing to meet this expectation could result in the discipline being criticized as lacking practical value and being regarded as inferior (Nogalski, Rutka, 2007).

The literature also emphasizes the importance of employing multiple, mutually verifying methods within management research (Denzin, 1970). This highlights the phenomenon of methodological pluralism, which assumes that solving complex research problems requires using a combination of methods from different disciplines and theoretical perspectives. As Krzyżanowski (1999) noted, this approach acknowledges the diverse ways of understanding the world and the corresponding diversity of methods and techniques available to researchers. However, this approach can sometimes lead to methodological anarchy or eclecticism, which undermines the coherence and reliability of the research. To counter these risks, researchers must carefully analyze the problem at hand and select methods that ensure methodological rigor while avoiding unnecessary complexity or inconsistency.

Considering the critical assessment of management science theory, we can observe an ongoing tension between methodological rigor and practical relevance. Achieving high levels of rigor, particularly through mathematical modeling, presents challenges such as the rationality of decision-makers, the difficulty of aggregating individual preferences into collective decisions, and the complexities of profit maximization. These issues suggest that management science has two distinct audiences: researchers who prioritize rigor and theoretical precision, and business practitioners who value the practical usefulness of the research.

For managers, the utility of research results is often more important than the degree of rigor involved in producing them (Krzyżanowski, 1999).

Given these challenges, there are several promising avenues for future research in management science. Firstly, research should explore the balance between rigor and practical application, particularly examining how research findings can maintain both high methodological standards and relevance to practitioners. Developing frameworks that bridge the gap between theory and practice would enhance the impact of management research.

Secondly, there is a need to investigate more deeply the phenomenon of methodological pluralism in management research. Future studies could focus on determining the optimal mix of methods from various disciplines, ensuring that the use of diverse techniques leads to comprehensive and reliable insights without falling into methodological eclecticism. Additionally, further exploration of how to standardize the selection of appropriate methods for specific research problems is crucial.

Thirdly, the impact of digitalization and emerging technologies on management science opens new fields of study. Future research can focus on how technological advancements, such as artificial intelligence, big data, and machine learning, can be integrated into management science methodologies to enhance both rigor and applicability. The incorporation of technology in management research could provide new opportunities for data collection, analysis, and predictive modeling, offering more precise and actionable insights.

Lastly, addressing the evolving needs of businesses in a rapidly changing global environment should remain a key focus. This includes expanding research on sustainability, ethics, and social responsibility in management practices. Understanding how businesses can adapt to these new demands while maintaining competitiveness offers rich ground for further inquiry.

In conclusion, while methodological rigor remains essential for producing credible research, it must be balanced with practical relevance to ensure that management science continues to provide valuable insights for both scholars and practitioners. Future research should aim to refine the methods and frameworks used in management science, ensuring their continued relevance in addressing the challenges faced by modern organizations.

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THE IMPORTANCE OF EMOTIONAL INTELLIGENCE IN THE PROFESSIONAL WORK OF A CONTEMPORARY MANAGER

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Purpose: Analysis and evaluation of the importance of emotional intelligence with special attention to its role in the professional work of a modern manager.

Design/methodology/approach: This study is a review and attempts to answer the question: what competencies of managers in Polish companies are desired today and do they also include those in the area of emotional intelligence? The author's thesis is that competences in the area of emotional intelligence are key competences of contemporary managers managing in conditions of uncertainty.

Findings: The analysis of the literature on the subject and the results of the report research indicate that the Decalogue of desirable competencies of modern managers is definitely changing. It is indisputable that substantive preparation, including hard competencies, intelligence and creativity, are essential for managerial positions, but soft skills such as empathy, composure, forbearance or the ability to cooperate in an enterprise, classified as emotional intelligence, are gaining key importance. Taking into account the uncertainty of events in the external environment of Polish enterprises, managers who possess highly developed emotional competences, such as self-awareness, stable self-esteem or composure, are now needed. The above is a prerequisite for meeting the challenges posed to managers by the contemporary business environment.

Research limitations/implications: The paper points out the competences of managers, particularly desirable in the current business environment, characterised by uncertainty. The paper highlights key competencies for times of crisis and a set of leader characteristics, with particular emphasis on the role of competencies in the area of emotional intelligence.

Practical implications: the author cites the results of a study of managers that demonstrates the need to take measures to offset deficits in emotional intelligence. As a basis for this, she points to the need to understand emotional processes in other people, the mechanisms of self-motivation, and the impact and influence of emotions on employees. Developing emotional intelligence is a process that requires conscious effort and practice. A manager wishing to broaden his or her skills in this area can benefit from a variety of strategies, exercises and activities. Trainings, workshops, team coaching or support groups that build community, enable people to learn from each other and share experiences will be helpful.

Originality/value: New and difficult challenges make it necessary to strengthen the mental resilience of managers and their knowledge of themselves and their emotions as necessary to analyse their own needs and strengthen adaptability. This means working on managing emotions and coping with stress. By developing competences in the area of emotional intelligence, such as self-awareness, a stable sense of self-esteem or self-control, it is possible to meet the challenges managers face in today's business environment.

Keywords: emotional intelligence, manager, professional work.

Category of the paper: The paper is a review.

1. Introduction

Successful managerial performance is not only related to factual knowledge, experience or hard skills. Nowadays, so-called soft skills, including understanding one's emotions, awareness of one's own capabilities, empathy and relationship management, are increasingly important in achieving success in companies. This set of skills is part of emotional intelligence.

D. Goleman takes the view that the professional success of a manager is influenced as much as 80% by emotional intelligence and only 20% by general intelligence. Studies and observations of the behaviour of business people show that only about 40-45% of professional success is due to knowledge and good subject matter preparation and general intelligence. In the remaining cases, it is work on oneself and diligence that are decisive, as well as a warm, calm character, i.e. personality, and in it the group of traits called emotional intelligence turned out to be the most important. Hence, it seems reasonable to conclude that emotional intelligence plays a key role in creating professional success.

A manager's emotional intelligence is a key element that influences employees' sense of satisfaction within a company. It is not only a set of skills, but also the ability to consciously use emotions in the management process, which has an impact on the work atmosphere, the commitment of the team and the overall wellbeing of employees. A manager with developed emotional intelligence is able to identify and control his or her feelings, which influences a calm and balanced approach to problems. Such a manager's attitude creates an atmosphere of safety in the team, which in turn contributes to lowering stress levels and improving employee motivation.

The aim of this paper is to present the importance of emotional intelligence with particular reference to its role in the professional work of a contemporary manager. The author's thesis is that competences in the area of emotional intelligence are key competences of contemporary managers, managing in conditions of uncertainty.

2. The concept and essence of emotional intelligence

The literature on the subject presents many definitions of emotional intelligence, but the most popular one is by D. Goleman, who refers emotional intelligence to a person's ability to recognise his or her own feelings and the feelings of others, the ability to motivate

and manage emotions, both his or her own and those of people with whom we have some kind of relationship.

Over the years, emotional intelligence has become the object of research by many authors, resulting in a number of definitions of the term in the literature. An explanation of the meaning according to selected authors is presented in Table 1.

Table 1.
Selected definitions of emotional intelligence

Author(s)	Title of publication	The concept of emotional intelligence
P. Salovey, D.J. Sluyter	<i>Rozwój emocjonalny a inteligencja emocjonalna: problemy edukacyjne.</i>	The ability to perceive, evaluate and express emotions appropriately, the ability to access feelings, the ability to generate them at times when they can support thinking, the ability to understand emotions and understand emotional knowledge, and the ability to regulate emotions so as to support emotional and intellectual development. The ability to keep track of others' as well as one's own feelings and emotions, to distinguish between them and to use this kind of information in guiding one's own thinking and actions.
A. Szczepaniak, K. Jabłkowska	<i>Historia rozwoju pojęcia inteligencji emocjonalnej.</i>	A range of non-intellectual capacities, competencies and skills that enable an individual to cope effectively with the demands and pressures of the surrounding environment.
E. Nęcka	<i>Inteligencja. Geneza, Struktura, Funkcje.</i>	A group of abilities to cognitively process information related to emotions or to problems arising from the fact that emotions exist.
C. Ott	<i>What is Emotional Intelligence?</i>	The ability to recognise one's own feelings and management of them, as well as to identify and respond effectively to other people's feelings.

Source: Own work based on: Salovey, Sluyter, 1999, p. 34; Szczepaniak, Jabłkowska, 2007, p. 230; Nęcka, 2005, p.101; Ott. <https://ohio4h.org/sites/...>, 18.09.2024.

With reference to the above definitions, it can be said that emotional intelligence represents a person's set of skills for effective personal, social and professional functioning.

3. Emotional intelligence capacity model

The ability model of emotional intelligence by Mayer and Salovey, is defined as a group of abilities to cognitively process information related to emotions or to problems arising from the fact of their existence. The authors formulated the most complete theory of emotional intelligence in the 1990s, where they presented a four-branch model of emotional intelligence abilities, the characteristics of which are included in Table 2.

Table 2.
Emotional intelligence capacity model

Emotional intelligence			
4. Reflective emotion regulation to support emotional and intellectual development (Emotion management)			
The ability to be open to feelings pleasantly and unpleasantly.	The ability to consciously engage with or disengage from emotions depending on the outcome of an assessment of their informational value or utility.	The ability to consciously track (monitor) emotions in relation to oneself and in relationships with other people (e.g. determining whether and to what extent they are explicit, typical, influential, legitimate).	The ability to control one's own emotions and those of others by moderating negative emotions and enhancing pleasant ones, without suppressing or overestimating the information they may carry.
3. Understanding and analysing emotions; using emotional knowledge			
The ability to name emotions and to understand the relationship between words and emotions as such (e.g. the relationship between , "liking" and , "love").	The ability to interpret the meaning that emotions carry in relation to interpersonal relationships (e.g. sadness often accompanies the loss of a loved one).	The ability to understand complex feelings, such as love combined with hate, or fear combined with surprise.	The ability to anticipate likely changes in emotional states, such as from anger to contentment or from anger to shame.
2. Integrating emotions into thinking processes			
Emotions give higher priority to certain ways of thinking by directing attention to relevant information.	Sufficient "food" and availability of emotions to be generated as an enabler of judgement and memory regarding feelings.	Emotional shifts in mood change an individual's perspective from optimistic to pessimistic, encouraging consideration of many different viewpoints.	Different emotional states affect problem-solving approaches in different ways, e.g. feeling happy promotes inductive reasoning and creativity.
1. Ability to perceive and express emotions			
The ability to identify emotions in one's own body states, feelings and thoughts.	The ability to identify emotions in other people, in art works, etc., through language, sound, appearance and behaviour.	Ability to express emotions accurately and to express emotional needs.	The ability to distinguish between precise and imprecise, sincere and insincere expressions of emotion.

Source: own elaboration based on: Salovey, Sluyter, 1999, pp. 36-37.

The table above shows four branches that represent mental processes ordered by rows: from the most to the least complex process, and by columns: from the most basic abilities to the more advanced ones.

This model represents emotional intelligence as four branches of processes:

Group I - the ability to perceive and express emotions. Human beings have an innate ability to perceive so-called primary emotions. However, perceiving secondary emotions, which are more complex, or distinguishing true, sincere emotions from insincere ones, requires learning new skills, cognitive abilities. As they develop, emotions are recognised more effectively and easily, not only in facial expressions, faces and attitudes, but also in art in the broadest sense, nature or objects of various kinds.

Group II - emotional use of thinking as the ability to understand and control emotions, to use them in cognitive processes, to think productively, to remember or to evaluate phenomena correctly. In short, it concerns the impact of emotions on intelligence.

Group III - a combination of abilities such as analysing and understanding emotions and, as a result, using emotional knowledge. Particularly important here are the abilities to name specific feelings correctly, to be aware of the complexity of certain emotions, emotional states, to be able to link them to specific situations, to determine their cause and to anticipate cause-effect relationships. The ability to identify them, to see the logical sequence in the experience of specific emotions, the relationship between emotional states and situations or their consequences is an extremely useful skill in interpersonal relationships.

Group IV - the conscious regulation of emotions so that they are conducive to emotional and intellectual development. The key skill here is to be open to emotions, whether positive or negative, any emotion can be conducive to development, depending on how it is used. What is important here is the ability to separate, at the right moments, emotion from action. Depending on the situation, surrendering to emotions can be beneficial or not, and it is important to know when to let emotions come to the fore and when it is better for the matter at hand to suppress them. Often, a cold re-analysis of the situation and one's own emotions also brings new conclusions and observations which are important for the further development of an individual's emotional intelligence. Awareness of one's own emotions, moods, the relationship between them and their influence on actions is the basis for consciously influencing other people's emotions, e.g. in motivation processes.

In summary, it can be said that the authors of the concept treat emotional intelligence as a set of personal competences of a person, which have a complementary function to purely intellectual abilities. A person endowed with high emotional intelligence is able to perceive emerging emotions, understand and manage them. He or she is also able to use them to support the thinking process.

4. The importance of emotional intelligence in a manager's career

In the literature, there are numerous confirmations from studies that address the relationship between emotional intelligence and effective human functioning in different areas of life. Some of them show a positive relationship between EI and professional achievement.

This position is shared by D. Goleman, who attributes particular importance to emotional intelligence to people in managerial positions. The author's research shows that the success of a manager's job depends on it. It is therefore a combination of self-awareness, social awareness, self-management and relationship management that has a positive impact on others. Concluding in his research, he identified 12 key competencies that distinguish outstanding leaders,

and managers. These include:

- emotional self-awareness,
- emotional self-control,
- goal-orientation,
- positive world view,
- adaptability,
- empathy,
- organisational awareness,
- ability to influence,
- the role of teacher and mentor,
- conflict management, inspirational leadership,
- teamwork.

The competences included in emotional intelligence are a direct factor for success in many areas of a company's activities, especially in terms of working with people in the broadest sense. Research shows that a high level of emotional intelligence has a significant impact on effectively dealing with all kinds of problems, demands or difficulties that a person encounters in their work.

Currently, a number of phenomena characterised by uncertainty, which came with the pandemic and the war in Ukraine, pose further challenges for managers. These difficult external conditions have a significant impact on companies and the people within them, not only economically and managerially, but also psychologically.

The above prompts the search for an answer to the question: which competences of managers in Polish companies are desired nowadays and do they also include those in the area of emotional intelligence?

An attempt to answer the question posed can begin with an analysis of the opinions of psychology and coaching specialists, which include B. Dyraga, who lists the following as five key competences for times of crisis:

- empathy - as the ability to put oneself in someone else's shoes, empathise and see reality from a different perspective. An empathetic manager is better able to understand the team, to objectively assess an employee's behaviour and actions.
- managing one's own emotions - the most difficult, in the author's opinion, of the five competences of a manager in times of crisis, because it requires solid, process-based work on oneself. This in turn requires that, in order to manage others effectively and responsibly, one must first learn to use one's own resources. One needs to recognise the mechanisms of one's behaviour in a crisis (among the emotions that war has activated, insecurity, anxiety, panic and the need for control come to the fore).
- the ability to talk about emotions in the team - the key here is for the manager not to be afraid of the subject of emotions, to be able to initiate conversations on difficult topics, to allow employees to share their feelings, fears, doubts, and to be able to conduct

an open dialogue in such a way that both parties benefit and are strengthened. The author points out here that organisations that build a mature emotional culture and reckon with the emotions and feelings of the people within it always win in times of crisis and change.

- being flexible and open to change - being able to treat difficulties as challenges rather than problems. You also need to be able to come to terms with a sense of lack of influence, to act from a position of here and now, and to have more trust in people.
- the manager's role as an ambassador for organisational wellbeing - understood as a general state of human wellbeing, encompassing physical, mental and emotional health, as well as life satisfaction and an overall sense of happiness. In today's challenging world, the health and wellbeing of our employees is crucial to the success of any business. Wellbeing in the workplace translates into satisfaction, productivity and overall organisational performance. It is important for a manager to be able to support people in building healthy habits, a positive company atmosphere and positive emotions that motivate others to perform and cooperate. This makes it easier to get through crises.

An analysis of the above list of competences, developed by the cited author, allows us to conclude that emotional intelligence, including a broad understanding of the needs of the human being in the company, and consequently a change in management culture, has gained key importance.

Similar conclusions can be drawn by analysing the results of the 2021 survey of managers in Poland, presented in the House of Skills survey report entitled "Polski menedżer. Praktyki, wyzwania, rozwój". The analysed report shows that what is needed now is a set of qualities of a leader, including competences from the area of emotional intelligence. As an example, composure was mentioned as one of the four most frequently indicated traits - Polish employees expect managers to remain calm, control their emotions and impulses, provide emotional support in stressful situations they constantly face.

In the same report, Polish managers signal that they are aware of the importance of empathy in managing people - they mention it as a component of trust, and at the same time indicate that building trust is the area currently focusing the most attention and energy on how to effectively develop an empathic approach to people in order to reconcile the so-called hard and soft aspects of management: to take care of results and productivity while showing the necessary sensitivity. There are fears of crossing the line beyond which people become less task-oriented, and loose authority as a result. Meanwhile, it turns out that empathy and business effectiveness are complementary, not opposing, areas. This can be seen in the day-to-day, ongoing work of teams, putting the employee at the centre and building their sense of influence and responsibility for results. The starting point is self-awareness of one's own emotions and attitudes, then building a standard of individual, specific managerial practices.

In conclusion, it can be assumed that the Decalogue of desired competences of modern managers is definitely changing. It is indisputable that substantive preparation, including hard competences, intelligence and creativity, are indispensable for managerial positions, but soft skills such as empathy, composure, forbearance or ability to cooperate in an enterprise are gaining in importance. The above may confirm the author's thesis that competencies in the area of emotional intelligence are key competencies of modern managers. Taking into account the uncertainty of events in the external environment of Polish enterprises, managers are currently needed who, in addition to acting efficiently, also possess highly developed emotional competences.

5. Summary

A manager's soft skills are a key component of managing people effectively, and among these, developing emotional intelligence is of particular importance. This is the ability to understand, control and effectively manage emotions - both one's own and when dealing with other people. In relations with employees, emotional intelligence plays a decisive role, as it enables a manager to understand the feelings of employees, which influences the building of lasting and positive relationships. A manager who is aware of his or her emotions is better able to recognise and respond to the signals of employees, which is crucial for effective communication.

Meanwhile, research results in this area are not very satisfactory. The Institute for the Development of Emotions, which conducted a study on emotional intelligence in Poland in 2019, showed, among other things, that:

- As many as 75% of those surveyed admitted that they did not control their nerves while at work.
- The overall results for emotional intelligence show that 53% of those surveyed have EI at a low level, 44% at a medium level and only 3% at a high level (the survey concerned those holding top management positions).
- Only 22% of the respondents have a highly developed ability to perceive emotions (43% medium, 35% low), but only 3% can use them at a high level (22% medium, 75% low). The ability to express emotions at a high level was found in only 8% of respondents (52% medium, 39% low), understanding emotions (34% medium, 66% low). On the other hand, referring to emotion management - none of those surveyed have this skill at a high level (38% medium, 62% low).

Deficits in EI are also confirmed by managers in the House of Skills Survey Report, where, when asked about their development needs, they most often indicate factors related to attitudes and personality, which may be a sign of feeling uncomfortable and less confident about their

perceived challenges. More than 36% of managers indicated the need to strengthen relatively fixed aspects of personality and attitudes, areas that are less susceptible to development (empathy, forbearance, patience, courage, creativity, consistency, decisiveness, etc.). Many managers see the need for change in themselves - people in this group may be at greater risk of stress due to feeling out of their comfort zone and less confident. Further indications are competences related to the managerial role: leading a team, the ability to motivate, building a good team atmosphere (15% in total), and personal and interpersonal competences such as assertiveness, communication skills, dealing with stress - 18% in total. About 12% of managers are unable to indicate what they need, which may be a sign of uncertainty about what is expected of them or difficulty in identifying their own competence gaps. It may also be related to a low capacity for insight, reflection, self-diagnosis.

New and difficult challenges mean that the mental resilience of managers needs to be strengthened. Knowing oneself and one's emotions is essential to analyse one's own needs and strengthen adaptability. This means working on managing emotions and dealing with stress. Coaching, workshops, team coaching or support groups that build community, enabling people to learn from each other and share experiences will help.

Developing emotional intelligence is a process that requires conscious effort and practice. A manager wishing to broaden his or her skills in this area can benefit from a variety of strategies, exercises and activities. The basis for development in this area is an understanding of emotional processes in other people, self-motivation mechanisms, and the impact and influence of emotions on employees. By developing competences in the area of emotional intelligence, such as self-awareness, a stable sense of self-esteem or self-control, it is possible to meet the challenges posed to managers by the modern business environment.

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ORGANISATIONAL RESILIENCE OF STARTUPS IN THE FACE OF CHALLENGES IN THE BUSINESS ENVIRONMENT IN POLAND

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Purpose: The purpose of this article is to explore the concept of organisational resilience, to profile Polish startups and to identify and analyse factors influencing their resilience in the face of changing market conditions, with a particular focus on those that determine their ability to overcome crises; and to draw conclusions on how these young companies can prepare for possible changes and challenges in the environment.

Methodology: The study was conducted using desk research and field research methods, which included a literature review, statistical analysis and a questionnaire interview method.

Findings: the study found that the key factors influencing the resilience of startups are organisational flexibility, rapid decision-making, management commitment and effective risk management. Startups that manifest these characteristics have a greater ability to adapt and survive in the face of crises. Strategies such as optimising costs, developing offerings and attracting diverse sources of funding have also proven to be important.

Research limitations/implications: The study was limited in scope due to the small research sample, limited to six startups, hence the research can be described as a pilot study and the results obtained can serve as hypotheses in future research on a larger sample of respondents using a variety of analytical tools.

Practical implications: Research findings suggest that Polish startups should invest in the development of flexible management structures and risk management strategies, which may increase their chances of survival and growth in a volatile market environment. Applying the research findings may help startups to be better prepared for potential crises.

Social implications: Promoting the organisational resilience of startups can increase the stability of the startup sector in Poland, which can have a positive impact on the economy and create new jobs.

Originality/value: The article brings a new perspective on organisational resilience factors in the context of Polish startups. The paper is addressed to management researchers and practitioners who are interested in the topic of startups, and to startup leaders looking for effective strategies to cope with market challenges.

Keywords: organisational resilience, Polish startups, adaptability in a crisis, startup resilience.

Category of the paper: Research paper, Case study.

1. Introduction

Today's business environment, characterised by dynamic change and unpredictable challenges, requires organisations to be flexible and adaptable. Startups in particular, as young and innovative enterprises, face unique difficulties that may threaten their survival and growth. In the context of these challenges, organisational resilience, understood as the ability of an organisation to survive, adapt and grow in the face of crises, becomes a key issue.

The purpose of this study is to identify and analyse factors influencing the resilience of startups in the face of changing market conditions, with a particular focus on those that determine their ability to overcome crises. A key **research problem** is therefore to identify which factors influence the organisational resilience of startups and which strategies to manage these factors contribute to successfully overcoming crises and business barriers. To explore the topic in more depth, a literature study was made and personal interviews were conducted with respondents on the practices of startups in Poland. Six cases of startups that experienced a crisis were analysed, which provided an opportunity to try to draw conclusions about effective strategies for operating in difficult conditions at the early stages of company development. In addition, the theoretical aspects of resilience based on the literature on the subject were examined and the profile of Polish startups in light of statistical data was shown in order to better understand the topic.

2. The concept of organisational resilience in the literature

The term '**resilience**' was first introduced by C.S. Holling, who presents the viewpoints of 'resilience' and 'stability' in his work 'Resilience and Stability of Ecological Systems' (Holling, 1973). Holling introduces **the concept of resilience** as the ability of an ecosystem to maintain its functions and structure in the face of change, and presents it as an active process associated with response, as well as a feature of change and adaptation. The work has formed **the basis for further research** on ecological resilience, but also on other different forms of resilience.

Communities and organisations are recognised as complex systems (Crichton et al., 2009). These systems are evolutionary, responsive to information and capable of self-organisation. (Andriani, 2003). In order to maintain its functions and stay ahead in an ever-changing environment capable of significant fluctuations, an organisational system must adapt and change. Without such an approach, in the face of difficult situations, guided solely by **a strategy based on return to the original state**, an individual may move into a developmental cycle unfavourable to adaptation. Crisis **resilience approaches**, on the other hand, can help an organisation to adapt to new environments and risks, providing a basis for managing

changing and uncertain environmental factors more effectively. **Adaptation**, in this case, refers to an organisation's response to disruptive and threatening situations, and its ability to restore normal functions. **Developing resilience** creates a dynamic adaptation process that takes into account the non-linear and complex relationships within an organisation's response. K.M. Sutcliffe and T.J. Vogus note that resilience refers to an organisation's ability to recognise threats, adapt to them, develop the ability to bounce back, and successfully restore its functions (Sutcliffe, Vogus, 2003). In effect, organisational resilience is a comprehensive concept, addressing the functioning of an organisation before, during and after an incident.

A universal and relatively comprehensive approach to the resilience category is presented in **ISO 22316:2017** - 'Security and resilience - Organisational resilience - Principles and attributes'. It is noted that the resilience of an organisation is its ability to absorb and adapt in a changing environment. Furthermore, **resilience is a multidimensional category**, influenced by strategic and operational factors.

Organisational resilience:

- a) It intensifies when behaviour is in line with a shared vision and goal,
- b) It is based on an up-to-date understanding of the organisation's context,
- c) It is based on the ability to absorb, adapt and respond effectively to change,
- d) It is based on good governance,
- e) It is supported by diverse skills, leadership, knowledge and experience,
- f) It is strengthened by coordination between management disciplines and input from technical and scientific areas of expertise,
- g) Relies on effective risk management (ISO, 2017).

Organisational resilience is regarded as **one of the fundamental factors** that shapes development and can be related to the measurement of activities in an entity at different levels of management (Tarapata, Woźniak, 2022). A. Zablocka-Kluczka believes that organisational resilience is a certain property that enables an organisation to **survive and develop sustainably**. On the one hand, it builds the organisation's insensitivity and invulnerability to the impact of crisis factors, while on the other hand, it builds the ability to resist the impact of crisis factors (Zablocka-Kluczka, 2012). This definition indicates that the resilience of an organisation can result from two basic attitudes of the owners, managers, lower level employees in the organisation: **a passive** attitude, which consists in avoiding threats and adapting to the changes that have arisen, and **a proactive** attitude, which consists in planned and conscious intervention in the environment to ensure the organisation's proper operating conditions and security (Tarapata, Woźniak, 2022).

M. Majchrzak notes that securing resilience should integrate an organisation's interior, its resources with external environments and **two dimensions - strategic and operational** (Majchrzak, 2020). A similar approach is presented by D. de Moura, P.A. Tomei, R. Martin-Rojas and R.G. Sánchez, who distinguish **four** levels in their model of levels of securing organisational resilience: the environmental dimension, the organisational behaviour

dimension, the individual employee behaviour dimension and the organisational practices dimension (de Moura et al., 2021). Other current approaches to defining organisational resilience are presented in Table 1.

Table 1.
Current approaches to the definition of resilience

Author	Definition
Hillmann, Guenther (2021)	Organisational resilience can be seen as, among other things, the ability to act, the outcome of an action, a process, the behaviour of an organisation and its employees, a strategy or a specific type of performance
Kahn et al. (2018)	Organisational resilience is the ability to absorb stresses and maintain or improve performance despite adversity
Välikangas, Romme (2012)	Organisational resilience is the sum of partial resilience, which has both strategic and operational dimensions
Sun et al. (2011)	Organisational resilience is a process that links an organisation's set of adaptive capabilities to a positive trajectory of entrepreneurial functioning after a crisis, disruption or challenge
Bishop, Hydoski (2010)	Organisational resilience is the ability of an organisation to return to the state it was in before the stressor/threat occurred

Source: own study based on: Tarapata, Woźniak, 2022, p. 12.

Building flexibility and resilience in an organisational structure can take place in different subject dimensions. Table 2 shows examples of the dimensions of ensuring organisational resilience.

Table 2.
Examples of dimensions of ensuring organisational resilience

Author	Dimensions
Kerr (2022)	Operations management, supply chains, information flow, human resources, products, business processes
De Moura, Tomei, Martin - Rojas, Sanchez (2021)	Risk management, vulnerability management, learning capability, change management, forecasting, proactive search for resources, financial management
Ahmed, Kilika, Gakenia (2021)	Positive adaptation and organisational flexibility, risk management, planning and forecasting, organisational crisis management
Wang, Müller, Zhu, Yang (2021)	Business process complexity, risk management, social impact (external stakeholders), collective attentiveness (action awareness)
Goat - Nadolna, Beyer (2021)	Information and decision-making processes, economic factors, organisational factors, social factors, personal factors
Varkoly, Jedrzejczyk, Kucęba, Kulej-Dudek (2019)	Portfolio of business competencies (soft and hard), employee training, decision-making processes, creativity, leadership
Jedrzejczyk (2016)	Managerial behaviour, organisational culture, work organisation, managerial errors

Source: own study based on: Tarapata, Woźniak, 2022, p. 16.

Analysing the dimensions presented, it can be deduced that they relate to both processes and resources and form a relatively complete picture of the factors that determine an organisation's resilience. Each organisation should individually identify **the key dimensions** that influence the development and shaping of its resilience, taking into account, among other things: industry specifics, market dynamics, complexity of business processes or internal

structures, business model, leadership style. The more accurate the identification of dimensions, the easier it will be to define measures of resilience (Tarapata, Woźniak, 2022, p. 15).

Summarising all the aspects discussed, it can be concluded that organisational resilience is **a multifaceted and comprehensive concept** that has a significant impact on the overall state of the business. Therefore, in today's reality, it is crucial to consciously design mechanisms to strengthen this resilience, treating it as an essential 'tool' for ensuring the stability of a given business entity.

3. Profile of Polish startups in light of statistical data

Initially, **the term startup** referred to all market-entry, new business entities, but over time the name has come to refer to a specific group of ventures that are associated with a growing sector of the economy based on communication and information technologies. It is expected that with the development of startups, **innovation** increases and the economy grows at a rapid pace, especially in developed countries.

The Polish Agency for Enterprise Development - **PARP** - defines a **startup in 2024** as "a dynamic, usually young company or project that aims to introduce an innovative product, service or solution to the market, seeking a business model that would ensure its profitable development. It is characterised by a high degree of flexibility and adaptability, often operating under conditions of high uncertainty." The characteristics that, according to PARP, characterise startups are (PARP, 2024a):

- Short operating history (up to 5-10 years).
- Innovation.
- Scalability.
- Higher risk than 'traditional' ventures, but also higher return on investment in case of success.

There are individual approaches to defining a startup **in the national and international literature**. Table 3 provides a summary of the main characteristics of a startup according to different authors.

Table 3.

Key features of a startup according to various authors

Author	Key features of a start-up
Blank (2013)	Temporary organisation looking for a scalable, repeatable and profitable business model. Relentless pursuit of defining a business model, continually testing business hypotheses in practice
McClure (2013)	Entities that are uncertain about who their customer is, what their product is and what their optimal revenue model is - i.e. they take a lot of market risk

Cont. table 3.

Thiel, Masters (2014)	An organisation that creates new solutions
Damodaran (2009)	Organisation with high growth potential at an early stage of development, no history, dependent on sources of capital, low survival rate
Glinka, Piaseczny (2015)	An emerging organisation that is defining and testing its business assumptions
Bursiak (2013)	Organisations in the early stages of development (up to 5 years) using external funding
Wasserman (2012)	An entity that follows a market opportunity regardless of its resources

Source: own study based on: Skala, 2017, p. 36.

When considering the definition of a startup, it is also worth considering **what a startup is not**. Taking into account the definition of S. Blank, it can be deduced that a startup will not be a company that uses a proven business model to reduce the risk of failure to a minimum. A startup will not be a company in a franchise system or any other form of traditional trade. The above conditions necessitate that some form of innovation be implemented that would make the answers to the questions proposed by D. McClure: "what is the product?", "who is the customer?", "how to make money from it?" uncertain and requiring confrontation with the market.

A. Skala (Skala, 2017) proposed **a diagram for the development of a startup**, pointing out the factors that determine its growth (Figure 1).

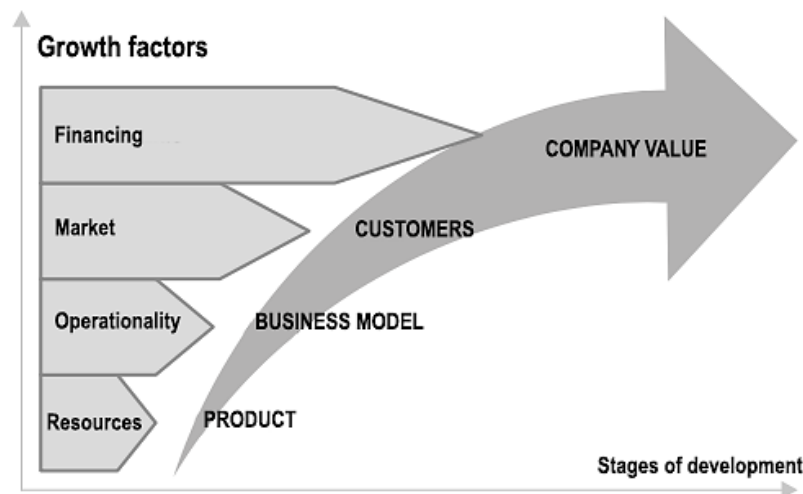


Figure 1: Diagram of a startups development and growth drivers.

Source: Skala, 2017, p. 36.

According to the Failory website, **9 out of 10 newly created startups fail**, 20% of them go out of business within one year and another 50% do not survive more than five years. Lack of funding, the actions of competitors and lack of market demand for the product or service are the most frequently cited reasons for business closure (Kotashev, 2024).

The Startup Poland Foundation has prepared **the report "Polish Startups 2023"**, for which it developed and conducted an online survey using the SurveyLab tool. The research was carried out between 4 July and 4 September 2023 with the participation of 4841 respondents,

the majority of whom are startup founders, with a small share of people employed at startups who are not founders. The selection of respondents was random, with no indication of preferred industries, business scales, sizes by employment, or development phases.

According to the report, the **largest number of startups in Poland have been operating for 3 to 4 years** - as many as 31%, 28% of startups have been operating for 1 to 2 years and 23% of startups have been operating for less than a year. Those operating for longer - over 5 years - are 15%. The remaining 3% are startups operating for more than 10 years (Startup Poland, 2023). The regions with the highest number of registered startups are the Dolnośląskie and Mazowieckie voivodships.

Respondents were also asked what **business model** the young innovative companies operate under, the results of which are shown in Figure 2. One of the most common responses was "B2B entrepreneur", meaning that Polish companies target large companies. The next most common answer was 'B2B small business', meaning that they direct their product or service to small companies. Only in third place was the answer 'Direct to consumer', i.e. (B2C) - a business model aimed directly at the customer. The structure of the Polish startup sector, in terms of preferred business models, has remained unchanged in recent years.

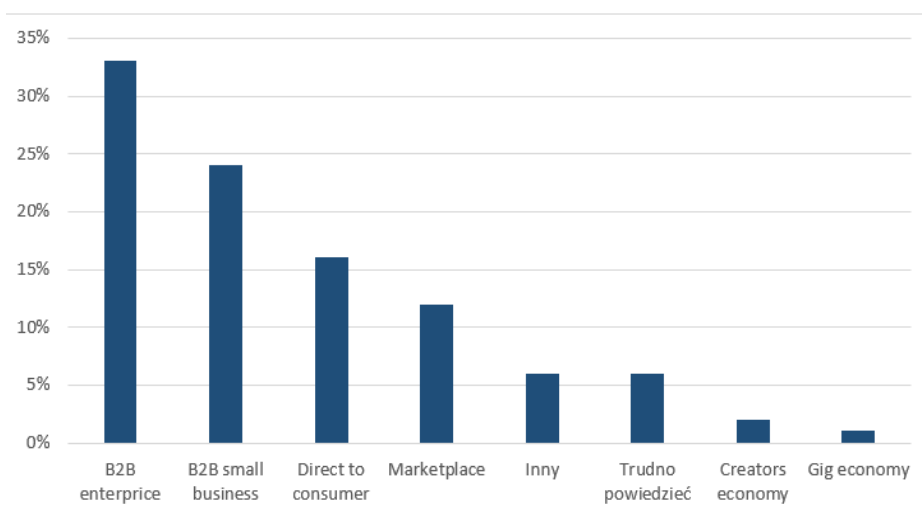


Figure 2. Business models in which Polish startups operate.

Source: own elaboration based on: Startup Poland: Polskie startupy 2023 (2023). Warszawa: Startup Poland, p. 34.

It is a common misconception that **founders** tend to be very young people, while the thought of founding a startup is more common among people over the age of 26. Startups are usually chosen by people with previous work experience, e.g. in corporations, other private companies or who have previously run their own company. The age and previous experience of founders before founding a startup are shown in the graphs in Figure 3 and Figure 4.

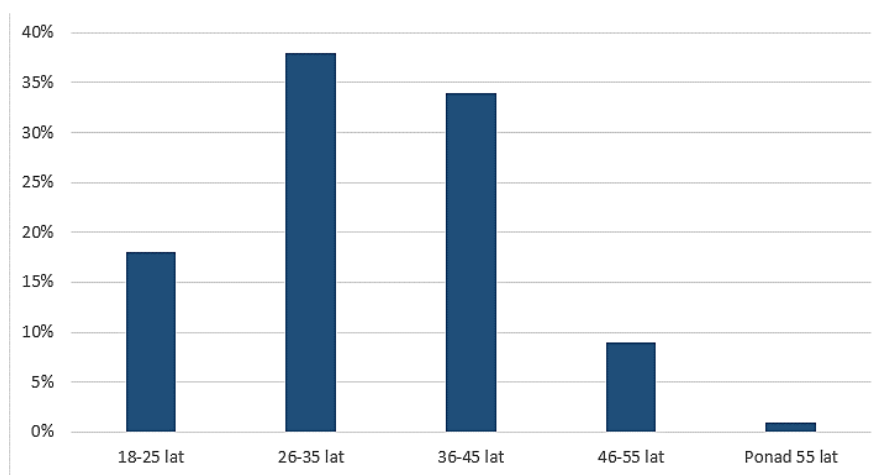


Figure 3. Age of founders at startup founding.

Source: own elaboration based on: Startup Poland: Polskie startupy 2023 (2023). Warszawa: Startup Poland, p. 37.

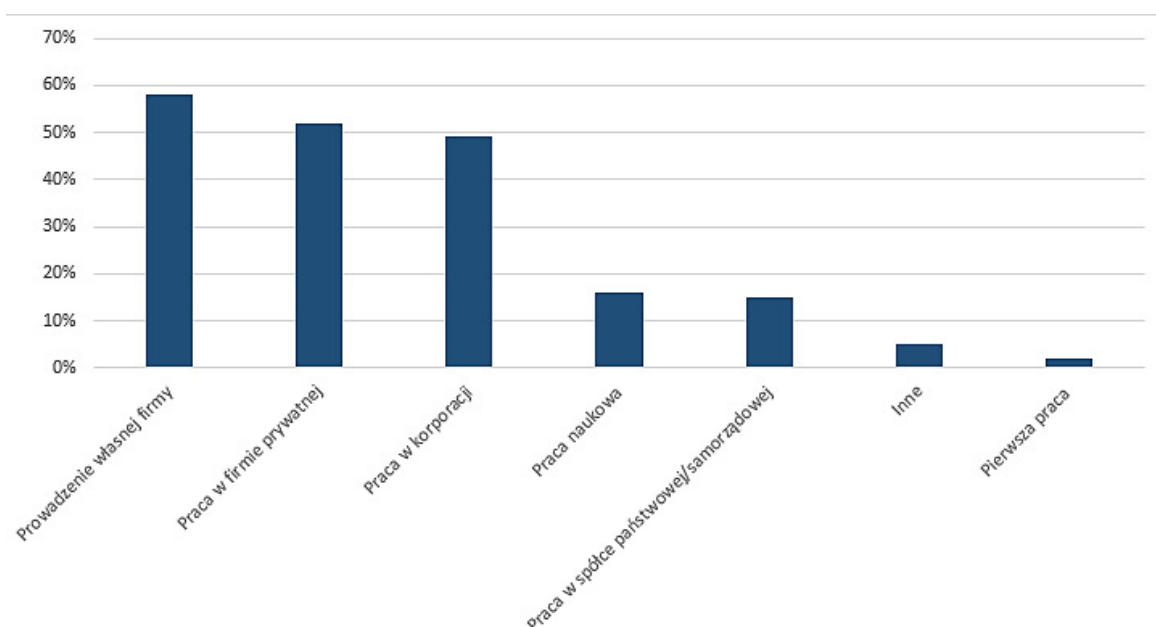


Figure 4. Previous work experience of founders.

Source: own elaboration based on: Startup Poland: Polskie startupy 2023 (2023). Warszawa: Startup Poland, p. 37.

A limited liability company is the most common form of business chosen by Polish startups. As many as 67% of respondents declared this legal status. First of all, a limited liability company is relatively easy to set up and does not require a large share capital. Owners of a limited liability company only risk up to the amount of the share capital contributed, unlike a sole proprietorship (which was chosen by 10% of respondents). This reduction in risk is particularly important for startups that operate in an environment characterised by high unpredictability and risk. With this solution, entrepreneurs can undertake innovative projects without fear of losing their assets if the business fails.

Most Polish startups operate as **small teams**, usually consisting of a few or a dozen people, according to the latest data from the Startup Poland Foundation. More than a third of these companies, 34%, employ between four and 10 employees, and almost one in five (19%) employs three people on a permanent basis.

Analysing **revenue models**, most young companies manage to make money through sales (e.g. products, services). The second popular form that generates revenue is licensing (rights to use a product or technology). In third place is business intermediation (Startup Poland, 2023).

According to the 'Global Entrepreneurship Monitor Poland 2023 Report', government grants, subsidies and programmes proved to be an important **source of funding** for 40% of startups. According to the "Polish Startups 2023" report 23% of startups benefited from NCBR (National Research and Development Centre) funding, 16% from PARP (Polish Agency for Enterprise Development) and 8% from PFR (Polish Development Fund) (PARP, 2024b). However, most startups also use their own funds - 76%. In terms of the amounts that Polish startups have managed to raise in all their attempts to obtain funding, 31% have managed to raise PLN 1-2 million, 19% have managed to raise PLN 2-5 million, while 14% have managed to raise between PLN 500 thousand and PLN 1 million and another 14% over PLN 10 million, as presented in Figure 5.

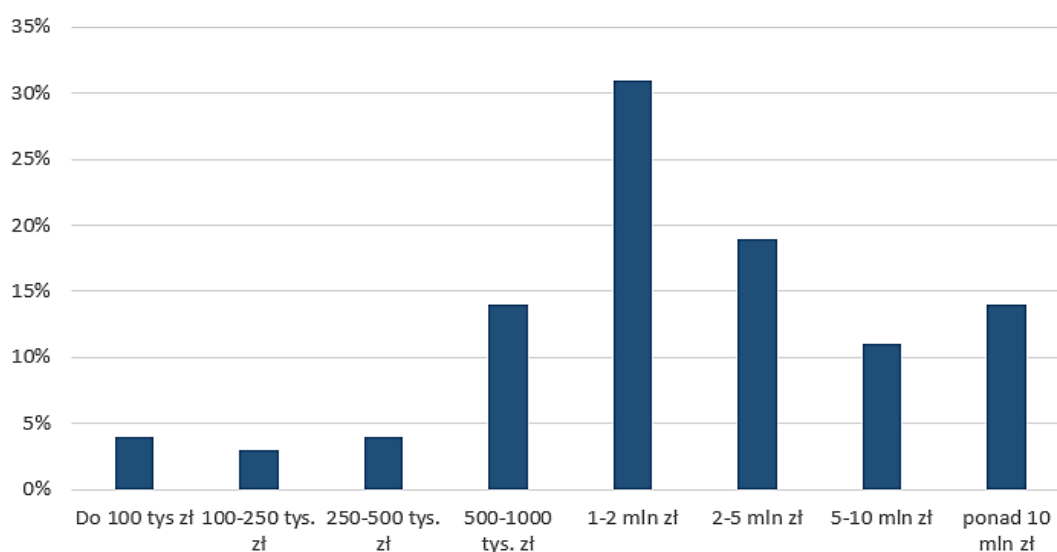


Figure 5. Total funding from all funding attempts.

Source: own elaboration based on: Startup Poland: Polskie startupy 2023 (2023). Fundacja Startup Poland, Warszawa, p. 79.

Key factors for the success of startups, especially self-funded ones, are the creation of products that meet real customer needs and a niche strategy. The product must be targeted at a group that is able to pay for it. An important element that differentiates startups in a competitive market is the focus on a narrow audience, which increases the chances of success. Flexibility, specialisation and rapid validation of the product on the market are key in the startup's development process. These activities allow the offer to be better tailored to customer needs and avoid creating unnecessary products (Ząbek, 2023).

4. Research methodology

The marketing research process proposed by S. Kaczmarczyk is characterised by its universality and can be adapted to different research areas (Kaczmarczyk, 2002). The stages of the research process are shown in Fig. 6.

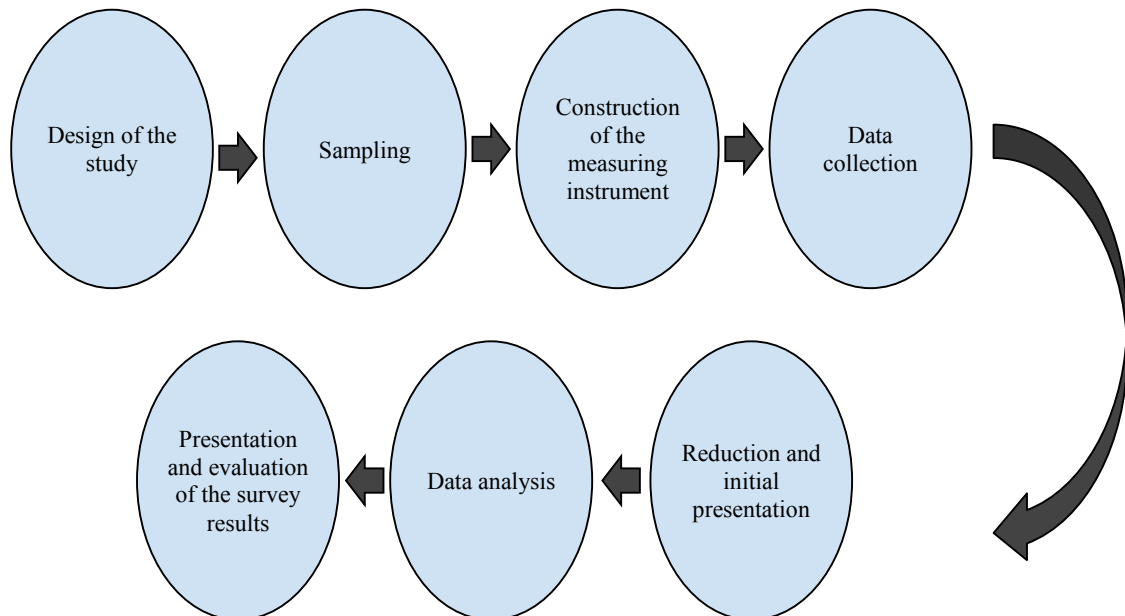


Figure 6. The marketing research process according to S. Kaczmarczyk.

Source: own elaboration based on: Kaczmarczyk, 2002, p .34.

S. Kaczmarczyk proposed and described in detail the methods that could be applied at each stage of the study and what the result should be at each stage. On the basis of the application and adaptation of this methodology, the process of the study course assumed:

- definition of the research problem,
- identification of the study population and the research unit,
- selection of the sample to be tested, choice of measurement forms and construction of the measuring instrument,
- selection of data analysis methods and their analysis,
- evaluation and presentation of data,
- development of research conclusions.

The research problem focuses on two key questions:

1. What factors influence the organisational resilience of startups in the face of changing market conditions?
2. What strategies for managing these factors contribute to successfully overcoming crises and barriers in their operations?

The study population consists of startups operating in Poland in a dynamic business environment. The basic **research units** are young enterprises meeting a criterion such as the experience of at least one crisis. In order to carry out the research process, without having a budget for the research project, the units that were easiest to reach were selected for the **sample**. A non-random sample (discretionary sample) was used, focusing on startups that met the required criteria and with whom direct contact could be made. The selection process also included scheduling interviews with representatives of the selected entities. **The form of measurement** is a primary, face-to-face survey, in the form of a personal interview with management representatives of the selected units.

A standardised interview - an interview questionnaire - **was chosen as the measuring instrument**. The essence of measurement is to ask questions that are addressed to the respondent and that directly intervene in consciousness, stimulating the respondent to respond. So, the way the questions are constructed and the types of questions have a strong influence on the results of the survey. The construction of the questionnaire was a study in itself, starting with the purpose of the study, determining the number and order of the questions and assessing their relevance, selecting the appropriate words, consulting experts, constructing a sample questionnaire and a trial measurement, and then modifying it as a result of logical analysis and, finally, developing the final version of the questionnaire. The conducted study involved open-ended questions, and no scaling of responses was used. The questionnaire contained 15 questions.

Data analysis is a key step for the correct processing and interpretation of the results obtained from the research, especially when the data are qualitative and derived from open-ended responses from respondents. Due to the nature of the research conducted, where the focus was on understanding and interpreting the subjective experiences and responses of companies, two main methods of data analysis were considered: thematic analysis and content analysis (Zaveri, 2023). Content analysis methods are more appropriate for quantitative research, so thematic analysis was chosen for the case of qualitative research. In this approach, recurring themes, patterns and meaning of the data are identified and analysed using an interpretive method. It focuses on the experiences and perspectives of participants to gain a deeper understanding of them. The thematic analysis process is flexible and iterative, enabling detailed exploration of subjective experiences and nuanced meanings in respondents' responses.

An analysis of the research results is presented later in this article. However, their evaluation - relevance, compliance, acceptance - is discussed in the "Discussion" section.

5. Analysis of the survey results

5.1. Research questions and characteristics of respondents

The survey focused on two **key questions**:

1. What factors influence the organisational resilience of startups in the face of changing market conditions?
2. What strategies for managing these factors contribute to successfully overcoming crises and barriers in their operations?

In an effort to understand the mechanisms for building organisational resilience in startups, **specific research questions** were posed:

1. What factors influence the organisational resilience of startups in dynamic market changes?
2. What strategies for managing the drivers of organisational resilience are most commonly used by startups?
3. How are startups adapting to changing market conditions?
4. What specific actions taken by startups contribute to successfully overcoming crises?
5. What are the best practices for managing organisational resilience that can be applied by startups in a dynamic market environment?
6. What inhibitors to effective organisational resilience management might exist in startups?
7. How do the experiences and decisions of managers affect the ability of startups to successfully deal with crises?

Six respondents took part in the survey. Below are **the characteristics of the respondents** and **the characteristics of the companies** they work for:

Role in the startup. One respondent is a co-shareholder and serves as CEO. Another respondent is also a shareholder. A third person is in charge of project coordination, optimising the user experience and creating concepts and strategies for operations. A fourth respondent acts as project coordinator and subscriber specialist. The fifth participant is an advisor and managing director. The last respondent is a development and marketing director.

Legal form. Six respondents took part in the survey, four of whom work in limited liability companies, one in a foundation and one in a simple joint stock company.

Enterprise size. The enterprises analysed comprised a variety of units by size classification: two were classified as micro-enterprises, two as small and two as medium-sized.

Age of the enterprise. With regard to the age of the companies analysed, one has been in operation for 2 to less than 3 years, one for 4 to less than 5 years, two for 3 to less than 4 years and two have 5 to less than 10 years.

Industry. The companies participating in the survey represented a variety of industries, including: one company from industry, one from agriculture, two from media, one from commerce and one from financial services.

Sources of funding for capital expenditure. In terms of sources of financing for capital expenditure, three companies use their own funds, two use EU subsidies and one finances investments through bank loans and credits.

Credit ownership. In terms of credit holdings, five companies have no credit commitments, while one company has a credit of between 1 and 3 years.

Area of operations. With regard to areas of activity, four companies operate exclusively in Poland, one operates in both Poland and the European Union, and one operates in multiple countries around the world.

The main products or services offered by the startup. Six startups from different industries took part in the survey. The first one produces hemp blocks for the construction of single-family houses, offering eco-friendly solutions. The second startup provides hemp cultivation services, including modern harvesting and processing technologies. Another entrant is a company that creates interactive multimedia content, engaging users through articles and analytics, using artificial intelligence to personalise the experience. Another podcasting startup enables interactive radio programmes, allowing listeners to actively participate. Another startup markets cutting-edge cosmetics, and the last offers flexible financial solutions such as loans and factoring, which are based on modern risk assessment algorithms.

Respondents' professional experience. In terms of the respondents' professional experience, one has 15 years of experience in startups, another has 10 years, a third has five years, a fourth has four years and two have two years of experience in the industry each.

5.2. Analysis of respondents' answers

The interview started with question 1:

Please tell us about a situation when the company has had experience with some major crisis or difficulty that has had a particularly large impact on the business.

Each respondent presented a different situation. The responses are shown in Tab. 4.

Table 4.
Respondents' answers to question 1

Respondents	Answers
Respondent 1	"One of the most serious crises we faced was the lack of funding for one of our production lines . Although we received financial support, it turned out that we lacked the funds to purchase a machine to dry the hemp blocks, which made it significantly more difficult for us to continue production".
Respondent 2	"We experienced a major crisis when the change in power reduced the need for support from existing clients , as public media returned to its previous state. As a result, interest from our existing donors decreased".
Respondent 3	"One of the biggest challenges we faced was opening our first stationary shop. The site was generating significant costs, especially as operating during the period of trading Sundays generated the highest turnover. Unfortunately, regulatory changes and long-term leases meant

	that the cost of doing business increased significantly. Additionally, the COVID-19 pandemic and increasing competition in the form of chains marketing cosmetics to other companies exacerbated the difficulties. Instead of focusing on developing e-commerce, we became too involved in developing stationary shops , which proved to be the wrong decision".
Respondent 4	"The biggest challenge we faced was a major conflict between partners , which led to decision-making paralysis and halted further company activities. This situation put the future of our startup in question and required urgent action to prevent the business from coming to a complete halt".
Respondent 5	"Our main problem has been a decline in contributions and reduced funding , which has had a significant impact on the business".
Respondent 6	"Our company faced a serious financial challenge due to the rapid growth rate. Despite a strong team of specialists and a refined product, we lacked the resources to further support our customers. At the time, the sector in which we operated was struggling with an unfavourable image, which further caused problems for our partners. This significantly limited our ability to raise funds for growth. As a result, we focused on seeking investment support, as bank financing proved unattainable".

Source: own elaboration based on interviews conducted.

An analysis of the responses to Question 1 Crisis experience, presented in Table 4, reveals several significant challenges that had a significant impact on companies' operations. Respondents highlighted that the lack of adequate financial resources often hindered the continuation of operations and the implementation of plans. Other significant difficulties included a reduction in interest from existing customers, either as a result of changes in the market environment or a shift in power. There were also internal conflicts, such as occasional problems between partners, which affected the companies' operations, paralysing decision-making processes and holding back further development. One respondent also indicated that regulatory changes, including new trade regulations, had increased operating costs and complicated the processes involved in hiring and running a business. These changes, combined with pandemonium and increasing competition, have contributed to the difficulty of maintaining profitability.

Respondents were then asked question 2:

What strategies were used to overcome these crises/difficulties?

Analysis of the responses to question 2. Several key common points can be identified that emerged in the various responses of the respondents. **Cost optimisation and increased profitability** can be singled out as the first strategy. Respondent 3 indicated that the company focused on improving financial performance by reducing operating costs and reducing its presence in expensive locations. Similarly, Respondent 6 indicated a focus on increasing the profitability of its lending and reducing risks, which allowed the company to better manage its finances. **Seeking funding** can be mentioned as another strategy. The startup concerning respondent 1 decided to issue shares through a brokerage house as a way to raise additional funds. The startup concerning respondent 6, on the other hand, undertook intensive efforts to raise financing, both domestic and foreign. Respondents also pointed to **the development of their offering and distribution channels**. Respondent 2's company expanded its offering and distribution channels by introducing new content formats, such as podcasts, to attract new audiences. Respondent 5's company, on the other hand, focused on increasing engagement

through the development of a mobile app and increased marketing activities. Respondent 4 pointed to **effective team and resource management**. The startup had made management changes, reducing the involvement of individuals in certain areas and delegating tasks to substitutes, which helped to adapt to changing conditions.

Question 3 to respondents:

Please describe what factors had the greatest impact on the company's ability to adapt and maintain resilience in these situations.

Analysis of the responses to Question 3. The question reveals several key aspects that were important to respondents:

- good management,
- agility and flexibility through in-house solutions,
- rapid decision-making,
- commitment of owners,
- constructive discussions,
- teamwork,
- brand recognition,
- image,
- analytical skills.

Respondent 1 indicated that a good management team and experienced investment advisors with knowledge of fundraising opportunities played a key role in the company's adaptability. Respondent 2 highlighted that organisational flexibility and agility, resulting from the ability to implement solutions internally, were key to the company's adaptability. Through close collaboration and rapid exchange of ideas, the startup was able to implement new solutions quickly. Respondent 3 pointed out that rapid decision-making and direct involvement of the owners enabled the startup to respond effectively to changing market conditions. Respondent 4 noted that constructive discussions and suggestions for action within the team were key, although their effectiveness did not always meet expectations. Respondent 5 highlighted that strong brand recognition and positive audience sentiment were important for the company's adaptation and resilience. Respondent 6 noted that the team's analytical skills and competence in risk management were important for assessing situations and taking effective action in response to challenges.

Respondents were then asked to answer question 4:

Please tell us about specific actions and initiatives your company is implementing or considering to adapt to new market conditions and maintain its organisational resilience.

Analysis of the answers to question 4 Several key strategies mentioned by respondents can be distinguished:

- employment of qualified specialists,
- development of product offerings and new channels,

- increase owner involvement,
- negotiations with business partners,
- new product development,
- intensification of marketing activities,
- focus on profitable customers,

The remainder of the interview covered the topics in questions 5, 6, 7 and 8 in turn:

How did the team respond to difficult situations and what practices were adopted?

What team activities have had the greatest impact on building organisational resilience?

What lessons have you learned from the crisis experience?

How have these lessons translated into the company's strategy and operations in the long term?

Analysis of the answers to questions 5, 6, 7, 8. Respondents described different **reactions of teams to difficult situations**. In some cases, managers made structural changes and assigned specific areas of responsibility, as there were sometimes disagreements within teams due to different opinions on solutions. At times, when faced with difficulties, teams experienced feelings of powerlessness and grief, leading to reduced contact between team members. There were instances of the team feeling stressed and uncertain about the future of the company. However, leaders tried to keep employees informed and reassure them that there were no planned staff cuts, focusing instead on optimising tools and processes to build a sense of security. In other cases, teams introduced regular meetings to monitor the situation on an ongoing basis and quickly adjust strategy. Sometimes, too, teams showed confidence by creating new products and maintaining open communication and a full understanding of the situation. Actions such as introducing and maintaining high quality internal communication to keep the situation under review and quickly adjust strategy played an important role in **building organisational resilience**. Respondents also highlighted the importance of involving the team and leaders in solving problems and maintaining trust and common purpose. Respondents identified several key **lessons learned from the crisis experience**. These included the need for thoughtful selection of co-founders and alignment of the governance structure, as well as the importance of marketing continuity and financial transparency. Other important lessons included flexibility in strategy adaptation and the importance of preparing for potential crises by developing contingency scenarios. Lessons learned from the crises have had a significant impact on companies' strategies and operations. Changes in management and organisational structures, improved communication with stakeholders, and a focus on flexibility and securing financing were key to long-term adaptation and growth.

After being confronted with a difficulty or crisis, companies may be more aware of the risks, so respondents were asked questions 9, 10 in turn:

Please list examples of best practices that your company is using or considering to increase its resilience to market changes.

What measures are you taking in your company to build organisational resilience to future crises?

Analysis of responses to questions 9, 10 In the context of the analysis of respondents' answers to the first two questions, **a variety of strategies and approaches** emerge that can be considered key to ensuring resilience in the face of unpredictable events. Among the most frequently mentioned actions that companies implement were human resources initiatives, such as hiring qualified professionals with the right competencies and experience. Diversifying funding sources, expanding product offerings and developing marketing campaigns are other key steps that allow companies to increase financial stability and conquer new market segments. Equally important is the development of e-commerce and product certification, which enables companies to gain a competitive advantage in foreign markets, as well as the introduction of loyalty programmes that increase customer loyalty. Further strategies used by startups include cost optimisation, focusing on implementing innovations and automating production processes. In addition, a hemp startup, for example, pointed out that automating processes and cooperating with research units and universities not only enables innovation, but also better adaptation to changing conditions. Furthermore, regular adaptation to industry news and legislation allows companies to better respond to regulatory changes, which is particularly important in industries with specific requirements, such as the cannabis industry. In the case of media startups, which raise finance mainly from fundraising and crowdfunding, companies also monitor and manage their funding sources in an effort to increase sustainability through a greater share of individual donors in budgets and diversification of funding channels, which minimises the risks associated with potential problems in obtaining grants.

In summary, the **strategies and approaches that can be considered key to ensuring the overall resilience of a startup** are:

- employment of qualified specialists,
- diversification of funding sources,
- expanding the product range,
- development of marketing campaigns,
- development of e-commerce,
- introduction of loyalty programmes,
- cost optimization,
- focus on the implementation of innovations,
- automation of production processes,
- cooperation with research institutes and universities,
- regular updating with industry news,
- regular compliance with legislation,

Later in the interview, question 11 was asked:

In your opinion, what are the main challenges of building organisational resilience in a startup?

Analysis of responses to question 11. Respondent 1 pointed to **understanding and identifying the vulnerabilities** within the company that undermine its resilience and how to effectively manage these areas. Respondent 2 highlighted **the financial constraints** and the nature of the foundation's work, which does not have a commercial business model. For the company Respondent 3 described the challenge of **having to obtain exclusivity to sell products**, which is not always a straightforward procedure and requires lengthy negotiations with business partners. Respondent 4 noted that the challenges are **time and knowledge**. The need for ongoing analysis and the acquisition of relevant competences requires a lot of time and effort. Respondent 5 pointed out **the lack of continuity of funding** and **the difficulty in obtaining large investments**, which differs from the situation in large companies where investments are more stable. Additionally, startups often struggle with limited institutional and organisational knowledge, operating on a trial-and-error basis. Another problem is the **small number of employees who perform many different roles**. Respondent 6 highlighted **the unpredictability of legislation** and **strong competition** from companies with more capital. **Maintaining a good team** is also a challenge.

Respondents were also asked about future plans for the startup. Question 12:

What are your startup's future growth plans and strategies (for the next 5 years)?

Analysis of the responses to question 12. 5 out of 6 respondents indicated that the companies will operate, grow and **build their resilience**. 1 respondent declared that there were plans to close the business. While this company has been building and **trying to build its resilience** further, it is not yet able to do so in one area, which is the agreement between shareholders.

Question 13 was then asked:

How does experience with crisis management and building organisational resilience inform these plans?

Analysis of responses to question 13. The majority of respondents emphasise that the experience of crisis management **mobilises closer analysis** and an understanding of resilience. Companies plan to:

- introduce more effective management methods,
- better secure key processes,
- adapt activities to the market,
- create more flexible processes,
- diversify finances, customers, business partners.

Question 14 was asked in the next part of the interview:

What factors do you consider to be key to a startup's survival and success in difficult market conditions?

Analysis of responses to question 14 Respondents cited as **key factors for the survival and success of a startup** in difficult market conditions:

- innovation,
- process automation,
- having a well-qualified management team,
- flexibility,
- a sense of the recipient's needs,
- proper cash flow management,
- good product,
- a strong team,
- effective PR,
- real sales,
- effective customer outreach,
- building customer loyalty,
- flexible adaptation to customer needs.

As management decisions often play a key role in shaping a company's strategy and actions in crisis situations, respondents were asked question 15:

Please tell us what roles managers' decisions play and how their experiences influence the strategies and actions taken in crisis situations.

Analysis of the responses to question 15 Analysis of the responses from respondents indicates that the experience and **competence of managers has a significant impact** on the way a company handles difficult moments. According to respondents, **managers with a wealth of experience are better equipped to assess the risks** and consequences of their decisions. This enables them to take more informed and effective action in crisis situations. Previously acquired knowledge enables them to avoid mistakes that could be replicated in the absence of knowledge. In addition, previously acquired practice also allows them to implement proven solutions. **Experienced leaders, on the other hand, often use tried and tested patterns, which can both support and limit** their ability to adapt in the face of new challenges. Lack of experience among managers can lead to mistakes and decision-making in areas where they do not have sufficient knowledge, which in some cases will not have a negative effect, while sometimes it can lead to unwanted consequences. Ultimately, according to respondents, managers' experience in identifying and managing risks is **a significant competitive advantage**. Managers who have gained practice in various business ventures are able to respond more quickly and effectively to crisis situations, highlighting the importance of their role in building organisational resilience.

5.3. Research conclusions

The analysis of the respondents' answers to the questions posed during the interviews allows conclusions to be drawn regarding the research questions formulated at the outset of the study.

Specific research question 1 What factors influence the organisational resilience of startups in dynamic market changes?

From the respondents' answers, the following factors affecting the organisational resilience of startups can be identified:

- good management,
- agility,
- rapid decision-making,
- commitment of owners,
- team cooperation,
- brand recognition,
- analytical skills,
- innovation,
- automation,
- cash flow management,
- a strong team,
- effective PR,
- flexible adaptation to customer needs.

Specific research question 2. Which strategies for managing organisational resilience drivers are most commonly used by startups?

From the respondents' answers, the following strategies can be identified for managing factors affecting organisational resilience:

- investing in the development of managers,
- implementation of flexible organisational structures,
- keeping decision-making processes short,
- involving owners in operational management,
- promoting teamwork,
- building brand recognition and a positive image.

Specific research question 3: How are startups adapting to changing market conditions?

The following are the specific actions indicated by respondents on how startups are adapting to changing conditions:

- employment of qualified specialists,
- development of product offerings and new channels,
- increase owner involvement,
- negotiations with business partners,

- new product development,
- intensification of marketing activities,
- focus on profitable customers.

Specific research question 4. What specific actions taken by startups contribute to successfully overcoming crises?

The following actions taken by the surveyed startups can be distinguished, which contributed to their successful overcoming of crises:

- optimise costs and increase profitability,
- seeking funding,
- development of the offer,
- development of distribution channels,
- effective team and resource management.

Specific Research Question 5: What are the best practices for managing organisational resilience that can be applied by startups in a dynamic market environment?

Summarising the respondents' answers, best practices for managing organisational resilience can be detailed:

- investing in the development of the team's soft skills,
- fostering a culture of innovation,
- risk management and scenario planning,
- implementation of technologies supporting automation,
- building networks and partnerships,
- diversification of revenue sources.

Specific research question 6. What inhibitors to effective organisational resilience management may exist in startups?

The factors inhibiting effective organisational resilience management, as perceived by respondents, are as follows:

- limited financial resources,
- immature organisational structures,
- growing too fast,
- lack of diversity in sources of funding,
- over-reliance on a single customer or market,
- lack of cooperation and communication within the team.

Specific research question 7. How do the experiences and decisions of managers influence the ability of startups to deal effectively with crises?

According to the respondents' answers, experienced managers are better equipped to assess risks and make effective decisions in crisis situations, thanks to their prior knowledge and practice. They can avoid mistakes and implement proven solutions. However, the use of tried and tested schemes can both support and limit the ability to adapt to new challenges. Lack of

experience can lead to erroneous decisions that do not always have negative consequences, but can cause unwanted consequences. Ultimately, the experience of managers is a key advantage in building organisational resilience.

In summary, conclusions and answers to the key research questions that underpin the analysis can be formulated.

Key research question 1. "What factors influence the organisational resilience of startups in the face of changing market conditions?"

Based on the research conducted, a number of factors can be identified that have a significant impact on the organisational resilience of startups. A key aspect is good managers who can effectively assess crisis situations and make informed decisions. Organisational agility and flexibility promote rapid adaptation to changing conditions, which in turn enables competitive advantage. Rapid decision-making, linked to short decision-making processes, enables an effective response to market challenges. Owner involvement in day-to-day operations significantly influences effective management. Team cooperation and effective communication within the group foster innovation and speed of project implementation. Additionally, brand recognition and a positive image are key, as a strong brand builds trust among customers. Analytical competence enables informed decisions based on data. Innovation and automation of processes contribute to organisational efficiency, and proper cash flow management ensures financial stability. A strong team and effective PR are also important to help build customer relationships. Flexible adaptation to customer needs is key to survival in the market.

Key research question 2. "What strategies for managing these factors contribute to successfully overcoming crises and barriers in their operations?"

In response to this question, several key strategies can be identified that startups are most likely to use to manage the factors affecting their organisational resilience. First and foremost, investing in the development of managerial staff, through training and competence enhancement, translates into better crisis management. Implementing flexible organisational structures enables rapid adaptation to changing market conditions. Keeping decision-making processes short allows a faster response to change, and involving owners in operational management promotes the rapid identification of problems. Promoting team collaboration increases efficiency, and building brand recognition and a positive image attracts customers and increases their loyalty. The aforementioned strategies contribute to successfully overcoming crises and increase the overall organisational resilience of startups.

6. Discussion

It is worth noting that **there is no absolute measure for organisational resilience**, but in order to measure this attribute of the organisation, it is worth involving all groups of employees. This will result in an improved ability to anticipate potential threats and identify and respond to vulnerabilities. Additionally, it will enable a better understanding of the stakeholders and dependencies that support strategic goals and objectives (Soliwoda, 2020).

It is worth noting that resilience is a criterion for assessing organisations. S. Somers (2009) and I.H.S. Sawalha (2015) emphasise that organisational resilience is **a proactive measure**, but Longstaff (2005) and Sawalha (2015) also write about **a passive measure**. Resilience is a proactive measure when it provides a basis:

- the conscious development of the organisation in all areas of its environment,
- the implementation of systems which allow certain actions to be planned appropriately, react to unexpected events and give early warning of problems.

The passive measure of resilience, on the other hand, describes the state of the organisation at a particular point in time. It is applicable to the adaptation of an organisation to new threats and scenarios or to the simple reconstruction of operations after a crisis situation.

The above considerations allow us to conclude that **the basis for resilience measurement processes** and the process by which resilience can be seen as a measure of organisational improvement is risk management (Tarapata, Woźniak, 2022, p. 15).

Measuring resilience is challenging, as there are **several approaches to assessing** this concept in different application areas, at different levels of strategic resilience and representing attempts to construct different measurement tools (Mallak, 1998, pp. 148-152; Somers, 2009, pp. 12-23; Vidal R., Vidal L, 2020, p. 135). It is widely accepted that resilience should be measured in order to improve the performance of the business, so more and more organisations are trying to do so, seeing it as a necessary condition for strategy development. Lack of sufficient knowledge about the level of resilience is a significant challenge that prevents organisations from accurately identifying areas for improvement and effectively allocating resources to resilience initiatives.

The next problem is to distinguish **resilience issues concerning startups specifically**. A variety of elements can influence the development of resilience in corporations, SMEs or startups, but research findings in this area are often inconclusive. Since there is not enough research that identifies factors that **exclusively influence the resilience of startups**, the results of this study, as well as the study of **factors in the context of SMEs**, can be taken into account. W. A. Demmer et al. also note that elements affecting the resilience of large corporations can be applied to SMEs (Demmer et al., 2011).

H. Torstensson et al. identified several key drivers of resilience. Conclusions were drawn with a study of **Swedish SMEs** in the textile and clothing sector. Three mainly asset categories were identified (Abylaev et al., 2014):

- Resourcefulness (tangible resources, intangible resources, financial resources, social resources, network resources).
- Competitiveness (flexibility, networking).
- Learning and culture (employee wellbeing, leadership, rapid management decision-making, collectivity).

Some disagree with this approach and believe that owning these assets is a necessary condition, but not necessarily a sufficient one, to strengthen a company's resilience, as it is the ability to manage these assets effectively that can produce the desired results.

As for **the present study**, 'although sampling error cannot be determined in **non-random** sampling, some people find this method very useful (Kotler, 1999). Non-random, or non-probabilistic, techniques are based on the subjective judgement of the researcher, do not require specialised knowledge, and sampling does not involve high costs and is not time-consuming. Several key factors should be taken into account when deciding on a sampling technique, the most important of which is the purpose of the survey. Therefore, our results can be assessed as consistent with the research goal and problem. The **relevance** of the survey, on the other hand, means that users will correctly interpret the results obtained, so in this direction, the results of the survey are presented and analysed in detail in the study. An important aspect of the evaluation of the results is also their **acceptance** by the users, who can formulate specific opinions on the presented results. Based on the article, companies can use the recommendations presented to better prepare for crises, which can lead to greater stability and long-term growth.

Probabilistic techniques are used in studies aimed at verifying hypotheses, while non-probabilistic techniques are appropriate for initial familiarisation with the issue under study. The choice of non-probabilistic techniques allows preliminary results to be obtained quickly (Miszczak, Walasek, 2013). So, the present study can be treated as a **pilot study** and the conclusions adopted as hypotheses for deeper, and more costly, future extended studies with representative random samples.

7. Summary

This article attempts to analyse the organisational resilience of Polish startups, which is becoming crucial in the context of dynamic market changes. The aim of the study is to identify factors influencing the ability of startups to survive and adapt in the face of uncertainty and crises. Based on a literature review and field research using questionnaire interviews with startup executives, the main elements building organisational resilience were identified:

flexibility, rapid decision-making, management commitment and effective risk management. Startups in Poland use various crisis management strategies, including cost optimisation, development of new products and sales channels, raising funding and intensifying marketing activities. The study also found that crisis experiences shape long-term growth strategies, leading to greater awareness of risks and better preparation for unexpected challenges.

In conclusion, the article highlights the importance of organisational resilience as a key success factor for startups in a changing business environment and provides practical tips for managing resilience. The findings of the study may be useful for both researchers and practitioners interested in innovative startup management. At the same time, the need for further research on organisational resilience on a larger number of startups in different sectors using different research tools is highlighted.

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INVESTIGATION OF PROCUREMENT PROCESS PROBLEMS IN A SELECTED DISTRIBUTION CENTRE

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Purpose: The main objective of this article is to identify and analyse the disruptions that occur in the procurement process of a selected distribution centre, together with suggestions for improvement.

Design/methodology/approach: The study used qualitative research, including participant observation and interviews. In addition, selected methods and techniques were used and techniques, including the FMEA (Failure mode and effects analysis) method and the A3 report.

Findings: Empirical studies indicate that the problems occurring in a distribution centre in the procurement process are mainly caused by the use of two non-integrated WMS (Warehouse Management System) systems.

Originality/value: The results of the research can be used to improve the procurement process in the studied distribution centre by using the proposed solution, i.e. integrating existing warehouse management systems, which will have a significant impact on reducing stock discrepancies.

Keywords: procurement process, distribution centre, FMEA, A3 report.

Category of the paper: general review.

Introduction

Today's market development offers many opportunities not only for companies but also for distribution centres, encouraging creativity and innovation. Changes are taking place in many areas directly or indirectly related to logistics. They are taking place in procurement logistics, warehousing and inventory management, and customer distribution logistics (Dyczkowska, 2013).

As a key element of any company's operations, procurement logistics is an integral part of the supply chain. It encompasses a set of processes related to the planning, organisation and execution of the procurement of raw materials, materials, components and other goods required

for production or service delivery. The same applies to the distribution centre, where procurement logistics, as the foundation of the organisation's operations, has a direct impact on the company's profitability and competitiveness. This is particularly true in the case of food distribution, where market dynamics, specific quality requirements and the need to maintain the cold chain present additional challenges for companies.

It is therefore essential that procurement processes are continually improved and integrated with the rest of the business, as they are the backbone of any organisation.

Therefore, the main objective of this article is to identify and analyse the disruptions that occur in the procurement process of a selected Italian food distribution centre, and to propose improvements. The study used qualitative research, including participant observation and interviews. In addition, selected methods and techniques were used, including the FMEA method and the A3 report.

In addition, the article attempts to verify the hypothesis: Problems occurring in the distribution centre during the procurement process are caused in particular by the use of two non-integrated WMS systems. The integration of a warehouse management system will have a significant impact on reducing discrepancies in stock levels.

The role and importance of procurement in the distribution centre – theoretical background

The increasing popularity of outsourcing business operations has led to sourcing becoming a business area of strategic importance. This means that as suppliers become more important to a company's competitive position, it has become increasingly important to align sourcing objectives with business objectives (i.e. strategic alignment). (van Weele, Rozemeijer, 2022).

Sourcing focuses primarily on the bottom-line benefits of purchasing through cost savings, ensuring on-time delivery and improving quality. How distribution centres can best mobilise their supplier networks to create a sustainable competitive advantage is a question that has yet to be fully answered. Operational excellence is therefore one of the key tasks of any procurement organisation. It should strive to ensure that the best products are delivered at the right time, in the best possible quality and at the best possible price to meet the needs of internal customers (van Weele, Rozemeijer, 2022, p. 49).

When considering how to develop procurement as a strategic business function, it is important to consider the key differences between organisations and industries. The roles, responsibilities and level of authority assigned to procurement vary even between companies in the same industry (van Weele, Rozemeijer, 2022, p. 49).

The main procurement responsibilities in the distribution centre are (van Weele, Rozemeijer, 2022, p. 49):

1. Operational Excellence:
 - Ensure timely and uninterrupted availability of purchased goods and services.
 - Working with suppliers to ensure continuity of supply and high product quality.
 - Optimise purchasing processes to reduce costs and and increase efficiency. Customer focus.
 - Ensure the smooth running of the purchasing department.
2. Controlling costs and reducing expenditure:
 - Negotiate favourable prices and purchasing terms.
 - Minimise the direct and indirect costs associated with the purchase and use of materials.
 - Procure materials and services with the best value for money.
 - Work with reliable suppliers who offer competitive prices.
 - Make informed purchasing decisions.
3. Supply risk management:
 - Diversify suppliers and avoid over-reliance on a single source.
 - Work with established and reputable companies.
 - Minimise technology and supply risks associated with supply.
4. Innovation and continuous improvement:
 - Working with suppliers on product and process and process innovation.
 - Collaboration with suppliers in research and development.

Procurement in a distribution centre is a complex process with many stages. Although the organisation of procurement is different in each company, the basic phases can be distinguished (Bozarth, Handfield, 2007; Żabińska, 2015):

1. Identify needs:
 - Identify the need for raw materials, materials, finished products or services.
 - Analysis of customer requirements and demand forecasts.
2. Description of user requirements:
 - Precise definition of order specifications (e.g. technical parameters, quantity, delivery date).
 - Communicate data to suppliers.
3. Identifying and evaluating suppliers:
 - Decide whether to source internally or externally (outsourcing).
 - Define the sourcing strategy.
 - Identifying potential suppliers and strategic market analysis.
 - Evaluate suppliers against criteria chosen to suit the organisation.

4. Supplier selection:
 - Selecting the supplier with the highest rating or, alternatively, the preferred supplier, i.e. a supplier with whom a successful relationship has already been established.
 - Negotiation or tendering.
5. Order preparation:
 - Establishing the terms of co-operation (timing, volume of deliveries, transport, packaging, payments, complaints).
 - Conclude a formal contract with the supplier (usually long term).
 - Establish a clear contractual order.
6. Receiving and checking:
 - Check quantity, quality and timeliness of delivery.
 - Compare with documentation and schedule.
 - In the event of delays or shortages, inform procurement management and propose solutions.
 - Possibility of complaints, renegotiation or cancellation of the contract.
7. Approval and payment of invoices:
 - Approve invoices in the system.
 - Settling accounts with the supplier.

Today's competitive market conditions are forcing DCs to take a fresh look at the procurement process. It is becoming necessary to view it in the context of the entire supply chain. This change of perspective requires taking into account the interdependencies between logistics subsystems within the company, the links with other functions of the company and, above all, the links with suppliers' logistics systems (Bendkowski, Radziejowska, 2005, p. 58).

Methodology

Qualitative methods such as participant observation and interview were used to investigate problems in the procurement process. According to Pegani A. (2023), the qualitative method in conducting scientific research is more effective and allows for a comprehensive coverage of the research topic. In addition, it allows for a more extensive amount of data to be obtained, thus focusing on a comprehensive analysis of the phenomenon in question (Pegani 2023).

The study used a range of research tools and techniques. These included:

- FMEA methodology - aimed at identifying and analysing the disruptions occurring in the different areas of the supply process in the DC under study. It also enabled the development of preventative measures by examining the cause-and-effect relationships for the disruptions identified.

- The A3 report - allowed for a more in-depth analysis of the occurrence of the highest priority disruption, C. The causes of its occurrence were identified and countermeasures were proposed to minimise or eliminate it.

Results

Identification and analysis of problems in the supply process using the FMEA method.

An FMEA analysis was used to identify and analyse failures in the supply process of a company that is the largest importer and distributor of high quality food products in Poland. In addition to the identification of disturbances, the FMEA method also enabled the investigation of their causes and effects.

On the basis of observations and interviews with employees, the following were analysed:

- Order preparation and placement.
- Transport and storage.
- Delivery acceptance.

Table 1 defines the frequency of disturbance (R), where its probability and characteristics are defined on a scale of 1 to 10.

Table 1.

Frequency of interference - R

Incidence	FMEA of the product	R	Frequency of disturbance
Unlikely	Interference is unlikely	1	Less than 1/1 000 000
Very rarely	Very few malfunctions	2	1 per 20 000
Rarely	Relatively few interruptions	3	1 per 4 000
On average	The fault occurs sporadically from time to time	4-6	1 per 1 000 1 per 400 1 per 80
Often	The fault is repeated cyclically	7-8	1 per 40 1 per 20
Very often	Disruption is almost inevitable	9-10	1 per 8 1 per 2

Source: Author's compilation based on interviews with company employees.

Table 2 shows the significance of disturbances (Z), also rated on a scale of 1 to 10, for disturbances ranging from very small and insignificant to very large, causing further problems. In contrast, Table 4 shows the probability of detection (W) of a fault.

Table 2.
Significance of interference - Z

Importance of the disruption to the customer		Z
Very small	Minimal impact, the customer does not notice, the disruption does not affect the conditions of use of the product.	1
Small	Minimal effect, causing minor discomfort, moderate deterioration of product properties may be noticeable.	2-3
Average	Interference causes limited dissatisfaction and minor inconvenience; the product does not meet needs or is a source of inconvenience; the user perceives shortcomings in the product.	4-6
Large	Customer dissatisfaction occurs; cost unknown.	7-8
Very large	High customer dissatisfaction, high costs due to total or partial spoilage. May compromise user safety or contravene legislation.	9-10

Source: Author's calculations based on interviews with company employees.

Table 3.
Probability of detection - W

Interference detection	Probability of detecting a fault	W
Very high	Very low probability of undetected interference, automatic control of 100% of components, installation of protection.	1-2
High	Low probability of undetected fault before end of operation; fault is obvious, multiple faults may go undetected.	3-4
Average	Medium probability of not detecting a product failure before the end of the operation; manual control difficult.	5-6
Low	Probability of non-detection of interference high, subjective judgement in terms of sampling.	7-8
Very low	High probability of non-detection; point is uncontrolled; fault not visible	9-10

Source: Author's calculations based on interviews with company employees.

As a result of the FMEA analysis (Table 4), 7 disruptions were identified, including 4 critical ones that exceeded a priority score of 100 (the score was determined based on interviews with company personnel). These included: inadequate forecasting of requirements, limited communication from the supplier, inadequate securing/storage of products, discrepancies in stock levels. Their causes and effects were then identified. Following in-depth analysis, preventive measures were proposed to increase their detectability and reduce their incidence. As a result, the detectability of some was increased and the incidence of all was reduced.

The disruption related to stock discrepancies scored the most points. The source of the problem is the use of two different WMSs, which leads to differences in stock levels between the two systems - and it is worth noting that the actual number of products in stock is often still different. Also important is the fact that data is entered manually into both programmes, which only adds to the difficulties and slows down the whole process. To overcome this disruption, a single WMS should be implemented that is tailored to the needs of all parties involved in the process, so that everyone can use it easily. This system should also allow for the use of RFID technology for data entry, which would greatly streamline the process and reduce human error that often occurs when activities are performed manually.

Problems were then identified in communicating with suppliers, who often did not respond to emails or phone calls. When contact was made, it was not uncommon for the supplier to give a cursory response rather than complete information. As a result, the company was unable to obtain and pass on information to the customer, often concerning the expected delivery date or confirmation that the quantity ordered would be delivered. As a result, there were quantity errors in deliveries due to the supplier's lack of production capacity. This led to a number of other problems, such as not being able to fulfil the customer's order on time, or trying to source similar goods immediately from another supplier, incurring additional costs. The solution is to develop and periodically run a supplier selection and evaluation process that would select the best suppliers while rejecting the problematic ones. It would also make it possible to develop an action plan for suppliers with an average score. As a result, communication with suppliers should improve.

Difficulties in forecasting customer demand due to inaccurate forecasting by the buyer or errors due to manual execution of the process were also identified. The food industry is characterised by fluctuating seasonal demand, which needs to be taken into account when planning demand for individual products. Unfortunately, the buyer is not always able to anticipate changes in customer buying trends for individual products. Therefore, the focus should be on automating and refining the process using IT tools that also enable the automatic collection of statistical data on demand variability.

Subsequently, irregularities were detected in the protection and storage conditions of the products. Food products require a certain temperature and ambient humidity - they must not be too high, as this causes spoilage of the articles, resulting in delays or non-fulfilment of the customer's order. Due to the need to store them in cold stores, additional costs are incurred, hence negligence on the part of the supplier. It is advisable to contact the supplier to raise this issue and, if this does not work, to change supplier.

As a result, out-of-stock situations have become common, causing disruption in downstream processes and often leading to delays in customer orders. The source of the problem is errors made by the supplier, either due to inadequacies in their system or the human factor in picking the delivery. The solution is to talk to the supplier to identify the source of the problem on their end and work together to develop countermeasures to reduce the number of errors.

In addition, distortions have been identified at the stage of acceptance of deliveries into stock, manifested in the acceptance of incorrect quantities of products or the acceptance of products that do not meet quality standards. This results in incorrect data in the system due to products that have been accepted but are not fit for consumption. This results in delays in fulfilling the customer's order, or even the inability to fulfil the order. The existing delivery control procedure should be analysed for possible improvements, followed by training of warehouse staff. It is also advisable to create a checklist of the next steps in the inspection process to be made available to staff - and to post signs with the key rules of the process.

The lowest number of points was given to the disruption caused by the difficulty of finding a suitable means of transport. Foodstuffs must be transported under controlled conditions, i.e. in refrigerated trailers, of which there are relatively few on the market. It is advisable to talk to a shipping company in order to find more hauliers and to conclude long-term contracts with them in order to have access to a more specialised fleet.

This was followed by a simulation of the proposed improvements, which primarily involved the implementation of a single WMS and the development and periodic implementation of a supplier selection and evaluation process. They also included discussions with suppliers and the freight forwarder with a view to attracting new carriers and securing permanent, long-term contracts with them. They also included changes to individual procedures and additional staff training in the areas concerned. As a result, the frequency of all disruptions was significantly reduced and the detection rate slightly increased. As a result, the company's entire procurement process has been streamlined.

Identification and analysis of problems in the procurement process using the A3 report. The A3 report was prepared for the inventory discrepancy failure, which received the highest score of C (priority number was 504) in the FMEA analysis. In addition, interviews with employees and observations confirmed that this failure had a significant and major impact on the procurement process in the DC. In addition, the A3 report provided a better understanding of the causes of the identified disruption in the procurement process so that appropriate remedial actions could be developed.

The A3 report identified the causes of the main disruption in the company's procurement process, namely the discrepancy in stock levels.

These included:

- Poor training of staff (short working hours due to high staff turnover - especially warehouse staff).
- Lack of accuracy.
- Lack of proper communication between departments.
- Complicated procedures (need to enter the same data into different systems - use of different systems, many unnecessary steps).
- Lengthy processes (manual operations), computer breakdowns and software bugs.
- Use of 2 non-integrated WMS.
- Poor division of labour (responsibilities).
- Lack of management supervision.
- Supplier errors (order errors, lack of communication - due to strained relationships with due to strained relationships with individual suppliers).
- Tense atmosphere between employees.

Table 4.
FMEA Worksheet

Area	Potential interference	Potential effects of interference	Potential causes of interference	Z	R	W	C	Recommended action	Responsibility	Results of actions			
										Z	R	W	C
Preparation and ordering	Inadequate demand forecasting	Inability to meet customer needs	Inaccurate forecasts, employee errors	9	5	3	135	Process Automation	Procurement Specialist	9	3	2	54
	Limited communication from supplier	Inability to meet customer needs	Lack of a process for the selection, evaluation and evaluation of suppliers	8	7	5	280	Develop and periodically review a supplier selection and evaluation process.	Manager	8	4	2	64
Transport and storage	Difficulties in finding suitable transport	Delayed order receipt, higher transport costs	Low availability of specialised carriers specialised in food transport	3	6	2	36	Alks with a shipping company	Transport Specialist	3	2	2	12
	Incorrect protection/storage of products	Product unfit for consumption - Delays in fulfilling customer orders	Neglect of duties	7	3	6	126	Discussions with the supplier	Procurement Specialist	7	2	4	56
Acceptance of delivery	Acceptance of incorrect quantity/quality of products	Delayed or impossible processing of customer orders	Lack of adequate supply control	3	4	4	48	Training on delivery control procedures	Manager	3	3	3	27
	Supply shortages	Delayed or impossible processing of customer orders	Supplier errors	7	4	3	84	Discussions with the supplier	Procurement Specialist, Manager	7	2	2	28
	Stock discrepancies	Need to take stock - delays in fulfilling customer orders	Use of 2 different WMS	7	9	8	504	Use of 1 WMS	Manager	7	3	3	63

Source: Author's calculations based on interviews with company employees.

Table 5.
Report A3

Problem: STORAGE DIFFICULTIES																																									
<p>1. Description of the problem</p> <p>Stock irregularities mainly due to the use of 2 independent and non-integrated WMS. and non-integrated WMS where data is entered manually.</p>	<p>4. Cause and effect analysis</p>																																								
<p>2. Current status</p> <p>The two WMS systems show different stock levels, while the actual stock levels are still different.</p>																																									
<p>3 Target state</p> <p>Use of a comprehensive WMS that enables the activities of all departments of the company and whose data will be in line with reality.</p>	<p>5. Preventive actions</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #c8e6c9;">Lp.</th> <th style="background-color: #c8e6c9;">Problem</th> <th style="background-color: #c8e6c9;">Action</th> <th style="background-color: #c8e6c9;">Who</th> <th style="background-color: #c8e6c9;">Deadline</th> <th style="background-color: #c8e6c9;">Status</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Poor training of employees (short working life due to high turnover - especially for warehouse staff).</td> <td>Investigate the reason for the high turnover and develop preventive measures (e.g. additional employee benefits), organise additional training.</td> <td>Manager</td> <td>01.04.2024</td> <td>Made</td> </tr> <tr> <td>2.</td> <td>Lack of accuracy.</td> <td>Development of an incentive system for employees.</td> <td>Manager</td> <td>01.03.2024</td> <td>Made</td> </tr> <tr> <td>3.</td> <td>Lack of communication between departments.</td> <td>Introduce additional communication tools (e.g. teams), organise cross-departmental integration.</td> <td>Manager</td> <td>01.03.2024</td> <td>Made</td> </tr> <tr> <td>4.</td> <td>Complicated procedures (need to enter the same data in different systems - use of different systems, many unnecessary systems, many unnecessary steps).</td> <td>Unify and integrate systems, analyse individual activities to shorten and automate the process.</td> <td>Manager / Dział IT</td> <td>01.05.2024</td> <td>Made</td> </tr> <tr> <td>5.</td> <td>Long-term processes (manual execution of activities).</td> <td>Automate the process of bringing items into stock using RFID technology.</td> <td>Manager</td> <td>01.05.2024</td> <td>Made</td> </tr> </tbody> </table>					Lp.	Problem	Action	Who	Deadline	Status	1.	Poor training of employees (short working life due to high turnover - especially for warehouse staff).	Investigate the reason for the high turnover and develop preventive measures (e.g. additional employee benefits), organise additional training.	Manager	01.04.2024	Made	2.	Lack of accuracy.	Development of an incentive system for employees.	Manager	01.03.2024	Made	3.	Lack of communication between departments.	Introduce additional communication tools (e.g. teams), organise cross-departmental integration.	Manager	01.03.2024	Made	4.	Complicated procedures (need to enter the same data in different systems - use of different systems, many unnecessary systems, many unnecessary steps).	Unify and integrate systems, analyse individual activities to shorten and automate the process.	Manager / Dział IT	01.05.2024	Made	5.	Long-term processes (manual execution of activities).	Automate the process of bringing items into stock using RFID technology.	Manager	01.05.2024	Made
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	6.	Computer and software failures.	Report problems to manufacturer, replace electronic equipment.	IT department	01.05.2024	Made
	7.	Use of 2 non-integrated WMS.	WMS unification and integration.	Manager / IT department	01.05.2024	Made
	8.	Poor division of labour (responsibilities)	Reorganisation of processes and responsibilities.	Manager	01.04.2024	Made
	9.	Lack of management control.	Establish regular management meetings with staff, organise internal audits.	Manager	01.03.2024	Made
	10.	Supplier errors (errors in orders, lack of communication - resulting from strained relationships with individual suppliers) with individual suppliers).	Discussions with suppliers - suggestions for streamlining the process with dedicated procurement platforms.	Procurement Specialist	01.05.2024	Made
	11.	Tense atmosphere between employees.	Talking to employees to find the source of problems, organising integration.	Manager	01.04.2024	Made

Source: Author's compilation based on interviews with employees and company matrices.

After analysing the causes identified, preventive actions were defined and the person responsible for them was appointed, along with a deadline for implementation.

Based on the observations, the most significant cause of inventory discrepancies was identified - the use of 2 non-integrated and independent WMS systems. The best solution is to implement a single WMS, which, despite the high cost, will deliver the best results in the long term. It will have a significant impact on process time and reduce employee frustration caused by constant system errors and the need to manually enter the same data twice. In addition, the new WMS will enable data entry using RFID technology. This improvement will require additional training in the use of the WMS system and the use of RFID technology, but attention to reducing employee turnover will significantly reduce training costs. This solution will allow the use of a comprehensive WMS that will enable the activities of all the company's departments and whose data will be in line with reality.

4. Conclusion

The study confirmed the following hypothesis The problems encountered in the DC during the replenishment process are mainly caused by the use of two non-integrated WMS systems. The integration of the WMS will have a significant impact on reducing stock discrepancies. The FMEA analysis identified stock discrepancies as a priority disturbance, while the A3 report enabled a more precise identification of its causes and impact on the research subject's procurement process. All this demonstrated the complexity of the problem and its impact on the company's operations. The research can be used in the activities of the research company.

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PROFESSIONAL BURNOUT ON THE EXAMPLE OF A SELECTED GROUP OF EMPLOYEES

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Purpose: The aim of this article is to identify and analyze the level, causes and symptoms of burnout among customer service employees. with customer service, as well as internal communication and professional development opportunities.

Design/methodology/approach: The study involved employees of the bank's customer service department, covering selected branches located in the Silesian Voivodeship. To identify the causes and symptoms of professional burnout, research was conducted using the Polish adaptation of the OLBI Occupational Burnout Questionnaire, which was enriched with questions about the personal experiences of a selected group of respondents.

Findings: The empirical study indicates that there are areas for improvement and change in the surveyed entity. As the main ones, respondents identified: time pressure and customer service requirements, as well as internal communication and professional development opportunities.

Research limitations/implications: The main limitation is the selection of the sample, i.e. customer service employees of the selected banking sector entity in Poland. The prevailing uncertain economic conditions and the global crisis have an impact on the generalization of the results in the analyzed context of burnout of direct customer service employees.

Practical implications: The obtained results can contribute to the development of management practice in the area of professional burnout, providing insight into the direct causes and symptoms of this phenomenon.

Originality/value: The results of this article can be useful for understanding the phenomenon of professional burnout among direct customer service employees of banking sector entities.

Keywords: professional burnout, customer service employees, banking sector.

Category of the paper: Research paper.

1. Introduction

Professional burnout syndrome is not a new phenomenon, but the scientific interest and description of this phenomenon, have a relatively short history. Burnout, a negative result of today's working environment and many stressful situations, has a variety of negative consequences for organizations and employees (Nikolic, Markovic, 2023). According to the

World Health Organization (WHO, 2019) definition, professional burnout is a syndrome resulting from chronic stress in the workplace, which manifests itself in feelings of exhaustion or lack of energy, greater mental distance from the work performed or negativism and cynicism related to the work being performed, and reduced professional productivity. This issue has until recently been treated rather distrustfully and skeptically by a considerable number of specialists dealing with mental health issues, and it still remains mainly in the field of interest of researchers with psychological training, which, according to Maslach and Leiter (2010), may have an impact on a certain one-sidedness of research and theoretical approaches in this field.

The phenomenon of professional burnout, as related to work, affects the professional and nonprofessional life of an individual. Research conducted around the world in this area has shown that the phenomenon of occupational burnout is subjected to all people doing professional work, although - depending on the profession, or professional group, it develops at different rates. Professional burnout, while not a disease entity, can have serious individual, social and organizational consequences. Professional burnout is an increasingly diagnosed problem among employees and can have a negative impact on their physical and mental health. The need to discern the magnitude of this phenomenon, which has undoubtedly been exacerbated by the COVID-19 pandemic, is evidenced by a number of reports that address the issue of burnout syndrome. According to the STADA Health Report 2022, as many as 25% of Polish adults feel they are on the verge of job burnout. This is the highest result among the 14 European countries participating in the survey. It is also worth noting the youngest group surveyed, those aged 18-24, as up to 36% feel they are close to professional burnout. This is all the more worrying because young people, who are at the beginning of their professional path, often lose track of the meaning of their work.

Working directly with customers poses special challenges for employees. The stresses inherent in customer service occupations involve the risk of developing stress, negative effects on employees' health and well-being, and reduced productivity. The employees of financial institutions come into a daily contact with the customers of the institution and this daily friction can cause them emotional exhaustion that can affect their performance, and finally cause professional burnout. In the studies of Mutsvunguma and Gwandure (2011), and Sowmya and Panchanatham (2011) it was found that bank employees sometimes felt that they were emotionally drained and exhausted from their work and sometimes had faced strained relations while collaborating with other people. In general, Dias and Angélico (2018) identified in comparison of fourteen studies on burnout syndrome in bank employees that individuals who worked forty hours or more a week and had immediate contact with clients were the most impacted by the disease. These jobs are characterized by high emotional demands, exposure to stressful and aggressive behavior on the part of customers, and a lack of opportunities to regenerate individual resources during work time. It is employees in customer contact and service occupations who have the highest levels of sickness absence (EWCS, 2017) due to the negative health effects of stress (depression, job burnout, other diseases). Hence, the aim of this

study was to identify and analyze the level, causes and symptoms of job burnout among customer service employees. The article also formulated the following research questions: (1) How does the syndrome of professional burnout manifest itself among customer service employees in a banking sector unit? (2) What are the causes of professional burnout syndrome?

This paper begins with the theoretical background, followed by an overview of materials and methods. The results are presented and discussed in the next section. The work ends with a summary and conclusions.

2. Theoretical background

Although a case of burnout was reported in 1953 in a nurse of a psychiatric hospital ward (Porczyk, 2013), the phenomenon was first defined by the term professional burnout in 1974 by Freudenberger (1974). In Poland, in turn, it became a subject of interest in the 1980s (Sęk, 2011). The fact that the name “burnout” is taken from colloquial language and is metaphorical in nature contributed to the skepticism of many professionals, as well as accusations that the concept is “unscientific.” Some have even derided it as pop psychology (Maslach et al., 2001). However, the issue of professional burnout has not emerged as an artificial creation, derived from an a priori accepted theory (Maslach et al., 2001). Rather, it reflects a social problem that has been growing for years, analyzed as “a homogeneous phenomenon, undifferentiated in its structure, strongly associated with stress” (Freudenberger, 1974). Burnout is accompanied by high arousal leading to overload of the body, arising from functioning in highly demanding work situations. These tendencies are not exhibited by all individuals, which emphasizes the role of individual differences (Freudenberger, Richelson, 1980), and the research from Damayanti (2019) found out, that significant work engagement between workers and their jobs can reduce occupational exhaustion.

The first - until the late 1970s - period of research on burnout syndrome, in the so-called pioneering phase, was dominated by case-study works, meticulous clinical descriptions of the syndrome made mainly by practitioners, who in initially enthusiastic and committed employees observed over time a number of negative changes associated with their profession. The identified symptoms were divided into affective, cognitive, physical, behavioral and motivation-related (Schaufeli, Enzmann, 1998). Burisch (2000) analyzed all the symptoms of burnout described in the literature it turned out that there are more than 130 in total. Most of these symptoms are very non-specific and can occur in a wide range of conditions, such as somatoform disorders, adjustment disorders and depression. The situation was further complicated by the fact that professional burnout attracted a lot of media and non-professional interest, and in the late 1970s and early 1980s it even became fashionable.

Based on the exploratory research conducted by Maslach and Jackson (Schaufeli, Enzmann, 1998) the operational definition most widely used in burnout research was developed. The scope of the research included; interviews, questionnaires, and observations of people's behavior conducted in natural settings in a wide range of "people-oriented" occupations, i.e., health care, education, mental health, social services. The measurement tool was a three-component model of the MBI (Maslach Burnout Inventory - Occupational Burnout Questionnaire). Constructed to assess the three components of the syndrome definition: emotional exhaustion (emotional exhaustion), depersonalization (depersonalization) and reduced sense of personal accomplishment (reduced personal accomplishment) (Sęk, 2011).

Emotional exhaustion refers to a person's feeling that he or she is emotionally overburdened and that his or her emotional resources have been significantly depleted (Brzeziński, Cierpiałkowska, 2008). Depersonalization refers to a negative, callous or overly indifferent reaction to other people, who are usually recipients of a person's services or objects of care on his part. Reduced sense of personal accomplishment refers to a decrease in a person's sense of competence and success at work (Brzeziński, Cierpiałkowska, 2008). It was soon observed that burnout was being experienced by people working in occupations where the frequency of contact with others was lower (Maslach et al., 2001). Thus, the definition of the syndrome was also modified, depersonalization was replaced by the term "cynicism" (cynicism), as an extension of distancing oneself not only from people, but also from work. In order to make burnout more specific to the work environment, the term "sense of personal achievement" was replaced by "sense of lack of professional efficacy" (lack of professional achievement) (Brzeziński, Cierpiałkowska, 2008).

The 1990s saw the extension of the concept of burnout to other professions outside the social services sector - managers, military officers, priests, IT specialists. In recent years, increasing importance began to be attached to the construction of consistent theoretical models of burnout. The absence of these models earlier in much of the research significantly reduced their explanatory power and made it difficult to draw practical conclusions about prevention and treatment.

Despite research and discernment in this area, there is no single consistent definition regarding this phenomenon. According to Freudenberg (1974), professional burnout is a condition that develops slowly over an extended period of experiencing prolonged stress and engaging all of one's life energy, and which ultimately has a negative impact on motivation, beliefs and behavior. Bańka (2000) defines professional burnout as the result of two types of stress: (1) occupational, which is closely related to helping others, coping with specific working conditions or sense of responsibility, (2) socio-cultural, which manifests itself in disappointment both in terms of the costs one should incur at work and the gains one should make (Bańka, 2000). Maslach (2010) identifies professional burnout as a psychological syndrome of emotional exhaustion, depersonalization and a reduced sense of personal achievement that can occur in people who work with other people in a certain way. According

to Sęk (2011), burnout is linked to the body's response to stress, the source of which is the work situation. Professional burnout syndrome is a set of symptoms resulting from excessive emotional and physical strain caused directly by stress in the workplace (Bartkowiak, 1999). Individuals working in occupations that require intense interpersonal contact with clients or the community are particularly vulnerable to this type of emotional stress, and professional burnout is increasingly being experienced by individuals at key points in their careers. Professional burnout can also be a reaction to prolonged overload of responsibilities, overly responsible and difficult tasks, as well as exhausting, monotonous and boring work (Lipowska, 2016; Hreciński, 2016). Other terms have been used to describe conditions similar to burnout, such as "overstrain", "neurocirculatory asthenia", "industrial fatigue", and "being burned out" (Benevides-Pereira, 2010).

Golembiowski and Munzenrider (1990) detail eight phases of occupational burnout, which differ in the level of each dimension: Phase I - low levels of all dimensions of burnout (the syndrome does not exist); Phase II - high level of depersonalization, low level of emotional exhaustion and sense of achievement; Phase III - high level of sense of personal achievement, low level of depersonalization and emotional exhaustion; Phase IV - high level of depersonalization and sense of personal achievement, low level of emotional exhaustion; Phase V - high level of emotional exhaustion, low level of sense of personal achievement and depersonalization; Phase VI - high level of depersonalization and emotional exhaustion, low level of sense of personal achievement; Phase VII - high level of emotional exhaustion and sense of personal achievement, low level of depersonalization; Phase VIII - high level of all dimensions of burnout (the syndrome has the highest intensity).

Litzke and Schuh (2007) za Freudenberger and North (2002) defined the phenomenon of burnout as the result of working under constant stress for an extended period of time, analyzing the process they distinguished different stages:

- Stage 1 - Strong need to prove one's worth. The employee forces himself to meet the high demands he has set for himself. He rejects all his own limitations and capabilities. An important stage is to perceive the discrepancy between pressure, compulsion and excessive ambition and a normal, healthy approach to the effective performance of employee duties.
- Stage 2 - He continues to build up his self-esteem by increasing his commitment, taking over all tasks and performing them himself as an expression of over-commitment. His approach to delegating tasks is negative, described as time-consuming and unnecessary.
- Stage 3 - Rejection of one's own needs, including personal needs - to improve performance at work. The employee limits social contacts, is not interested in various forms of relaxation and rest, and sexual needs are also disturbed. Another symptom of burnout is sleep disorders, resulting in the abuse of caffeine, nicotine or alcohol, in extreme cases sleeping pills.

- Stage 4 - There is overloading of the body with excessive demands, which manifests itself in a large decrease in energy. The employee gets lost in performing normal tasks, begins to make mistakes, i.e. failing to keep proper appointments or being late, etc.
- Stage 5 - Total change of life priorities, basic life goals are reevaluated. The employee becomes isolated, treats social contacts as unnecessary and aggravating.
- Stage 6 - Since the environment and life values are disavowed, naturally, as a defense reaction of the organism, the mechanism of displacement occurs. The employee separates himself completely from the surrounding world, becomes cynical and intolerant, bitter, lacks patience and sensitivity. His efficiency is lowered, and he also experiences the first physical ailments. From this point on, professional help is needed to stop further development of the syndrome.
- Stage 7 - With no orientation, sense of life or plans for the future, the employee also loses hope for improvement and becomes completely alienated. He performs tasks mindlessly and automatically, and seeks solace in alcohol, drugs, narcotics.
- Stage 8 - Isolation progresses, and any attempt to reach the employee is perceived as an attack. Paranoid states appear.
- Stage 9 - In this phase, the employee has lost his own identity. He perceives his work as schematic, performed mindlessly and routinely.
- Stage 10 - Panic attacks appear, the employee experiences social phobia, and becomes completely discouraged.
- Stage 11 - The person is already at such a stage of exhaustion that he or she develops depression. Suicidal thoughts also appear.
- Stage 12 - The final stage of burnout. Exhaustion of the body in all spheres of life.

The causes of professional burnout vary widely, but research on this problem has identified a number of factors that increase the risk of burnout (Kuc, Moczydłowska, 2009). These causes are both individual, related to the characteristics of the employee, his personality and the way he functions in the work environment, and organizational, related to the culture of the organization, the motivation system, the organization of work and the dominant management styles. The emergence of professional burnout syndrome is also attributed to causes such as (Trelak, 2005): (1) frustration over lack of professional success, (2) variety of interactions related to other people's problems, (3) a strong need to maintain a professional image - people who help others in connection with their profession are forced to maintain introversion because people need certain forms of behavior from them and functioning. Maintaining a professional image is extremely difficult and very often leads to a loss of contact with one's "true self" (the so-called helper's mask).

Professional burnout is the result of the interaction of many factors, both individual and organizational. Understanding these causes can help identify and implement effective management strategies to prevent burnout and improve employee well-being. The key

recommendations for preventing and eliminating occupational burnout are based on stress management interventions, social support, employee decision-making participation, employee engagement, a high level of autonomy and control, and high quality performance management (Adamopoulos, Syrou, 2022; Gabriel, Aguinis, 2022).

3. Methodology of research

The subject of the study is the phenomenon of professional burnout among direct customer service employees in a selected Polish bank. Under the influence of professional burnout, the employee reacts disproportionately to the circumstances, and the associated stress affects mental functioning, which also has various consequences. The main purpose of the article is to identify and analyze the causes and symptoms of professional burnout among customer service employees. The article also formulates the following research questions: (1) How does the syndrome of job burnout manifest itself among customer service employees in a banking sector unit? (2) What are the causes of professional burnout syndrome?

In order to achieve the purpose of the article and answer the research questions, an empirical study was conducted in a selected entity. The tool used to conduct the study is a Polish adaptation of the OLBI (The Oldenburg Burnout Inventory) questionnaire of occupational burnout. The OLBI questionnaire was developed by Demerouti in 1999 (Demerouti et al., 2003) and the study used its Polish adaptation developed by Chirkowska-Smolak (2018). The tool provides an opportunity to measure two dimensions of burnout (and engagement): exhaustion and commitment withdrawal/cynicism. The questionnaire contains 16 items, eight items to measure each dimension. Each subscale contains four items worded in a positive way (e.g. "When I work, I usually feel full of energy"; "I always find new and interesting sides to my work") and four worded in a negative way (e.g. "There are days when I feel tired even before I go to work"; "Sometimes I get sick at the thought of work") (Chirkowska-Smolak, 2018). The survey used a 4 point Likert scale, ranging from 1 (strongly agree) to 4 (strongly disagree), with no central (undecided) option. After recoding the results of the reverse-phrased items, the average for each subscale is calculated - a high score indicates professional burnout. In addition, the questionnaire was supplemented with questions about respondents' feelings about the causes and symptoms of professional burnout and the employer's assistance and involvement in this area. Respondents were asked about: the symptoms of professional burnout they noticed in themselves, the symptoms associated with experiencing professional burnout, the most stressful factors during their professional work, and where they seek help and whether the employer takes measures to eliminate this phenomenon.

Table 1.
Sample description

Respondent	Statistics	
Age	20-25	38 %
	26-35	59%
	35-50	3%
	> 50	0%
Gender	Male: 35	58%
	Female: 25	42%
Work experience	< 5	52%
	6-10	30%
	> 10	18%

Source: own study.

The survey was conducted among 87 direct customer service employees in branches of a selected Polish bank, located in the Silesian province. The survey was conducted in January 2024 in the form of an online questionnaire. The link to the questionnaire was distributed to 87 employees of the selected bank branches via business mail. 60 completely completed questionnaires were received back. The description of the research sample is included in Table 1. The survey questionnaire was completed by 60 respondents, among them were 35 men and 25 women, those aged 26-35 accounted for 59%, those aged 20-25 accounted for 38%.

The smallest group (only 3%) were respondents aged 35-50, there was no respondent in the group over 50. In the surveyed group, the largest group were employees with seniority of less than 5 years (52% of respondents). Another group consisted of employees with seniority of 6 to 10 years (30% of respondents), the least numerous group are respondents working for more than 10 years (18% of respondents).

4. Results

The OLBI burnout questionnaire, which contains test items of both positive and negative nature, allows assessing the degree of burnout among a selected group of respondents. The tool consists of two main dimensions: exhaustion and lack of commitment. The results will first be presented to indicate whether there is a syndrome of professional burnout, i.e. responses negatively defining working conditions in the company. This will make it possible to find out the factors influencing such feelings of the respondents and indicate areas in need of change. Questions defining the dimension of lack of commitment, namely those numbered: 1, 3, 6, 7, 9, 11, 13, 15 illustrate distancing from work. These items are designed to determine the employee's relationship with his job, his identification with his position and his desire to continue employment of this nature. The answers given to each question are presented in Table 2.

Table 2.
Dimension of lack of involvement

Statement	Strongly agree	Agree	Disagree	Strongly disagree
1. I always find new and interesting aspects of my work.	8	24	16	12
3. I increasingly often speak negatively about my work.	5	9	29	17
6. Lately, I have been thinking less and less at work and have begun to do my job routinely.	21	32	7	0
7. I encounter positive challenges at work.	3	28	20	9
9. Over time, a person begins to distance themselves from what they do at work.	11	17	24	8
11. Sometimes I feel sick thinking about work.	7	19	14	20
13. This is the only kind of work I can imagine doing.	0	9	7	44
15. I feel more and more committed to my work.	1	32	11	16

Source: own study.

The second part of the questionnaire, i.e. questions: 2, 4, 5, 8, 10, 12, 14, 16 concerned the dimension of exhaustion. The distribution of answers is presented in Table 3.

Table 3.
Dimension of exhaustion

Statement	Strongly agree	Agree	Disagree	Strongly disagree
2. There are days when I feel tired even before I leave for work.	3	16	32	9
4. I need more time after work to relax and feel better.	10	13	22	15
5. I can handle the demands of my job (work pressure) quite well.	24	24	12	0
8. I often feel emotionally drained during work.	4	11	36	9
10. After work, I have enough energy to engage in activities that I enjoy.	30	10	11	9
12. After work, I usually feel exhausted and worn out.	7	14	15	24
14. I usually cope well with the amount of work I have to do.	13	31	11	5
16. When I work, I usually feel full of energy.	0	32	12	16

Source: own study.

The collective analysis of the questionnaires illustrates the overall feelings of the respondents towards work. In order to identify the employees who experience burnout syndrome or are at risk, a score was calculated for the individual responses. The results indicate that approximately 26% of employees experience burnout syndrome, while 16% are at high risk of its occurrence.

The next part of the study concerned the symptoms and causes of burnout among customer service employees. The first question aimed to identify the physical symptoms of burnout. Symptoms related to sleep disorders, difficulty concentrating, headaches and discouragement

seem to be the most frequently reported by respondents. The results of the study indicate that abdominal pain is more common in women, while increased sweating is more common in men. Respondents were then asked about symptoms of burnout that affected them directly. The vast majority of respondents indicated a feeling of failure and guilt. This indicates a significant challenge related to self-esteem and the pressure that may be present in the work environment. Another significant symptom is the routine performance of work, monotony and lack of variety in the performance of duties, which can lead to a loss of interest and commitment to work. Problems in interpersonal relationships are also observed, such as isolation from co-workers and a lack of trust in them. This indicates the existence of difficulties in communication and building relationships in the workplace. Some respondents experience reduced motivation and lack of energy to work. These symptoms indicate physical and mental exhaustion associated with performing daily professional duties.

The next question asked respondents' opinions of the most stressful and aggravating factors in their position. Inadequate wages were cited as the most important area of stress, suggesting that salary levels are a key aspect affecting the stress levels of customer service employees. Next indicated were conditions for personal development and job security. This confirms that from career perspective, speed of professional development and a sense of job stability have a significant impact on stress levels in this occupational group. The vagueness of goals, excessive or contradictory demands and limitation of initiatives, low level of participation in decision-making, inadequate evaluation of service activities are also significant sources of stress among respondents. Difficulty reconciling professional roles and family responsibilities, and physical and organizational working conditions are other factors identified as sources of stress, but with a much lower percentage of indications than the previous factors.

The next question asked respondents to indicate what activities, actions they reach for in situations where they face work-related stress. Differences in responses between the sexes in ways of coping with stress are noticeable, but there are also some common patterns. Gathering with family and friends is popular among both sexes. Sleep is a common way, but women seem to use this form of stress management more often. Physical activity is chosen by both sexes, but more often by men. Women, on the other hand, are more likely to choose reading books. Housework and shopping are more often chosen by women than men. Substance use such as alcohol, cigarettes and coffee is used by both sexes. Other modalities, such as meditation, art and hobbies, are more often chosen by men.

Next, an effort was made to discern whether respondents seek help and to whom they report in case of professional problems. The results indicate that most respondents seek help from their supervisor. This may suggest that there is trust in management in the workplace and an expectation of support from direct superiors. Analysis of the results from a gender perspective reveals that men and women have some differences in preferences. The results indicate that women are more likely than men to seek help from immediate family members. Respondents seem to prefer social support in the form of help from friends, colleagues and

family, which may indicate the importance of interpersonal relationships in terms of coping with work problems. Some respondents also declare that they do not seek help from anyone. This phenomenon requires in-depth analysis, which may include issues of shyness, a sense of independence, or a lack of confidence in available sources of support. Although the option of seeking help from a specialist was not the most frequently chosen option, about 17% of respondents seek help from experts. The results indicate that about 45% of respondents feel support from their employer for stress management, such as access to specialists. Employees appreciate the transparency and clarity of communication. Respondents also appreciate a clear bonus and bonus system. 61% of respondents consider their workplace to be friendly, while appreciating feedback from superiors.

5. Discussion and conclusion

The purpose of the article was to identify and analyze the level, causes and symptoms of job burnout among customer service employees. The article also formulated the following research questions: (1) How does the syndrome of professional burnout manifest itself among customer service employees in a banking sector unit? (2) What are the causes of professional burnout syndrome?

Analyzing the results obtained, it can be seen that a large part of the respondents do not find interesting sides of their work. Almost half of the surveyed customer service employees do not encounter positive challenges in the workplace. This may indicate insufficient motivation of employees due to a lack of appreciation and inspiration to act and carry out their duties. This often causes frustration and lowers work efficiency. It is also possible that negligence related to the area of professional development, such as failure to invest in the development of the competencies of the people employed or to enable internal promotion, is the cause of such a state. The survey results also indicate that almost $\frac{3}{4}$ of the respondents are thinking less and less in their work and begin to perform it routinely. A significant number of respondents are beginning to gain distance from what they do, while almost half of the respondents do not feel engaged in their work. Performing daily activities according to the usual routine and monotony can become tiring, which, as indicated earlier, is one of the factors influencing the occurrence of job burnout, a decrease in quality and commitment to work. Boring, routine work is also a common cause of mistakes.

In addition, 23% of respondents say they are increasingly negative about their work, and almost $\frac{1}{4}$ of respondents feel negative emotions at the thought of it. On the other hand, it is worth noting that as many as 85% of respondents believe that this is not the only kind of work they could do. This means that a large number of those employed do not identify themselves with the company, and perhaps treat work in the company only, as a temporary

position on their career path. These results may also suggest a reason for the high turnover of employees in the customer service department of the entity under study.

The results of the empirical research conducted indicate that 1/3 of the respondents have such days when they feel exhaustion even before they leave for work. Exhaustion is a state of fatigue in the body as a consequence of intense physical exertion and mental and emotional tension associated with work. Nearly one-third of those surveyed feel exhausted and worn out after work, a similar percentage indicating that after work they no longer have enough energy to engage in various pleasure activities. It is noteworthy that as many as almost half of those surveyed say they need more to relax and recuperate after work. Long-term fatigue is one of the main factors in the formation of burnout syndrome, leading to a decrease in efficiency, an increased risk of making mistakes, and thus a decrease in the overall productivity of the company. An important aspect is the adjustment of the number and type of duties to the predisposition and qualifications of employees. Some of the respondents indicated that they were uncomfortable with the demands of the job (time pressure) and that they could not cope with the amount of work to be done. Emotional exhaustion during work is felt by almost half of the surveyed direct customer service employees. Analyzing the empirical results obtained, it should be borne in mind that working directly with customers in a banking establishment involves many challenges, among them is working under time pressure and stress, or dealing with various problems and moods of customers, even more so in the sphere of finance and banking.

Among the main symptoms they noticed in themselves, respondents identified those related to sleep disturbances, difficulty concentrating, headaches and discouragement. This suggests that these aspects may be strongly related to the experience of job burnout. There are some differences between the responses given by men and women, especially in the context of headaches, sleep disturbances and difficulty concentrating. These differences may be related to individual experience at work and may indicate the diversity of individual responses to occupational stress in this professional group.

In conclusion, the results suggest that customer service employees at banking facilities experience a variety of symptoms associated with job burnout, including both physical and emotional aspects. It is important to take care of mental health and the emotional realm in the workplace, and identifying these symptoms can be crucial for effective preventive action. The analysis of responses in the area of burnout draws a picture of a multidimensional phenomenon, the effects of which are felt by direct customer service employees. Feelings of fatigue, lack of positive feelings and challenges, feelings of failure, interpersonal problems, monotony at work and loss of motivation and energy are the main aspects of this phenomenon. Analyzing these aspects allows us to gain a deeper understanding of the preferences of direct customer service employees to seek support when certain problems occur. It is important to take into account gender differences and identify potential areas where the employer can introduce additional support.

The main limitation in this research is the selection of a sample, i.e. customer service employees of a selected entity of the banking sector in Poland. Among the customer service employees of the banking sector, in particular those servicing the area of loans and advances, the uncertain economic conditions and the global crisis are not without significance for the generalization of the results in the analyzed context of burnout.

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ANALYSIS OF THE PACKAGING OPTIMISATION PROCESS USING A SELECTED PRODUCT AS AN EXAMPLE

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Purpose: Packaging plays a key role in modern industry, serving not only a protective function, but also marketing, information and environmental functions. This literature study on packaging aims to understand packaging technologies, innovations being introduced and the application of lean principles to optimise packaging processes. The introduction to this study includes an overview of the basic functions of packaging, its impact on the product life cycle and the growing importance of sustainability in the context of ecology. As global markets become increasingly competitive, companies are looking to minimise costs and waste by implementing lean methodologies. A key aspect of the study is to identify the most effective tools used in lean packaging that contribute to supply chain optimisation, cost reduction and increased product quality. An analysis of the literature will provide an understanding of how innovative packaging approaches can enhance the competitiveness of companies in the global marketplace. The article discusses the various types of packaging used in the company. It focuses on the implementation of lean packaging principles to minimise waste and increase the efficiency of packaging processes. One of the key elements of the article is the presentation of a new type of packaging that has been designed to increase the number of packages that fit on a single pallet. This makes it possible to reduce the amount of ‘air carried,’ which translates into optimised transport and storage costs. The new packaging is characterised by its ergonomic shape and the possibility of greater compression, allowing more efficient use of pallet space. The implementation of this innovative solution contributes to a significant improvement in logistical efficiency within the company.

Design/methodology/approach: This article briefly reviews the literature in the area of lean management and lean packaging and packaging concepts. A simulation method - mathematical calculations - has been used. Observations were also made of packaging methods and an analysis of the packaging procedures and guidelines in place at the company under study.

Findings: The aim of this paper was to analyse the packaging of clips in the company under study using lean packaging tools and a simple simulation of the proposed solution options.

Practical implications: Companies should constantly analyse the packaging solutions they and their competitors use and aim to exclude those that are harmful to the environment and not cost-effective for the company itself. Other packaging-related problems, besides under-utilisation of loading space, include: inadequate securing of goods, poor labelling of packaging (incomplete information about the contents of the package on the label), half-empty trucks due to the inability to stack pallet units, negative environmental impact, etc. Most of these problems lead to financial losses for the company, which is why it is important to act preventively and design product packaging wisely with the help of specialists, as this will lead to tangible benefits.

Originality/value: Since the selection of appropriate packaging, the arrangement of goods in individual and collective packaging and their adequate protection are aimed at maximising the number of packages on the pallet, reducing transport and storage costs and the risk of damage to the goods, the topic addressed is relevant to the activities of the company under review.

Keywords: lean management, lean packaging, packaging, space optimization.

Category of the paper: case study.

1. Introduction

Regardless of the type of goods a company intends to store, sort and deliver to its customers, transport packaging is an absolute must in manufacturing, trade and logistics. Today, approximately 97% of all goods manufactured worldwide require packaging, and a large percentage of these cannot be transported without packaging. The packaging itself has functions: informational, manipulative, protective, transporting, but also marketing functions: the attractiveness of the packaging determines the amount of sales, and many products, such as alcohols, sweets or cosmetics, are bought more because of the packaging than the content itself (Kozar, 2023; Motowidlak, 2023; Kamińska, 2020; Świętoń, 2020; Dudziński, 2014). This is because in marketing, ‘it is assumed that packaging gives the commodity its “personality”, becoming its business card enabling the consumer to notice “his” commodity and recognise it among many similar ones (Malinowska, 2011; Ratajczak, 2021). Packaging is an essential element for both transport and storage management, and performs many functions that benefit both the packaged goods and the environment. The main participants in the global packaging market are the European Union countries, the United States, Japan and China. In contrast, the US is the largest user of packaging, followed by China, which will overtake the US, according to a report compiled by Smithers Pira (Rodriguez, 2024). The US packaging industry is estimated to grow from 713.7 billion units in 2021 to 764.5 billion units in 2026¹. The global packaging market is forecast to grow at a compound annual growth rate (CAGR) of 3.9% between 2023 and 2028. Growth is expected to slow to a 2.1% CAGR between 2028 and 2050. The global packaging market is expected to reach US\$2.23 trillion by 2050. Per capita consumption of packaging is expected to increase globally by 2050, with the fastest growth rates in low- and middle-income regions. These markets have significant room for expansion as more consumers move from minimal or informal packaging solutions to more standardised, formal packaging options (Rodriguez, 2024). Changing demographics and differences in packaging needs mean that packaging consumption markets vary around the world. The packaging industry is constantly evolving, influenced by demographic changes, economic development and consumer demands. Low- and high-income countries show different

¹ <https://www.bonfiglioliconsulting.com/en/learning/whats-next-trends-and-opportunities-in-the-us-packaging-industry/>, 9.2024.

packaging needs; for example, the desire for sustainability and premium packaging in high-income countries is not the same as in lower-income regions. These key trends are studied in detail, along with the impact of population growth and decline, as well as demographic changes on product consumption and packaging development. In 2020, more than 6.5 million tonnes of packaging entered the Polish market (GUS, 2022). According to the new proposal, all packaging on the EU market must be recyclable or reusable by 2030 and packaging waste is to be reduced by 10% by 2035². The structure of the packaging market by the construction material used clearly shows that the packaging produced globally is mainly made of paper and cardboard and plastics. 40% of the plastic and 50% of the paper used in the EU is used for packaging (Projekt rozporządzenie PPWR, 2022). Metal packaging also occupies a fairly significant share of the market (17.3% world, 18.2% Europe), while only a small amount of packaging is produced from glass, wood or other materials. The consumption of packaging both in Poland and globally is increasing year by year. Between 2009 and 2019, the amount of packaging waste generated in the European Union increased by 13.6 million tonnes (20.5%) (GUS, 2022). In Poland, the mass of municipal waste generated in 2021 was 13.7 million tonnes, an increase in generation of more than 4% compared to the previous year³. According to experts' predictions, in the coming years, the Polish packaging market will approach the markets of developed Western European countries in terms of structure. The share of paper and cardboard packaging will increase by about 4-5%, while the share of metal packaging will decrease. Such a high consumption of packaging in both the largest world economies and developing economies drives the packaging market and forces it to provide new solutions that will translate into benefits for producers, consumers, packaged goods and the environment. The multifaceted nature that packaging must have in today's economy makes it an extremely interesting topic to research and then use as an element to improve logistics processes in companies and supply chains (Sastre, 2022).

2. The role of packaging and lean packaging

Packaging logistics plays an important role in today's economy, as well-chosen packaging can significantly increase a company's market share (Bányai, 2023; Morashti, 2022). According to the Polish Committee for Standardisation, packaging is a product used to protect other products from damage, as well as to protect the external environment from any impact of the packaged product. DIN 55 405 specifies that packaging consists of (Wyszkowska 2013):

² <https://www.rajapack.pl/blog-pl/przepisy-dotyczace-opakowan-w-roznych-krajach-jak-dostosowac-sie-do-miedzynarodowych-wymogow-prawnych>, 9.2024.

³ https://ungc.org.pl/wp-content/uploads/2024/06/Gospodarka_obiegu_zamknie%CC%A8tego_w_opakowaniach.pdf, 9.2024.

- packaging media - products of packaging materials that are designed to cover and hold packaged goods together,
- packaging materials - the materials from which packaging is made,
- auxiliaries - any means which, together with the packaging means, serve to package and close and prepare the goods for shipment.

Packaging plays a very important role in supply chains, as without transport packaging that is properly designed and manufactured, the proper functioning of the supply chain is not possible (Biuletyn..., 2016, p. 2). They perform extremely important functions in companies. Packaging is an element that conditions the correct and efficient flow of transport, production and also storage processes (Jedlinski, 2021).

The following packaging functions can be distinguished (Wozniak, 2011):

- production function - it allows the preparation of the right amount of products, components needed at the input of production, and the reception of the right amount of goods at its output,
- marketing function - in marketing terms, packaging plays an important role. It enables the product and the company to stand out from the competition,
- utility function - this refers to any reuse of packaging by the buyer, or use for other purposes,
- logistical function - this function facilitates all transport, storage and handling operations. Packaging is most often provided with special logistics labels that facilitate the tracking of goods in the system and also allow the identification of warehouse locations.

Packaging in terms of logistics should fulfil a number of functions, which include (Bendkowski, 2002; Cyrek, 2015):

- protective function - aimed at protecting goods from deterioration, or loss of quality, caused by mechanical, climatic or human factors,
- transport and storage function - aimed at facilitating all transport and storage processes through the appropriate dimensions of packaging, adapted to the area and capacity of transport and storage means,
- handling function - to facilitate mechanical or manual handling work,
- recycling and environmental function - a function that allows packaging to be reused for its original purpose or for other purposes, and to be disposed of appropriately,
- information function - packaging is a kind of information carrier. This function refers to the control of processes related to the protection of product quality throughout the production cycle.

The broad set of packaging functions translates into the maintenance of a positive level of customer service, allowing the logistical 7W principle to be realised, as not only are the products delivered in the right quality, but they are also delivered in the right quantity at the

right time (Roncero, 2021). Packaging has many important functions and many different types of packaging have been developed to fulfil these functions. Each type of packaging is adapted to specific conditions and accepted norms and standards. Packaging can be divided according to (Mruk, 2001):

- the essential role they perform,
- the type of material from which the packaging is made,
- construction or shape,
- the possibility of using it in marketing.

There are many types of packaging, each with many different requirements⁴. Packaging is considered from the environmental aspect - biodegradable and non-biodegradable, from the marketing aspect - active (influencing demand) and passive, which do not influence consumer choices. In the distribution aspect, a distinction can be made, for example, between rented packaging or packaging included in the price of the goods (Driscoll, 2020). In logistics, a distinction is made between transportable, code-marked and non-code-marked packaging, stackable packaging and packaging where stacking is not possible. Lean Management is the choice for those companies that want to improve organisational agility and thus meet the conditions of today's ubiquitous and aggressive competition. 'The truth is that Lean Management is the most strategic approach you can use to transform your business' (Byrne, 2013). Although Lean Management has its origins in the manufacturing enterprise and was known as Lean Manufacturing, as its popularity grew, the name of the concept was transformed into Lean Management (Walentyńowicz, 2013). Once improvements were achieved and consolidated in manufacturing areas, attempts were made to apply Lean principles and methods to other areas, or types of business, in order to gain a significant competitive advantage there too. Hence names such as Lean Office, Lean Development, Lean Administration, Lean Healthcare, Lean Service, Lean Logistics or Lean Packaging. These are developments of Lean Management and the application of its assumptions and instruments to the organisation and management of non-manufacturing areas in a manufacturing company or in other activities. Lean packaging aims to minimise waste and maximise efficiency. The idea is to use fewer resources and reduce costs at the same time. Lighter materials, recyclable options and a reduction in unnecessary components are used. This derives from the concept of lean manufacturing, which has its roots in the Toyota Production System. Lean packaging is an approach that draws heavily on the philosophy of lean manufacturing, or waste-free production. The key principles are^{5,6} (Wandosell, 2021):

- Minimising waste: Using packaging that generates as little waste as possible. This can include reducing the use of plastic, using reusable packaging or biodegradable materials. Reducing waste means using packaging that is not only lighter but also easier to recycle.

⁴ <https://3lp.eu/rodzaje-opakowan-i-ich-funkcje-w-logistyce/>

⁵ <https://lean.org.pl/transformatcja-lean-schumacher-packaging/>

⁶ <https://www.econocorp.com/packaging-efficiency-and-lean-manufacturing-strategies-for-success/>

For example, many companies are switching to packaging made from biodegradable or compostable materials such as paper or cornstarch.

- **Space optimisation:** Designing packaging to maximise the use of space during transport, which reduces costs and CO2 emissions. Designing packaging that makes optimal use of space is key. Compact packaging helps maximise the use of available space in transport vehicles, which in turn reduces the number of transports needed. This in turn reduces CO2 emissions and transport-related costs.
- **Innovation in materials:** The use of modern materials that are lighter and more durable, which also helps to reduce costs and waste. Technological advances are making it possible to create new materials that are both lighter and stronger. An example is multilayer laminates, which combine the properties of several materials while offering greater product protection⁷.
- **Processes and technologies:** the use of modern technologies and automation in the packaging process, which increases efficiency and quality. Automation and advanced technologies play a key role in lean packaging. The use of robotics and vision systems allows for more precise packaging of products, which reduces the risk of errors and increases process efficiency.

This approach is particularly important in the context of rising material costs and environmental awareness. Space optimisation is a key element of lean packaging, which focuses on maximising the use of available space when transporting and storing products. Here is how this can be achieved⁸ (Galvan-Nina, 2022; Chruściel, 2022; Barbosa, 2024):

1. **Compact packaging:** Using packaging that perfectly fits the dimensions of the product, minimising empty spaces. For example, instead of using standard boxes, packaging adapted to the shape and size of the product can be used.
2. **Modular packaging systems:** Using packaging that can be easily stacked on top of each other, like blocks. This allows for efficient use of vertical space in warehouses and transport vehicles.
3. **Design for optimisation:** Engineers can use CAD tools to design packaging that maximises the use of space. These programmes create simulations that show how best to arrange products to minimise wasted space.
4. **Multifunctional packaging:** Packaging that is used not only for transport, but also for storing products without the need for additional containers. For example, containers that can be used both in transport and in shop as displays.
5. **Using tape to bind the packaging:** Instead of using larger boxes, products can be bound with tapes or film, allowing for more flexible placement in the transport space.

⁷ <https://www.packaging-gateway.com/features/lean-packaging-reduce-waste-increase-productivity/>

⁸ <https://www.econocorp.com/packaging-efficiency-and-lean-manufacturing-strategies-for-success/>

These techniques and strategies not only help to save space, but also contribute to lower transport and storage costs and reduce environmental impact.

Lean packaging is applicable across industries, adapting to the specific needs of each sector⁹ (Urban, 2023; Womack, 2003; Nowak, 2018; Packaging Cans..., 2024). Here are some examples:

1. Food industry: food companies are using packaging that is lighter and easier to recycle. For example, some brands are switching to packaging made of biodegradable materials that not only protect products but also reduce environmental impact (Geueke, 2018).
2. Cosmetics industry: reusable and refillable (refillable) packaging is popular in the cosmetics industry. Customers can purchase products in refillable packaging, which reduces waste (Magnier, 2015).
3. E-commerce industry: online shops use packaging that is optimised for shipments. These are often modular packaging that can be adapted to different product sizes, minimising empty space in the parcel and reducing transport costs.
4. Electronics industry: electronics companies often use advanced packaging technologies to protect fragile products while reducing package size. For example, moulded cardboard inserts are used, which fit perfectly into the shape of the devices.
5. Pharmaceutical industry: In the pharmaceutical industry, product safety and protection are key. Lean packaging helps to optimise packaging processes, reducing material waste while ensuring adequate protection of drugs and supplements.

These examples show how versatile and effective solutions based on lean packaging principles can be (Innovations..., 2024). The tasks of lean packaging focus on several main objectives (Gaspersz, 2011):

- Waste minimisation: Reducing the amount of waste generated by packaging, both during production and after use of the product.
- Cost optimisation: Using materials and processes that are economically efficient, reducing packaging and logistics costs.
- Increasing efficiency: Improving packaging and transport processes to make them as efficient and less time-consuming as possible.
- Improving sustainability: Using environmentally friendly materials and introducing practices that aim to reduce the carbon footprint.
- Improving customer satisfaction: Creating packaging that is easy to use, aesthetically pleasing and functional, resulting in a better customer experience.

Lean packaging is an approach that aims to reduce waste and increase efficiency in packaging processes, while maintaining quality. Implementing lean principles in packaging can lead to significant cost savings, improved productivity and customer satisfaction.

⁹ <https://www.packaging-gateway.com/features/lean-packaging-reduce-waste-increase-productivity/>

3. Analysis of the current packaging and possibilities of improving the packaging for the selected article

The analyzed company prefers pallet units with a uniform design, which is optimal throughout the supply chain and with dimensions of 1200x760 mm and 1140x800 mm, which are the optimal solution for both container sea transport and land transport. Additionally, the maximum height of pallet units is 1000 mm, as the entire supply chain is adapted to this height and any changes in this dimension negatively affect the loading capacity and transport efficiency. In order to better use the means of transport in terms of their cargo capacity, so-called filling solutions are used, i.e. a solution consisting in the full use of the cargo capacity of the means of transport by temporarily separating the cargo unit during transport. The analyzed company aims in its activities to eliminate pallet units that cannot be stacked, as they limit loading possibilities. The company has a three-level classification of pallet units based on their stackability:

1. Type 3 – stacking of up to 2 pallet units with a weight similar to the pallet unit, which is the base on which the next pallet units are placed (2 x the gross weight of the pallet unit).
2. Type 2 – stacking of up to 1 pallet unit with a weight similar to the pallet unit, which is the base on which the next pallet units and the top filler are placed (1.5 x the gross weight of the pallet unit).
3. Type 1 – stacking of any pallet unit and the top filler with a weight specified by the manufacturer-supplier (usually the gross weight of the stacked pallet unit is equal to the weight of the pallet unit on which the base is placed).

The preferred solution by the company is type II packaging, while the least desirable is type I and packaging that cannot be stacked. The maximum weight that can be stacked on a pallet unit should be specified by the manufacturer. In order for a pallet unit to be considered stackable, the following conditions must be met during testing:

- a) no damage or permanent marks on the packaging or its parts (here understood as: individual packaging, collective packaging, pallet unit), on materials intended for handling and on the product itself,
- b) no effects that lead to non-compliance with other requirements contained in the standards.

Pallet units that are not stackable must be marked in an appropriate manner. A special label must be placed on the left side of the pallet unit label. Information on the possibility of stacking pallet units is also very useful when arranging goods in the warehouse.

In addition to the most obvious requirement for packaging, i.e. that it has no impact on the price of the product, it should also be: convenient to transport, handy (i.e. it should be possible to remove it from the shelf, transport it to the car, bring it into the apartment, etc.), matched to the product so that it does not move inside the packaging (protective function) and easy to open.

The most commonly used packaging material is cardboard, while the company constantly strives to minimize the amount of packaging materials used. Technicians responsible for designing product packaging must take into account the following constraints stemming from the environment (expectations and capabilities of customers, suppliers, supply chain requirements) and the organization's internal environment (needs of the sales network):

- a) no possibility of changing the product design (sometimes a change is permissible), even if it would have a positive impact on transport possibilities (filling rate, fewer transports, etc.),
- b) the need to pack certain products in sets, even if packing them separately would be more beneficial (taking into account the customer's needs),
- c) the need to adapt the dimensions of the packaging to the available handling equipment and means of transport,
- d) the need to adjust the weight of consumer packaging so that the customer can remove the package from the shelf on their own,
- e) taking into account the way a given item is displayed in the store (limited space for product presentation, product intended for a shelf or hanger, etc.).

Taking into account the above-mentioned limitations that packaging designers have to deal with, it can be assumed that the biggest challenge is packing large and heavy furniture. Here, the possibility of packing one item in several packages should be considered, which involves the need for appropriate exposure and clear communication in the store. The design of such packaging is a very complex process and requires many additional analyses and tests, which is why the selection of packaging materials and the creation of a packaging design for such large items usually begins at the product design stage. Unfortunately, it has been noticed that smaller items are not given as much attention, as by definition, many more of them can be transported in one transport than larger products. However, general cargo items have a very large share in the assortment of the analyzed company, and customers are more likely to buy home accessories than furniture. This relationship forces the need for constant availability of smaller items in the store. Well-chosen packaging will help in this case:

- a) ensure the right amount of products in the store,
- b) limit the number of transports necessary to transport a given number of items,
- c) limit the number of pallets used,
- d) reduce transport costs,
- e) increase the margin on the product,
- f) reduce the negative impact on the environment.

A good example of an item whose packaging contributes to the transport of significant amounts of air are food sealing clips. The product is sold in two different packages: 30 pieces per package and 10 pieces per package. A set of 30 clips contains: 20 clips 6 cm long and 10 clips 11 cm long. In a set of 10 clips, all have the same size - their length is 11 cm (Figure 1, 2). Regardless of the set, the clips are 1.6 cm wide and 2 cm thick (Table1).

Table 1.
Dimensions of food clips

Set	Clip height	Clip width	Clip thickness
Set of 30 pieces	11 cm i 6 cm	1,6 cm	2 cm
Set of 10 pieces	11 cm	1,6 cm	2 cm

Source: company materials and after Migdalska A.: Analysis of the packaging optimization process on the example of a selected product. Engineering thesis 2014 supervisor: J. Grabowska.



Figure 1. Food clips set of 10.

Source: www.ikea.pl



Figure 2. Packaging of a set of 30 clips.

Source: www.ikea.pl

Currently, the clips are packed in plastic bags, which also transport air unnecessarily. A bag containing a set of 30 clips has dimensions of 16x18x3 cm (height x width x depth), while a bag for a set of 10 clips has dimensions of 25x18x3 cm. The packaging method is shown in drawings number 3 (Figure 3).



Figure 3. Packaging of a set of 10 clips and 30 clips.

Source: www.ikea.pl

As for the set containing 30 clips, the level of air in the individual package was reduced to a minimum. As can be seen in the photo, the bag is almost completely filled with clips. However, the chaotic way in which they are arranged causes some problems with the arrangement of individual packages in the collective package, which contributes to a decrease in transport efficiency, i.e. the amount of goods transported in one transport. The difficulty here lies primarily in the different sizes of the clips. On the other hand, the package containing 10 clips of the same size is an example of wasting cargo space due to the significant level of air transported in the bag. Table 2 contains a set of data on the packaging solutions used for these products.

Table 2.

Data on packaging solutions for clips

Set	Dimensions of individual package	Dimensions of collective package	Number of individual packages in collective package	Dimensions of pallet unit	Number of individual packages on pallet unit
30 of clips	16x18x3 cm	38x38x29 cm	70 packaging	115x77x93 cm	840 packaging
10 of clips	25x18x3 cm	38x38x29 cm	95 packaging	115x77x93 cm	1 140 packaging

Source: company materials and after Migdalska A.: Analysis of the packaging optimization process on the example of a selected product. Engineering thesis 2014 supervisor: J. Grabowska.

In this paper, an improvement of the packaging of clips will be proposed, while maintaining the following assumptions:

- the dimensions and appearance of the product remain unchanged,
- the contents of the set do not change,
- the possibility of changing the dimensions of the collective packaging,

- d) the dimensions of the pallet unit cannot exceed the dimensions of the Euro pallet 120x80x100 cm,
- e) the new packaging method cannot translate into an increase in the price of the product,
- f) the new packaging method cannot be more expensive than the previous one.

In order to better illustrate the impact of the change in packaging on the company's results in various areas, the following data was adopted, which will help to better estimate the possible benefits of the proposed changes. For the purposes of this case study, it was assumed that the company:

- a) sells about 10 million of each set of clips worldwide per year,
- b) each year, for a set with 30 and 10 clips, respectively, it ships about 12 and 9 thousand pallets (a total of 21 thousand pallets),
- c) the goods are transported in 40-foot containers, which can hold about 45 euro pallets loaded in two layers,
- d) a total of 467 containers with clips must be shipped each year.

In order to identify the best packaging solution, several packaging scenarios were simulated for each set. The first and key change that was decided to be introduced was to replace the plastic bag with a heat-shrinkable film, which perfectly adapts to the shape of the product, reduces the level of air in the package, and additionally protects the products well during transport. The introduction of a new type of packaging also involves the need to properly arrange the clips in order to give them a form that allows the use of heat-shrinkable film.

For a set of 10 clips, two product packaging methods were taken into account - a single-layer package measuring 16x11x2 cm and a two-layer package measuring 8x11x4 cm. The adopted dimensions of the collective packaging are 55x40x33 cm, while the dimensions of the pallet unit are 110x80x100 cm. The unit consists of 3 layers of four cartons each (Figure 4).

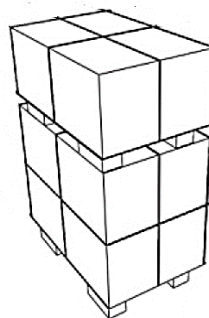


Figure 4. Design of a three-layer cargo unit with dimensions of 110x80x100.

Source: own study.

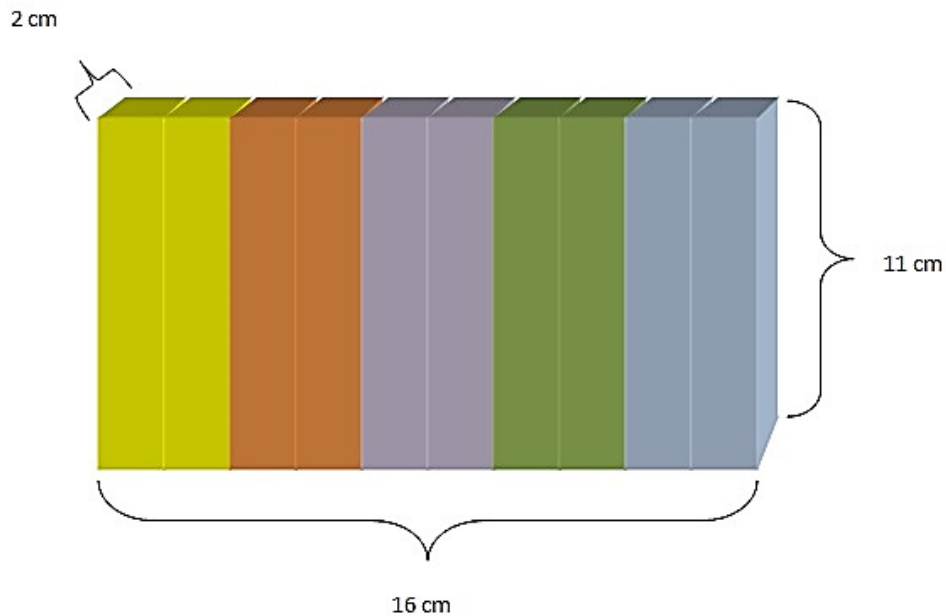


Figure 5. Single-layer clip arrangement – variant 1.

Source: own study.

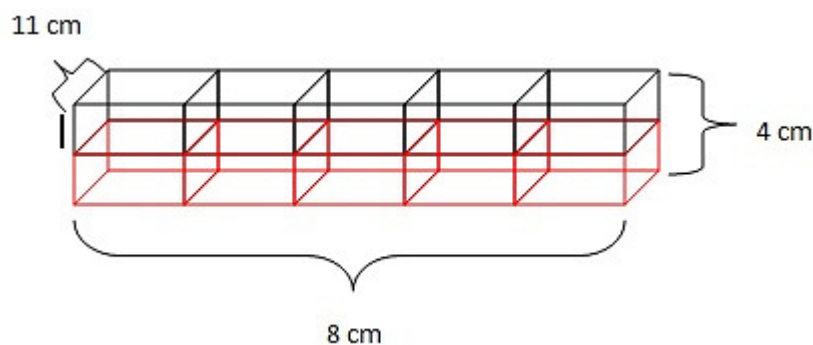


Figure 6. Two-layer arrangement of clips – variant 2.

Source: own study.

For variant 1, three different scenarios were tested (different arrangements of unit packages in the collective packaging). The first scenario (scenario 1.1.) assumed arranging the clips with the shorter side (11 cm) to the longer side of the collective packaging (55 cm). This allowed for the creation of two rows of 5 unit packages in each, leaving a space of 55x8 cm between these rows. The height of the packaging allowed for the arrangement of as many as 16 layers of unit packages. The space in the middle of the collective packaging was filled with an additional 40 unit packages by using the third dimension of the unit package, i.e. 2 cm of the side. Thanks to this solution, it was possible to fit 200 unit packages in the collective packaging. The second scenario (scenario 2.1.) assumed arranging the clips in such a way that the 2 cm side was adjacent to the 40 cm side of the collective packaging, and the 16 cm side was adjacent to the 55 cm side of the collective packaging. This solution turned out to be disadvantageous due to the inability to completely fill the space inside the box, even when using a different arrangement to fill the gaps. This solution allowed for packing 138 clip packages. Similar results were achieved in the third scenario (scenario 3.1.), which assumed arranging the 2 cm clips sideways

to the 55 cm side of the collective packaging. This scenario showed that a maximum of 192 individual packages could fit in the collective box. All scenarios proved that in order to fully use the capacity of the collective box, several arrangements of individual packages should be used, which allows for better filling of the packaging space. The first scenario was considered the most advantageous, which practically allowed for the elimination of transported air, while optimizing transport efficiency. Figure 7 shows a top view of the filled bulk packaging.

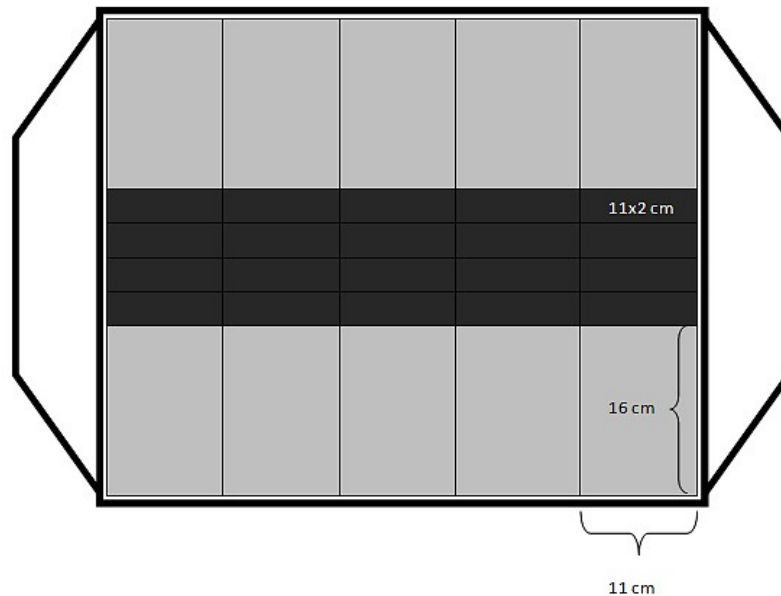


Figure 7. Scenario 1.1. – arrangement of clips packed in 10 pieces, single layer, in a collective package measuring 55x40x33 cm.

Source: own study.

The packages marked in light grey are arranged, as mentioned earlier, in 16 layers, while the dark grey packages are arranged in 2 layers. In total, the collective package holds 200 individual packages. Interesting observations were provided by conducting the next 3 simulations for variant 2. Arranging ten clips in 2 layers allowed for 200 individual packages to be placed in the collective package in as many as two scenarios. The first of them (scenario 1.2.) assumed the arrangement of 8 layers 4 centimetres thick and 25 individual packages in each. This effect was achieved by arranging the clips with an 8 cm side along the 40 cm side of the collective package. As a result, we obtained a result of 200 individual packages in the collective package. The second scenario (scenario 2.2) allowed the same result to be achieved by arranging the clips with a 4-centimeter side along a 40-centimeter side and an 11-centimeter side along a 55-centimeter side. In this arrangement, we obtained 4 layers 8 centimeters thick, each containing 50 individual packages. The last scenario (scenario 3.2), in which the clips were arranged with a 4-centimeter side along a 55-centimeter side of the carton, turned out to be completely unprofitable due to the fact that too much free space was left, which could not be filled in any way due to the incompatible dimensions of the individual packages. Of the two scenarios providing for the storage of 200 individual packages in

a collective package, scenario 1.2 is preferred, as the narrowest side (4 cm) of the individual package is arranged in such a way that the height of each layer in the collective package is translated. The individual packages are laid flat, which makes them more stable, and this method of packaging significantly speeds up and facilitates the process. In the case of a solution where the individual packages are laid vertically and the 4-centimeter side is the base, the packers have to spend additional time stabilizing the packages during loading - the narrow base causes the individual packages to tilt and are not tipped over. Below is a visualization of the preferred arrangement of clips packed in 10 pieces in two layers.

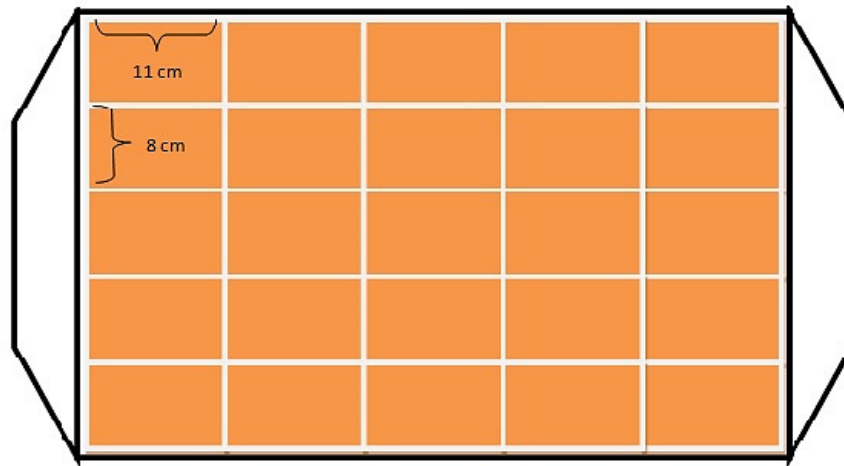


Figure 8. Scenario 1.2. – arrangement of clips packed in 10 pieces in two layers of 5 pieces each, in a collective package measuring 55x40x33 cm.

Source: own study.

The results of the presented simulations are summarized in the table below.

Table 3.

Summary of results obtained during simulation scenarios

Criterion	Scenarios					
	1.1.	2.1.	3.1.	1.2.	2.2.	3.2.
Number of unit packages	200	138	192	200	200	176
Number of layers	16 i 2	3	2	8	4	4
Method of arrangement***	11x16x2 cm	16x2x11	2x11x16 cm	11x8x4 cm	11x4x8 cm	4x11x8 cm
Unfilled space	no	yes	yes	no	no	yes

*** dimension placed along the longest side of the collective packaging (55 cm) x dimension placed along the shorter side of the collective packaging (40 cm) x dimension corresponding to the height of the collective packaging.

Source: own study.

Based on the data presented above, it can be stated that the optimal number of unit packages in a collective package with the dimensions we have adopted is 200 pieces. With a pallet unit made of 12 collective packages, the number of unit packages on a pallet is 2,400 pieces, which increases the number of consumer packages on a pallet unit by 1,260 pieces or 110%.

This change allows for a reduction in the number of pallets shipped worldwide annually from 9 to 4 thousand, and consequently the number of containers (transports) from 200 to 89 per year. Such a decrease in the number of pallets shipped and transports performed also translates into a reduction in CO₂ emissions into the atmosphere, as well as a reduction in the amount of packaging materials used, which also has a positive impact on the natural environment.

Set of 30 clips – scenarios

Similar scenarios were generated and tested for a thirty-piece set of clips. Two alternative packaging options were considered again – single- and double-layer. Then, the impact of the arrangement of individual packages in the collective carton on the number of packages that could fit in it was examined. In this case, it was also decided to use heat-shrinkable film, as it is cheaper than plastic bags and, in addition, it minimizes the amount of air transported in the package, as it adheres perfectly to the product. Due to the specificity of the product, the collective package was widened by 1 cm and has dimensions of 56x40x33 cm. Two methods of packaging sets of 30 clips are visualized below.

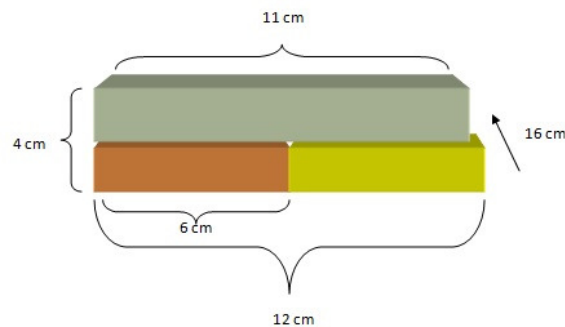


Figure 9. Two-layer arrangement of clips – variant 1.

Source: own study.

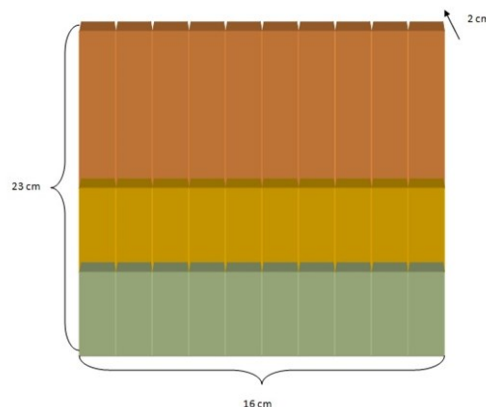


Figure 10. Single-layer arrangement of clips – variant 2.

Source: own study.

Four different scenarios were simulated for each variant. Possible ways of arranging consumer packages were tested, but none of the obtained results proved sufficiently satisfactory. Although using both variants it was possible to increase the number of consumer packages in collective packages, it was not possible to completely eliminate the transport of air in collective packages. Each scenario involved the need to leave a smaller or larger fragment of unused space inside the package. The best results for the first variant were obtained in the scenario that assumed:

- a) arranging individual packages with a 4-cm side along the shorter side of the collective package (40 cm) and a 12-cm side along the longer side (50 cm),
- b) filling the free space with 12 additional packages,
- c) arranging two layers of individual packages.

As a result of this packaging method, the collective carton contained 92 individual packages, which is 22 more than with the current packaging method. The remaining scenarios allowed for the storage of 90, 88 and 62 pieces of individual packages in the collective packaging. The four scenarios carried out for the first variant yielded significantly worse results. The obtained results indicated the possibility of storing 93, 74 and 68 individual packages in the collective packaging. In this case, too, it was not possible to eliminate unnecessary air in the packages. Additionally, storing so many individual packages requires arranging them in several different ways in the collective packaging. This solution is disadvantageous due to the fact that it is much more labor-intensive and time-consuming. Slowing down the packaging or increasing its level of complexity generates additional costs, and the company tries to avoid such solutions. Below are visualizations of two packaging scenarios that allowed for the storage of the largest number of individual packages in the collective packaging. Unused space in the packaging is marked in black.

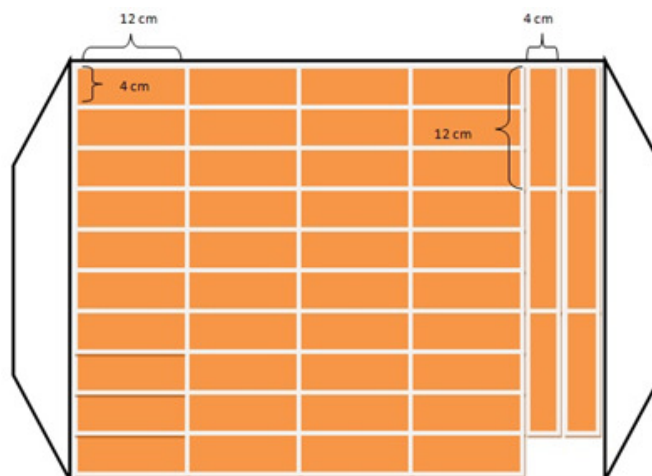


Figure 11. The best scenario among all simulated for variant 1.

Source: own study.

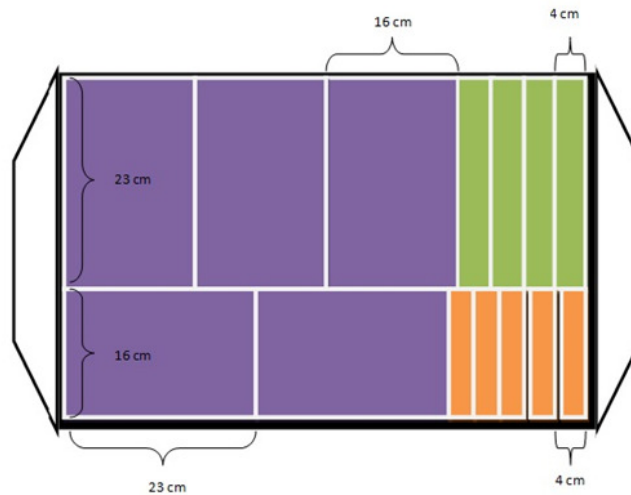


Figure 11. The best scenario among all simulated for variant 2.

Source: own study.

In the scenario, the unused space is 1 cm lost on the 40 cm wall of the collective packaging and the space at the location of the individual packages marked in orange in the drawing - it is not possible to create a second layer, and this results in a loss of 10 cm in the height of the packaging. Nevertheless, thanks to this solution, we can still pack 23 more individual packages than with the current packaging method. This translates into an increase in individual packages on a pallet from 840 to 1116 pieces, which is 33%. The solution reduces the number of pallets from 12 thousand to 9 thousand, and as a result, the number of necessary containers (transports) drops from 267 to 199 per year. Comparing the results of all simulations carried out for both products under consideration, it can be stated that while the solution for a set of 10 clips is satisfactory, the packaging for a set of 30 clips requires additional changes. The solution to the problem of transported air may be to select non-standard packaging and create a pallet unit with dimensions other than the Euro pallet. Since analyzed company often ships goods with non-standard dimensions and is willing to create pallet units with non-standard dimensions by using the so-called loading ledgy instead of wooden pallets, it is worth taking a closer look at these possibilities and adapting the packaging to the product. The problem is worth attention for several reasons:

- a) product is a permanent element of the analyzed company assortment and is on the company's bestseller list,
- b) it is a relatively light product, which allows it to be used as a top filler in mixed transports,
- c) analyzed company has many similar products in its assortment, so developing an efficient packaging solution can translate into significantly greater benefits in the future.

For the BEVARA product, it is also worth considering the possibility of packaging the product in ready to sell - tear away packaging. Good arrangement of the product (i.e. flat) makes it stable enough to qualify as a product suitable for this packaging solution. This would allow for a reduction in packaging material, facilitate display in the shop, limit the manipulation

activities related to displaying goods in the shop, etc. However, the limitation here may be the expectations of the sales network, in which shop managers and persons designated for this purpose plan the shop space and organize space for individual items.

4. Conclusive remarks

Based on the analysis of the current packaging method for the product and the comparison of the results from the simulated scenarios, it can be clearly stated that packaging has a huge impact on the logistics costs in the company, mainly those related to transport, but also handling. Reducing the number of shipped containers from 200 to 89 (in the case of the best scenario for the article 10 clips) also reduces costs by approximately 110%. The example of a set of 10 clips shows how much simple solutions can change, and at the same time, this example shows that even giants in the field of logistics should still work on improving the solutions currently used. Small changes such as: replacing the packaging material, arranging the articles in a specific order in order to give the packaged product the right shape, appropriate arrangement in the collective packaging allows for a significant improvement in results in areas such as: transport efficiency, reducing the negative impact on the environment (lower consumption of packaging materials, fewer transports and therefore lower exhaust emissions, etc.), increase the margin on the product.

Ill-considered and carelessly designed packaging can lead to many losses, primarily financial, but also time and resources. That is why it is so important for suitably qualified technicians to work on the packaging already at the stage of designing the product itself. It is then possible to identify some potential problems and take appropriate steps to prevent them. What is more, the packaging design process cannot be limited to individual packaging. It is necessary to simultaneously plan a possible collective packaging and a pallet unit so that the packaging is as efficient as possible. Only such an approach can ensure the creation of packaging that is advantageous from the point of view of costs and logistics.

The packaging process itself should also be taken into account. The arrangement of products in the collective packaging should not be too complicated and allow for automatic/manual loading that does not require too many complicated movement activities, as well as eliminate the possibility of confusing the sequence of individual packages. The collective packaging can hold an exceptionally large number of individual packages, but when the packaging method is too complicated, it unnecessarily absorbs the time and energy of employees, and also increases the risk of errors, which are associated with double work and another loss of time. In summary, companies should constantly analyze the packaging solutions used by themselves and competitors and strive to exclude those that are harmful to the environment and cost-ineffective for the company itself. Even in the analyzed company assortment, you can find many products

that are still transported with unnecessary air, although a solution to get rid of it has long been developed. There are also often packages of too large dimensions, which the customer is not able to transport to the destination themselves, despite the fact that analyzed company focuses on the image of a self-service company. Other packaging-related problems, apart from not fully utilising the loading space, also include: inadequate securing of goods, poor labelling of packaging (incomplete information on the contents of the packaging on the label), half-empty trucks due to the inability to stack pallet units, negative impact on the environment, etc. Most of these problems lead to financial losses in the company, which is why it is so important to act preventively and design product packaging wisely, using the help of specialists, as this will allow you to achieve measurable benefits.

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ANALYSIS OF THE OPTIMAL ORDER OF DIAGNOSTIC ACTIVITIES USING AN IT TOOL – A CASE STUDY

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Purpose: The article deals with the problem of supporting a decision-making process in manufacturing enterprises. It concerns the possibilities of software algorithm determining the optimal path of knowledge acquisition in the form of an expert system. As part of the research, the conditions for developing the inference module and the knowledge base were determined. In order to assess the usefulness of the analysed expert system, its validation and simulation analysis of determining recommendations regarding decisions made by system's user were carried out.

Design/methodology/approach: The research include the following tasks: literature study in the field of expert systems, analysis of existing IT solutions supporting decision-making processes in manufacturing enterprises, analysis of applied expert systems and conditions for their implementation, determination of design assumptions in terms of functional and non-functional requirements, preparation of expert system architecture, development of a knowledge base in the expert system, development, programming and verification of the expert system's inference module, formulation of final conclusions and indication of directions for further development of the expert system.

Findings: The study resulted in the development of the IT tool supporting a decision-making process in a production process. The developed expert system is intended to provide the expert with advice on the knowledge acquisition path that he should take in order to minimize the cost of inference. In order to perform this task, the system performs simulations and conducts the inference process on them, checking which path, with the parameters provided by the expert, is the best. The core of the application is the inference module of the system. It is used to perform simulations and derive the canonical form of the final hypothesis, and to determine the nesting levels of individual statements.

Research limitations/implications: At the current stage of development, the application's capabilities developed in the research, are limited. This is due to the fact that the database of statements that are interrogative conditions can only consist of a few dozen statements and the number of depths cannot exceed 10 levels, because the computational load becomes so serious that conducting a simulation would take too long for the expertise to be useful. In the current state, the increase in the load on the machine on which the inference process is run grows exponentially with the addition of subsequent statements that are interrogative conditions.

Further development of the application depends on finding a metaheuristic that will provide a solution that meets the requirements in a sufficiently short time. The solution to this problem might be achieved with a genetic algorithm.

Originality/value: The value of the research is the identification of elements determining a decision-making process in a production enterprise. The conducted research resulted in developing and implementing the expert system, the task of which is to provide support in the decision-making process based on the transferred knowledge. The application module is responsible for interpreting the knowledge entered into the system and transferring the processed knowledge in the form of specific advice.

Keywords: IT solution, expert module, optimization of hypothesis verification cost.

Category of the paper: research paper, case study.

1. Introduction

The changes taking place in the global economy mean that companies are forced to adapt more and more to the internal and external conditions of their operations. The key to success in many industries is the right decisions, made at the right time, within the scope of specific activities. This applies in particular to manufacturing companies, due to the high complexity of the technological processes implemented, which require advanced technology and technical infrastructure. The decision-making process requires support from IT tools, which are largely based on expert knowledge. Avoiding incorrect decisions and minimizing inefficient activities is crucial for the production environment. Due to the specificity of its activity, each manufacturing company has a strictly defined production profile, which requires a specific technical infrastructure, technical and technological solutions and competent staff. Taking into account the criterion of the stability of the functioning of a manufacturing company, special attention should be paid to ensuring the continuity of the production process in relation to the existing technical and organizational capabilities. IT support for production management processes requires strictly defined data processing. Taking into account the functional scope of the serviced domain areas, the following can be distinguished (Klonowski, 2004):

- partial systems that are used within a single field and include selected utility functions;
- single-domain systems, which usually include all the functional functions required within a given field. The use of such a solution usually does not require computerization of other departments or modification of the structure of information and decision flows in a production enterprise. There is a situation in which input data to single-domain systems is entered directly by the operators of these systems;
- multi-domain systems, which offer integrated functions in at least two subject areas. These systems usually have different domain scopes and degrees of integration. However, to achieve full system integrity, integration at the database level is necessary. Using system integration significantly reduces the workload associated with entering data and ensuring its currency and consistency.

For determining an effective decision in the field of production system diagnostics is the determination of the optimal path of taking actions, which allows for reducing operating costs and the time needed to make the final decision. Considering the criterion of maintaining the continuity of the production process, the process of technical support of the production system is becoming increasingly important. The basic tasks of this process include (Pająk, 2006):

- achieving failure-free operation of production equipment and machines while maintaining their characteristics, which enables ensuring the needed quality of products,
- minimizing losses resulting from potential failures of machines and devices and costs related to the repair of these machines and devices,
- maintaining safe operating conditions for machines and devices. The production system service is focused on activities aimed at minimizing potential damage to technical equipment.

The essence of technical service and diagnostics of the production system becomes the more important the more complex the production system is, both in terms of the number of machines and devices operated, as well as the scope and scale of the technological processes carried out. Technical diagnostics includes the following processes and tasks:

- monitoring, i.e. observation of quantitative and qualitative changes in values that characterize the course of operation of machines and technological devices without affecting the device,
- supervision, i.e. processing and transmitting information about the technical condition of machines and technological devices and influencing these devices in order to obtain the desired condition,
- diagnosis, i.e. detection of any abnormalities or an increased probability of their occurrence.

The expert system can be used in manufacturing enterprises, both those where serial production takes place (e.g. car production) and those where mass production takes place (e.g. hard coal production). The problem to be solved is of a praxeological nature. It concerns the possibilities of software algorithm determining the optimal path of knowledge acquisition in the form of an expert system. As part of the research, the conditions for developing the inference module and the knowledge base were determined. In order to assess the usefulness of the analysed expert system, its validation and simulation analysis of determining recommendations regarding decisions made by system's user were carried out. As part of the research, the following tasks were carried out:

- literature study in the field of expert systems,
- analysis of existing IT solutions supporting decision-making processes in manufacturing enterprises,
- analysis of applied expert systems and conditions for their implementation,

- determination of design assumptions in terms of functional and non-functional requirements,
- preparation of expert system architecture,
- development of a knowledge base in the expert system,
- development, programming and verification of the expert system's inference module,
- formulation of final conclusions and indication of directions for further development of the expert system.

2. The scope of application of expert systems as a theoretical background to the research

E. Feigenbaum noticed that the key factor that determines the level of quality of expert systems is knowledge that is recorded in the form of a knowledge base. The inference schemes contained in the expert system are of much less importance (Shortliffe, Buchanan, 1984). Therefore, the creator of the system is not forced to precisely determine how to solve the problem, but only to clearly formulate what the problem is and to gather knowledge that characterizes the problem to be solved in a declarative form. In contrast to procedural programs (based on data structures and computational algorithms), expert systems require expert knowledge contained in the knowledge base and an inference module.

An expert system can be defined as a computer program designed to solve specialized problems (Mulawka, 1997). An expert system can also be defined as a knowledge-based system in which knowledge and reasoning procedures are modelled after experts. In turn, the knowledge base itself is separated from the reasoning system and other modules of the expert system (Dohn et al., 2013). Researchers emphasize that it is necessary for the knowledge base (the part of the program containing expert knowledge) to be separated from the reasoning module (the part of the program solving the problem) in an expert system (Nieberliński, 2000; Gregory et al., 2016). Generally, it can be stated that expert systems are those computer programs that support solving problems requiring domain knowledge based on the experience of experts. Moving on to the characteristics of expert systems, their typical properties can be indicated (Zoleński, 2014):

- in expert systems it can be noticed that in order to solve the problem it is necessary to separate the knowledge base from the inference module and other system modules,
- advanced research is being carried out on automatic knowledge acquisition (e.g. inductive reasoning, case-based reasoning), but the main source of knowledge is the knowledge and experience of industry experts,
- the operation of the expert system is based on the use of logical models in which rules are applied in the form of conditional statements,

- the inference process there may be a dialogue with the user, who can analyze the provided partial results. In turn, the expert system may require supplementing the data in order to carry out further processing,
- knowledge is usually recorded in an explicit form, and several universal logical laws are applied in the inference module (Zieliński, 2000).

2.1. The structural and functional scope of the expert systems

The issue of expert systems, whose primary goal is to make an optimal decision based on codified knowledge contained in the knowledge base, has been studied since the 1970s. Analyzing this entire period, one can find numerous implementations of advanced and multi-module knowledge processing systems (e.g. CLIPS). It should be emphasized that the key problem of expert systems is to create a coherent knowledge base, which remains the most difficult and risky (from the point of view of return on invested financial resources) stage of developing an expert system.

To minimize the risk of incorrect knowledge input into the knowledge base, validation of inputs and consistency with other rules in the knowledge base has become increasingly important. The basic assumption when creating a knowledge base is to introduce subsequent rules, implemented by domain experts with unique knowledge in a specific field of the system. However, even such an assumption may be insufficient, which means that the introduced rules will be contradictory. Hence the need for validation to eliminate such a situation.

An important application of expert systems were implementations in the manufacturing industry. The main reason for their relatively high popularity was the need to consolidate expert knowledge, which was being lost due to natural reasons, such as the change of specialist staff from experienced to unfamiliar with the field. This resulted in large losses in the company, which could not be avoided without effective knowledge transfer. Such transfer can be ensured by expert systems. The role of the expert in consolidating knowledge focuses on introducing knowledge in the appropriate representation, which additionally requires in-depth knowledge of the IT system, which is rarely encountered. A much more frequent case is the transfer of knowledge from an expert to a knowledge engineer, who not only has in-depth knowledge of the IT system, but also has knowledge of concepts from the field of knowledge. He translates the expert's formulations into the expert system representation. After the knowledge base has been formed, it then becomes possible for new people to use the system. Additionally, it is possible to automate the acquisition of expertise through automatic measurements, which, after verification of correctness, can be used for inference by the inference module in the expert system.

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There are numerous advantages of expert systems. Separating the inference module and the knowledge base enables cheaper and easier creation of the system itself, as well as its subsequent modification or operation. Expert knowledge occurs in an explicit form, written in a language close to natural, which results in its ordering and structuring. The knowledge base can be updated or expanded without violating the integrity of the system (Nieberliński, 2000). Usually, the knowledge contained in the bases is in the form of multi-level nested rules, which can be extended with subsequent exceptions or new rules, which allows for the development of knowledge bases in an incremental manner, depending on the existing needs regarding the scope and detail of domain knowledge. It is also possible to create skeleton systems (shells), which are inference modules without knowledge bases (Nieberliński, 2000; Evans, 2004). Creating knowledge bases in an expert system is much easier, and thus can be implemented by knowledge engineers working in the company, without the interference of external companies. Expert knowledge is of great importance for the functioning of the company, which is difficult to obtain, and without its proper storage it can be irretrievably lost. Expert systems have the advantage of enabling its collection, as well as its verification, correction, development, appropriate ordering and categorization. Knowledge stored in databases can be used multiple times and transferred to different recipients. Multi-stage verification of knowledge using an expert system means that codified knowledge can be at a higher level than the knowledge of individual experts. Reducing the values of variables to binary form allows to avoid combinatorial explosion (Kowalski, 1989). For example, instead of recording the exact temperature of a device, it may be enough to have information whether its temperature is within a given range. Logical models used in knowledge databases - binary information may be sufficient for the inference module. In inference modules, instead of two-valued logic, approximate inference can be used. A statement may then have an approximate truth or approximate certainty - such a record often allows for a better representation of the hidden knowledge of the expert, which in turn allows for a better description of the problem model and available data. Approximate inference combines some of the advantages of logical models and continuous models. The disadvantage of approximate inference is the greater complexity of knowledge and the inference system. Quantitative variables can be interpreted qualitatively,

taking into account the most important features of the data, their classification and selection (Gołuchowski, 2007). An expert system can draw conclusions based on knowledge with a low level of structure, for which there are no analytical mathematical models. In such situations, the space of solutions is finite, which allows for exploring the entire space. On the other hand, when the size of the space is large, blind and heuristic search algorithms should be used (Cytowski, 1991). Expert systems can also use knowledge in a declarative form, which is easier to describe and formalize. However, such an approach requires experience, because if the specific features of the applied search methods are not taken into account, the inference module may hang even in simple and correctly formulated tasks (McCabe, Clark, 1998).

2.2. Conditions of the implementation of expert systems

The most important issue in the design and implementation of expert systems is the process of acquiring knowledge from domain experts. Limited knowledge of these systems results in a deficit of specialists/experts in the field of knowledge engineering who have the appropriate experience in acquiring and verifying the tacit knowledge of experts (Cholewa, Pedrycz, 1987). The process of implementing an IT system in an enterprise is always risky. In the literature, one can find the six-person-month rule, i.e. "if the time and human involvement at this level does not bring satisfactory results, further work should be stopped, accepting the loss of the previously incurred expenses, because the losses may significantly increase" (Zoleński, 2008). A similar situation can be observed in the implementation of expert systems. It is extremely important to clearly define the appropriate application of the expert system. A cost-effective implementation takes place if the problem to which the expert system is to be applied meets clearly defined requirements. Most problems occurring in practice do not meet these requirements. The progress of technology, reduction of the costs of implementing computer systems and increasing awareness on both sides of the implementation should lead to improved efficiency of expert system implementations.

The fundamental problem in implementing expert systems is the excessive expectations of future users in terms of the scale and scope of expert system functionality, which makes it difficult to reach a compromise that satisfies both parties to an IT project. Unfortunately, there is a widespread misconception that large expert systems comprehensively solve a wide range of problems with a high level of difficulty. Such an approach is associated with high financial outlays, which the majority of companies are not convinced of. The calculated level of risk for both parties is often unacceptable. In connection with the above, it is profitable to use expert microsystems for supporting a certain class of tasks, the knowledge bases of which are created ad hoc by users. Wider use of expert microsystems allows for much higher efficiency of implemented implementations with a significant reduction in financial outlays and risk. The use of microsystems builds the experience gained by employees in creating, implementing and using these systems, which can be used in the implementation of large expert systems. An additional benefit resulting from the implementation of microsystems are the

knowledge bases created, which can be used in the future as components of an integrated modular system. The current benefits of using microsystems are usually not large, but an important effect is the experience gained by users in the field of knowledge engineering. Participation in the preparation and validation of the knowledge base, thorough knowledge of substantive issues and mastering the principles of formalizing, organizing and documenting knowledge, often has a much greater value than the current benefits resulting from the use of the microsystem. The most important features of an expert microsystem include (Dohn et al., 2013):

1. The knowledge base, created according to the specific needs of the microsystem users, is usually relatively small.
2. The knowledge representation is simple; it includes from a dozen to several dozen rules contained in the knowledge base.
3. The application of the microsystem is adapted to the current needs of users.
4. The expert microsystem has a structure in which the knowledge base and the inference module have been separated. The inference module usually comes from the skeleton expert system.
5. The expert microsystem is a link in a longer chain of data processing.

Expert microsystems, apart from supporting expertise, can also perform other functions, such as (Dohn et al., 2013):

- management of simulation and computational processes,
- automation of repetitive activities such as organizing information or automatically generating reports,
- implementation of logical operations,
- training users in the area of knowledge engineering,
- experimenting with inference modules.

The basic advantages of implementing expert microsystems include (Dohn et al., 2013):

- significant reduction of the risk associated with the implementation of the microsystem, financial outlays are fully acceptable,
- exploitation of microsystems enables gaining experience in the field of knowledge engineering,
- exploitation of microsystems defines further possibilities in the areas of potential applications for larger expert systems,
- archived knowledge bases can be used to create larger expert systems,
- employee potential can be better used. Implementation of microsystems for performing current tasks increases employee engagement, strengthens the bond with the enterprise and improves work efficiency.

3. The description of the research method - the expert system supporting a decision-making process in the production environment

The developed expert system is intended to provide the expert with advice on the knowledge acquisition path that he should take in order to minimize the cost of inference. In order to perform this task, the system performs simulations and conducts the inference process on them, checking which path, with the parameters provided by the expert, is the best. The core of the application is the inference module of the system. It is used to perform simulations and derive the canonical form of the final hypothesis, and to determine the nesting levels of individual statements. All these operations are intended to provide the expert with advice on the optimal or suboptimal path, the difficulty of obtaining the final hypothesis (in relation to the degree of nesting) and the statement (expert opinion) that should be asked about first.

3.1. The operation of request module

Due to the different costs of determining the logical values of individual statements, which are query conditions, it may turn out that the cost of asking about several statements (expert opinions) may be lower than the cost of asking about the value of one statement. The inference module therefore takes into account the costs of performing individual expert opinions (understood here as determining the value of the statement that is the condition of the rule) and is guided by the criterion of the lowest cost of obtaining the final hypothesis. For the inference module, this cost is an abstract entity, it does not have to mean a cost in the literal sense (money). The cost may consist of many different results:

- time of acquiring knowledge,
- impact on other elements of the system, e.g. acquiring knowledge may involve stopping production,
- financial cost of acquiring knowledge,
- difficulty of acquiring knowledge - in a production environment this may mean having to pump water out of a tank, turning off heaters in a room, etc.

Based on the cost, we can say that the system is therefore universal, because regardless of the industry, the definition of cost may be different. Therefore, the expert's task is also to determine such a cost function that will well reflect the field for which the knowledge base is implemented.

3.2. Use case diagram

The use case diagram includes system users and the functionalities that have been prepared for them. Each user has permissions to perform the actions indicated in the diagram (Fowler, 2005; Martin, 2014). The expert has the permissions of a standard user, as does the administrator. Only a guest can register - all the rest are already logged into the system (Authentication verified them as users with specific roles). The expert can also perform actions allowed for a standard user, as the expert role always goes hand in hand with the user role. Each user, except the administrator, can be blocked and deprived of access to the system and its functionalities. Similarly, unblocking can only be performed by the admin, not by changing the password or similar operation.

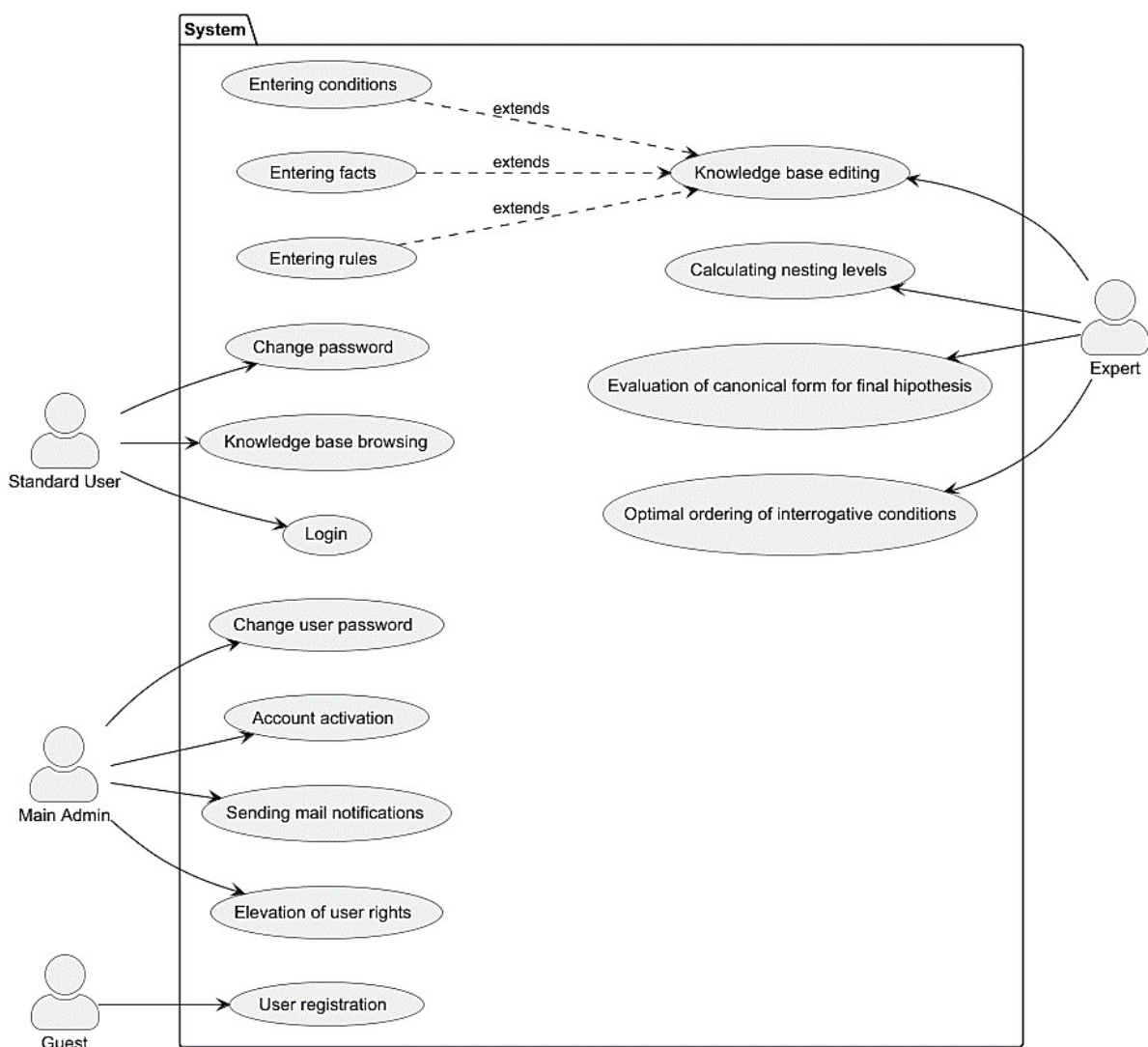


Figure 1. Use case diagram.

Source: own elaboration.

The expert system, in its inference part, performs the following 5 main operations:

- generating random permutations of query conditions along with their logical values,
- assigning nesting levels to statements,
- determining the statement about which knowledge should be acquired first in order to minimize the cost of inference,
- determining the optimal path for determining the value of statements by the expert,
- deriving the canonical form of the final hypothesis.

Determining the optimal path for determining the value of statements and the canonical form of the final hypothesis allows the system user to make a recommendation in order to achieve the lowest inference cost.

3.3. Generating a set of permutations

The basic algorithm of the reasoning system is the generation and determination of the optimal path of knowledge acquisition. This method consists of two stages:

- generation of random permutations of query condition sequences and, in the generated order, assigning logical values to statements until the final hypothesis is determined (the logical value will have a specific value: True or False),
- determination of the optimal path for determining the logical value of the final hypothesis based on the expected values of the expert opinions (according to the criterion of the least cost).

The size of the generated set of random permutations depends on the number of query conditions. The number of cases to be generated is determined by the formula:

$$n = 10^{a+1} \quad (1)$$

where:

n – the number of cases generated,

a – the number of statements that are interrogative conditions.

For $a = 4$ the number of generated cases will be equal to $n = 100,000$. This number of permutation cases allows for the repetitive acquisition of the same processing results of the inference module.

The inference module uses two-valued logic, where:

- 1 - stands for truth,
- -1 - stands for false.

We assume that 0 means no knowledge. Using such a representation greatly simplifies the evaluation of logical expressions at a later stage, especially since the rules in the knowledge base are Horn clauses. Therefore, any evaluation of a logical expression can be simplified.

For example:

$$A \wedge B \Rightarrow C \quad (2)$$

The logical value of statement C can be obtained as follows:

$$(C) = \min(W(A), W(B)) \quad (3)$$

where $W(x)$ - the numerical value of the statement with index i , lack of knowledge and no attempt to acquire it is marked as 0 - lack of knowledge.

3.4. Cost of acquiring knowledge - final hypothesis

The cost of determining the logical value of the final hypothesis is the sum of the costs of acquiring knowledge about the individual component statements (logical values of these statements). It is usually not the sum of the costs of acquiring knowledge about all statements, because examining just some of them can guarantee obtaining the logical value of the final hypothesis. For the permutation of statements - interrogative conditions: A, B, C, D, the cost of acquiring knowledge - the logical value of the final hypothesis will be as follows:

$$K = \sum_{i=1}^a K(i) \cdot W(i) \quad (4)$$

where:

K – total cost,

a – number of statements that are interrogative conditions.

$K(x)$ – the cost of acquiring the logical value (knowledge) of the statement with index i $|W(x)|$ - modulo the numerical value of the statement with index i , lack of knowledge and no attempt to acquire it is marked as 0 - lack of knowledge.

For the knowledge base containing the above statements, the formula will look as follows:

$$K = K(A) * |W(A)| + K(B) * |W(B)| + K(C) * |W(C)| + K(D) * |W(D)| \quad (5)$$

4. The presentation of the results of an example of reasoning using the developed expert system

Carrying out the inference process requires first preparing input data in the form of rules and conditions (Fig. 2).

System configuration EXPERT_SYSTEM_USER					
Statements Rules and conditions Estimation					
Rules					
Label	Conclusion	Description			
R1	K	symptom a occurs			
R2	K	symptom a is absent and symptom is present			
R3	K	symptoms c and d occur			
R4	W	symptoms d and k occur			

Conditions					
Rule if positive	Statement				
R1	true	A			
R1	false	B			
R2	false	A			
R2	true	C			
R3	true	C			
R3	true	D			
R4	true	D			
R4	true	K			

Figure 2. Rules and conditions introduced for simulation purposes.

Source: own elaboration.

The statement table shows the entered statements along with the levels that were calculated based on the given rules and conditions (Fig. 3).

System configuration EXPERT_SYSTEM_USER						
Statements Rules and conditions Estimation						
Label	Interrogative condition	Description	Probability	Cost	Level	
A	Yes	Device damaged	..0.2	200	0	
B	Yes	Device damaged	..0.4	300	0	
C	Yes	Device damaged	..0.3	100	0	
D	Yes	Device damaged	..0.1	400	0	
K	No	Component faulty	..		1	
W	No	Component faulty	..		2	

Figure 3. Statements entered with nesting levels calculated based on rules and conditions.

Source: own elaboration.

System configuration EXPERT_SYSTEM_USER

Statements Rules and conditions Estimation

Final hypothesis
W

Canonical form of the final	Expected value on the choice of the first statement	The best path to execute interrogative
<p>Canonical form of the final hypothesis</p> <p>The expression contains only query conditions</p> <p style="text-align: center;">(D AND ((A AND NOT B) OR (NOT A AND C) OR (C AND D)))</p>		

Figure 4. The entered statements along with the levels that were calculated based on the given rules and conditions.

Source: own elaboration.

System configuration EXPERT_SYSTEM_USER

Statements Rules and conditions Estimation

Final hypothesis
W

Canonical form of the final	Expected value on the choice of the first	The best path to execute interrogative
<p>Average expected value of query path: 612</p> <p>For the start query A the expected value was obtained: 663</p> <p>For the start query A the expected value was obtained: 752</p> <p>For the start query A the expected value was obtained: 586</p> <p>For the start query A the expected value was obtained: 445</p>		

Figure 5. Presentation of the expected value of the final hypothesis evaluation.

Source: own elaboration.

System configuration EXPERT_SYSTEM_USER

Statements Rules and conditions Estimation

Final hypothesis
W

Canonical form of the final
Expected value on the choice of the first
The best path to execute interrogative

The best path to query questions is:

1. The diagnosed device has a symptom d
2. The diagnosed device has a symptom c
3. The diagnosed device has a symptom a
4. The diagnosed device has a symptom b

Figure 6. Presentation of the optimal path to determine the value of statements.

Source: own elaboration.

The analysis performed allowed us to establish the canonical form of the final hypothesis (Fig. 4). The statement table shows the entered statements along with the levels that were calculated based on the given rules and conditions.

In addition, the evaluation value of the final hypothesis was established (Fig. 5) and the optimal path to determine the value of statements – 427 (Fig. 6).

5. Conclusions

To sum up the analysis and considerations undertaken in the research, the following conclusions can be formulated:

1. The dynamic development of the demand for knowledge determines research in the field of creating IT tools supporting knowledge management processes, including the creation of domain expert systems.
2. Improving decision-making processes requires IT support. In connection with this, we can observe a wide range of IT solutions that, in a more or less comprehensive way, enable automation and effectiveness of decisions and actions in business processes. Expert systems contain modules that constitute algorithmic solutions to problems that require mass data processing.

3. As part of the conducted research, an expert system was developed and implemented, the task of which is to provide support in the decision-making process based on the transferred knowledge. The application module is responsible for interpreting the knowledge entered into the system and transferring the processed knowledge in the form of specific advice.
4. As part of this work, a computer application was developed and verified that implements the following main functionalities:
 - creating new knowledge bases,
 - introducing statements and rules to knowledge bases,
 - conducting inference on knowledge bases,
 - evaluating the canonical form of the final hypothesis,
 - determining the optimal order of performing actions,
 - determining the optimal first interrogative condition,
 - evaluating the level of nesting of statements based on the rules and conditions introduced to the knowledge base.
5. Finalizing the application required the following tasks:
 - establishing design assumptions (requirements analysis, application architecture development),
 - establishing the database structure,
 - developing a use case diagram,
 - developing an ERD diagram,
 - developing a class diagram,
 - developing a knowledge representation in the database,
 - validating the knowledge base,
 - developing the expert system's reasoning module (description of the algorithm's operation along with its block diagram),
 - verifying the algorithm's operation.

6. Discussion on further development of the application

At the current stage of development, the application's capabilities are limited. This is due to the fact that the database of statements that are interrogative conditions can only consist of a few dozen statements and the number of depths cannot exceed 10 levels, because the computational load becomes so serious that conducting a simulation would take too long for the expertise to be useful. In the current state, the increase in the load on the machine on which

the inference process is run grows exponentially with the addition of subsequent statements that are interrogative conditions.

Further development of the application depends on finding a metaheuristic that will provide a solution that meets the requirements in a sufficiently short time. The solution to this problem may be the use of a genetic algorithm (Kwaśnicka, 1998). A limited number of generated solutions, but on the other hand, also the diversity of cases provided by mutations and crossovers, will allow the user to return valuable advice on the decisions made, despite the large number of statements with the query condition flag. Another improvement of the system may be recursive validation of the existence of a loop, which can prevent the system from hanging up on the server side (to avoid a situation in which a statement in the rule condition will be a conclusion at a higher level of the same path, which would lead to the creation of an infinite loop).

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PROCESS MINING OF PRODUCTION SUPPORTED BY MES SYSTEMS – A CASE STUDY

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Purpose: The primary purpose of this paper is to use a process mining method on collected and appropriately prepared event logs from the MES class system of the entity under study.

Design/methodology/approach: With the classical process mining approach using the XES standard, the Alpha algorithm and Petri nets, event logs of the manufacturing process were analysed. To perform the analysis, 379,341 rows of data were extracted from the MES system, representing 7194 instances and 76 different activities.

Findings: a key result of the presented research is the conclusion regarding the quality of the data generated by the controllers. Timestamps for events in the MES system may need to be corrected.

Research limitations/implications: The paper presents a case study for a specific set of controllers and an MES system. For this particular configuration, additional mechanisms are required to synchronise time stamps from one location (e.g. an NTP server). The results may be different for a different hardware and software configuration of the MES system.

Practical implications: The result of the research carried out in this paper also leads to conclusions of a practical nature. Incorrect synchronisation of times makes it impossible to control and analyse the process as a whole, even when the whole process is working correctly as an assembly of individual operations. The guidelines developed were passed on to those responsible for the operation of the MES system.

Originality/value: In the literature, various case studies can be found for process mining including event logs of ERP systems of others. The authors did not find similar studies for MES systems. In particular, the classical approach for log preparation requires awareness of potential time synchronisation problems.

Keywords: manufacturing execution system, process mining, plc.

Category of the paper: Research paper.

1. Introduction

With the dynamic development of technology, the evolution of manufacturing processes has become an integral part of modern businesses. Based on Michael Hammer's literature, it can be concluded that the evolution of manufacturing processes is essential for maintaining a competitive advantage in today's dynamic market. Companies that continually improve their processes can respond quickly to changing customer needs and market trends, resulting in greater customer satisfaction and a greater chance of success (Hammer, Champy, 2009). In response to these challenges, exploring manufacturing processes has become an important area of research.

Process mining is an emerging discipline that is based on process models and data mining. Production process mining refers to the analysis and study of activities undertaken to identify and evaluate new opportunities for improvement and optimise existing processes in manufacturing facilities. It aims to increase productivity, improve quality, reduce costs, minimise cycle time and make production more flexible and reactive.

At present, the use of MES-class information systems to support processes at the activity level in production operations is becoming increasingly popular in many manufacturing companies. The use of modern methods to analyse processes at the level of individual production stages appears to be an interesting area of scientific interest.

The main objective of the paper is to analyse the production process in a company using process mining methods on collected and appropriately prepared event logs from the MES class system for a selected production process of the studied entity.

2. Theoretical Background

The classic approach to organising a manufacturing process in ERP (or MRP) systems involves defining articles, structures (BOM) and processes for the structures. The tasks in the process should have defined resources. It is only by linking the resources to a database using controllers that keep the states of these resources up-to-date that the production process can be precisely controlled.

2.1. Manufacturing Execution Systems

MES (Manufacturing Execution Systems) play a key role in modern production management. MES are integrated IT systems that monitor, control and optimise production processes in real time. They make it possible to track every stage of production, from raw materials to finished products, thereby increasing efficiency, reducing costs and improving quality.

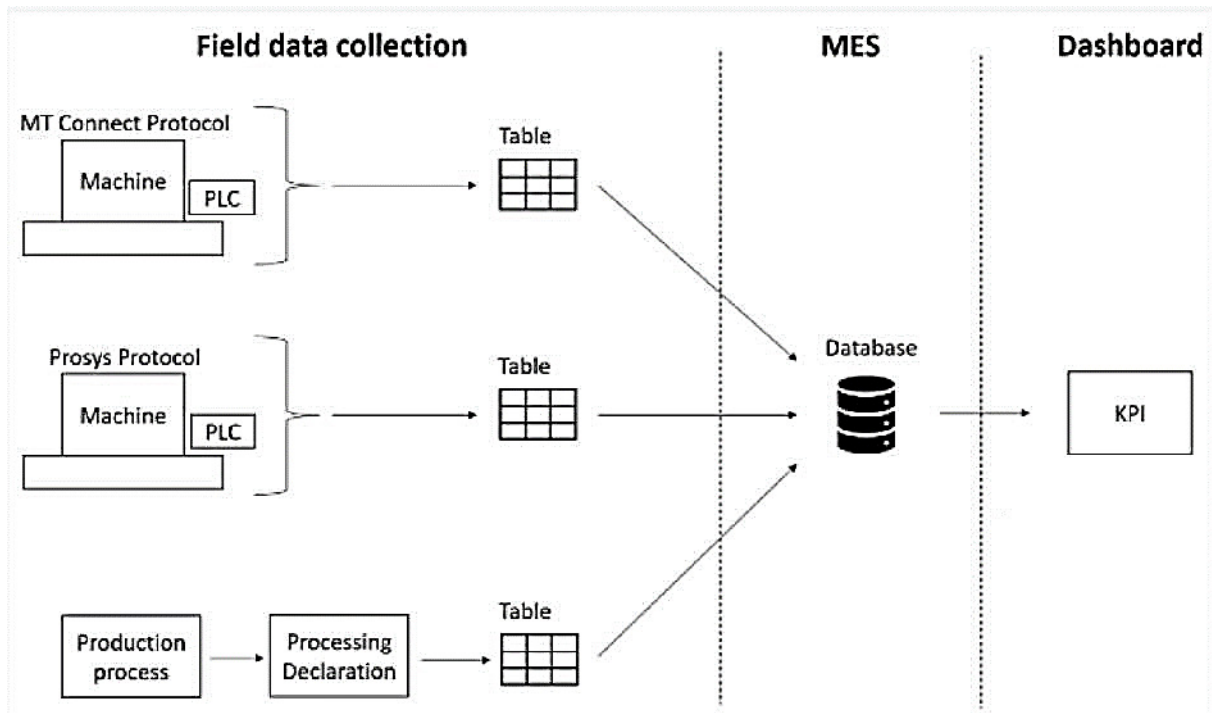


Figure 1. Machine data collection in the MES system.

Source: (Bianchini et al., 2024).

One of the main tasks of MES is to collect and analyse production data. These systems integrate with other management systems, such as ERP (Enterprise Resource Planning), enabling full synchronisation of data and processes across the enterprise. For example, MES can automatically update stock levels based on actual raw material consumption, which minimises the risk of production downtime.

The literature highlights the numerous benefits of implementing MES, such as increased transparency in production processes, better resource management and the ability to respond quickly to changes in market demand (Johnson, 2021; Smith, 2020). In addition, MES support Industry 4.0 initiatives by enabling integration with IoT (Internet of Things) technologies and cloud-based data analytics (Brown, 2022).

2.2. Process Mining

Process mining technology is gaining importance as a tool for analysing and optimising business processes. In recent years, research in this area has focused on integrating with modern technologies such as artificial intelligence (AI) and machine learning (ML) for more advanced process data analysis. One key area of research is the use of AI and ML to automatically discover process models from event log data. Research shows that these technologies can significantly improve the accuracy and efficiency of process analysis (Wil van der Aalst, 2024). Furthermore, these techniques enable the prediction of future events and the identification of potential problems, which is crucial for proactive process management (Attias, 2024). Another important line of research is the application of process mining in various industry sectors.

Examples include applications in healthcare, where the technique helps to optimise patient pathways and improve the quality of care (Rebuge, Ferreira, 2012). In the manufacturing sector, process mining is used to identify bottlenecks and optimise production flows (Thiede et al., 2018).

Process mining combines traditional model-based process analysis and data-driven analysis techniques. As shown in Figure 2, process mining can be seen as a link between data science and process science. Process mining seeks a confrontation between event data (i.e. observed behaviour) and process models (either manually performed or automatically detected).

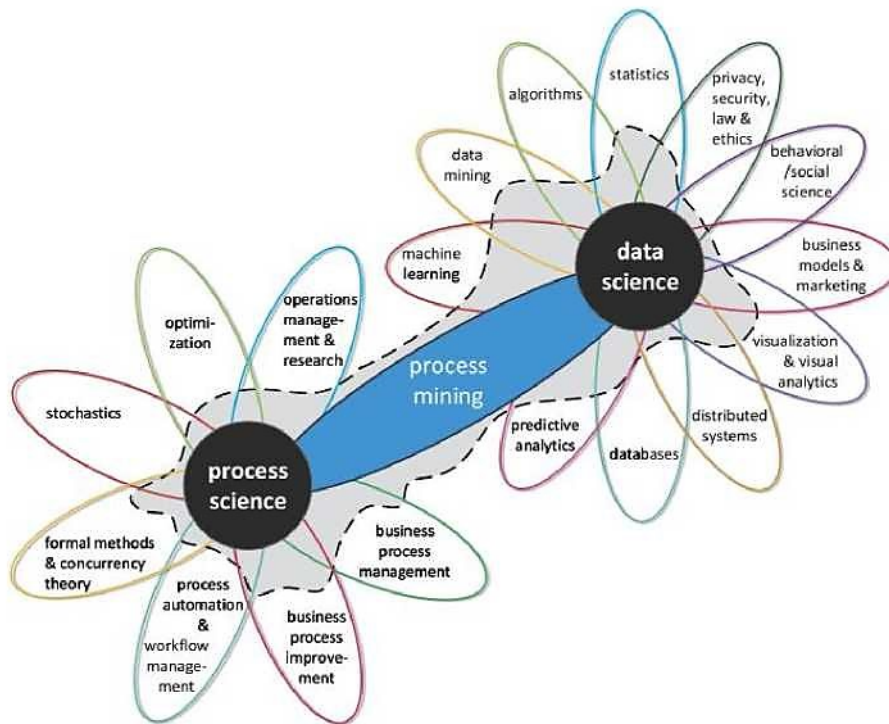


Figure 2. Illustration of the link between process science and data-driven techniques.

Source: van der Aalst, 2016, p. 18.

The main approaches to data science tend to be process-independent. Data mining, statistics and machine learning techniques do not consider comprehensive process models. Process science approaches are process-oriented, but often focus on modelling rather than learning from event data. The unique positioning of process mining makes it a powerful tool for using the increasing availability of data to improve complex processes. Process mining has only recently emerged as a sub-discipline of both data science and process science, but the relevant techniques can be applied to any type of operational process (organisations and systems) (van der Aalst, 2016).

3. Methods

On the methodological side, the process mining technique involves the use of several tools and standards implemented in the explorer. In this paper, the ProM environment version 6.12 was used, as well as a standard sequence of steps for the prepared event log including data conversion to the XES standard and then the use of the Alpha algorithm allowing for the preparation of a process model in the form of a Petri net. The result enables the use of further plug-ins such as conversions to the BPMN standard diagram, among others.

XES standard

The XES standard defines a grammar for a markup-based language, the purpose of which is to provide information systems designers with a standardised and extensible methodology for capturing the behaviour of systems using the event logs and event streams that are defined in the XES standard. This standard includes an XML schema describing the structure of an XES event log/stream and an XML schema describing the structure of an extension of such a log/stream. In addition, this standard contains a core set of so-called XES extension prototypes that provide semantics for certain attributes recorded in the event log/stream ('IEEE Standard for EXtensible Event Stream (XES) for Achieving Interoperability in Event Logs and Event Streams,' 2023)

Alpha algorithm

The α or α -miner algorithm is an algorithm used in process mining to reconstruct causality from a set of event sequences. It was first proposed by van der Aalst, Weijters and Maruster. The aim of Alpha Miner is to transform an event log into a workflow network based on the relationships between different activities in the event log. An event log is many sets of traces, and a trace is a sequence of activity names (van der Aalst et al., 2004).

Alpha Miner was the first process discovery algorithm ever proposed and gives a good overview of the purpose of process discovery and how different actions are performed within a process. Alpha miner was also the basis for the development of many other process mining techniques, such as heuristics and genetic exploration.

The Alpha algorithm starts by transforming the event log into direct trace, sequence, parallelism and selection relations and then using these to create a Petri net describing the process model. Initially, the algorithm constructs a trace matrix. Using the trace matrix, a process model can be constructed. Based on the relationships, a trace-based matrix is discovered. Using the trace-based matrix, locations are discovered.

Petri nets

Petri nets are the oldest and best-studied process modelling language for modelling concurrency. Although the graphical notation is intuitive and simple, Petri nets are executable and many analytical techniques can be used to analyse them (van der Aalst, 2016).

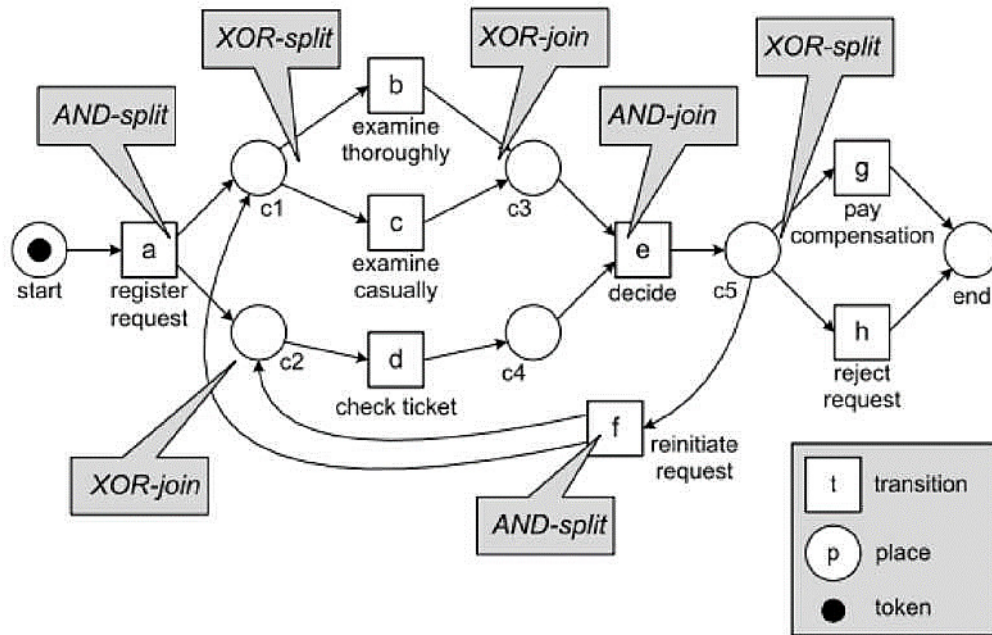


Figure 3. Example of a Petri net.

Source: van der Aalst, 2016, p. 60.

Figure 2 shows an example Petri net with labelled logic gates, locations and transitions. The AND and XOR gates represent transitions to the next place in the process or to the next action.

BPMN notation

Business Process Modelling Notation (BPMN) has become one of the most widely used languages for modelling business processes. BPMN is supported by many tool vendors and has been standardised by OMG. Figure 3 shows a process model in BPMN notation.

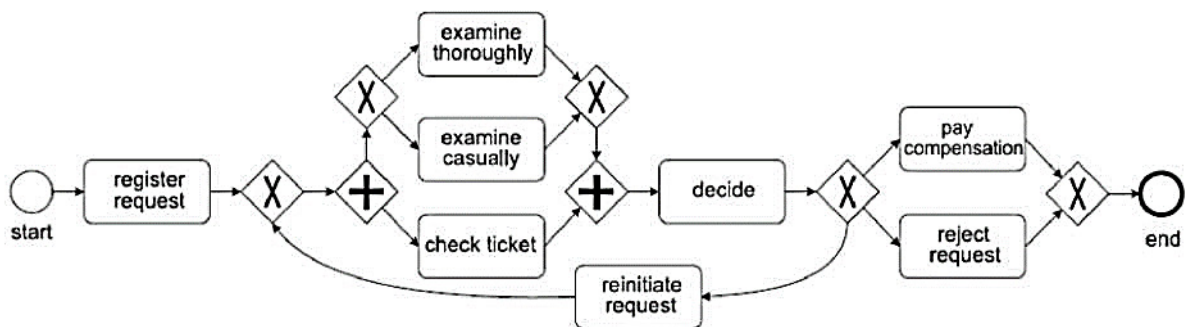


Figure 4. Process model in BPMN notation.

Source: van der Aalst, 2016, p. 69.

Business Process Modelling Notation (BPMN) is a graphical notation that represents the stages of a business process. BPMN represents the end-to-end flow of a business process. The notation is specifically designed to coordinate the sequence of processes and messages that flow between different process participants in a related set of activities (Facility Management Group...).

3.1. Data sets

Each action that has been performed by an MES system command has been recorded in the system, a time stamp has been given and, depending on the type of task (device type), the data from the process performed, the data collected by the scanner or the logical value of the sensor. In the system, the collected data is assigned to a particular device, which can perform one or more operations on one or more programmes.

The raw data extracted from the MES system is not suitable for mining, it must first be properly prepared. Two types of files have been generated from the system from which the data will be extracted. Their adaptation to a common form differs. In the files that are generated from the process equipment, all blank rows must first be removed. In the next step, a description of the activity that was performed was added to each record. In the last step, redundant data has been deleted.

The second type of data that was extracted from the system is the data that the scanner collected. Once exported, all that was needed was to remove the redundant columns.

For the analysis, 379,341 rows of data were downloaded from the MES system, representing 7194 cases and 76 different activities. The downloaded data were reduced to a common form, which is shown in Table 1.

Table 1.
Single case of analysed data

JOB	ID	DATA
113232620545000	beam	2023-06-27 10:59:17
113232620545000	RGTP30	2023-06-27 11:04:36
113232620545000	Disc & Drum RGT	2023-06-27 11:04:36
113232620545000	Brake RGT	2023-06-27 11:04:36
113232620545000	LFTP10	2023-06-27 11:05:27
113232620545000	Disc & Drum LFT	2023-06-27 11:05:27
113232620545000	Brake LFT	2023-06-27 11:05:27
113232620545000	BrkAsm_L	2023-06-27 11:08:55
113232620545000	BrkAsm_L	2023-06-27 11:09:00
113232620545000	BrkAsm_L	2023-06-27 11:09:05
113232620545000	BrAsmRb_L_ALL	2023-06-27 11:10:27
113232620545000	RSARGT	2023-06-27 11:10:28
113232620545000	BrkAsm_R	2023-06-27 11:10:29
113232620545000	BrkAsm_R	2023-06-27 11:10:33
113232620545000	BrAsmRb_L_ALL	2023-06-27 11:10:34
113232620545000	BrkAsm_R	2023-06-27 11:10:40
113232620545000	NutRw_L	2023-06-27 11:11:01
113232620545000	RSALFT	2023-06-27 11:11:37
113232620545000	NutRw_R	2023-06-27 11:11:52
113232620545000	BrAsmRb_R_ALL	2023-06-27 11:12:06
113232620545000	BrAsmRb_R_ALL	2023-06-27 11:12:15
113232620545000	ShockAbsorberRH	2023-06-27 11:12:39
113232620545000	SqzNtLRGT	2023-06-27 11:13:06
113232620545000	ABS_L	2023-06-27 11:13:06
113232620545000	StdBlt_L	2023-06-27 11:13:19
113232620545000	StdBlt_L	2023-06-27 11:13:25
113232620545000	KAPSEL_PRAW_NISK	2023-06-27 11:13:34

Cont. table 1.

113232620545000	StdBlt R	2023-06-27 11:13:37
113232620545000	StdBlt R	2023-06-27 11:13:42
113232620545000	ShockAbsorberLH	2023-06-27 11:13:46
113232620545000	SqzNtLLFT	2023-06-27 11:14:17
113232620545000	ABS R	2023-06-27 11:14:17
113232620545000	KAPSEL LEWY NISK	2023-06-27 11:14:45
113232620545000	BBHRGT	2023-06-27 11:15:10
113232620545000	BHRGT	2023-06-27 11:15:23
113232620545000	BBHLFT	2023-06-27 11:16:00
113232620545000	RA LFT	2023-06-27 11:16:09
113232620545000	BHLFT	2023-06-27 11:16:14
113232620545000	SCN DISK LFT	2023-06-27 11:16:23
113232620545000	RA RGT	2023-06-27 11:17:10
113232620545000	CLPRRGTABV	2023-06-27 11:17:10
113232620545000	CLPRRGTBW	2023-06-27 11:17:10
113232620545000	RA_RIGHT_CHECK	2023-06-27 11:17:33
113232620545000	Caliper_RGT	2023-06-27 11:17:37
113232620545000	CLPRLFTABV	2023-06-27 11:18:01
113232620545000	CLPRLFTBLW	2023-06-27 11:18:01
113232620545000	RA_LEFT_CHECK	2023-06-27 11:18:39
113232620545000	Caliper_LFT	2023-06-27 11:18:40
113232620545000	P1313 L	2023-06-27 11:21:56
113232620545000	P1313 R	2023-06-27 11:21:56
113232620545000	Rack Position Axle	2023-06-27 11:22:35
113232620545000	Rack ID Axle	2023-06-27 11:22:36

Source: own work

In the table, the 'ID' column is the case number, the 'JOB' column is the classifier and the 'date' column is the timestamp for each case.

4. Results

By examining the figures from the variant flow diversity tracking module in the system, which are shown in Figure 4, it can be seen that there is a large number of different process runs in the analysed period. The table indicates a value of 6521 different runs in 7194 processes, which represents more than 90% of all results.

Traces	7 194
Events	379 341
Event Classes	76
Attributes	3
Variants	6 521
Events per Trace	52,73
First Event	2023-06-12T05:31:29Z
Last Event	2023-07-08T13:50:19Z

Figure 5. Figures from the variant tracking module.

Source: own work.

Considering the technological process of building modules and the activities where repair activities may occur the number of different flows should not be so high. Comparing the flow processes in the system to the physical process, it can be seen that the activities do not follow the technological sequence for the module build.

Figure 5 shows the part of the process from the variant that obtained the highest repeatability.



Figure 6. Most recurrent option.

Source: own work.

When investigating the problem associated with the lack of correct process sequence in the modules, the focus was on understanding exactly why this anomaly occurs. To do this, the focus was on Atlas Copco's Power Focus 6000 EC key controllers, which are responsible for data with incorrect time stamps. An analysis of the controller settings showed that there were problems with the wrong time setting on the controller. In order to set the correct data, the automatic time setting option was selected in communication with the internal NTP server.

Analysis of the results on subsequent days showed that the results continued to be marked with the wrong timestamps. After further testing to apply the correct settings, it was found that there are two main problems. Firstly, there is a problem with internally keeping the correct time on the controller. This could be due to inaccuracy of the internal clock or problems with the time synchronisation mechanism on the controller itself. Secondly, limitations have been encountered regarding the ability to increase the frequency of synchronisation with the internal NTP (Network Time Protocol) server. This means that the controller cannot update its time more frequently from the NTP server, which affects data quality.

The process between 29 and 30 June 2023 was used to generate the Petri nets. Three separate networks can be identified in the generated data. Figure 4 shows the identified network sections in the process analysed.

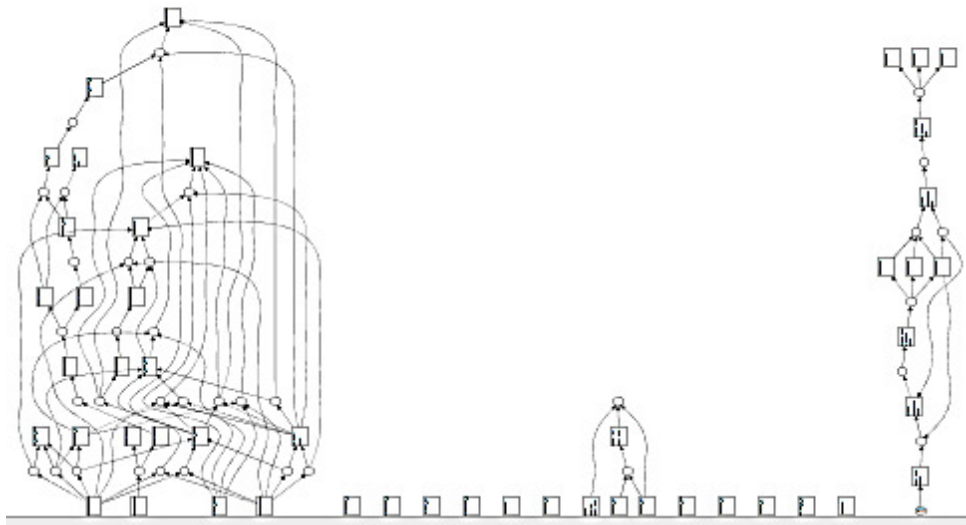


Figure 7. Petri nets generated (slice).

Source: own work.

The generated Petri nets should represent a single coherent process. The appearance of three separate, unconnected threads indicates anomalies in the data, which consist of incorrect timestamps

5. Discussion

In order to properly explore production processes, a prerequisite is to have the correct data. If one of the controllers shows incorrect hours and there is no way to change this, it is worth finding another source of data. The solution to this problem can be to give a stamp when accepting data into the host system (MES). The proposed method ensures that the data in the system will always have data from one source, which is guaranteed to be correct.

Table 2.

Proposal to add a new column for data collection

JOB	ID	DATA - controller data - transmitted by the controller	Data - data sent by the MES master system
113232631153000	ABS_L	2023-06-29 00:13:44	2023-06-29 00:17:45
113232631153000	ABS_R	2023-06-29 00:16:02	2023-06-29 00:16:57

Source: own work.

Table 2 shows how the new data should be located and where it should be taken from. Implementation should be carried out by changing the data source in the reports to that indicated.

6. Conclusions

The results of the study unequivocally confirm that it is possible to analyse and evaluate production processes on the basis of event logs from an MES-class IT production system and process mining methods. Although the investigated event logs did not contain consistent data, they made it possible to learn about the assembly process and to find an error in the system in the form of malfunctioning system clocks.

The results of the study, together with a proposal for implementing the changes, will be presented to those responsible for developing the MES system. Once the changes have been completed, the data should be collected again and the assembly process analysed again.

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PROBLEMS OF MEDICAL WASTE LOGISTICS IN A SELECTED CITY HOSPITAL

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Purpose: The aim of the article is to analyze problems related to the logistics of medical waste in the Silesian Municipal Hospital. The research issues focused on the analysis of currently used solutions, the causes of existing problems and proposals for improvements aimed at improving the quality of medical waste management processes in the hospital. The research will focus on analyzing areas related to the collection, storage, transport, and disposal of medical waste.

Design/methodology/approach: In the research presented in this article, an analysis of the literature on the processes of the waste management was used. The research focused on analyzing areas related to the collection, storage, transport, and disposal of medical waste. The analysis covered also procedures related to the segregation of medical waste and compliance with applicable regulations. The research focused also on assessing the effectiveness of existing logistics processes in waste management and identifying potential areas requiring improvement. IGrafx program was used for research and modeling.

Findings: The research showed some problems related to human resources, waste storage, transportation of medical waste and disinfection of carts and storages. Therefore, carrying out this assessment and analysis of the medical waste logistics management system allowed to propose corrective actions and improvements in the areas that most require improvement and adversely affect the waste logistics process.

Research limitations: The research limitation was an access to some data in the hospital. In the future similar research should be carried out in another hospitals in Silesia region.

Practical implications: Carrying out this assessment and analysis of the medical waste logistics management system allowed to propose corrective actions and improvements in the areas that most require improvement and adversely affect the waste logistics process. The introduction of the proposed improvements will increase the efficiency of the process and contribute to minimizing the risk of current problems occurring in the future.

Originality/value: The article shows the scale of the problem that can occur in many hospitals in Poland. Additionally, the article presents some recommendations for hospital staff, which aimed at minimizing the health risk to patients and staff, as well as improving compliance with standards and procedures set in the hospital.

Keywords: medical waste, hospital waste, medical waste logistics.

Category of the paper: Case study.

1. Introduction

Nowadays, medical facilities such as the Silesian Municipal Hospital, which is analyzed in the work, play a key role in providing appropriate health care for patients. With the increase in the number of patients and constantly developing medical technology, the amount of generated medical waste also increases, which creates various types of problems for the medical waste management area in the hospital. Medical waste logistics is an important element leading to the proper functioning of the hospital and maintaining appropriate sanitary standards. Improper management of medical waste may lead to various consequences for medical staff, patients, and the entire natural environment.

The aim of the work is to thoroughly analyze problems related to the logistics of medical waste in the Silesian Municipal Hospital. The research issues focused on the analysis of currently used solutions, the causes of existing problems and proposals for improvements aimed at improving the quality of medical waste management processes in the Municipal Hospital. The research will focus on analyzing areas related to the collection, storage, transport, and disposal of medical waste. The analysis will also cover procedures related to the segregation of medical waste and compliance with applicable regulations. The research will also focus on assessing the effectiveness of existing logistics processes in waste management and identifying potential areas requiring improvement. The work will also present practical solutions that can contribute to more efficient and effective management of medical waste at the Silesian Municipal Hospital. The research was conducted in 2023-2024.

2. Conceptual background

2.1. Waste definition

Waste is objects and substances that are most often created because of human activity, they are useless, which means that the person who has them gets rid of them. The Waste Act of December 14, 2012 defines waste as "any substance or object that the holder gets rid of, intends to get rid of, or is obliged to get rid of" (Dz.U. 2022, poz. 699). These may be various types of products that are unused, damaged or past their expiration date, as well as residues from various types of production or food processes. Waste is also harmful to the environment and human health; its toxicity can contaminate the air, water, and soil. They are also dangerous to all types of living organisms, because during decomposition they produce various bacteria and viruses, which pose a direct threat to the lives of animals and other organisms. Waste logistics mainly involves the creation of logistic chains that connect the place of waste generation with the place of its use, processing, and reuse. This process should be carried out in a comprehensive and

orderly manner. Considering the logistic systems used in waste management, they include a waste processing subsystem, i.e., segregation, storage, movement, processing and making secondary raw materials available for reuse (Gajdzik, 2009).

2.2. Waste classification and main sources

Waste classification can be done using various criteria, such as the chemical and physical properties of the item, toxicity, and using different categories divided depending on the origin of the waste. The classification should show the genesis of waste, its properties, ecological harmfulness, usefulness, and its production (Lipińska, 2016).

The main source of waste is human activity, waste is generated in various spheres of human functioning. According to Rosik-Dulewska (2015), the main cause of excessive waste is irrational resource management. They are produced in households through normal human functioning, because of economic, industrial, and service activities, and they are also residues from various types of substances and objects. The next aspect is human consumerism, namely people buy items that they do not really need, replacing old things with new ones, even though the old ones still serve their purpose. They buy single-use items that they quickly throw away. An important issue in this topic is also ineffective segregation causing environmental pollution. It extends the recycling process, making it more time-consuming and expensive. However, an increase in the amount of waste in landfills leads to their faster filling, which means that new storage places must be created, which are a burden on the natural environment. Improper segregation leads to wastage of resources that could be used to produce new products and raw materials in the future. It is also a threat to human health - ineffective segregation of, for example, medical and hazardous waste directly exposes people to harmful substances that pose a threat to their health. Garbage surrounds us on all sides, it is thrown onto sidewalks, along roads, and it litters forests, ponds, and lakes. This waste includes unburned cigarettes, chewing gum, bottles, tissues, and many other things that pollute the environment and atmosphere and pose a threat to the lives of animals. The generation of waste should be eliminated or limited by those who produce it and those who are its recipients, regardless of the degree of harmfulness or threat to human life and health and to the environment, regardless of the quantity or place of its production (Gwoździewicz, Witkowska-Kita, 2007).

2.3. Medical waste characteristic and classification

Medical waste that people encounters every day comes in the form of solid and liquid substances. According to the Waste Act, medical waste is "waste generated in connection with the provision of health services and conducting research and scientific experiments in the field of medicine" (Dz. U. 2022, poz. 699). They arise because of medical activities carried out in closed and open medical facilities, research facilities, veterinary units, in facilities that conduct experiments on living organisms, and occur in various types of institutes, clinics and sanatoriums. Medical waste is a substance that is very dangerous to the health and life of

hospitalized patients, as well as to the entire staff of a hospital. Medical waste includes waste in the form of blood and its derivatives, all types of tools and sharp objects such as scalpels, needles and syringes, waste generated during procedures, namely dressings and surgical gloves. The next type is biological and contaminated waste, medical waste also includes human remains. All the previously mentioned wastes are substances and objects that carry viruses, bacteria and other pathogenic substances that can lead to serious illnesses and, in the worst cases, even death. Medical waste that is generated because of direct contact with patients' blood is very dangerous. People can get a serious infection through contact with used syringes or gauze pads that have been in contact with a sick person. Patients may have very serious infectious diseases, which can cause diseases such as HIV, hepatitis B or plague to be contracted even in the slightest contact with their blood (Topolska, 2017; Bataduwaarachchi et al., 2018). Medical waste management in Poland is defined by several regulations that aim to ensure safe and compliant waste management procedures. These include waste segregation, storage, transport, and disposal (Bilitewski et al., 2006).

In Poland, approximately 200,000 tons of medical waste are generated annually, approximately 15% of which is infectious waste. This waste requires special treatment - it is infectious and pathological waste. They are characterized by the presence of various types of chemicals, bacteria, fungi, and toxins. Hazardous medical waste is generated in almost all stages of hospital operations, and this process cannot be avoided. Waste is generated in hospitals, starting from performing surgeries and treatments, through diagnoses and tests, to admitting patients. In a proper waste management process, each stage should be carefully described and scrupulously followed, and each hospital should have its own, well-developed procedure on how medical waste should be handled. Workplaces should have instructions on how employees should handle this waste to minimize occupational risk. The proper process of medical waste management must include appropriate waste storage, collection, transport, segregation, and safe disposal (Forowicz, 2012).

Medical waste is divided into (BDO, 2023, Procedura Nr QP-12/E):

Infectious medical waste - this is hazardous waste that contains live microorganisms or their toxins that are known or there are reliable grounds for assuming that they cause infectious diseases in humans or other living organisms. Waste codes: 18 01 02*, 18 01 03*, 18 01 80*, 18 01 82*.

Hazardous non-infectious medical waste "SPECIAL" - this is hazardous waste that contains chemical substances known or for which there are reliable grounds for believing that they cause infectious diseases in humans or other living organisms or may be a source of environmental infection. Waste codes: 18 01 06*, 18 01 08*, 18 01 10*.

Non-hazardous medical waste "OTHER" - this is medical waste that does not have hazardous properties. Waste codes: 18 01 01, 18 01 04, 18 01 07, 18 01 09, 18 01 81.

Highly infectious medical waste - i.e. waste that has been identified or is reasonably suspected to contain biological pathogens that pose a particular threat to humans.

Hazardous waste has at least one hazardous property that is characteristic of this type of waste. However, hazardous medical waste is characterized by the fact that it contains biological pathogens, i.e., "cellular microorganisms with the ability to cause disease symptoms or the products they produce, external and internal human parasites or the products they produce, cell-free particles capable of replicating or transferring genetic material, including genetically modified cell cultures or products produced therefrom" (Dz.U. 2008, poz. 1284). The waste catalog contains the previously mentioned waste numbers marked 18 01. These wastes marked with the additional symbol "*" are hazardous medical waste - they include, for example, body parts, organs and blood containers marked with the code 18 01 02*. All waste listed with "*" contains pathogenic pathogens associated with the content of organic tissue, biological infectious agents and hazardous chemicals derived from drugs that are used in the treatment of malignant tumors using chemical methods (Stelmasiak, Pieprzny, 2012).

The following types of containers can be distinguished (Regulation of the Minister of Health of October 5, 2017, on the detailed method of dealing with medical waste (Dz.U., 2017, poz. 1975, EKOMED, 2023):

- **red containers** – intended for collecting waste with codes: 18 01 02*, 18 01 03*, 18 01 80*, 18 01 82*, e.g., residues from feeding people from infectious disease wards, blood, waste containing toxins or microorganisms,
- **yellow containers** – intended for collecting waste with codes: 18 01 06*, 18 01 08*, 18 01 10*, e.g., chemical reagents – containing dangerous substances, cytotoxic drugs,
- **different colour containers e.g., blue** – intended for collecting waste with codes: 18 01 01, 18 01 04, 18 01 07, 18 01 09 18 01 81, e.g., surgical and treatment tools, dressings, including plaster casts, bedding.

Due to the potential danger associated with infectious waste, this waste should be stored in an appropriate manner. Special rules for the collection of infectious waste apply to infectious waste that has been identified or is reasonably suspected of containing biological pathogens that are classified in category A in accordance with point 2.2.62.1.4.1 of Annex A to the so-called ADR agreements (Dz.U., 2023, poz. 891). This waste is collected at the place of its generation to:

- inner packaging consisting of:
 - a single-use bag made of red polyethylene foil, durable and resistant to moisture and chemicals, which can be closed once, which, after filling and closing, is placed in a second bag meeting the same requirements,
 - a rigid, moisture-resistant, mechanically resistant to puncture or cut red container (in the case of medical waste with sharp ends and edges),
- outer packaging, which is a red container, durable, resistant to moisture and chemicals, made in a way that allows disinfection, and can be tightly closed.

It is also worth considering the proper arrangement of medical waste containers. "Proper" placement should be understood as a place where the risk of exposure to external factors, such as moisture or chemicals, is minimized. The location of containers should also exclude their contact with people other than those who segregate or transport them. The basic mistake made when it comes to the proper arrangement of waste containers is relying solely on the easy accessibility of the container. Unfortunately, there are still cases in which waste (just before being placed in the container) is transferred over a "clean" area where sterile instruments are located - e.g., a countertop. The container should therefore be placed in a place that minimizes the risk of intersection of the "sterile" and "non-sterile" zones, while maximally shortening the path of waste to the place of its collection (Reinhardt, 2017).

The amount of medical waste generated in Poland each year makes its proper disposal extremely important. Medical waste is largely considered hazardous waste, which is why its recovery and storage often proves impossible. One of the most frequently practiced methods of waste disposal is still thermal transformation of waste.

However, very important is the way in which this type of waste is disposed of. In accordance with the applicable legal provisions, it should be carried out by thermal transformation on the counter (D10) in a facility adapted for this purpose, while respecting the so-called Principles of Proximity. Proper segregation of medical waste allows to minimize their dangerous impact on people, animals, and the natural environment, which nowadays remains one of the key aspects of the joint effort. Implementing these few simple rules, as well as establishing cooperation with a reliable and competent entity, allows the highest safety standards to be maintained during the entire waste transport and disposal process (Windfeld, Brooks, 2015). The NIK report showed that the "proximity principle" applicable to infectious medical waste was not observed: 60% of entities disposing of such waste accepted it from outside the voivodeship, and 80% of such entrepreneurs transferred the accepted infectious medical waste to other entities. The main reason for the problems was the collapse of the medical waste management system on a national scale, caused by, among others, closing or stopping the operation of parts of installations processing such waste. Consequently, prices for waste disposal increased significantly during the audited period, from approximately 7% to almost 67% on average. During the period under review, the total costs of collection and disposal of infectious medical waste incurred by the audited hospitals amounted to almost PLN 38.3 million. The largest increase in costs - by almost 640% - was recorded in the Provincial Infectious Diseases Hospital in Warsaw and in the District Hospital in Zakopane - by over 578% (NIK, 2023).

3. Problems with medical waste logistics in selected hospital

Silesian Municipal hospital has been operating successfully for 47 years and has two units. The hospital provides medical services in the field of inpatient treatment and specialized outpatient health care. It serves approximately 12,000 patients annually from the whole Silesia region. Hospital is divided into 6 buildings numbered A-F. Each building houses different hospital wards and produces different medical waste. All waste from the above-mentioned buildings and departments must be properly segregated and disposed of in accordance with applicable medical waste management regulations. Ensuring proper waste management is crucial to maintaining high hygiene standards and, above all, the safety of patients and medical staff.

3.1. Analysis of disruptions related to human resource problems in medical waste management

1. In the hospital, there is a clear disproportion between the amount of waste generated and the number of employees responsible for segregating and removing waste from individual hospital departments, which generates several problems related to maintaining hospital procedures at the highest level. The number of trolleys and employees in the hospital is limited, so following the procedures is practically impossible. Due to the shortage of employees, problems such as irregular emptying of containers and lack of immediate response to excess waste occurring in the departments occur. This causes garbage to accumulate on the hospital premises, thus having a greater impact on hospital patients. Garbage accumulates in the wards, which reduces the quality of hygiene standards in the hospital and reduces the safety and satisfaction of patients who may feel discomfort caused by the presence of accumulated garbage.
2. Another problem related to staff shortages leads to delays in the entire logistic process of medical waste management. When a specialist company dealing with the removal of waste for disposal arrives, it may encounter the problem of a lack of people who will be able to hand it over the waste, for example because they will be on the round.
3. The next problem concerns the too few cleaners employed in the hospital staff. This leads to a situation in which there is one person in each department who is responsible for maintaining proper order and segregating and collecting waste. This situation may lead to overload for a given person, and therefore may reduce the effectiveness of their activities and may affect various types of health problems.

3.2. Analysis of disruptions related to the problem of waste storage and waste collection for disposal

1. Limited storage space is the main problem in the proper management of medical waste. The small number of waste containers and shelves in the warehouse makes the segregation process significantly more difficult, which deviates from the established standards and procedures. The result is that properly sorted waste in the wards, despite careful segregation of the cleaners in the waste warehouse, ends up in one container regardless of the color of the bag. Blue, yellow, and red bags in the warehouse should be stored in separate containers but are thrown into one due to lack of space in the warehouse. This situation quite seriously violates the principles, sanitary standards, and procedures for proper management of medical waste.
2. The next problem in warehouse management is water drainage in the warehouse and old equipment. After collecting waste for disposal, employees must thoroughly wash the warehouse using special cleaning agents. The staff does not have modern equipment, so the warehouse is cleaned using a garden hose, which has low pressure, so the accuracy of washing the warehouse is not effective.
3. Another problem of waste storage management is the lack of appropriate waste monitoring systems. A significant problem resulting from the lack of such a system is the difficulty in precisely determining the amount and type of waste generated in the warehouse. Monitoring systems also make it possible to precisely determine how long a given type of waste can be safely stored in warehouse conditions. The lack of a monitoring system also affects the accumulation of waste in the warehouse, which significantly worsens hygienic conditions, which may negatively affect the health of personnel dealing with medical waste.
4. An additional problem is the lack of waste collection by an external company during the weekend, which leads to waste overflowing into the storage space, which not only complicates the work of the staff responsible for waste but may also pose a threat to the health of employees. During weekends, the amount of waste generated in the hospital does not decrease and may even increase compared to individual days of the week. Waste workers are unable to do anything about this fact and are forced to store waste collected from hospital wards on the warehouse floor, which significantly violates the designated procedures and increases the chances of infection of the body, for example with a used needle.

3.3. Disturbance analysis related to problems with the route and road intended for the transport of medical waste

The problem of the route and transport route of medical waste is an important element in the context of efficient and proper management of medical waste management in the hospital. Currently, the waste transport process within the hospital is as shown in Figure 1.

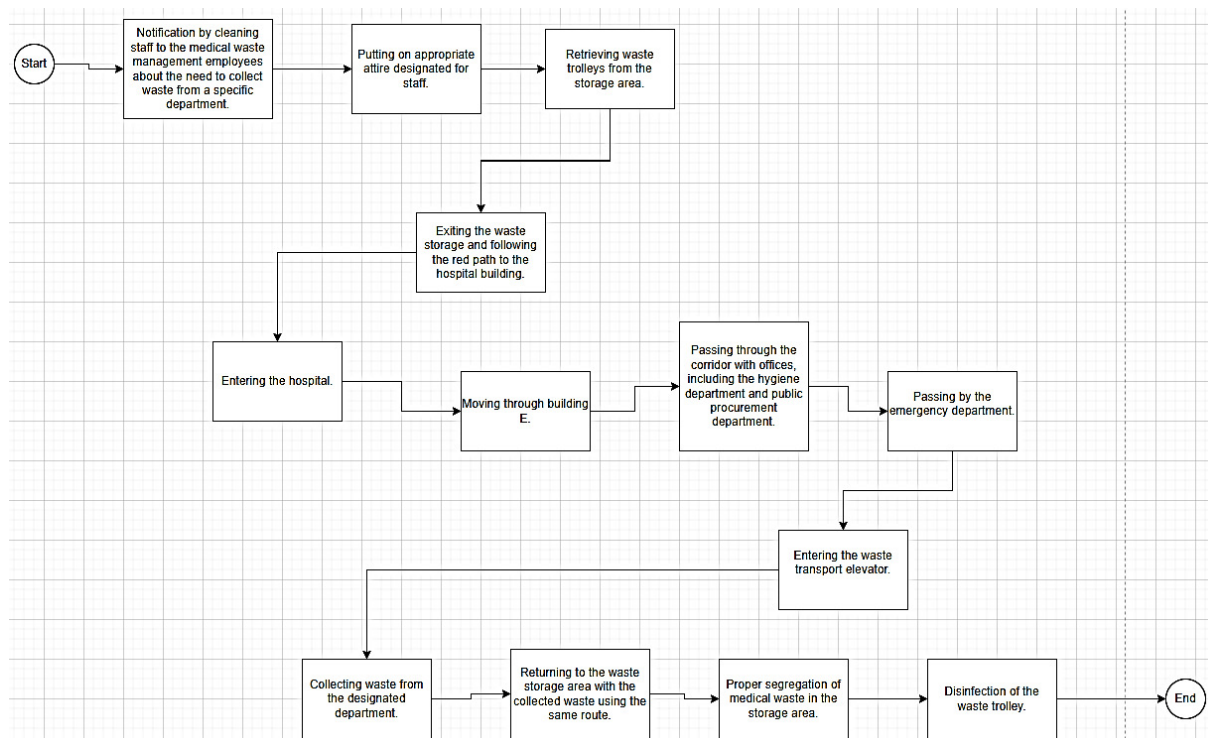


Figure 1. Waste transport route.

Source: own work.

1. The first problem concerns the need to always transport waste using the same transport route designated in the procedures, which causes problems when the route is blocked and impassable for the waste trolley or when the elevator fails. Such situations cause significant downtime in waste collection and extend the entire process of collecting medical waste. Moreover, in the event of an elevator failure, another problem arises, namely, employees responsible for medical waste are forced to use the elevator intended for patients and hospital staff to get to a given ward, which may lead to a situation where medical waste will move in the same elevator as lunches for patients as well as the patients themselves. This situation significantly violates hygiene standards and increases the risk of infection, but also causes discomfort for patients because medical waste leaves an unpleasant smell in the elevator.
2. Further problems related to the extension of the process related to the collection of waste from the departments, and at the same time the entire process, are generated by the fact that in the event of an elevator failure, the staff dealing with medical waste cannot use the elevator at any time, because patients are the priority, so if there is patient, then the waste worker must wait until the elevator is empty. Considering the number of patients and the frequency of their movement using the elevator, the time needed to collect garbage from the wards and the entire process of medical waste management is significantly extended.

3. The next problem causing disruptions in the appropriate medical waste management process is the transport route designated in the procedures for collecting waste from hospital wards. To follow the procedures, employees must walk with garbage along the entire building E of the hospital. This route is too long and completely unsuitable for equipment such as medical waste carts, which poses significant challenges to employees due to its structure. There are numerous holes and unevenness on the road, and it is not an asphalt road, but a road covered with gravel and stones. Additionally, after crossing this road and reaching the interior of the hospital building, employees must cover a large part of the hospital to get to the elevator intended for transporting medical waste. After collecting waste from the site, waste management staff must return to the warehouse with a full cart of waste via the same transport route, which is an even bigger problem. The disruption that comes with unsuitable routes and too few workers on shift is when waste handlers break rules and procedures to avoid accidents, cause delays in the overall process, and effectively manage medical waste. Employees follow their route through the ambulance ramp, which is much shorter but does not comply with established procedures. An additional problem related to the road occurs in winter. The presence of snow and ice makes it significantly difficult for employees to move around with a waste cart. Irregularities covered by a layer of snow or ice make it difficult to control the truck, may damage it and are also dangerous for the employees themselves, who may be exposed to injury caused by such conditions. Large amounts of snow can also make the route completely impossible and then the waste management staff is forced to clear the snow from the route with a shovel, which has a significant negative impact on the regularity of waste collection and causes significant delays in the entire process.

4. Proposals for improvements to problems identified in the city hospital

4.1. Improving the process related to the lack of human resources

1. To improve the process of managing available human resources, attention should be paid to optimizing the staff's work schedule. For this purpose, an analysis should be carried out to determine the hours at which the greatest amount of waste is generated in given wards and the employees' schedules should be adjusted accordingly to these periods to avoid the problem of excessive amounts of waste in wards and to limit patients' contact with medical waste in the hospital. Another proposal that will certainly improve and optimize the waste management process is to hire a new employee for this area. This idea will involve additional costs for the hospital, but it also brings many benefits that will significantly improve the efficiency of waste management. Improving

the efficiency of operations, increasing safety, accelerating the entire process and the ability to assign tasks to a new employee in areas where deficiencies are noticeable may exceed the expenses incurred related to his employment. The introduction of a new employee will also allow for more accurate segregation and removal of medical waste, will contribute to greater compliance with waste management procedures and will improve the response to an increase in the amount of waste at specific hours.

2. The above-mentioned improvement proposals will also help solve the problem of lack of staff at the pickup site when a specialist external company arrives. An additional proposal to avoid this problem is to automate the process of notifying employees about planned garbage collection. Using mobile notifications will be a simple but effective option. Thanks to notifications, medical waste area employees will be able to adjust their duties to be available when collecting waste from the warehouse. The use of these improvements will minimize delays and problems related to waste collection, increase liquidity and efficiency, and improve cooperation with an external company.
3. The next step is to implement activities that involve one cleaning person taking care of the entire department. To solve this problem, it is necessary to analyze which wards involve the most cleaning and segregation work and apply improvements to specific places. The best solution to this problem is, of course, to employ an additional cleaning person, which will allow for better planning of human resources and employ two cleaners in a department that requires more work compared to others. Implementing all the above-mentioned proposals and applying them appropriately will significantly contribute to minimizing the hospital's problems related to the insufficient number of employees responsible for medical waste management.

4.2. Proposals for improvements to the problems of medical waste storage and waste collection for disposal

To solve problems related to waste storage, it is necessary to take actions that will increase the optimization and improve processes related to waste storage and segregation.

1. The most logical and best solution to this situation is to expand the existing medical waste warehouse and, at the same time, increase the storage space intended for waste. This process will allow for better organization of space, purchase of new containers and shelves, which will make the segregation process easier for employees and will allow for proper storage of waste in accordance with the established rules. For this purpose, the arrangement of waste containers should be carefully considered, and the shelves should be installed appropriately. Another activity that should be considered when building a new warehouse is ensuring appropriate conditions for storing medical waste. For this purpose, an appropriate air conditioning system should be used to maintain the appropriate temperature required for appropriate storage of medical waste. An important aspect is also thorough and tight protection of the warehouse against moisture to

maintain dry conditions for storing waste. It is also important that no insects or rodents enter the warehouse, and that the storage complies with all sanitary standards.

2. Another improvement that needs to be implemented is the introduction of a new water drainage system to the warehouse. For this purpose, the drain grid should be enlarged, and a minimum slope should be used, which will direct the disinfected water towards the drain grid. Additionally, modern tools should be introduced to disinfect the warehouse. It will be a great help for employees to purchase a pressure washer, which will be much better for disinfection than a garden hose. At the same time, the use of modern equipment will allow for faster and more thorough cleaning of the warehouse from dirt, blood and germs remaining after medical waste. This equipment will shorten the warehouse disinfection process and make the work of the staff much easier. This will also increase the level of maintaining appropriate hygiene requirements.
3. The next improvement concerns the introduction of waste monitoring systems to the warehouse. The implementation of modern systems will enable effective management of medical waste during storage and will facilitate the entire process. Technologies that can be implemented include, for example, weight sensors for containers and an RFID system. Weight sensors in the containers will allow continuous control of the amount of collected waste, it will allow employees to better manage storage space, and the hospital will obtain data on how many kilograms of waste are collected on a given day. Thanks to these measurements, waste management staff will be able to constantly check how much waste is in the warehouse, and this process will improve the efficiency of sorting and help in timely removal of waste from the warehouse. Another improvement is the use of RFID technology, which will allow each waste container to be marked in a unique way. Thanks to this technology, it will be possible to control how much of each type of waste has been collected by dividing the waste into individual bag colors, and it will be possible to precisely determine the storage time. The RFID system will improve logistics processes by quickly and effectively finding specific waste and will allow for the control of specific containers individually.
4. The next improvement aims to solve the problem of lack of medical waste collection on weekends. To effectively deal with this problem, improvements should be implemented to improve this process. The first is negotiation with the company with which the hospital has a contract to establish a new waste collection schedule, which would assume waste collection at least 6 times a week, and if necessary, even 7 times. During the conversation, it should be emphasized that the change is forced due to logistical reasons and the hospital's problems related to maintaining proper order in the medical waste warehouse, and without this change it is practically impossible to maintain applicable sanitary standards, hospital procedures, or occupational hygiene rules. The introduction of this improvement will, of course, not be possible without increasing the costs associated with concluding a contract for waste collection from 6 to 7 days

a week, but to comply with any standards, such a step is inevitable. This process will generate additional expenses, but thanks to this, the hospital will improve employee safety and the efficiency of the medical waste management process. The benefits that will result from the new contract will exceed the potential costs of concluding it. Thanks to the fact that waste will be collected more often than before, the hospital and employees responsible for waste will get rid of the problem of having to store waste on the warehouse floor, which poses a potential threat to employees' health and significantly flexes hospital procedures. An emergency option that can be used if none of the companies collecting waste for disposal agrees to sign a contract for 6 to 7 days a week will be the need to organize additional containers in the warehouse. Additional containers will also mean that it will be necessary to organize a place in the warehouse or in the entire hospital building where these containers can be placed. The location of new containers must be easily accessible and enable appropriate waste segregation for the employees responsible for it. The introduction of this solution will help avoid problems that occur when waste accumulates excessively in the warehouse and will help maintain order during the period when waste collection is limited.

4.3. Proposals for improvements to the transport route for medical waste storage and waste collection for disposal

To effectively solve problems related to waste transport, a number of actions should be taken to facilitate the process of moving medical waste within the Silesian Municipal Hospital.

1. The first improvement, which will eliminate problems related to blocking the waste transport route, avoid the problem of elevator failure and at the same time optimize the waste management process at the Municipal Hospital, will be the use of an innovative idea that assumes the creation of a special warehouse with a chute for medical and other waste. For this purpose, a room must be developed on the hospital premises that can be used for this type of waste storage. In each of the departments, a special waste chute will be created in a designated waste room called the "dirt room". The cleaners stored the previously collected and properly sorted garbage in a dirt bin and when the garbage from the entire ward was collected, the staff responsible for the cleanliness of the ward called the people collecting medical waste, and they had to follow the designated route in accordance with the procedures and move to a given floor at elevator assistance. After introducing this improvement, people cleaning the ward, after cleaning the entire ward, will throw the collected and properly sorted garbage into the waste chute located in the dirt bin, and the garbage thrown into it will go directly to the waste warehouse, from which the staff will someone responsible will take them away. Thanks to this solution, the need to use an elevator will be eliminated and problems that may occur along the waste transport route will disappear. This idea will significantly increase the flexibility of waste transport and facilitate the work of staff responsible for waste

generated within the hospital. Of course, the use of such a solution involves costs, which include, among others: installation of special waste chutes, development of the hospital room and its modernization to meet specific requirements. However, the use of such a solution will shorten the entire process of waste collection and transport, reducing the need for employees to walk through each of the hospital departments to collect waste, thus increasing the efficiency of the entire process. An important aspect of this improvement is also the fact that contact with patients and hospital staff is reduced to practically a minimum. By throwing garbage into a special chute, from which the garbage goes to a collection point in a special room, the risk of possible threats related to patient infection and other sanitary problems is eliminated. To sum up, the creation of a warehouse with special chutes in each of the departments will significantly facilitate and speed up the entire waste collection process, and at the same time will make the process much more effective and safer.

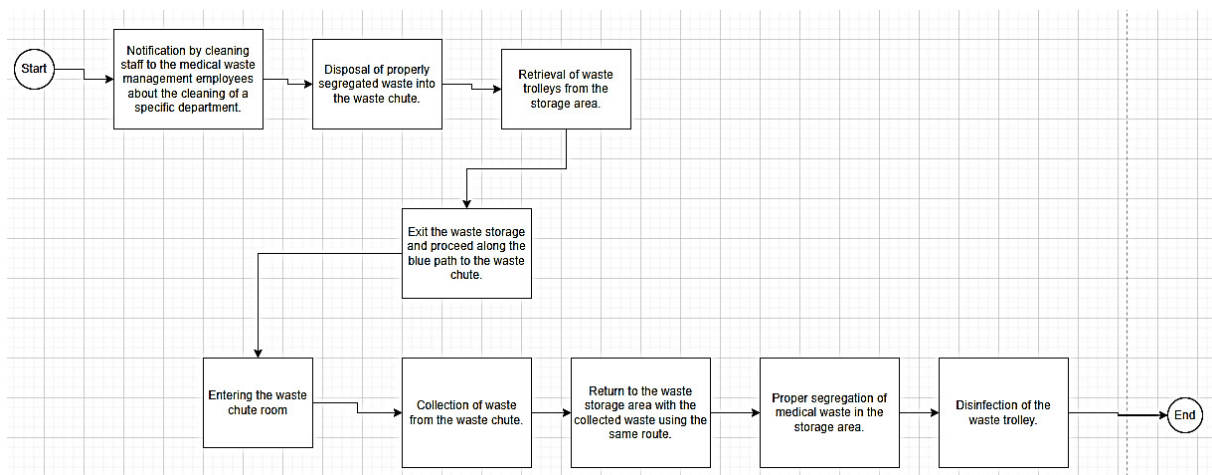


Figure 2. Waste transport route after the improvement.

Source: own work.

Figure 2 shows the simulated waste transport process after introducing an improvement in the form of a waste warehouse in the hospital and the use of chutes in each of the departments. The presented process shows that the introduction of this improvement will shorten the entire process of transporting medical waste within the Municipal Hospital by over 16 minutes.

- Another improvement aims to determine a new, more optimal medical waste transport route compared to the current one. The current medical waste transport route leads along the red path shown in Figure 2. The new route assumes that employees responsible for waste transport would enter the hospital building from the side of building C. The introduction of this change assumes shortening the transport time and improving the efficiency of this process. After entering building C, employees only need to go through one corridor, and they will find themselves at the elevator intended for waste transport. The introduction of the route change will eliminate the need for staff

responsible for waste to travel through a large part of the hospital area, shortening the time needed to cover the route along Building E and reducing the contact of waste with hospital staff and patients. Another feature that will make navigating the new route easier will be the use of the asphalt road leading to building C, which will allow employees to move the truck freely and reduce the risk of damaging it. The introduction of this route will increase the efficiency of the waste transport process, shorten transport time and eliminate unnecessary maneuvers and difficulties in moving with a trolley on a gravel surface. Changing the route will facilitate the daily work of medical waste management staff and minimize delays.

5. Summary and conclusion

During the research related to the problems of medical waste logistics at the Silesian Municipal Hospital, it was possible to become thoroughly acquainted with the applicable hospital procedures and regulations governing the management of medical waste. The acquired knowledge allowed for understanding the problems, responsibilities of the staff responsible for waste and existing work standards. Thanks to this knowledge, it was possible to propose improvements at work to improve staff working conditions, compliance with regulations and changes in the management system.

Regarding potential threats that may occur during the transport of medical waste, the analysis of transport processes at the Municipal Hospital allowed for the identification of threats related to, among others: inappropriately planned waste transport route and problems related to the construction of the road along which the waste moves. The analysis carried out allows for the proposal of actions to streamline the transport process and improve staff safety.

In the context of quality and risk management in waste transport, the subject of risk and quality management during transport was introduced, which allowed to identify areas requiring improvement and propose effective solutions that will contribute to minimizing the risk occurring in the process of transporting medical waste.

The problem of technology and tools supporting waste logistics- getting acquainted with the equipment and technology used at the Silesian Municipal Hospital, which supports the process of waste logistics at the hospital, allowed us to see the shortcomings in this process related to inappropriately adapted equipment. Thanks to this, it was possible to propose the introduction of more modern equipment and automated technology, which will contribute to the optimization of the process and increase its efficiency.

Additionally, disruptions occurring in medical waste management were identified. The identification of disruptions occurring around waste management allowed for the introduction of improvements in those areas that require them and are crucial in the context of

efficient management of medical waste logistics and the effective operation of individual processes occurring in this area.

In addition, recommendations have been prepared for medical staff and patients to increase safety and minimize the risk of infection. Activities related to the introduction of recommendations for hospital staff and patients have been appropriately analyzed and specific actions have been introduced aimed at minimizing the health risk to patients and staff, as well as improving compliance with standards and procedures set in the hospital.

In case of identification of disruptions that may occur during the transport of medical waste, specific actions were proposed to minimize the risk of problems occurring during the transport of medical waste. Their use will significantly contribute to increase the safety of the entire process.

Therefore, carrying out this assessment and analysis of the medical waste logistics management system allowed to propose corrective actions and improvements in the areas that most require improvement and adversely affect the waste logistics process. The introduction of the proposed improvements will increase the efficiency of the process and contribute to minimizing the risk of current problems occurring in the future.

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GENERATIVE AI ROLE IN BUILDING 3PL COMPANIES' RESILIENCE

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Purpose: The purpose of this study is to evaluate the impact of generative artificial intelligence (gen-AI) models on the operational resilience of third-party logistics (3PL) companies. The research explores how gen-AI supports 3PL companies in adapting to changing market conditions, managing supply chain disruptions, and building resilience across various operational dimensions.

Design/methodology/approach: This study adopts the Analytical Hierarchy Process (AHP) methodology, integrating expert feedback to prioritize the influence of gen-AI models on four key resilience criteria: flexibility, velocity, collaboration and integration, and agility. Experts assessed the role of six gen-AI model types in enhancing these criteria.

Findings: The study found that agility (0.322) and velocity (0.309) were the most significant criteria for enhancing 3PL resilience, underscoring the importance of rapid adaptation and operational flexibility in logistics. Among the six evaluated gen-AI models, Model 5, which generates sounds (such as speech or music) from text, consistently ranked highest across all criteria, particularly for flexibility and velocity. This suggests that sound-based AI technologies can play a crucial role in automating dynamic processes and real-time communications in 3PL operations.

Research limitations/implications: The study was limited by a relatively small sample size and focused on four key criteria, which may have impacted the comprehensiveness of the findings. Future research could expand the analysis by incorporating additional criteria and increasing the respondent pool to minimize biases. Investigating the reasons for Model 5's dominance and exploring why Model 6 (code and algorithm generation) scored lowest could offer deeper insights into the evolving role of AI in logistics.

Originality/value: This study provides novel insights into the application of gen-AI in enhancing the resilience of 3PL companies. It highlights the strategic importance of AI-driven sound generation in logistics operations and offers a structured framework for prioritizing AI model investments. The findings are valuable for logistics companies, supply chain managers, and decision-makers aiming to optimize their operations and enhance resilience through AI technology.

Keywords: 3PL (third-party logistics), AHP (Analytic Hierarchy Process), generative AI, resilience.

Category of the paper: Research paper.

1. Introduction

Third-Party Logistics (3PL) companies must continuously strive to enhance their operational resilience to effectively manage disruptions and ensure continuity of operations. In the era of technological advancement, generative artificial intelligence (gen-AI) is playing an increasingly pivotal role in building resilience by supporting logistics processes at various levels, from communication automation to operations optimization. Research shows that the use of AI in logistics can significantly improve the flexibility and agility of operations, which is crucial for 3PL companies facing the growing complexity of global markets (Rahman et al., 2021; Zhu et al., 2022; Toorajipour et al., 2021). Gen-AI, with its advanced machine learning algorithms, enables logistics companies to automate processes, generate content, and optimize operations in real time. Its ability to process large data sets and support decision-making in dynamic operational conditions makes it an indispensable element of modern logistics (Ellaturu, Rajalakshmi, 2024; Liu, Lee, 2018). The choice of this research topic stems from the growing need to understand how gen-AI can support the resilience of 3PL companies. Operating in increasingly complex and disruption-prone supply chains, these companies require tools that allow them to quickly react and adapt their operations.

Generative AI may be the solution to these challenges, but there is a need for a detailed examination of its impact on the resilience of 3PL companies. Therefore, the following research question has been formulated:

RQ.1: What is the impact of gen-AI models on the resilience of 3PL companies?

This question forms the basis of the present analysis, which aims to evaluate how various generative AI models can support the operational resilience of 3PL companies, particularly in terms of their ability to adapt to changing market conditions and respond to disruptions in supply chains.

2. Theoretical background

2.1. Gen-AI in logistics processes

We have witnessed dynamic developments in industry and services in past years. Artificial intelligence has undoubtedly been a significant catalyst for change. Companies strive to gather as much information as possible from all processes, allowing them to tailor their products or services to meet customer needs (Eggert et al., 2011). To maximize profits, firms seek ways to manage data most efficiently. In the era of Industry 4.0, generative artificial intelligence has become an indispensable part of intelligent manufacturing, increasing automation rates, and improving process efficiency. (Peres et al., 2020) Its proficiency in

processing large data sets and generating human-like text has significantly facilitated communication between humans and machines. (Rane, Nitin et al., 2023)

Artificial intelligence can be defined as a subdiscipline of computer science that focuses on a systematic approach to data processing, performing functions typically similar to human intelligence, such as reasoning, learning, and self-improvement. However, a universally accepted definition of this term still needs to be created (ISO, 2017).

Artificial intelligence has become indispensable in automating and digitizing supply chain operations (Dolgui, Ivanov, 2021). Specifically, its integration into supply chain management fundamentally alters prevailing business practices and managerial responsibilities. A 2018 Gartner report identified AI as the most crucial strategic technology. The report forecasted that global investment in AI-based applications would surpass \$50.2 billion by 2021, and international revenue from the AI market would reach \$2.59 trillion by the same year (Gartner, 2018; Statista, 2018).

Over time, AI has come to be defined as a scientific field focused on creating intelligent machines capable of performing tasks that typically require human intelligence, such as understanding language, recognizing patterns, learning, and solving problems (Kilani et al., 2022). AI is crucial in analyzing large datasets, employing scientific techniques, particularly machine learning, to identify decision-making patterns and minimize human intervention (Aggarwal et al., 2022). AI and algorithmic decision-making significantly impact daily life, with applications in healthcare, business, government, education, and justice, steering us towards a more algorithm-driven society (Kaur et al., 2022). Advancements in technology have led to the rise of Generative Artificial Intelligence (gen-AI), focusing on creating systems capable of generating new data that resemble original data, such as texts, images, or sounds, in a manner indistinguishable from human-created data (Yu and Guo, 2023). Future gen-AI tools will likely train on data from the Internet, blending original and AI-generated data, prompting questions about the evolution or degradation of these tools (Martínez et al., 2023). Generative AI models encompass a variety of technologies, each with distinct characteristics and applications. It usually is about the models which allow to (Gonzalo-Brizuela et al., 2023; Knott et al., 2023; Kmieciak, Skórnóg, 2024):

- Models capable of generating text responses to questions or commands using advanced machine learning techniques.
- Models can transform text into images using sophisticated generative AI techniques to create realistic and detailed visuals.
- Models specialize in converting text into three-dimensional images, offering new computer graphics and design possibilities.
- Models focus on transforming images into text, enabling the creation of descriptions and narratives based on visual data.
- Models capable of generating videos from text, opening new avenues in film production and animation.

- Models specialize in generating sound from text, applicable in speech synthesis and music creation.
- Models focus on transforming text into programming code, aiding developers in automating and optimizing coding processes.
- Models designed to generate scientific texts, supporting researchers in creating and editing publications.
- Models that create new algorithms, pushing the boundaries of automation and innovation in algorithmics.
- Models producing text and images, representing a significant advancement in AI technology.

Authors assume that mentioned models could be gathered into six basic gen-AI models types:

- Models which generate text responses from commands.
- Models which generate images from text.
- Models which generate text from images.
- Models which generate videos from text.
- Models which generate sounds (speech or music) from text.
- Models which generate programming code and/or algorithms from text.

The business world is experiencing a technological revolution, with AI playing a crucial role in transforming operations and competition (Sestino et al., 2022). Generative AI, a particularly dynamic AI area, fosters innovation and creativity across various sectors (Haughes et al., 2021). Its applications in e-commerce and finance enhance customer experiences and business operations, making them more efficient and market driven. On a global scale, AI introduces new models of cooperation and competition among companies, significantly impacting international business relationships. According to Pallathadka et al. (2023) and Xiaong et al. (2020) AI and ML-based technologies are applied in: sales management and forecasting, fraud detection and security management, improving customer experience in e-commerce and finance and optimizing manufacturing processes, developing new forms of business cooperation and competition, business social network development and strategic human resource management. Modern scientific literature highlights the diverse applications of generative artificial intelligence models across various fields. These models, products of ongoing AI research and development, reflect a deepening understanding of technology. Their diversity enables a broad spectrum of applications, from simple tasks to complex processes requiring advanced analysis. Significantly, these models drive development and innovation in many sectors, shaping the technological future. As AI evolves, these models are expected to become more sophisticated, offering new capabilities and applications across an even wider range of domains. In logistics, the incorporation of Generative Artificial Intelligence (gen-AI) holds significant potential for enhancing operational

efficiency, improving decision-making, and increasing resilience. As logistics companies navigate complex supply chains, gen-AI can transform how they manage and optimize their processes. Example logistics processes and areas of logistics concern supported by gen-AI could be:

- demand forecasting (Skórnóg, Kmiecik, 2023).
- assortment management (Kmiecik, 2023).
- supply chain operations improving (Frederico, 2023)
- improving operations due to Industry 4.0 perspective (Javaid et al., 2023).
- logistics operation costs reduction (Haddud, 2024).

One of the most interesting issues connected with these manuscripts is how gen-AI could influence logistics companies' resilience.

2.2. 3PL companies resilience

Logistics companies play a crucial role in today's global market. They are responsible for efficiently managing the flow of goods, data, and information (Shaharudin et al., 2014; Shanker et al., 2022). Their role and significance constantly evolve with technological advancements, especially in the context of emerging generative artificial intelligence (gen-AI). Technologies with potential for mass application in logistics can be divided into those whose wider deployment is forecasted for less than 5 years (robotics and automation, the Internet of Things, cloud logistics, big data analytics, augmented reality, and low-cost sensor solutions) and those for more than 5 years (autonomous vehicles, artificial intelligence, 3D printing, unmanned aerial vehicles, blockchain, next-generation wireless networks, bionic enhancements, virtual reality, and digital twins). Mass personalization is also being added to the mentioned technologies as one of the concepts related to innovation in logistics (Liu et al., 2018). One of the biggest trends in logistics companies is the attempt to implement blockchain-based technology (Tiwari et al., 2023). Third-party logistics (3PL) companies define themselves through a wide range of activities, including planning, executing, and controlling the flow and storage of goods, services, and information from the point of origin to the endpoint (Hazen et al., 2014). Their activities encompass domestic and international transportation, inventory management, warehousing, order fulfillment, and the management of information and finances related to these processes.

Regarding competitiveness, 3PL companies constantly strive to gain a competitive advantage. In a highly competitive market, logistics companies often focus on achieving leadership positions in a given niche (Yildiz, 2017). Outsourcing is most often associated with 3PL and 4PL (fourth-party logistics). 3PL companies offer comprehensive logistics services, including transportation, warehousing, inventory management, packaging, and other related services (Selviaridis, Spring, 2007). The use of modern technology is also frequently integral to the operations of logistics enterprises. Authors often emphasize that innovation is central to

the business models of logistics enterprises, and recent years have confirmed the increased growth of innovation within logistics companies (Lagorio et al., 2022). In an era of increasing competition and dynamic technological changes, logistics companies must continuously adapt their business models and services to enhance their resilience to disruptions. The authors believe that the integration of gen-AI in logistics can open new opportunities to increase the resilience of these companies in today's market. In the literature, there are a lot of factors that influence positively on 3PL companies' resilience in the contemporary supply chain (table 1).

Table 1.
3PL companies' resilience factors

Example papers	Proposed 3PL companies' resilience factors based on logistics' resilience literature
Finck, Tillmann (2022)	Flexibility, recovery plans
Jüttner, Maklan (2011)	flexibility, velocity, visibility, and collaboration
Ivanov, Dolgui (2021)	redundancy, real-time monitoring, visibility, and recovery plans
Wieland, Wallenberg (2013)	agility and robustness
Liu et al. (2018)	risk management culture, agility, integration
Deng, Noorliza (2023)	external integration
Gkanatsas, Krikke (2020)	operational risk and black swan events handling, reverse operations handling

Source: own elaboration.

According to the presented table, the following 3PL companies' resilience factors could be distinguished: flexibility; velocity, visibility, collaboration, redundancy, real-time monitoring, recovery plans, agility, robustness, risk management culture, internal integration, external integration, black swans events handling, reverse operation handling.

- Flexibility means the ability to quickly and efficiently adapt to changing conditions and customer needs. (Stevenson, Spring, 2007)
- Velocity refers to the time needed for change and the pace of change in the face of threats, risks, and potential disruptions (Jüttner, Maklan, 2011)
- Visibility is the capacity to have a clear view of supply chain operations and information. It enables better inventory management and response to environmental conditions Caridi et al., 2014).
- Collaboration indicates the extent to which a company works closely with partners, suppliers, and customers to ensure smooth operations (Barratt, 2004).
- Redundancy involves having backup systems, processes, or resources in place to ensure continuity in case of disruptions (Sheffi, 2005).
- Real-time monitoring is the ability to access and process information instantly, facilitating immediate decision-making and response (Ngai et al., 2008).
- Recovery plans involve pre-established strategies and procedures to restore normal operations after a disruption or emergency (Chopra, Sodhi, 2014).
- Agility is the ability to quickly adjust operations and strategies in response to unexpected changes or challenges in demand or supply (Yusuf et al., 2004).

- Robustness refers to the strength and reliability of a company's processes and systems to withstand disruptions or uncertain without significant impact (Tang, 2006).
- Risk management culture emphasizes proactive identifying, assessing, and mitigating risks to ensure smooth supply chain operations (Manuj, Mentzer, 2008).
- Internal integration is the degree of coordination and communication among different departments within the company (Flynn et al., 2010).
- External integration refers to seamless interaction and cooperation with external partners, suppliers, and customers to make the supply chain more effective (Frohlich, Westbrook, 2001).
- Handling black swan events involves the preparedness and strategies in place to deal with highly unpredictable and rare disruptive events (Taleb, 2007).
- Reverse operation handling is the capability to effectively manage reverse logistics, such as returns, recycling, and disposal (Guide et al., 2009).

3. Methods

3.1. Data collection

In this study, expert feedback was integral to assessing the defined criteria, ensuring a broad spectrum of perspectives was considered. A structured questionnaire was created based on five principal conceptual drivers identified through a combination of industry expertise and academic literature. To reduce the necessary number of responses in the conducted survey research and increase the likelihood of obtaining more responses, the authors decided to reduce the selected factors enhancing the resilience of 3PL and to compress gen-AI models based on their similar functionalities. In the scientific article, the evaluation criteria were reduced to four key factors: flexibility, velocity, collaboration and integration, and agility. This decision was made based on their overarching importance and their ability to incorporate other criteria:

- Flexibility is a fundamental aspect of supply chain management as it enables quick and efficient adaptation to changing conditions and customer needs. It includes aspects such as redundancy and recovery plans, as it allows companies to adjust to unforeseen situations by implementing backup systems and strategies to restore normal operations after disruptions.
- Velocity refers to the time needed to implement changes and the pace of changes in the face of threats, risks, and potential disruptions. It integrates elements such as real-time monitoring and visibility, as rapid adaptation requires current access to accurate information and the ability to make immediate decisions.

- Collaboration and integration are crucial for the smooth functioning of the supply chain, encompassing both cooperation with external partners (external integration) and internal coordination within the company (internal integration). This criterion also includes a risk management culture and the ability to handle black swan events, as effective collaboration and integration with partners and internal departments allow for a more comprehensive approach to identifying, assessing, and mitigating risks.
- Agility is key to quickly adjusting operations and strategies in response to unexpected changes or challenges related to demand or supply. It integrates aspects such as robustness and the ability to handle reverse operations, as strong and reliable processes and systems enable efficient disruption management and effective handling of returns, recycling, and disposal.

Mentioned approach to resilience main factors is similar to approach presented in Maghroor et al. (2024), where the main factors are divided into: agility, visibility, flexibility, collaboration and information sharing.

In building the survey, gen-AI models were also aggregated based on their functionalities into the following models:

- Model 1 (generate text responses from commands).
- Model 2 (generate images from text).
- Model 3 (generate text from images).
- Model 4 (generate videos from text).
- Model 5 (generate sounds (speech or music) from text).
- Model 6 (generate programming code and/or algorithms from text).

To gather the necessary input, an Analytical Hierarchy Process (AHP) survey was used. The survey utilized a linguistic scale for evaluating pairwise comparisons. Participants (table 2) were asked to compare the importance of each criterion relative to the others, translating their qualitative judgments into a quantitative framework to the others, translating their qualitative judgments into a quantitative framework

Table 2.

Brief description of experts

Expert	Years of experience in 3PL company*	Current position**	Size of enterprise***
1	4-6 years	Senior-level	Large
2	7-10 years	Senior-level	Large
3	1-3 years	Mid-level	Large
4	4-6 years	Managerial	Medium
5	4-6 years	Senior-level	Small
6	1-3 years	Mid-level	Large
7	1-3 years	Mid-level	Small

* Ranges in years: 1-3; 4-6; 7-10; above 10.

** Current position: Mid-level; Senior-level; Managerial; Executive.

*** Depends of number of employees: Mikro (1-9); Small (10-49); Medium (50-250); Large (above 250).

Source: own elaboration.

The AHP methodology facilitated a detailed and systematic approach to integrating expert evaluations, thereby strengthening the overall analysis and ensuring a thorough consideration of the criteria.

3.2. The Analytic Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP), introduced by Saaty (1980), is a well-established approach in multi-criteria decision-making (MCDM) due to its structured methodology. AHP effectively decomposes complex decision problems into hierarchical levels, including objectives, criteria, sub-criteria, and alternatives, facilitating a thorough evaluation (Saaty, 1980). In this study, AHP was employed to evaluate the impact of Generative AI models on supply chain resilience, focusing on four main criteria: Flexibility, Velocity, Collaboration and Integration, and Agility. For each criterion, six models were compared to prioritize the best-performing models. In implementing AHP, the decision-making process begins with constructing a hierarchical model of the problem, outlining various levels such as the main goal, primary dimensions, and subordinate criteria (Mondragon et al., 2019). This is followed by pairwise comparisons, where decision-makers assess the relative importance of each criterion using Saaty's scale, which ranges from 1 (equal importance) to 9 (extremely more important), with intermediate values for varying degrees of preference (Mathiyazhagan et al., 2015).

The nine-point scale offers a detailed framework for capturing preferences. It enables decision-makers to express subtle differences in importance between criteria, ranging from "equally important" to "extremely more important" (Saaty, 2008). However, Prusak et al. (2016) note that the complexity of this scale can lead to inconsistencies. When decision-makers are presented with numerous options, distinguishing between nearly similar levels of preference can be challenging, potentially affecting the reliability of the results (Ishizak et al., 2011).

In practice, simpler scales are often preferred because they are easier to understand and apply (Chan, Chan, 2004). For instance, using a reduced number of scale points can enhance consistency by reducing cognitive load, especially when the decision-making process involves a limited set of criteria (Basak, 2011). This adjustment can be particularly beneficial when the practitioners involved are accustomed to different assessment methods.

In this study, the primary criteria for assessment include Flexibility, Velocity, Collaboration and Integration, and Agility. To evaluate these criteria, pairwise comparison matrices were developed based on expert judgments.

The experts provided their assessments using a custom scale of (Strong Importance, Moderate Importance, and Equal Importance). To ensure consistency with the Analytical Hierarchy Process (AHP) methodology, these judgments were converted into Saaty's standard scale, which ranges from 1 to 9. This conversion aligns with the AHP framework, allowing for a standardized comparison of the criteria. The pairwise comparison matrices were constructed to quantify the relative importance of each criterion. By applying Saaty's scale, which provides

a range of values from "equally important" (1) to "extremely more important" (9), the converted judgments facilitate a structured and comparative analysis.

In the next step, the focus shifts to calculating the eigenvalue and eigenvector to determine the relative importance of each attribute. This process begins with the computation of the Geometric Mean (GM) of the pairwise comparison matrix, which simplifies the calculation of the highest eigenvalue.

The Geometric Mean method is employed to aggregate the judgments provided in the pairwise comparison matrix. This method involves calculating the geometric mean of the values in each row of the matrix, which helps in deriving the importance weights for each criterion. By doing so, the method simplifies the subsequent determination of the highest eigenvalue, which is crucial for assessing the consistency and accuracy of the decision-making model.

The eigenvalue and eigenvector calculations enable the derivation of priority weights for each attribute, facilitating a structured and quantifiable evaluation process within the AHP framework.

An essential component of AHP is assessing the consistency of the pairwise comparisons. Inconsistencies can arise from subjective biases, so the consistency ratio (CR) is calculated to evaluate the reliability of the judgments. To ensure the validity of the matrices, the consistency index (CI) and consistency ratio (CR) were calculated using the following formulas:

$$C.I. = \frac{\lambda_{max} - n}{n - 1},$$

$$C.R. = \frac{C.I.}{R.I.}$$

where CI is the consistency index and RI is the random index, which depends on the number of criteria (Saaty, 1980; Malczewski, 1999). A CR value greater than 0.10 suggests that the pairwise comparisons may be inconsistent, requiring revision (Feizizadeh et al., 2014).

The Analytic Hierarchy Process (AHP) was used to evaluate and prioritize the role of Generative AI in enhancing the resilience of third-party logistics (3PL) companies. The similar approach, but with Fuzzy AHP method was presented previously by Maghroor et al. (2024) to examine the gen-AI role in supply chain resilience. The analysis considered four key criteria: Flexibility, Velocity, Collaboration and Integration, and Agility. By constructing an aggregated pairwise comparison matrix, the AHP methodology provided a basis for deriving normalized priority vectors (weights) for these criteria, allowing for a structured evaluation of the impact of Generative AI on 3PL resilience (figure 1).

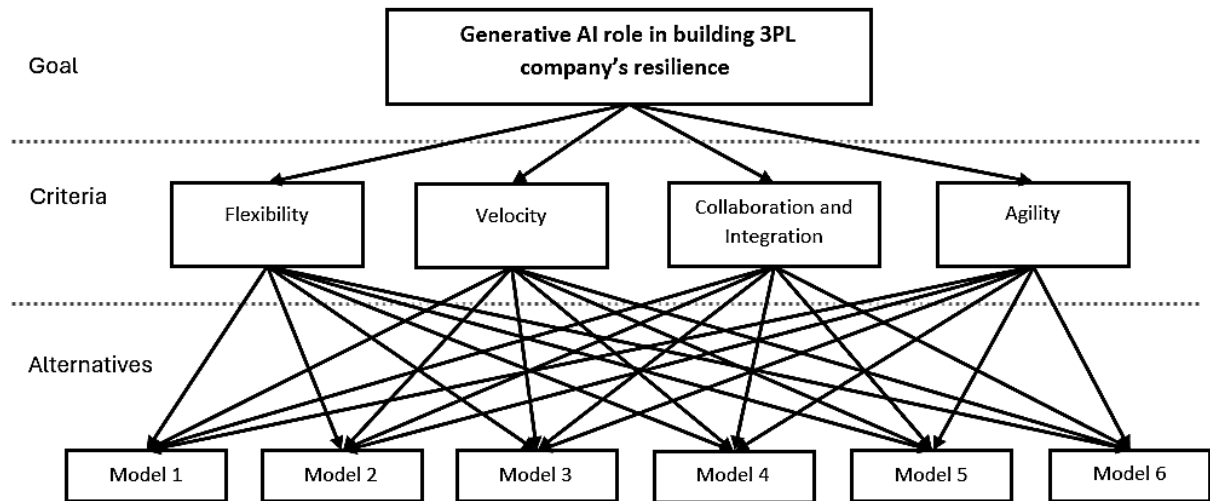


Figure 1. AHP structure.

4. Results

4.1. Criteria weights and consistency analysis

The aggregated pairwise comparison matrix (table 3) for the four criteria resulted in the following normalized priority vector: Flexibility (0.205), Velocity (0.309), Collaboration and Integration (0.164), and Agility (0.322). The Consistency Ratio (CR) for this matrix was 0.0209, which is below the threshold of 0.1, indicating that the judgments were consistent and reliable.

The priority vector (figure 2) suggests that Agility (0.322) and Velocity (0.309) are the most significant criteria for enhancing the resilience of 3PL companies through Generative AI. Agility, which refers to the ability to quickly respond to changes in the supply chain environment, and Velocity, which emphasizes speed and efficiency, are key factors in building a robust and responsive 3PL operation. Flexibility (0.205) and Collaboration and Integration (0.164) are also important but were given less priority by the experts, highlighting the need for adaptability and seamless cooperation among stakeholders in the logistics network.

Table 3.
Aggregated Pairwise Comparison Matrix for Criteria

Criteria	Flexibility	Velocity	Collaboration and Integration	Agility	Priorities
Flexibility	1.000	0.743	1.104	0.855	0.205
Velocity	1.346	1.000	1.219	1.219	0.309
Collaboration and Integration	0.906	0.820	1.000	0.464	0.164
Agility	1.170	0.820	2.155	1.000	0.322
$\lambda_{max} = 4.056, CI = 0.0188, CR = 0.0209$					

Source: own elaboration.

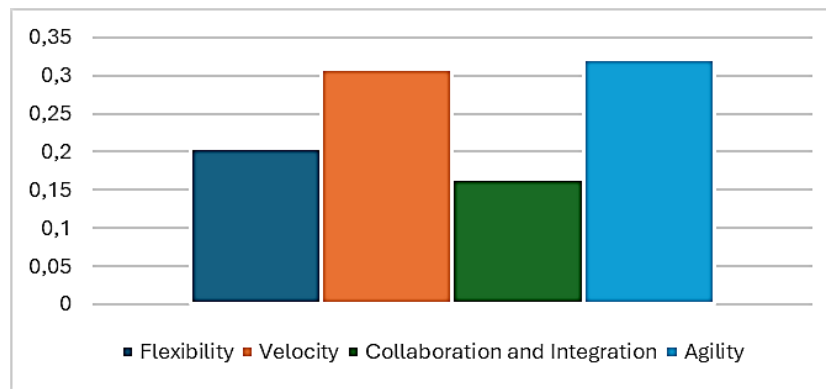


Figure 2. Priorities for criterias.

Source: own elaboration.

4.2. Model weights under each criterion

The AHP analysis also calculated the weights of various Generative AI models under each criterion to determine their effectiveness in building resilience within 3PL companies. Each model's weight was calculated based on aggregated expert judgments, with consistency checks confirming the reliability of the results.

4.2.1. Flexibility

The weights for the models under the Flexibility criterion were: Model 1 (0.088), Model 2 (0.185), Model 3 (0.171), Model 4 (0.184), Model 5 (0.295), and Model 6 (0.078). The CR for this criterion was 0.0081, indicating consistent judgments. Model 5 showed the highest weight (0.295), suggesting it is the most effective in enhancing flexibility in 3PL operations, allowing companies to adapt to varying demand and supply conditions. Aggregated pairwise comparison matrix is shown in table 4 and the priorities are shown in the figure 3.

Table 4.

Aggregated Pairwise Comparison Matrix for Models under Flexibility

Flexibility	F-Model 1	F -Model 2	F -Model 3	F -Model 4	F -Model 5	F -Model 6	Priorities
F-Model 1	1.000	0.424	0.581	0.424	0.313	1.258	0.088
F-Model 2	2.358	1.000	1.076	0.855	0.679	2.358	0.185
F-Model 3	1.723	0.930	1.000	1.170	0.424	2.536	0.171
F-Model 4	2.358	1.170	0.855	1.000	0.679	2.015	0.184
F-Model 5	3.192	1.472	2.358	1.472	1.000	3.471	0.295
F-Model 6	0.795	0.424	0.394	0.496	0.288	1.000	0.078
$\lambda_{max} = 6.050$, CI = 0.0100, CR = 0.0081							

Source: own elaboration.

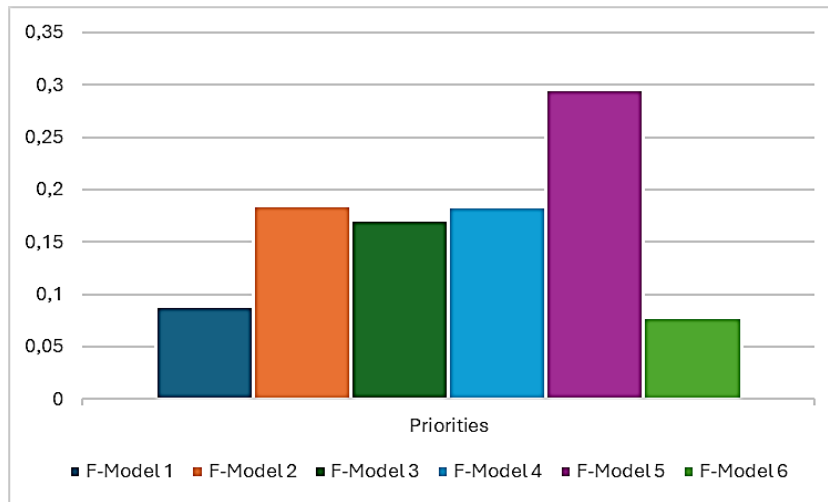


Figure 3. Priorities for flexibility.

Source: own elaboration.

4.2.2. Velocity

Under the Velocity criterion, the weights were: Model 1 (0.103), Model 2 (0.194), Model 3 (0.158), Model 4 (0.183), Model 5 (0.271), and Model 6 (0.091). The CR was 0.0077, which indicates high consistency in the expert judgments. Model 5 again scored the highest weight (0.271), highlighting its effectiveness in optimizing speed and efficiency in 3PL processes. Aggregated pairwise comparison matrix is shown in table 5 and the priorities are shown in the figure 4.

Table 5.
Aggregated Pairwise Comparison Matrix for Models under Velocity

Velocity	V-Model 1	V-Model 2	V-Model 3	V-Model 4	V-Model 5	V-Model 6	Priorities
V-Model 1	1.000	0.540	0.540	0.631	0.394	1.170	0.103
V-Model 2	1.853	1.000	1.170	0.855	0.855	2.358	0.194
V-Model 3	1.853	0.855	1.000	0.679	0.540	1.873	0.158
V-Model 4	1.584	1.170	1.472	1.000	0.581	1.601	0.183
V-Model 5	2.536	1.170	1.853	1.723	1.000	3.000	0.271
V-Model 6	0.855	0.424	0.534	0.624	0.333	1.000	0.091
$\lambda_{max} = 6.048, CI = 0.0096, CR = 0.0077$							

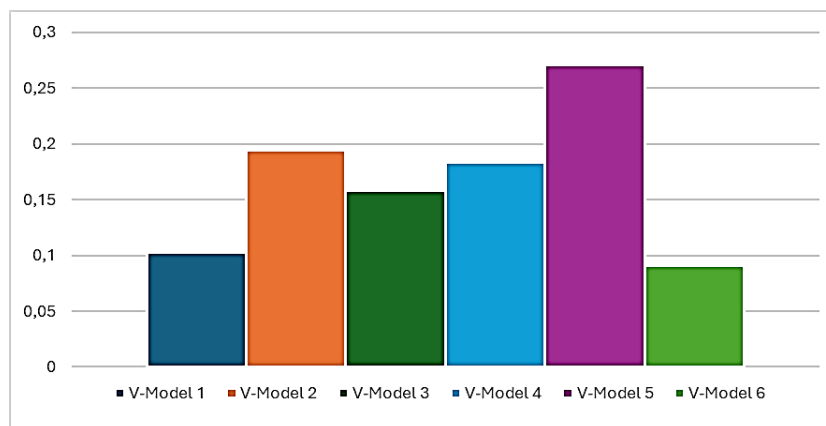


Figure 4. Priorities for velocity.

Source: own elaboration.

4.2.3. Collaboration and integration

For Collaboration and Integration, the weights were: Model 1 (0.095), Model 2 (0.163), Model 3 (0.203), Model 4 (0.221), Model 5 (0.253), and Model 6 (0.065). The CR was 0.0167, confirming consistency. While Model 5 maintained a strong position (0.253), Model 4 (0.221) and Model 3 (0.203) also demonstrated significant potential, suggesting their effectiveness in fostering collaborative relationships and integrating various supply chain functions. Aggregated pairwise comparison matrix is shown in table 6 and the priorities are shown in the figure 5.

Table 6.

Aggregated Pairwise Comparison Matrix for Models under Collaboration and Integration

Collaboration and Integration	CI-Model 1	CI-Model 2	CI-Model 3	CI-Model 4	CI-Model 5	CI-Model 6	Priorities
CI-Model 1	1.000	0.679	0.461	0.288	0.367	1.873	0.095
CI-Model 2	1.472	1.000	1.000	0.731	0.461	3.227	0.163
CI-Model 3	2.168	1.000	1.000	1.170	0.855	2.967	0.203
CI-Model 4	3.471	1.369	0.855	1.000	0.930	2.758	0.221
CI-Model 5	2.728	2.168	1.170	1.076	1.000	3.227	0.253
CI-Model 6	0.534	0.310	0.337	0.363	0.310	1.000	0.065
$\lambda_{\max} = 6.104$, $CI = 0.0207$, $CR = 0.0167$							

Source: own elaboration.

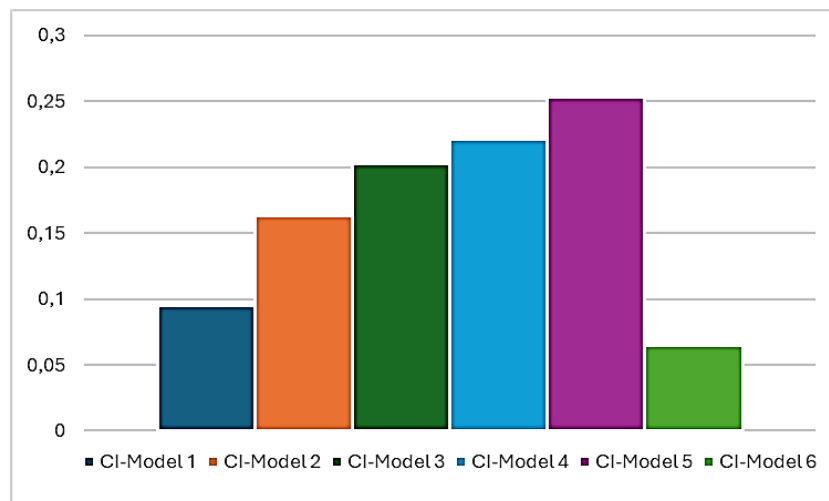


Figure 5. Priorities for velocity.

Source: own elaboration.

4.2.4. Agility

The model weights under the Agility criterion were: Model 1 (0.120), Model 2 (0.176), Model 3 (0.134), Model 4 (0.211), Model 5 (0.270), and Model 6 (0.089). The CR for this criterion was 0.0160, indicating consistent judgments. Model 5 (0.270) and Model 4 (0.211) emerged as the top models, underscoring their ability to enhance agility by enabling quick adaptation to changes in the logistics environment. Aggregated pairwise comparison matrix is shown in table 7 and the priorities are shown in the figure 6.

Table 7.
Aggregated Pairwise Comparison Matrix for Models under Agility

Agility	A-Model 1	A-Model 2	A-Model 3	A-Model 4	A-Model 5	A-Model 6	Priorities
A-Model 1	1.000	0.461	1.170	0.731	0.424	1.170	0.120
A-Model 2	2.168	1.000	1.000	0.855	0.679	1.601	0.176
A-Model 3	0.855	1.000	1.000	0.731	0.394	1.601	0.134
A-Model 4	1.369	1.170	1.369	1.000	0.930	3.000	0.211
A-Model 5	2.358	1.472	2.536	1.076	1.000	3.000	0.270
A-Model 6	0.855	0.624	0.624	0.333	0.333	1.000	0.089
$\lambda_{max} = 6.099, CI = 0.0199, CR = 0.0160$							

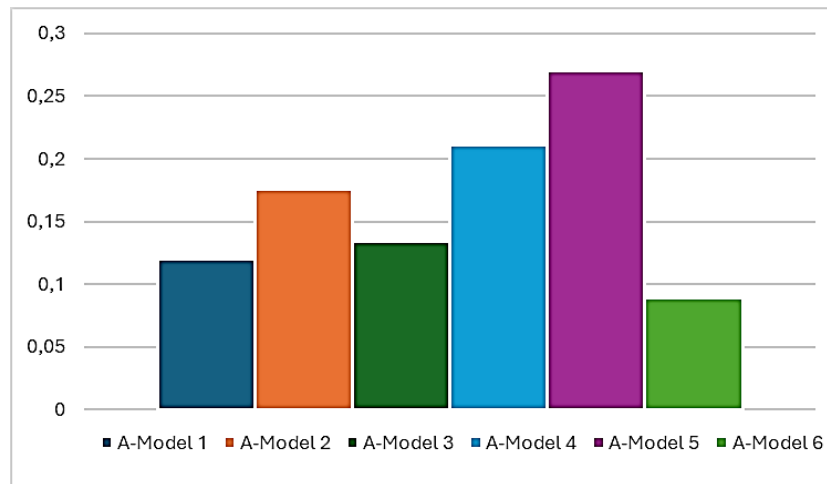


Figure 6. Priorities for agility.

Source: own elaboration.

4.3. Interpretation of results

The results indicate that Model 5 consistently outperformed other models across multiple criteria, particularly in Flexibility and Velocity, with the highest weights of 0.295 and 0.271, respectively. This suggests that Model 5 is particularly effective in enhancing the adaptability and speed of 3PL companies, which are crucial for resilience. Model 4 and Model 2 also performed well, especially under the Collaboration and Integration and Agility criteria, highlighting their potential to improve cooperation and rapid response capabilities within 3PL operations.

These findings provide important insights for decision-makers in 3PL companies seeking to enhance resilience through the adoption of Generative AI. Prioritizing Model 5 would likely yield the most significant benefits across key resilience dimensions, while Model 4 and Model 2 could be strong alternatives for specific operational focuses.

The AHP method effectively offered a structured framework for evaluating the role of Generative AI in building the resilience of 3PL companies. The consistency checks verified the reliability of the expert judgments, ensuring robust and valid findings. This study contributes valuable insights into how Generative AI can be leveraged to strengthen 3PL operations, guiding both academic research and practical decision-making in logistics management. Future

research could explore additional criteria or incorporate alternative decision-making methods to refine and expand the analysis

5. Discussion

The results of the analysis confirm the key role of gen-AI in enhancing the resilience of 3PL companies providing logistics services. The AHP analysis showed that among the four criteria — flexibility, velocity, collaboration and integration, and agility — agility (0.322) and velocity (0.309) were the most important for building 3PL resilience, reflecting the significance of quickly adapting and responding to changing market and operational conditions. This finding addresses the research questions, indicating that operational efficiency in the context of 3PL logistics largely depends on the ability to react quickly and efficiently adjust processes in response to unforeseen challenges, such as supply chain disruptions. AI models, particularly Model 5 (generating sounds, such as speech or music from text), stood out in supporting the key aspects of flexibility and velocity. These results suggest that sound-based technologies can play an essential role in logistics by supporting dynamic processes like communication or the automation of real-time notifications. Interestingly, Model 5 received the highest weight in almost all analyzed criteria, indicating its versatility and potential to support various dimensions of operational resilience.

These data clearly respond to the research question regarding the role of gen-AI in building the resilience of 3PL companies. The results show that generative models, particularly those related to sound, can significantly impact process optimization and the velocity of response to supply chain disruptions. Rapid adaptation to changing market conditions and the ability to respond to unforeseen challenges, such as supply chain disruptions, are crucial for the operational efficiency of 3PL companies (Sullivan, Wamba, 2022; Belhadi et al., 2021). These findings align with previous studies highlighting the importance of agility and velocity in managing supply chain disruptions (Yandrapalli, 2023; Belhadi et al., 2021).

In the context of flexibility, generative AI has proven to be a critical element supporting dynamic processes, such as communication and real-time notification automation. Research indicates that AI-based technologies contribute to improving supply chain flexibility and adaptive capabilities, as confirmed by Yandrapalli's (2023) findings. The application of AI in automating communication processes can significantly enhance operational flexibility, which is key in changing market conditions.

In supply chain literature, Christopher and Holweg (2011) emphasize the importance of effective communication as a foundation for supply chain resilience. In our study, collaboration and integration were rated as less important than agility and velocity, suggesting that in dynamic market conditions, response speed and adaptability may take precedence over

long-term collaboration (Richey et al., 2023). This may be surprising in the context of dominant theoretical approaches, which often emphasize collaboration as a key element of resilience.

One unexpected result of this study is the relatively lower weight assigned to the criterion of collaboration and integration (0.164) compared to the other criteria. Literature often highlights that collaboration and integration are crucial for building supply chain resilience, especially in the context of risk management (Richey et al., 2023). These findings may suggest that in the face of sudden disruptions, organizations may focus more on rapid adaptation and flexibility, leading to a shift in supply chain management approaches. A possible explanation for this result is that the experts involved in the study may have considered velocity and agility to have a more direct impact on 3PL responses to supply chain disruptions, particularly in the short term. In dynamic and changing market conditions, rapid action may be prioritized, and integration with partners or internal collaboration may be seen as less critical in situations requiring immediate response.

The results of this study have significant implications for both business practice and further theoretical research. From a practical standpoint, 3PL companies can leverage gen-AI, particularly in the area of sound generation (Model 5), to improve response velocity and agility in their logistics operations, including supporting offered value-added services (VAS). The implementation of such technologies can contribute to process automation, such as AI-based communication systems that notify real-time disruptions or further enhance well-known techniques like pick-by-voice in order picking. Moreover, Model 5 can support operational flexibility processes, enabling quick adjustments to changing market conditions and unforeseen disruptions. The development of research on various AI models and their impact on different resilience criteria can expand theoretical knowledge and provide practical insights for their implementation in various industries.

6. Conclusions

The aim of this article was to examine the impact of generative artificial intelligence (gen-AI) models on the resilience of 3PL companies. Based on the study conducted on an objective research group, the following conclusion is: The dominance of the Agility and Velocity factors over the Collaboration & Integration and Flexibility. Results suggest that 3PL companies primarily focus their resilience-building strategies on dynamic operational and tactical actions. This approach probably enables them to make decisions tailored to their needs in the specific moment. Further research is recommended to verify these assumptions and to explore how these factors influence company performance and the decision-making process. Additionally, the observed advantage of model 5 (models generating sounds, such as speech or music, from text) over other analyzed models is noteworthy. It may indicate an upcoming trend

in the development of models for this type of company. A potential next step could be conducting detailed studies among experts to identify the reasons for this dominance and to understand why model 6 (models generating programming code and/or algorithms from text) achieved the lowest scores in the study.

The research can support 3PL companies in enhancing the resilience of their operations by leveraging appropriate gen-AI models. With targeted investments and solutions tailored to the specific needs of the companies connected with gen-AI, it is possible to improve key performance indicators and overall business outcomes. It is also important to note that the survey was conducted on a relatively limited sample size. To confirm these preliminary findings and minimize potential biases, it would be necessary to increase the number of respondents and ensure a well-structured participation of various respondent groups. The limitation of evaluation criteria to four key factors significantly influenced the results; therefore, future studies should consider a broader set of criteria to enable a more comprehensive analysis of the interactions between them.

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ENERGY EFFICIENCY OF A WATER AND WASTEWATER COMPANY – CASE STUDY

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Purpose: Producing energy from renewable sources is the challenge of our time, given the increasing demand for energy. Biomethane from the anaerobic digestion of sewage sludge is a valuable source of renewable energy. Its production is also environmentally beneficial, reducing greenhouse gas emissions and waste. Using the biomethane produced to generate electricity leads to energy self-sufficiency for the local authority in a closed loop economy.

Design/methodology/approach: The article presents the results of a detailed analysis of the biogas-energy management of Przedsiębiorstwo Wodociągów i Kanalizacji Spółka z ograniczoną odpowiedzialnością, based in Rybnik, with regard to the production of electricity from biogas produced at the sewage treatment plant.

Findings: The results collected from 2013 to 2023 allow us to conclude that the green energy produced at the Rybnik Wastewater Treatment Plant covers 40% of the plant's electricity needs, thus ensuring compliance with the provisions of the new EU Urban Wastewater Treatment Directive, which aims to achieve energy self-sufficiency for wastewater treatment plants by 2035. At the same time, the cogeneration system covers 100% of the heat requirements of the wastewater treatment plant. The environmentally friendly production of green energy also brings economic benefits to the company.

Originality/value: Maximising the use of biomethane produced at wastewater treatment plants results in the unit being self-sufficient in energy without the need to import energy from external sources. This means that the unit is able to generate enough energy from available internal sources (e.g. solar, wind, geothermal, biomass and energy from waste) to meet its needs. Energy self-sufficiency helps protect the environment by reducing greenhouse gas emissions and saves money by reducing the cost of purchasing energy from external sources. In addition, these measures can set an example for other companies, encouraging them to make similar investments in renewable energy and efficient energy technologies.

Keywords: biomethane, biogas, sewage treatment plant, energy, cogeneration, energy efficiency.

Category of the paper: Case study.

1. Introduction

Changing criteria for assessing the performance of wastewater treatment plants are leading to continuous improvements in treatment processes, which in turn are increasing the energy intensity of the plants. The energy transition programme implemented in the European Union is forcing the maximum use of all possible energy sources in order to achieve energy independence. This article presents the results of ongoing research in the field of biogas and energy management at the Rybnik-Orzepowice Wastewater Treatment Plant in the period 2013-2023 and presents the conditions and prospects for achieving energy independence.

1.1. Biogas balance in Poland

Biogas is one of the most important sources of renewable energy. Due to the high demand for gas and the promotion of climate protection, biogas production is of strategic importance for Europe. According to a report by the European Biogas Association (EBA), European biomethane production will increase by 20% in 2022 compared to 2021, reaching 21 billion cubic metres ([https://e-magazyny.pl/...](https://e-magazyny.pl/)). Unfortunately, the use of biogas in Poland is still low. The share of biogas in energy production from various RES sources in Poland has practically stopped at 2.6% (Analizy statystyczne GUS..., 2023) (Table 1).

Table 1.

Share of individual renewable energy carriers in renewable energy generation 2018-2022

Specification	2018	2019	2020	2021	2022
	%				
Solid biofuels	76,1	73,4	71,6	69,3	64,5
Solar energy	0,7	1,1	2,0	3,3	6,0
Water energy	1,4	1,4	1,5	1,6	1,3
Wind energy	9,1	10,6	10,9	10,9	12,6
Biogas	2,4	2,4	2,6	2,5	2,6
Liquid biofuels	7,5	8,0	7,8	8,1	8,0
Geothermal energy	0,2	0,2	0,2	0,2	0,2
Municipal waste	0,8	0,8	1,1	1,2	0,8
Ambient heat from heat pumps	1,8	2,1	2,4	2,9	3,9

Analizy statystyczne GUS..., 2023.

According to estimates by the European Biogas Association (EBA), Poland will produce 1.98 billion cubic metres of biomethane in 2024 and 3.26 billion in 2030 ([https://e-magazyny.pl/...](https://e-magazyny.pl/)). In our country, a large untapped source of biogas is wastewater, as only a small proportion of wastewater treatment plants produce and use biogas. According to CSO data, biogas production from wastewater treatment plants increased by only 1.21% from 2016 to 2020 (Analizy statystyczne GUS..., 2022) (Figure 1). The largest increase in biogas procurement occurred in the 'other biogases' group, with an increase of 81.25% over the period analysed. This group includes agricultural biogas and biogas from food industry waste.

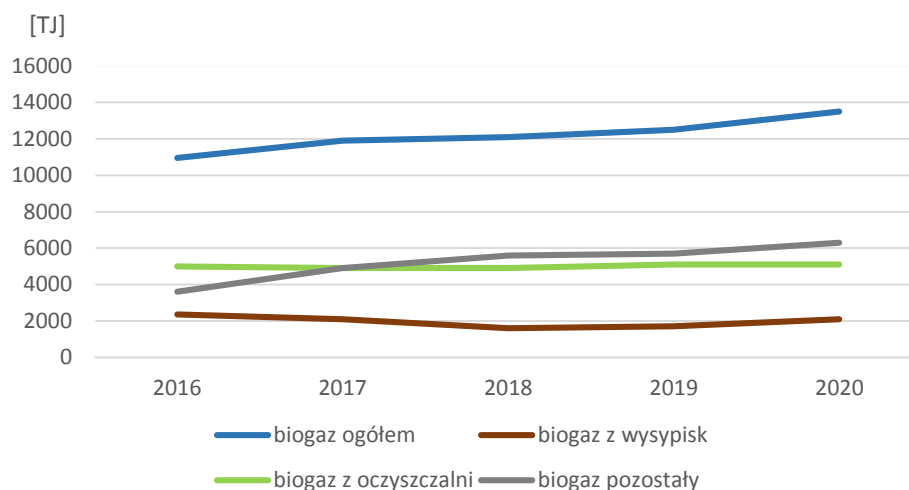


Figure 1. Biogas generation 2016-2020 in TJ.

Source: Analizy statystyczne GUS..., 2022.

1.2. Electricity production from renewable energy sources

Producing energy from renewable sources is the challenge of our time, given the growing demand for energy. Energy from renewable sources is environmentally friendly. In Poland, renewable energy from solar radiation, water, wind, geothermal resources, energy from solid biofuels, biogas and liquid biofuels, as well as ambient heat from heat pumps are used (Analizy statystyczne GUS..., 2023).

Table 2.

Electricity production from renewable energy sources

Specification	2018	2019	2020	2021	2022
	GWh				
Total	21617,2	25 458,8	28 226,6	30 568,5	37 688,6
Water	1 970,0	1 958,4	2 118,3	2 339,2	1 968,2
of which:	299,0	312,0	423,4	328,3	303,2
power plants with a generating capacity < 1 MW	528,5	538,2	526,3	632,9	558,7
power plants with a power output of 1-10 MW	1 142,5	1 107,6	1 168,6	1 378,0	1 106,4
power plants with a generating capacity > 10 MW	12 798,8	15 106,8	15 800,0	16 233,5	19 779,5
Wind	5 333,2	6 441,2	6 932,8	6 398,4	5 934,1
Solid biofuels	85,0	104,8	181,8	353,8	301,6
Municipal waste	1 127,6	1 135,0	1 233,9	1 307,3	1 394,2
Biogas	169,6	178,0	183,5	204,7	227,7
of which:	336,5	350,8	373,3	367,8	343,6
Biogas from landfills	621,6	606,2	677,0	734,9	822,9
Biogas from sewage treatment plants	2,0	2,0	1,9	1,7	1,3
Other biogas	300,5	710,7	1 957,9	3 934,4	8 309,7

Source: Analizy statystyczne GUS..., 2023.

Production of electricity from renewable sources in Poland is steadily increasing, with the largest share coming from wind power, which will increase by as much as 54.5% in 2022 compared to 2018. The largest increase, 28 times, is in photovoltaic energy production. In the case of biogas, although total energy production is on an upward trend, electricity

generation from biogas produced in wastewater treatment plants is slightly decreasing (Table 2). In Poland there are about 64 municipal biogas plants producing biogas from organic waste including municipal sewage sludge, 161 agricultural biogas plants and 70 microbiogas plants ([https://magazynbiomasa.pl/...](https://magazynbiomasa.pl/)). Many WWTPs do not have biogas recovery facilities or, as in the case of the Rybnik-Orzepowice WWTP, do not make full use of them. Therefore, there is a need to modernise and expand existing facilities and build new biogas plants at municipal wastewater treatment plants in order for these facilities to achieve zero emissions in the future.

Table 3.
Capacity of renewable energy power plants

Specification	2018	2019	2020	2021	2022
	MW				
Total	8 344	9 406	12 325	16 502	22 567
Water of which:	968	974	977	975	984
power plants with a generating capacity < 1 MW	92	93	96	92	100
power plants with a power output of 1-10 MW	184	188	188	190	191
power plants with a power output > 10 MW	692	692	692	692	692
Wind	5 766	5 838	6 298	6 967	8 150
Solid biofuels	735	732	734	803	894
Municipal waste	87	91	100	91	91
Biogas	225	233	261	251	278
of which:	52	55	54	48	52
Biogas from landfills	72	74	86	76	74
Biogas from sewage treatment plants	102	104	121	127	152
Other biogas	562	1 539	3 955	7 416	12 170

Source: Analizy statystyczne GUS..., 2023.

1.3. Heat production

Renewable heat production plays a very important role in the energy mix. In Poland, the production of heat from renewable energy sources will increase by 57.7% between 2018 and 2022. The largest increase, by a factor of 3, is from municipal waste. There is a decrease in heat production from biogas (Table 4).

Table 4.
Heat generation from renewable energy sources

Specification	2018	2019	2020	2021	2022
	TJ				
Total	14 809,1	17 644,6	21 204,8	23 511,4	23 353,2
Solid biofuels	13 401,3	15 901,9	18 655,4	20 942,8	20 847,4
Municipal waste	476,6	730,7	1 611,9	1 598,9	1 574,5
Biogas	922,5	1 004,2	927,5	959,3	919,1
Of which:	31,4	35,5	47,7	38,6	45,2
Biogas from landfills	106,2	105,6	97,0	148,7	130,8
Biogas from sewage treatment plants	784,9	863,2	782,9	772,0	743,1
Other biogas	3,4	4,6	5,5	5,0	7,7
Bioliquids	5,3	3,1	4,5	5,3	4,6

Source: Analizy statystyczne GUS..., 2023.

2. Characteristics of sludge management at the sewage treatment plant Rybnik-Orzepowice

The Rybnik-Orzepowice WWTP is a mechanical-biological treatment plant with a design capacity of 27,500 m³/d. The plant also includes a technological line for sludge treatment. It provides for sludge stabilisation by methane fermentation, final dewatering and hygienisation. The digestion process is carried out in two Separated Closed Digesters (SCC), each with a capacity of 2500 m³. The main product of the digestion process is biogas, which is desulphurised on a bed of peat. The biogas is stored in a biogas tank (ZB) with a capacity of 550 m³. The biogas produced by digestion is combusted in a CHP unit with an electrical output of 192 kW and a thermal output of 232 kW. The digested sludge is dewatered on a belt press, hygienised with quicklime and then sent for management. The heat from the CHP is used to heat the process facilities, including the WWTP chambers, the WWTP administration building and the hot water production (Fig. 1).

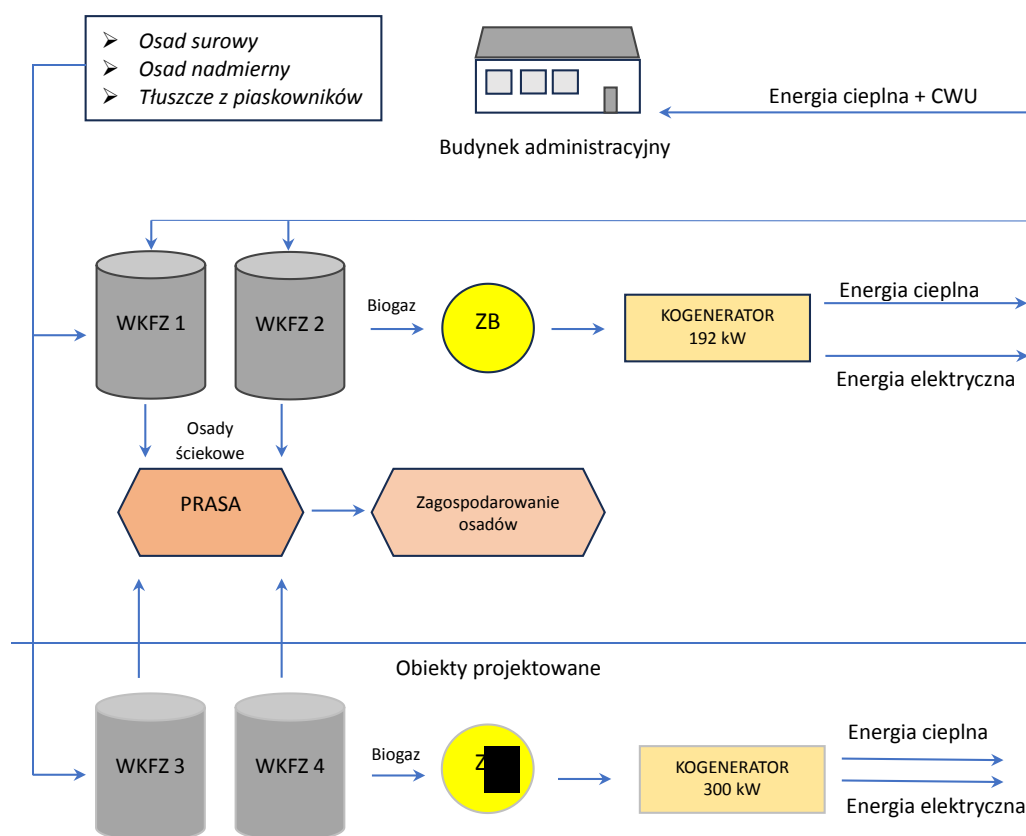


Figure 1. Diagram of the sludge section of the sewage treatment plant in Rybnik-Orzepowice with visualisation of the facilities planned as part of the expansion of the cogeneration system.

Source: company source data.

The WWTP in Rybnik-Orzepowice produces on average about 3000 m³ of biogas per day. Annual summaries of the amount of biogas produced show that biogas production remains stable, and any decrease in production is due to maintenance work on the WWTP digesters (Fig. 2).

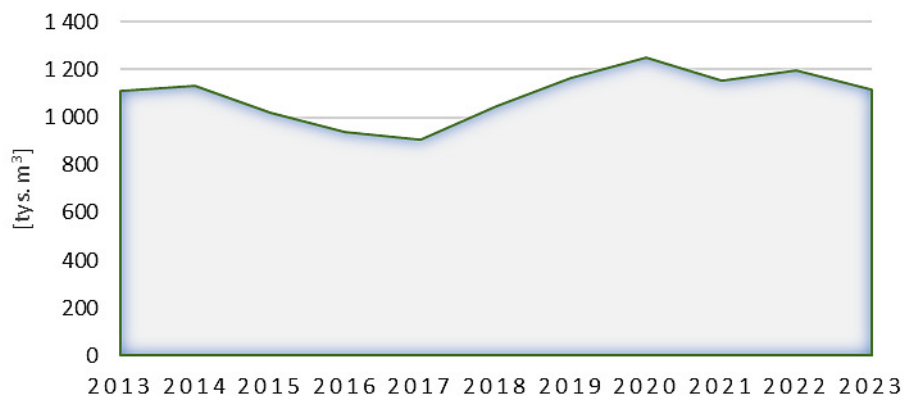


Figure 2. Biogas production [thousand m³] at the Rybnik-Orzepowice wastewater treatment plant from 2013 to 2023.

Source: company source data.

3. Energy demand of the sewage treatment plant in Rybnik-Orzepowice

The electricity demand at the Rybnik-Orzepowice wastewater treatment plant is approximately 3300 MWh per year (Fig. 3).

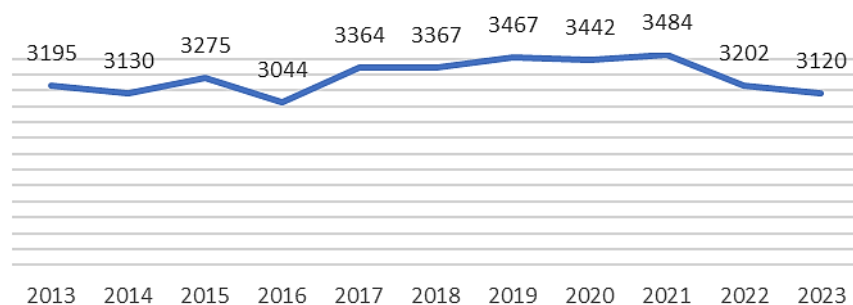


Figure 3. Total electricity consumption at the Rybnik-Orzepowice wastewater treatment plant [MWh] from 2013 to 2023.

Source: company source data.

The annual production of green electricity from biogas at the Rybnik-Orzepowice WWTP (data for 2023) is 1202 MWh. 96% of the electricity produced is used for the plant's own needs. The part of the energy that cannot be consumed due to technical conditions is sold to the TAURON network, which accounts for approximately 5% of the total energy produced. PWiK Sp. z o.o. receives certificates of origin for energy from renewable sources from the production of electricity. The current production of electricity at the Rybnik-Orzepowice

Wastewater Treatment Plant covers approximately 40% of the plant's total electricity needs. The structure of electricity consumption by year is shown in Figure 4.

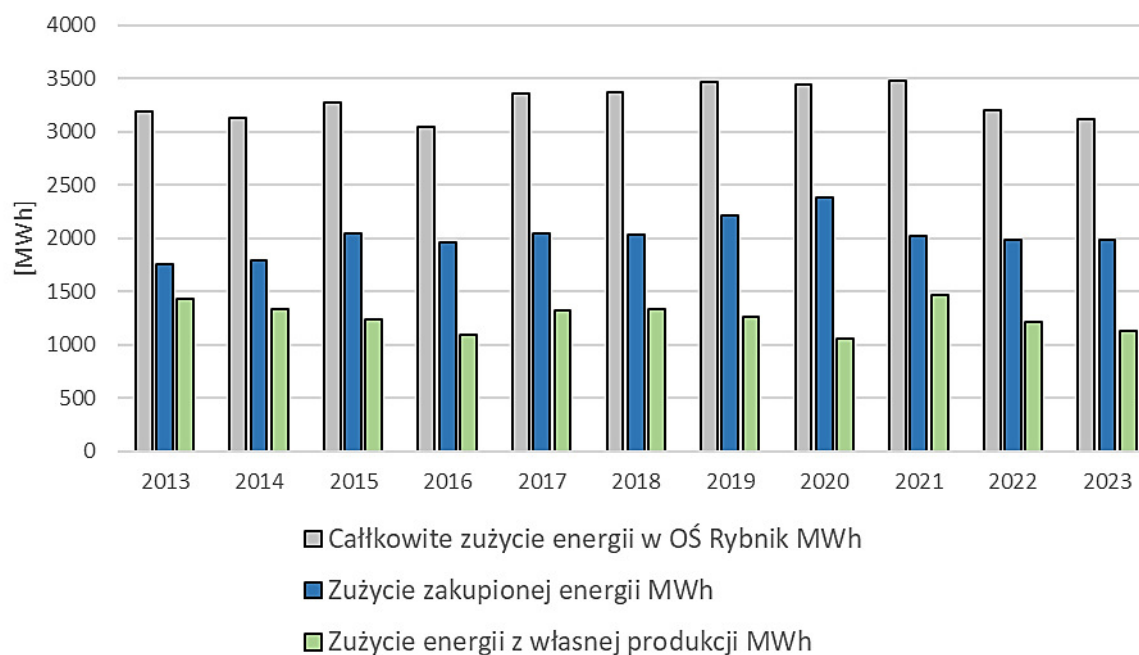


Figure 4. Consumption structure of purchased and own electricity [MWh] at the Rybnik-Orzepowice wastewater treatment plant in the period 2013-2023.

Source: company source data.

The sewage treatment plant in Rybnik-Orzepowice uses 60% of the biogas produced, which opens up the possibility of extending the cogeneration installation with another unit together with the necessary infrastructure to make full use of the biogas already extracted and even increase production (Fig. 5).

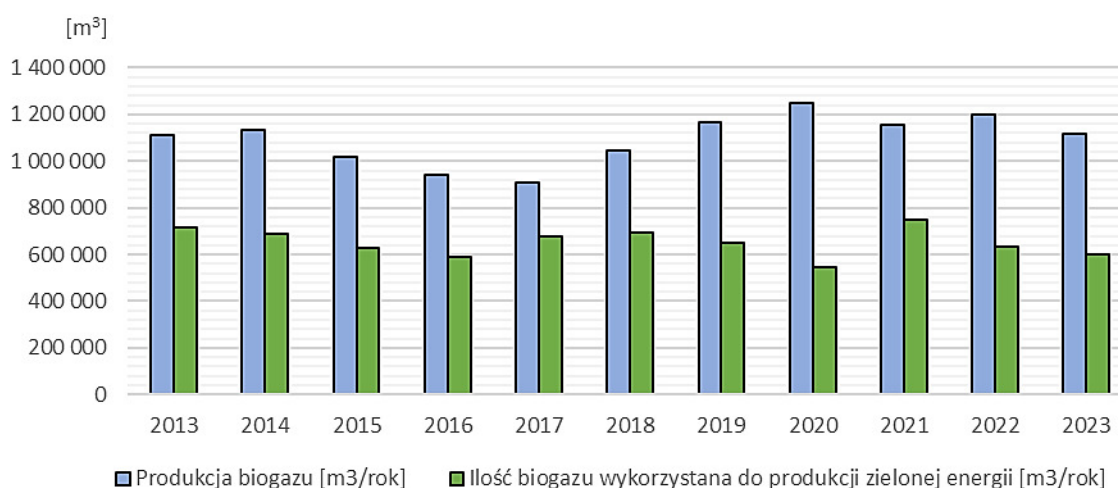


Figure 5. Use of biogas production at the Rybnik-Orzepowice wastewater treatment plant [m³] for green energy production in 2013-2023.

Source: company source data.

4. Energy efficiency of electricity production from biogas

The biogas produced at the Rybnik-Orzepowice WWTP is characterised by relatively stable parameters and contains on average about 64% methane, 35% carbon dioxide and 0.002% hydrogen sulphide. The calorific value of biogas produced from sewage sludge is about 23 MJ/m³. As mentioned in the previous chapter, 60% of the biogas produced is used to produce electricity and heat, assuming that there are no unforeseen failures of the CHP unit or other conditions that prevent production. On average, 1 m³ of biogas produced in the Rybnik-Orzepowice treatment plant produces about 2 kWh of electricity. Based on the data on the amount of gas consumed and the amount of energy produced in the cogeneration process (Table 4), the efficiency of the cogeneration system was calculated using the following formula (Zaluska, Piekutin, Magrel, 2018, pp. 51-56):

$$\text{Energy efficiency} = \frac{\text{Amount of biogas consumed for electricity and heat production [m}^3\text{]}}{\text{Amount of electricity produced from cogeneration [MWh]}}$$

As the analysis shows, the energy efficiency of the biogas extracted at the Rybnik-Orzepowice treatment plant is stable (Figure 6).

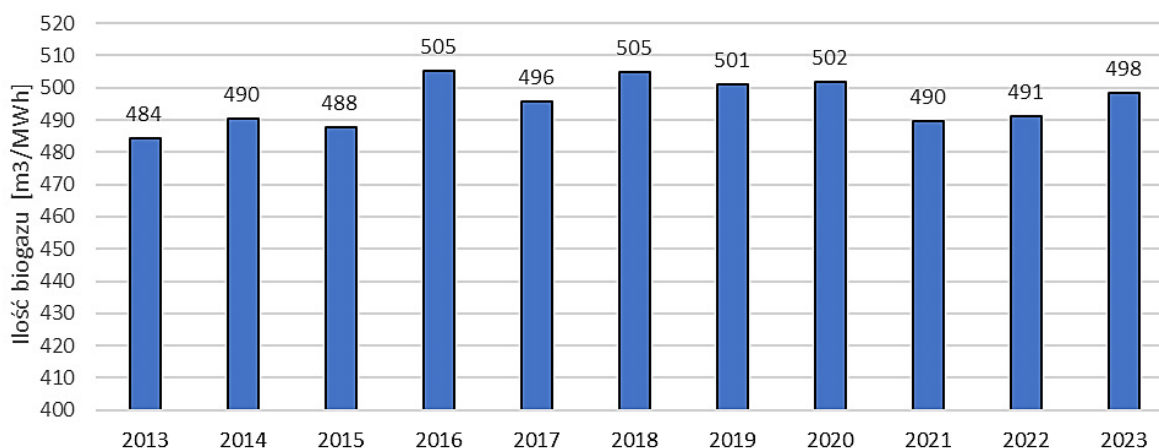


Figure 6. Use of biogas production at the Rybnik-Orzepowice wastewater treatment plant [m³] for green energy production in 2013-2023.

Source: company source data.

5. Analysis of electricity purchase costs

Sewage treatment plants are among the facilities with a significant demand for electricity, and the price of energy is constantly rising. The Rybnik-Orzepowice WWTP consumes approximately 3300 MWh of electricity per year. The average cost of purchasing this amount of energy between 2013 and 2023 would be PLN 1.3 million/year. Thanks to the installation of

a cogeneration unit, 1300 MWh of the demand will be covered by own production. Taking into account the period from 2013 to 2023, the cogeneration unit produced more than 14,474 MWh of electricity, which corresponds to savings of PLN 5 million due to not buying energy from the grid. The calculations were based on the average price of energy including distribution (Fig. 7) (Table 5).

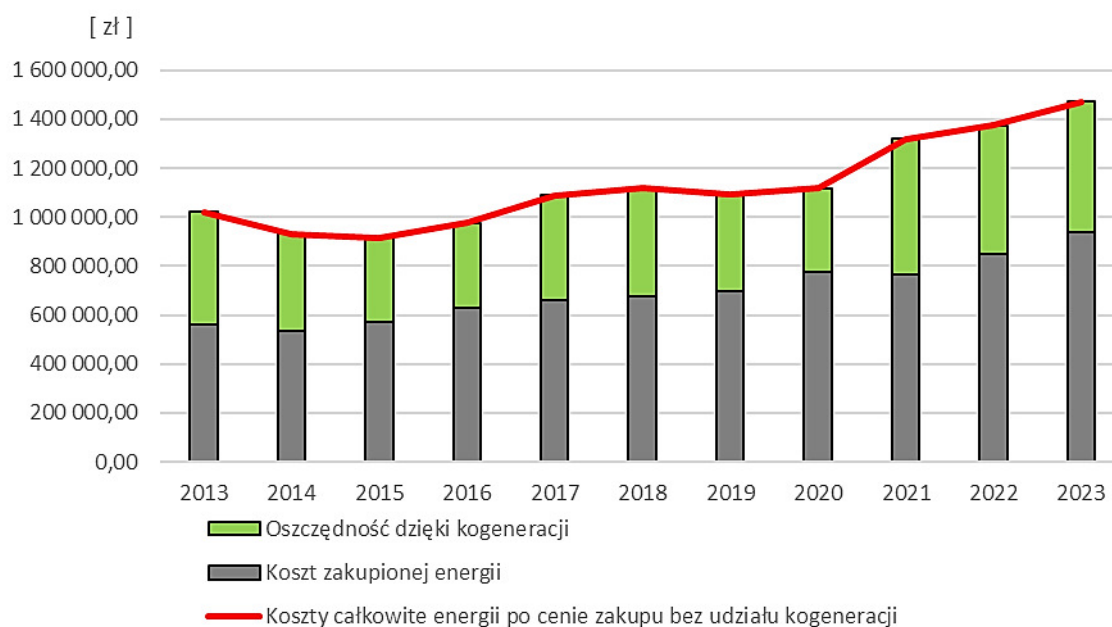


Figure 7. Analysis of the costs of purchasing electricity for the sewage treatment plant in Rybnik-Orzepowice [PLN] in the period 2013-2023.

Source: company source data.

Table 5.

Analysis and compilation of biogas production and energy use system data at the Rybnik-Orzepowice wastewater treatment plant

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Amount of biogas used for electricity and heat production [m ³]	717 306	689 994	627 023	587 073	675 035	695 076	650 323	546 412	747 042	630 701	599 028
Amount of electricity produced from biogas [MWh]	1481	1407	1286	1162	1362	1377	1298	1089	1526	1284	1202
Volume of biogas consumed for the production of 1 MWh [m ³] = energy efficiency (efficiency)	484	490	488	505	496	505	501	502	490	491	498
Profit from sold electricity [PLN]	9 263,76	12 625,99	8 556,88	12 762,21	6 838,01	8 700,10	9 891,17	5 574,92	15 834,15	25 998,76	55 561,77
The value of green certificates	227 837,04	268 599,82	148 318,67	87 928,54	48 442,94	158 833,51	165 913,61	176 326,00	271 437,25	245 099,55	176 389,88
Profit from non-purchased energy [PLN]	459 016,40	398 641,90	345 395,71	348 211,41	427 613,61	442 150,86	395 704,95	343 873,23	555 664,13	522 608,55	533 264,61
Profit from non-purchased fuel [PLN]	22 500,00	22 500,00	22 500,00	22 500,00	22 500,00	50 000,00	50 000,00	50 000,00	100 000,00	180 000,00	100 000,00
Final profit (from sold energy + certificates + unpurchased fuel + unpurchased energy [PLN])	718 617,20	702 367,71	524 771,25	471 402,16	505 394,55	659 684,47	621 509,72	575 774,15	942 935,53	973 706,86	865 216,25

Cont. table 5.

Final profit per MWh [PLN] Economic efficiency	485,22	499,20	408,06	405,68	371,07	479,07	478,82	528,72	617,91	758,34	719,81
Cogeneration operating costs [PLN]	553 747,37	548 111,70	538 245,09	482 292,84	656 927,80	552 653,38	517 044,95	541 874,42	628 141,28	448 651,32	653 716,12
Final profit minus operating costs of cogeneration [PLN]	164 869,83	154 256,01	-13 473,84	-10 890,68	-151 533,24	107 031,08	104 464,77	33 899,73	314 794,25	525 055,55	211 500,14
Final profit minus operating costs per MWh [PLN] Economic efficiency	111,32	109,63	-10,48	-9,37	-111,26	77,73	80,48	31,13	206,29	408,92	175,96

Source: own elaboration.

6. Energy efficiency

The green energy produced at the Rybnik WWTP covers 40% of the plant's electricity needs, ensuring compliance with the new EU directive on urban wastewater treatment, which aims to make the plant energy self-sufficient by 2035 (<https://www.europarl.europa.eu/...>). At the same time, the cogeneration system provides 100% of the thermal energy needs of the technological facilities and the administration building. An assessment was carried out to determine whether the environmentally beneficial production of green energy would also bring financial benefits to the company. For this purpose, a detailed economic analysis was carried out (Table 5) and the final profit per 1 MWh of electricity produced was calculated using the following formula (Zaluska, Piekutin, Magrel, 2018, pp. 51-56):

$$\text{Economic efficiency} = \frac{(\text{Profit from electricity not purchased} + \text{value of certificates} + \text{profit from electricity sold} + \text{cost of fuel not purchased}) - \text{operating costs}}{\text{Amount of produced electricity [MWh]}}$$

The results are given in Table 5 and visualised in the following graph (Fig. 8).

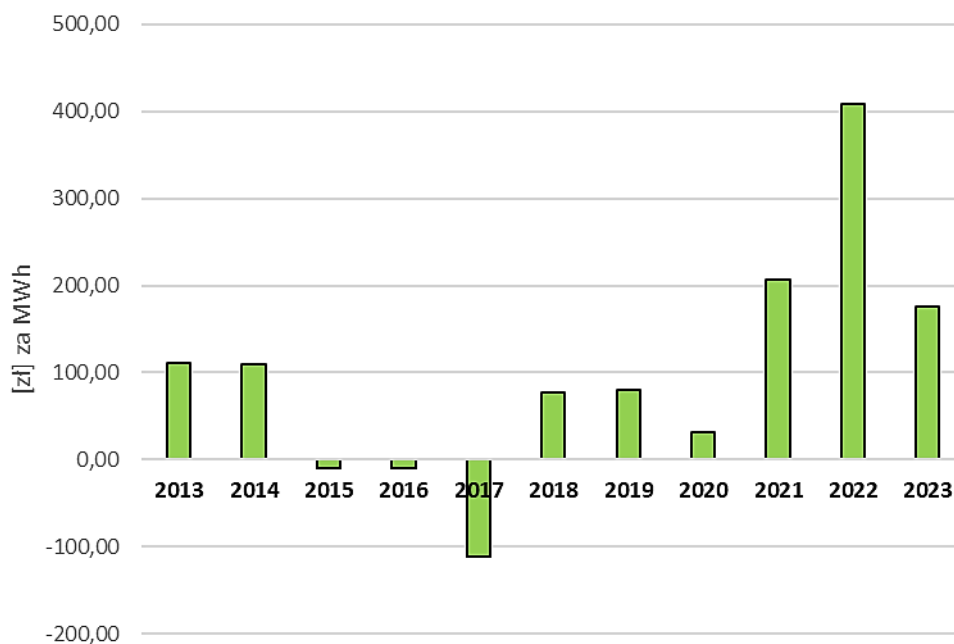


Figure 8. Final profit per 1 MWh [PLN]. Economic efficiency.

Source: company source data.

A loss was recorded between 2015 and 2017, which was largely due to the unit's operating costs including breakdowns. A sample statement of expenditure for 2017 showed that depreciation was the largest item (Fig. 9).

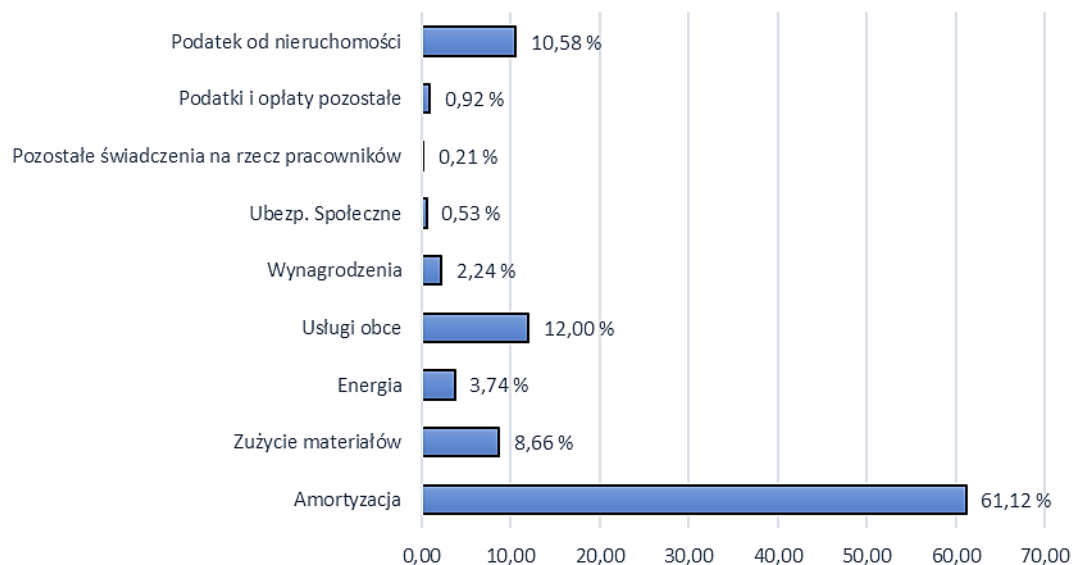


Figure 9. Percentage breakdown of CHP system operating costs - 2017.

Source: company source data.

The listing of 'green certificates' on the RES Rights Market also had a significant adverse effect on the economic performance, with a record decline in value in 2016, 2017 (Fig. 10).

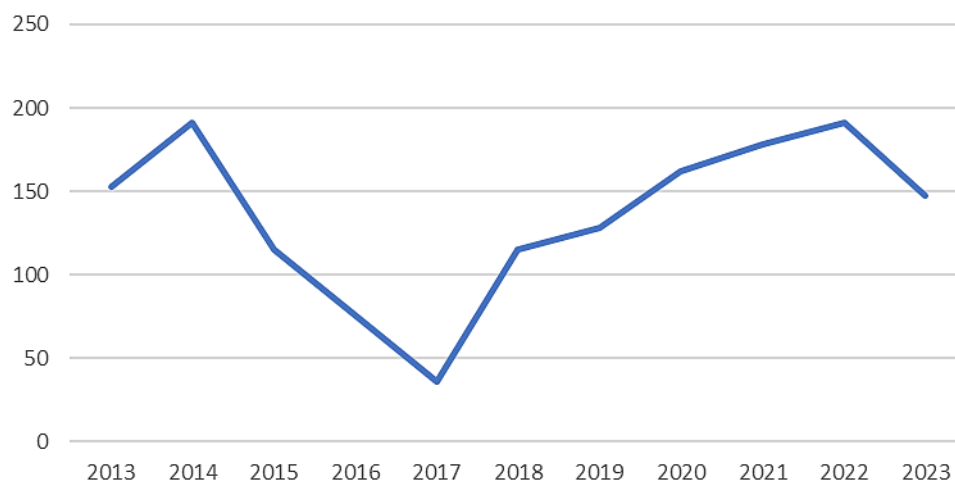


Figure 10. Value of “green certificates” [PLN/MWh].

Source: company source data.

In summary, the stand-alone production of energy from biogas is financially profitable for the company, especially in years when the CHP and digesters (WKFZ) have not undergone any maintenance and have been operating trouble-free. The above analysis confirms the rationale for building a second CHP unit with a double biogas production node to ensure a constant biogas flow and continuous production of electricity and heat from renewable energy sources.

7. Summary

The requirements for municipal wastewater treatment plants in the draft of the new Waste Water Directive are becoming increasingly stringent. This applies both to the reduction of the permissible values for the biogenic elements nitrogen and phosphorus in the treated wastewater and to the implementation of technology for the removal of micropollutants in the fourth treatment stage. Such high-efficiency wastewater treatment will require the provision of significant amounts of electricity and heat for the efficiency and effectiveness of the technological processes.

In parallel with the intensification of treatment processes, it will be necessary for the energy required for this to be generated by the operators of the treatment plants, with particular attention being paid to identifying and exploiting the potential for biogas production (<https://www.europarl.europa.eu/...>). This will ensure that these plants achieve energy neutrality while reducing greenhouse gas emissions.

The production of electricity from biogas at municipal wastewater treatment plants is the optimal solution. The sludge process waste generated during treatment, which is a continuous stream, can be stabilised in the digestion process and the biogas by-product obtained can be used to produce green energy.

As the evaluation of the economic and energy efficiency of the cogeneration system at the Rybnik-Orzepowice WWTP has shown, the production of electricity from biogas is cost-effective and there is still potential for increasing its efficiency. It is therefore necessary to extend the CHP node at the plant by building another pair of digesters to ensure greater stability and reliability of the CHP system. The additional plant will allow full use to be made of the biogas currently produced, increasing its production and achieving both environmental and economic benefits.

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DETERMINANTS OF CORPORATE SOCIAL RESPONSIBILITY IMPLEMENTATION IN BANKING INSTITUTIONS IN POLAND AND RWANDA – A COMPARATIVE ANALYSIS

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Purpose: The objective is to identify and characterize the determinants of the implementation of the CSR concept in banking institutions in Poland and Rwanda. This article examines both internal and external factors influencing CSR practices in these countries, offering insights into how different contexts shape CSR strategies.

Design/methodology/approach: A comparative analysis is used to evaluate CSR determinants in Polish and Rwandan banks. The study reviews literature, regulatory documents, and case reports from both countries to assess external factors and internal factors.

Findings: The research identifies distinct differences and similarities in CSR implementation between Poland and Rwanda. Polish banks operate under comprehensive EU regulations and a developed economic environment, while Rwandan banks face evolving national policies and focus on socio-economic development. Technological advancements and market pressures vary significantly, reflecting the different stages of economic and technological development in each country.

Research limitations/implications: The study is limited by the availability and comparability of data across different countries. Future research could expand to include additional countries and sectors for a more comprehensive analysis. Longitudinal studies could provide deeper insights into the long-term impact of CSR implementation.

Practical implications: Banks in both Poland and Rwanda should tailor their CSR strategies to align with local and global expectations. Effective CSR practices can enhance reputation, operational efficiency, and customer loyalty. Banks should integrate CSR into their corporate strategies, foster a supportive organizational culture, and leverage technological advancements to improve their CSR efforts.

Social implications: The research underscores the role of CSR in promoting social and environmental progress. By adopting effective CSR practices, banks can contribute to community development and environmental sustainability. This may influence public attitudes towards corporate responsibility and inform policy development.

Originality/value: This paper provides a comparative analysis of CSR determinants in banking institutions across Poland and Rwanda, highlighting how different cultural and economic contexts impact CSR practices. It fills a gap in the literature by offering a detailed comparison and contributing to a deeper understanding of global CSR strategies.

Keywords: Corporate Social Responsibility, Banking Sector, Poland, Rwanda, CSR Determinants.

Category of the paper: theoretical paper.

1. Introduction

Corporate Social Responsibility (CSR) plays a key role in implementing the development strategies of banking institutions around the world. Implementation of the CSR concept is related to managing business activities in an economically, socially and environmentally responsible manner. Fundamentally, corporate social responsibility is a business strategy wherein organizations incorporate social and environmental issues into their operations and stakeholder relations. Corporate Social Responsibility is defined by the European Commission (2020) as "the responsibility of companies for the effects they have on society". The Commission additionally recommends that companies establish a procedure to incorporate social, environmental, ethical, human rights, and consumer concerns into their core strategy and business operations, working closely with their stakeholders. This all-encompassing strategy not only tackles current societal challenges but also promotes trust and long-term company sustainability. A company can become more environmentally friendly and accountable by implementing Corporate Social Responsibility, a self-governing business model, to its stakeholders, the public, and itself. Through corporate social responsibility, also known as corporate citizenship, businesses can be knowledgeable about the effects they are having on the environmental, social, and economic spheres of society (Gheraia, Saadaoui, Abdelli, 2019). "The ongoing commitment by business to contribute to economic development while improving the quality of life of the workforce and their families as well as of the community and society at large" is how the WBCSD defines corporate social responsibility (Dahlsrud, 2006).

The dual emphasis of CSR on social welfare and economic progress is shown by this description. The way that CSR is seen and used around the world has changed dramatically in recent years. The Global Reporting Initiative (2021) states that investor demand for transparency and regulatory developments has led to a growing trend towards mandatory CSR reporting. One significant driving force behind the promotion of full CSR disclosures among large public-interest entities, for example, has been the European Union's Non-Financial Reporting Directive (NFRD) (European Union, 2021).

For banking institutions, CSR is of particular importance due to the role banks play in the economy, while having a significant impact on the environment and society. CSR activities, which center on topics like sustainable finance, ethical lending practices, financial inclusion, and community development, have been increasingly important in the banking industry. Research shows that banks with strong CSR programs typically see improvements in customer loyalty, reputation, and operational efficiency (Scholtens, 2009). The implementation of Corporate Social Responsibility in banking institutions is a complex and multifaceted process. It is shaped by a number of conditions, both internal and external, which include socio-economic development, government policy, legal regulations, stakeholder expectations, market competition, implemented corporate strategies, organizational culture, among others.

The purpose of the article is to identify and characterize the determinants of the implementation of the CSR concept in banking institutions in Poland and Rwanda. The article presents a comparative analysis of the determinants of CSR implementation in these countries, showing the differences and similarities in the approach to implementing the concept in two different cultural contexts and economic contexts.

2. Methods

The choice of the research method was subordinated to the defined purpose of the study and was aimed at conducting a comparative analysis of the internal and external determinants of CSR implementation in Poland and Rwanda. In order to identify and characterise the determinants of the implementation of the concept of corporate social responsibility in banking institutions, the method of systematic literature review was applied (Czakon, 2020). In order to check the state of the art using this method in the area of corporate social responsibility, a selection and subsequent selection of primary literature was made based on databases primarily Scopus and Google Scholar. Based on the “snowball” method, a list of publications was completed. The focus was on key words, i.e. “corporate social responsibility: and “determinants of corporate social responsibility implementation”. The criteria for the selection of literature were the time range of publications (2004-2023) and the fields, i.e. social sciences and business, management and accounting.

The data obtained, presented in Figure 1, show that a steady increase in the number of publications on the CSR concept can be observed between 2004 and 2023. This demonstrates the great importance and topicality of the subject matter undertaken in this area.

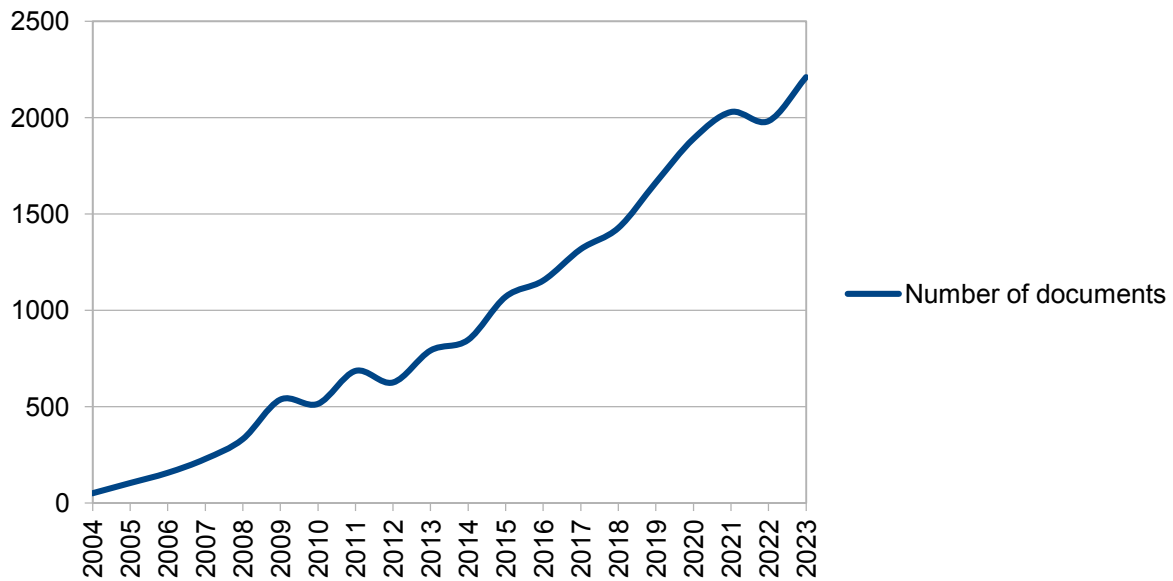


Figure 1. Number of publications on Corporate Social Responsibility from 2004 to 2023.

Source: Scopus database.

3. External and internal determinants of CSR implementation in banking sector institutions

The implementation of Corporate Social Responsibility in the banking sector is shaped by a number of determinants. The most common division that is used in the literature is the division into external and internal determinants. They influence the success associated with the implementation and development of the CSR concept in banking institutions. These determinants can also be the cause of many barriers that hinder or inhibit the implementation of the CSR concept. Understanding these determinants is crucial for banks in Poland and Rwanda to tailor their CSR strategies effectively, ensuring alignment with both local and global expectations. Externally, the regulatory environment, socio-economic development, technological advances, market pressures, and stakeholder expectations significantly shape CSR practices. Internally, factors such as corporate strategies, corporate culture, management commitment, and employee engagement play a pivotal role. These factors, divided into internal and external, are discussed in this subsection.

3.1. External determinants

Regulatory Environment

One important external factor influencing the adoption of CSR is the regulatory environment. Many countries have regulations requiring banks to disclose non-financial information, which includes aspects of social and environmental responsibility. Strict EU rules

set comprehensive requirements on social responsibility and environmental sustainability in European Union countries, which requires banks to implement more demanding CSR programs (European Commission, 2023). Not only is adherence to these standards required, but it also establishes banks as reputable and accountable organizations.

Socio-economic development

The implementation of the CSR concept in banks is the result of many socio-economic conditions affecting their operations. Banking institutions must adapt their strategies and activities to social expectations and economic challenges, which are increasingly linked to the pursuit of sustainable development in which the CSR concept fits (Jeucken, 2001). The implementation of CSR strategies in these institutions brings them real benefits in social and economic terms, and contributes to a better reputation. Banks are increasingly implementing CSR in response to the needs of local communities. Therefore, an important element is to understand the socio-economic conditions of the country or region in which banks operate. According to the needs of the community of a given area identified by the banks, these institutions can undertake a variety of initiatives related to, for example, supporting environmental and social initiatives, investing in local infrastructure, implementing educational programs, or promoting the availability of banking services for low-income people in the fight against financial exclusion, etc.

Technological Advancements

The implementation of CSR is influenced by external factors such as the development of innovation, technological advances, digitization, and artificial intelligence. Innovation helps banks operate more sustainably and efficiently. Digital banking reduces the need for physical branches, thereby reducing its impact on the environment. Artificial intelligence is playing an increasingly important role in the process of providing services to banking institutions' customers. In addition, technology has the potential to improve accountability and openness of CSR reporting, making it easier for stakeholders to track and evaluate CSR initiatives (Ejoh, Omoile, 2023). Thus, the level of innovation, access to new technologies in a country has a strong impact on the development of CSR practices in banking institutions. The use of technology in the implementation of CSR projects has an impact on innovative approaches to pro-social and pro-environmental solutions.

Market Pressures and Consumer Expectations

Important external elements are consumer expectations and market forces. Today's socially conscious consumers want banks to show a significant commitment to corporate social responsibility. Banks are now expected to go beyond traditional financial services and contribute meaningfully to societal and environmental well-being (Porter, Kramer, 2007). Consumer loyalty is increasingly tied to CSR, with research showing that customers are more likely to engage with banks that align with their personal values (Freeman et al., 2010). Failure to meet these expectations can harm a bank's reputation and erode customer trust, leading to a potential loss in market share (Fatma et al., 2015). Market pressures also significantly

influence how banks adopt CSR strategies. Investors, regulators, and competitors are driving the need for sustainable business practices, which has led to an increased focus on environmental, social, and governance (ESG) factors within the industry (Forcadell, Aracil, Úbeda, 2019). Investors are particularly keen on CSR as it enhances long-term value creation and mitigates risks (Eccles, Ioannou, Serafeim, 2014). Furthermore, regulatory frameworks are evolving, requiring banks to meet higher standards of social responsibility, especially in relation to environmental sustainability (El-Kassar, Singh, 2019). Banks that are slow to integrate these expectations risk reputational damage and diminished competitive advantage (Pérez, Rodríguez del Bosque, 2015). As demonstrated by McDonald's success in using CSR to boost customer loyalty, businesses that embrace CSR can foster stronger customer relationships, increase brand equity, and drive long-term financial performance.

Stakeholder Influence

Stakeholder expectations are another important determinant of CSR implementation at banking institutions. Investors, customers and local communities are increasingly demanding that financial institutions take pro-social and pro-environmental measures. Stakeholders are coming to expect banks to participate in sustainable practices and make positive social contributions. Influence from stakeholders, like as consumers, shareholders, and community organizations, is also very important in determining CSR strategies. Customers are increasingly paying attention to whether banks engage in CSR activities. This can influence their decisions on choosing banking services. In turn, investors are increasingly paying attention to non-financial ESG (Environmental, Social, Corporate Governance) indicators when making investment decisions, prompting banks to be more responsible in their actions (Zabawa, Łosiewicz-Dniestrzańska, 2023). These indicators are playing an increasingly important role in banks' decisions on various transactions.

3.2. Internal Determinants

Values, corporate strategies and organizational culture

CSR implementation in banking institutions is strongly linked to corporate strategies. Banks whose strategic goals are related to CSR more effectively implement activities in this area. These activities implemented as part of the strategy may include engaging in social and environmental initiatives, investing in sustainable projects, creating and developing financial products that support sustainable development. The core of the bank's CSR strategy is its corporate culture, which is a key factor supporting CSR implementation. Organizations that promote values such as ethics, responsibility and sustainability are more likely to implement CSR concepts in conjunction with daily business practices. Creating the right organizational culture that supports CSR initiatives is key to achieving long-term success for CSR activities. Robust CSR programs are likely to be encouraged by a culture that places a high value on sustainability, social responsibility, and ethical behavior. For instance, it is frequently simpler for banks to incorporate CSR into their operations if they have a strong culture of honesty and

community involvement (Liang, Renneboog, 2020). Many factors influence organizational culture. Figure 2 illustrates the impact of organizational culture factors on CSR.

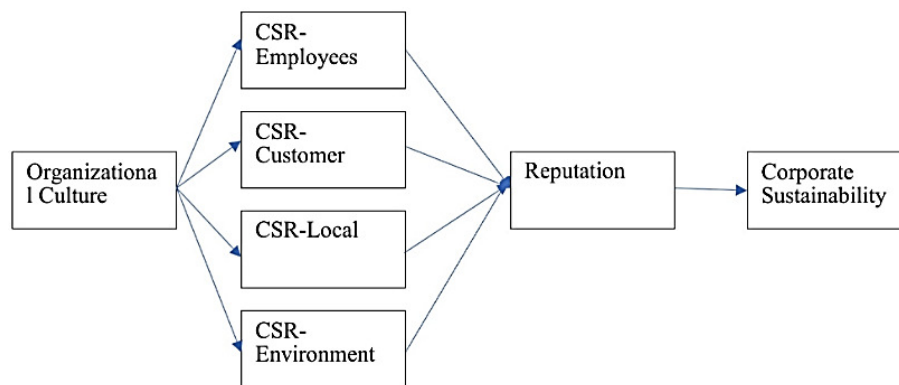


Figure 2. The impact of organizational culture factors on corporate social responsibility and Corporate Sustainability.

Source: Siyal, Ahmad, Riaz, Xin, Fangcheng, 2022.

According to Siyal, S., Ahmad, R., Riaz, S., Xin, C., Fangcheng, T., 2022 Corporate Social Responsibility (CSR) and reputation (R) play pivotal roles in driving corporate sustainability (CS). A strong corporate reputation is linked to numerous advantages, such as the ability to negotiate better contracts, attract talent, and charge premium prices, all of which contribute to sustainability. Empirical studies have shown a positive and significant association between reputation and CS, positioning reputation as a crucial factor for enhancing corporate sustainability. Moreover, organizations with strong CSR practices tend to build a favorable reputation, which in turn strengthens their competitive advantage and long-term viability. CSR initiatives focused on employees, customers, the environment, and local communities are particularly influential, as they not only boost an organization's reputation but also promote its sustainability. This is especially evident in industries like hospitality, where CSR initiatives have been directly linked to sustainable performance. Consequently, improving CSR practices enhances a company's reputation, which subsequently fosters corporate sustainability. In this context, organizational culture factors that emphasize CSR are key contributors to both reputation-building and achieving sustainable business outcomes.

Committed to Leadership and Management

Commitment to leadership is an important internal factor. A company's entire culture is influenced by the top management's strong commitment to corporate social responsibility. Prioritizing CSR increases a leader's likelihood of allocating required resources, defining specific CSR goals, and making sure CSR is integrated into the overall strategy plan (Habba, 2024). Therefore, it is very important to promote the right leadership style, the so-called responsible leadership, which influences the motivation and involvement of an organization's employees in CSR activities.

Employee Engagement

One further crucial internal component is employee engagement. Successful implementation of CSR initiatives is typically observed in banks where staff involvement is proactive. Training initiatives, staff involvement in CSR decision-making, and volunteer opportunities for community service are just a few examples of how to engage employees. As a result, the overall impact of CSR activities is increased by engaged employees' propensity to endorse and support them (Dekoulou, Anastasopoulou, Trivellas, 2023). The effective implementation of CSR-related activities is therefore significantly influenced by the appropriate competence and commitment of employees. In this regard, it is very important to ensure the continuous development of employees' CSR-related knowledge and skills.

Internal Communication and Education

Successful implementation requires good internal communication as well as education on CSR programs and goals. Banks must make sure that staff members are aware of the value of corporate social responsibility and how their work fits into the bigger picture. Internal newsletters, workshops, and regular training sessions can all aid in raising awareness and developing a culture of accountability inside the company. (Matuszak-Flejszman, Łukaszewski, Budna, 2023).

4. Analysis of the determinants of CSR implementation in banking institutions in Poland and Rwanda

The implementation of corporate social responsibility in Polish and Rwandan banking institutions is influenced by many internal and external factors. For banks that want to align their CSR initiatives with stakeholder expectations and national development goals, it is important to understand these factors. The main internal and external factors affecting CSR implementation in the Polish and Rwandan banking sectors are analyzed in this section.

4.1. Implementation of CSR in banking institutions in Poland in the context of analysis of key determinants

Regulatory Environment

Banks in Poland, realizing the growing social expectations and legal regulations, are increasingly integrating their activities with those related to corporate social responsibility (Róžańska, 2016). Regulatory pressure, both at the national, European and international levels, is one of the main determinants of CSR in Polish banks. Banks in Poland are required to comply with many regulations promoting corporate social responsibility and sustainable development. Examples include EU regulations on, for example, non-financial reporting, such as the Directive of the European Parliament and of the Council (2014/95/EU), which obliges certain

large entities to publish CSR information. There are other national and international standards, reporting tools in this area, i.e. the Global Reporting Initiative (GRI), ISO 2600 standard on corporate social responsibility, UN guidelines relating to business and human rights, international guidelines of the Global Compact and others (Barczyk, 2023). However, as many authors point out, there is a need to develop a single comparable reporting template in the area of CSR (Wróbel, 2016; Barczyk, 2023).

Socio-economic development

Global trends in sustainability, responsible management and investment also permeating the Polish market are prompting banks to take a more conscious approach to CSR (Scholtens, 2009). The economic crises have caused many banking sector institutions around the world, including Poland, to have to change their approach to governance, risk management and public trust. In this regard, CSR activities undertaken by banking sector institutions in Poland are playing an increasingly important role.

Technological Advancements

Technological progress, the development of innovations plays an important role in the development of banking sector institutions in Poland. Available digital tools, modern technologies such as artificial intelligence (AI), Big Data, blockchain, and fintechs have a direct impact on the implementation of CSR concepts in banks. (Davenport, Kirby, 2016; Gomber, Koch, Siering, 2017). They contribute to reducing the environmental footprint, improving transparency, accessibility of financial services. Technologies such as blockchain enable banking institutions to increase transparency and accountability in managing financial data, which is important for CSR (Tapscott, Tapscott, 2016). On the other hand, the development of these technologies and tools poses challenges for banks in terms of cyber security, which is an important part of the corporate social responsibility measures taken.

Market Pressures and Consumer Expectations

An important external factor influencing the implementation of CSR in banks in Poland is growing customer expectations and competitive pressures. Customers in Poland anticipate that banks would actively handle social and environmental issues, which has led to more extensive CSR policies (Zieliński, Jonek-Kowalska, 2023). Increasing competition in the banking sector has prompted banks to use CSR activities as a differentiating element (Jeucken, 2001). CSR has become an important tool for building relationships with customers, creating an image and improving reputation.

Stakeholder Influence

Increasingly, stakeholders expect Polish banks to act not only in the interests of their shareholders, but also for the broader good of various social groups (Freeman, 2010). There is a growing public awareness in Polish society of the issues of ethical behavior and sustainable development, which is prompting banking sector institutions to incorporate social, ethical, environmental, more responsible management aspects into their operations. For example, shareholder engagement in Poland has resulted in increased accountability and openness in CSR

reporting (Paluszak, Wiśniewska-Paluszak, 2019). Banks are paying increasing attention to publicizing CSR reports to a wide range of stakeholders.

Values, corporate strategies and organizational culture

The key internal factors influencing the implementation of CSR in banks in Poland is their organizational strategy and culture, as well as their values. An organizational culture conducive to CSR motivates employees to engage in pro-social and environmental activities. Numerous banks in Poland have a long history of endorsing environmental sustainability and community programs, which is fundamental to their corporate culture (Sułkowski, Fijalkowska, 2019). Strategies in banks in Poland are increasingly directing their strategic goals towards CSR activities, creating special committees and CSR programs including environmental protection activities, support for local communities, financial education, etc. The banks in Poland analyzed by Bednarska-Olejniczak (2016) demonstrate a strategic approach by implementing long-term plans for CSR activities. There are many examples of banks operating in Poland that place a strong emphasis on sustainability and social responsibility in their corporate strategies.

Committed to Leadership and Management

The implementation of policies for CSR requires banks to be committed at the level of the board of directors and managers. Bank managers in Poland are paying increasing attention not only to the financial dimension, but also to the social dimension and the servant role towards society (Waliszewski, 2022). Managers of Polish banks play a key role in implementing CSR by setting strategic directions for sustainable development, shaping organizational culture, making decisions on responsible investments and managing stakeholder relations. In this regard, it is very important to raise the awareness and knowledge of bank managers in Poland so that they can contribute to further social, economic and environmental development.

Employee Engagement

In order for CSR activities to be implemented in an effective manner, it is necessary to involve employees in these activities. On the other hand, initiatives in this area aimed at bank employees themselves are also important. The results of the analysis conducted by Bednarska-Olejniczak (2016) indicate that banks in Poland implement a number of CSR activities in favor of employees concerning taking care of employee safety and health, counteracting unfair practices, employee volunteering, support and development programs for employees, work-life balance. These activities are also aimed at increasing employee involvement in CSR activities. According to Paluszak, Wiśniewska-Paluszak (2018) Polish banks have seen an increase in staff participation and success rates in environmental sustainability programs.

Internal Communication and Education

Internal communication has a huge impact on the effective implementation of CSR initiatives. Banks in Poland are increasingly taking advantage of modern technologies, digital tools, AI, social media, online platforms, which enable banks to transparently and quickly communicate their CSR activities. In this way, they can quickly and effectively inform stakeholders, including their employees, about plans, initiatives, pro-social and environmental

activities, which fosters lasting relationships and trust (Ogrizek, 2002). Necessary in this regard are ongoing programs to raise the knowledge and awareness of employees, which can significantly affect the effectiveness of implemented CSR initiatives.

4.2. Determinants of CSR implementation in banking institutions in Rwanda

Regulatory Environment

The Rwandan government has played a proactive role in promoting CSR through various policies and regulations. The National Strategy for Transformation (NST1) emphasizes sustainable development, urging banks to engage in CSR activities that contribute to the country's socio-economic goals. Additionally, the Rwanda Governance Board (RGB) encourages companies, including banks, to adopt CSR practices that align with national priorities, such as poverty reduction and environmental sustainability (Government of Rwanda, 2017). On the other hand, multinational organizations frequently have an impact on CSR standards and practices in Rwanda, where the regulatory environment is changing (Nahimana, 2024). The following table provides a summary of the key regulations and their impact on CSR implementation in Rwanda's banking sector.

Table 1.

Key Regulations and Their Impact on CSR Implementation in Rwandan Banking Sector

Regulation/Policy	Description	Impact on CSR Implementation
National Strategy for Transformation (NST1)	Emphasizes sustainable development and CSR in corporate practices.	Encourages banks to integrate CSR into their strategic objectives.
Rwanda Governance Board (RGB) CSR Guidelines	Provides guidelines for CSR activities in line with national priorities.	Increases accountability and alignment of CSR with national goals.

Source: Nahimana, 2024.

Socio-economic development

Rwanda, being a developing country, focuses its CSR activities on social and economic development. Rwanda's socio-economic context, characterized by a focus on inclusive growth and poverty alleviation, also drives CSR in the banking sector. Banks are encouraged to support community development projects, financial inclusion, and initiatives that contribute to the country's vision of becoming a middle-income economy by 2035. The emphasis on socio-economic development creates a conducive environment for banks to engage in meaningful CSR activities that address local needs (Diop, Ibrahim, Lo Hog Tian, Yang, Widener, Spicer, 2023). Banks often engage in microfinance projects to improve access to financial services mainly for small businesses and low-income individuals. This is crucial for stimulating the local economy and creating new jobs.

Technological Advancements

Technological innovation is revolutionizing CSR in Rwanda's banking sector. With digital banking solutions becoming more widespread, banks are increasingly able to reach underserved populations, thus contributing to financial inclusion and socio-economic development. Fintech advances allow for efficient implementation of CSR initiatives, such as mobile banking and digital literacy programs, which make financial services more accessible to rural and low-income communities. These technology-driven CSR efforts are not only increasing the social impact of banks but also helping to enhance customer satisfaction by improving financial management (UNCTAD, 2023). As banks continue to integrate technology into their CSR strategies, they position themselves as leaders in digital transformation, promoting both societal benefits and sustainable business growth (GSMA, 2023).

Market Pressures and Consumer Expectations

Growing investor and consumer interest in sustainability is driving Rwandan banks to adopt CSR programs that tackle regional socioeconomic issues. Socially conscious consumers expect companies, including banks, to demonstrate a commitment to ethical and sustainable practices. This pressure from the market has pushed banks to incorporate CSR initiatives focused on environmental sustainability, poverty reduction, and improving financial access, thereby aligning with consumer expectations (Murasi, Osiemo, 2024). Investors are also prioritizing businesses with solid CSR credentials, recognizing that CSR enhances long-term profitability, brand reputation, and customer loyalty (McDonald's Corporation, 2023; Pérez, Rodríguez del Bosque, 2015). This alignment of consumer and investor expectations has positioned CSR as a competitive advantage for banks, helping to differentiate them in the marketplace while fostering customer and stakeholder trust.

Stakeholder Influence

The implementation of CSR in Rwanda is greatly impacted by stakeholder pressure, especially from international partners, civil society organizations, and customers. Consumers encourage banks to take on CSR projects that correspond to social standards by demanding that they do so on a regular basis. Furthermore, expectations for corporate social responsibility are frequently associated with relationships with international financial institutions, which push local banks to improve their social and environmental performance (Murasi, Osiemo, 2024). To make sure that CSR activities in Rwanda fit local requirements, banks frequently work with community groups and non-governmental organizations on these projects (Gahamanyi, Mulyungi, Shukla, 2018). Customers increasingly expect banks to be involved in community improvement activities.

Values, corporate strategies and organizational culture

Organizational resources, values, corporate strategy and organizational culture are important internal factors that influence how CSR is implemented in Rwandan banks. Financial institutions with a corporate culture that places a high priority on moral principles and social responsibility typically have more extensive CSR programs. As an illustration of the bank's

approach to social responsibility The Bank of Kigali, for instance, has put in place a strong framework for corporate social responsibility that includes programs in health, education, and environmental sustainability. This demonstrates the bank's commitment to social responsibility. The Bank gives priority to projects that will have the greatest possible social impact and address a variety of social issues, such as promoting gender parity, preserving the environment, reducing poverty, and creating shelters for vulnerable populations like women and orphans (Bank of Kigali, 2023).

Committed to Leadership and Management

Dedication from the leadership is essential because it determines the priorities for CSR and how resources are allocated. For example, in Rwanda, prioritizing corporate social responsibility can result in creative solutions that are adapted to local requirements, encouraging increased community involvement (Bank of Kigali Group Plc., 2024). Strategic leadership ensures that CSR is not merely an afterthought but is integrated into the organization's core values and long-term vision. This commitment also fosters a culture of responsibility and accountability, inspiring employees at all levels to participate in socially beneficial projects. Leaders play a pivotal role in ensuring that CSR initiatives align with both organizational goals and community needs, bridging the gap between profitability and social impact (Kotler, Lee, 2023).

Employee Engagement

Employee engagement is another essential element in the successful implementation of CSR initiatives. When employees are actively involved, CSR programs are more likely to succeed and achieve meaningful results. Banks in Rwanda are increasingly trying to build an organizational culture that encourages social responsibility through training and education programs for employees. In doing so, the banks want to increase employee awareness and involvement in CSR activities. These programs aim to raise employee awareness of the importance of CSR and motivate them to contribute to the bank's broader societal goals (Frederic, Osiemo, 2024). By involving employees in CSR activities, banks not only enhance their social impact but also strengthen employee loyalty and morale. An engaged workforce is more likely to advocate for sustainable practices and become ambassadors for the organization's CSR efforts. Research has shown that organizations with high levels of employee involvement in CSR tend to have better performance in both social impact and financial metrics (Pérez, Rodríguez del Bosque, 2015).

Internal Communication and Education

Effective internal communication and education are also vital for the successful integration of CSR into an organization's operations. Banks that prioritize internal communication around CSR are better positioned to engage their employees, foster a unified understanding of CSR objectives, and create a cohesive approach to implementing CSR programs. For instance, internal newsletters, CSR workshops, and dedicated CSR teams help maintain continuous dialogue about the company's social responsibility goals. By educating employees about CSR,

banks create a well-informed workforce that understands the broader impact of their actions. Additionally, internal communication ensures that all employees, from senior management to entry-level workers, are aligned in their CSR efforts, which contributes to a more organized and effective implementation of these programs (McDonald's Corporation, 2023). This internal focus strengthens the bank's ability to contribute positively to societal goals while maintaining consistent engagement with employees, customers, and stakeholders.

To sum up the implementation of corporate social responsibility (CSR) in financial institutions in Rwanda is influenced by a variety of internal and external factors, including stakeholder pressure, legislative frameworks, socioeconomic conditions, and organizational culture and leadership. Together, these factors influence how well-run and long-lasting CSR programs are in Rwanda's banking industry. The country's emphasis on inclusive development means that banks will play an increasingly important role in advancing social and environmental progress through corporate social responsibility (CSR), including it into their overall business strategy. Despite the many benefits associated with implementing CSR, banks in Rwanda face a number of challenges related to, for example, limited human and financial resources, lack of uniform standards for reporting and measuring the effectiveness of CSR activities.

Based on the presented analysis comparing external and internal determinants of CSR implementation in banking institutions in Poland and Rwanda, a comparison of key determinants is summarized in Table 2.

Table 2.

Comparison of key determinants of CSR implementation in banking institutions in Poland and Rwanda

Determinants of CSR implementation	Determinants of CSR implementation in Poland	Determinants of CSR implementation in Rwanda
External conditionality		
Regulatory Environment	EU regulations, comprehensive guidelines	National policies, evolving regulations
Socio-economic development	Development Developed economy, high consumer awareness	Developing economy, focus on basic needs
Technological Advancements	Advanced infrastructure, robust tools	Growing, but limited infrastructure
Market Pressures and Consumer Expectations	High pressure, high expectations	Increasing, less pronounced
Stakeholder Influence	Diverse stakeholders, strong influence	Growing, community and government focus
Internal conditionality		
Values, corporate strategies and organizational culture	Well-defined, global standards	Integrating with local development goals
Committed to Leadership and Management	High commitment, active promotion	Growing commitment, focus on impact
Employee Engagement	Structured programs, high engagement	Increasing, grassroots involvement
Internal Communication and Education	High level, formal training programs	Developing, growing awareness

Source: own elaboration.

As the analysis has shown, the implementation of social responsibility practices in banking organizations in Poland and Rwanda is a multi-dimensional process, dependent on various external and internal factors. Although the determinants of CSR implementation in banking institutions in Poland and Rwanda differ, there are some similarities. Both countries recognize the importance of CSR to operate more responsibly and, above all, to build better relations with stakeholders, both external and employees, as well as to improve image. In Poland, there is more emphasis on regulations and stakeholder expectations, while in Rwanda, CSR activities are strongly oriented towards supporting socio-economic development, particularly of local communities. In both countries, there is a noticeable trend of integrating the concept of corporate social responsibility into the business strategy of banks, which indicates the growing importance of CSR in business activities.

5. Summary

Corporate social responsibility, due to the operation of banks based on public trust, is of particular importance for their operations (Róžańska, 2016). Banks, as institutions with a high impact on society and the economy, are increasingly paying attention to the implementation of CSR practices and activities aimed at sustainable development. This is conditioned by a number of factors, both external related to the macro environment, as well as market and internal conditions. Understanding these determinants and how they affect banks' CSR activities is key to their effective social responsibility management. Integrating these CSR factors into daily business practices allows banks to build greater trust and loyalty among various stakeholder groups and promotes sustainability. As the comparative analysis conducted for banks operating in Poland and Rwanda shows, CSR is as important an element of their activities despite operating in slightly different socio-economic conditions. The peculiarities of local conditions mean that the approach to CSR in banking institutions in Poland and Rwanda is tailored to the specific needs and challenges of the country. However, global trends are evident that are influencing banks in both countries to recognize the growing role of CSR.

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INNOVATION MANAGEMENT IN THE CONTEXT OF BUILDING ORGANISATIONAL RESILIENCE

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Purpose: The study aims to identify the role of innovation management in building organisational resilience. The rationale for undertaking research on this topic stemmed from the scarcity of scientific studies in this matter.

Design/methodology/approach: The research on this subject was conducted by examining a range of literature from both international and Polish sources.

Findings: The publication focusses on issues of innovation management and organisational resilience. In this context, the paper pays attention to the external and internal environment of the organisation. It's also important to emphasize that the research done identifies the lack of universal definitions of innovation and organisational resilience in the literature. Furthermore, analysis of the factors influencing organisational resilience was carried out. The article also discusses examples of good innovation management practices in the context of organisational resilience illustrating these factors.

Originality/value: The issue discussed in this article concerns innovation management, because it's increasingly being seen as a crucial tool for enhancing organizational resilience. Innovation management is crucial for building organizational resilience as it equips companies with the tools to adapt to change and anticipate future challenges. By fostering a culture of continuous improvement and strategic foresight, organizations can navigate disruptions effectively, ensuring long-term stability, competitive advantage, and sustained growth. Organizational resilience ensures stability and effective crisis response, both crucial for long-term success and sustainability of an organisation in a dynamic environment.

Keywords: Organisational resilience, innovation, innovation management.

Category of the paper: A literature review.

1. Introduction

In a rapidly changing business environment, organisations face challenges that require not only ongoing responses to change, but also strategic preparation for the future. Today, organisations are operating in a turbulent environment and are increasingly aware of the implications associated with emerging risks and their potential impact on their operational risk. According to the Marsh Risk Resilience Report¹, significant risks that may affect an organisation's operations include, but are not limited to, those posed by pandemics, cyber-attacks, new technologies, climate change/ESG (environmental, social and governance) issues, regulatory changes or geopolitical risks.

In the context of these emerging risks, global social, technological, economic and environmental changes, a key aspect is becoming innovation management increasingly treated as a tool for building organisational resilience. Organisational resilience refers to an organisation's ability to adapt, survive and thrive in the face of unpredictable events and diverse challenges (Tarapata, Wozniak, 2022). In the aspect of innovation management, the resilience of an organisation is influenced by a wide variety of factors. Important in this respect is the innovative capacity of organisations, their introduction of effective innovation management practices, which are not only a condition for survival, but also the foundation for long-term development, gaining and maintaining competitive advantage and achieving success.

The aim of this article is to identify the role of innovation management in the context of building organisational resilience. To achieve this objective, an analysis of the factors influencing organisational resilience was carried out and examples of good innovation management practices in the context of organisational resilience illustrating these factors are presented.

2. Methods

The literature analysis focused on determining the role of innovation management in the context of building organizational resilience was based on a systematic literature review (Czakon, 2020). The aim was to check the state of knowledge in the indicated areas. As part of this method, the basic literature on the subject was selected using databases such as Scopus and

¹ The Marsh Risk Resilience Report is based on the results of a survey conducted in early 2021 among nearly 1000 Marsh clients doing business in nine regions around the world and representing more than 36 different industries, including manufacturing, energy, real estate, retail, construction, healthcare, banking, and financial and professional services. The objective of the study was to assess the resilience of organisations to the following risks: pandemic, climate/ESG (environmental, social and governance), cyber/new technology, geopolitical, and regulatory in: Risk Resilience Report Keys to Building a More Resilient Business: Anticipation, Forecasting, and Agility, 2021.

Google Scholar. This was followed by a selection phase of publications, using the following keywords: 'innovation management' and 'organisational resilience'. The list of publications has been supplemented based on the 'snowball sampling'. One of the criteria for the selection of literature was the language of the publication (Polish and English) and the time range of the publication (2003-2024). As a result of the literature selection, a database of publications was developed. Appropriate bibliometric analysis techniques were also used. It was limited to keywords, fields (business, management and accounting, and social sciences) and document type (articles, conference publications, books, and book chapters).

Figure 1 presents an analysis of the number of publications in the period 2003-2024 on the concept of innovation management, based on the Scopus database.

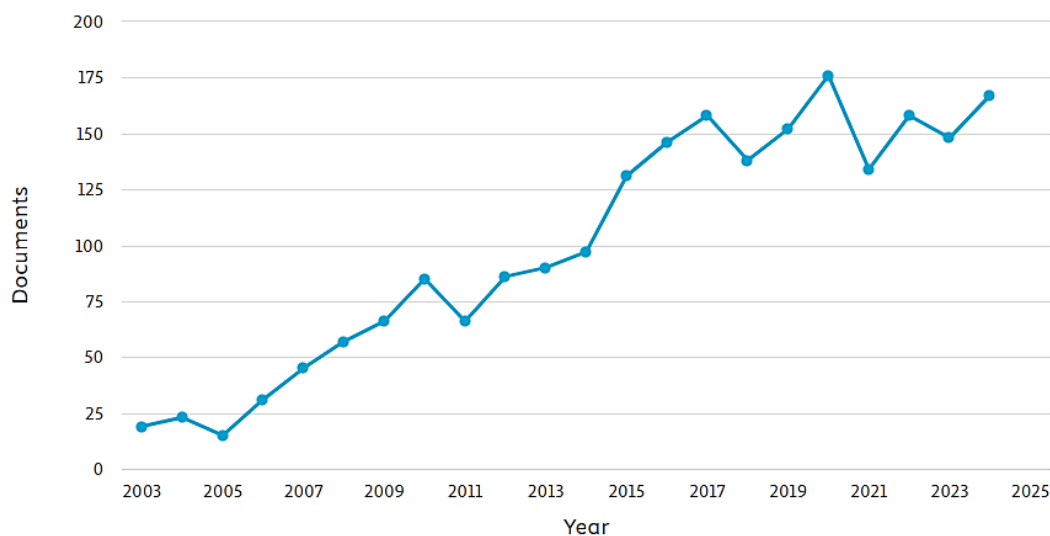


Figure 1. Number of publications on innovation management from 2003 to 2024.

Source: Scopus database.

Based on Figure 1, an upward trend in interest in innovation management among the researchers can be observed from 2003 to 2024. In the first decade, the graph shows a steady increase in the number of publications. It reflects the growing interest in innovation management due to the dynamic development of technology and increasing competition in many sectors of the economy. After rapid growth in previous years, the rate of growth slowed markedly between 2011 and 2016. The number of publications grew less rapidly, reaching around 100 papers per year. The years 2016-2019 are characterised by a renewed increase in the number of publications. This may be linked to global interest in digital transformation, innovation in business models and the implementation of new technologies. From 2020 onwards, fluctuations in the number of publications are visible. These may have been related to the disruption caused by the COVID-19 pandemic, which affected research and industry priorities. During this period, the number of publications fluctuates around 150 per year, indicating a continuing interest in the topic, albeit without a clear upward trend. It is, however, noticeable from 2023 onwards.

Figure 2 shows an analysis of the number of publications in the period 2003-2024 on the concept of organisational resilience, based on the Scopus database.

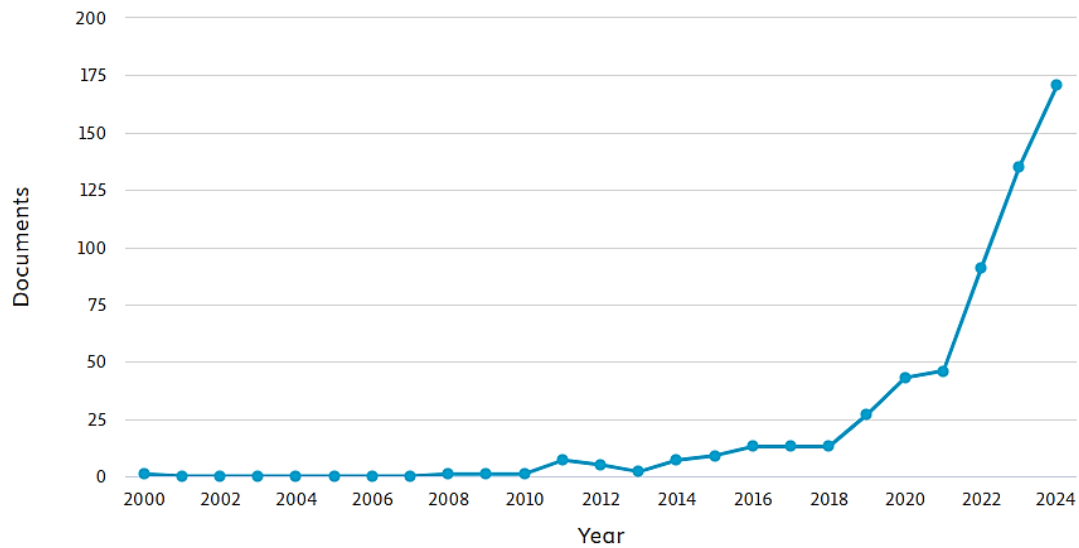


Figure 2. Number of publications on organisational resilience from 2003 to 2024.

Source: Scopus database.

Based on Figure 2, it is reasonable to assume that the number of publications remained very low between 2000 and 2010. It is likely that the topic of organisational resilience was not yet widely developed or was at an early stage of research. A gradual increase in the number of publications has been noticeable since 2010, but the rate of increase has been relatively low. This may be indicative of a growing interest in the topic, which however remained limited to a narrow group of researchers or specific industries. Since 2018, there has been a rapid increase in the number of publications. The most noticeable increase is observed from 2020 onwards.

3. The role of innovation management in the context of building organisational resilience

Today's organisations, due to an increasingly unpredictable and volatile environment, face the need not only to respond to current challenges, but also to strategically prepare for future changes and threats. In the context of these changes and threats, organisations need to build their resilience. An important role in this regard is played by innovation management, which is recognised by many authors as a key tool for building organisational resilience. Innovation management includes activities concerning the planning, organisation, coordination and supervision of innovation processes (Baruk, 2006; Łunarski, 2007). In this context, it is extremely important to prepare and implement an innovation strategy and to monitor activities undertaken in this regard. Innovation management can also be related to the search for

innovations based on available resources that will improve the competitiveness of the entity on the market (Pomykalski, 2001).

The issue of innovation management is also related to the external and internal environment of the organisation. Some researchers use the term 'internal environment' in the context of the internal environment (Studencka, 2016; Cheda, 2023). Its components are the conditions and forces operating inside a given entity (Piekara, 2010). They are understood to include those with managerial and leadership competence in the organisation, employees and the organisational culture (Griffin, 2008). The external environment, on the other hand, is considered as everything that surrounds the organisation externally, outside its boundaries and influences it or can potentially influence it (Griffin, 2008; Kozminski, Piotrowski, 2007).

In the context of the external environment, its dimensions should be considered: volatility, complexity, uncertainty. The first of these refers to changes in the activities of competitors regarding the development of technology, the tastes of potential consumers and the fluctuation of demand (Zhou, 2006). Under such conditions, organisations are forced to introduce new solutions to respond to changes in market needs. It must therefore be concluded that innovation is the basis for the existence and evolution of organisations. The complexity of the environment refers to its diversity. The more diverse the environment is, the faster and more dynamically managers should make decisions to monitor and analyse changes in the entity's environment (Szymaniec-Mlicka, 2014). The organisation's environment should also consider ongoing processes of an unpredictable nature (Bombola, 2014).

According to A. Chodyński (2021), innovation management in an organisation is related to the need for the organisation to have skills relating primarily to (Chodyński, 2021):

- a) Recognition, in particular on the basis of the analysis of the entity's environment made.
- b) Appropriate classification, related to the entity's strategy.
- c) Acquisition (e.g. of technology and sources of external knowledge) and creation of procedures in this respect.
- d) Generation in the form of the creation of technical solutions.
- e) Assimilating different types of innovation - process, product, marketing and strategic.

Bearing in mind the above considerations, one must conclude that innovation management is mainly about the ability to organise the innovation process appropriately. Innovation management is the process of systematically supporting and implementing new ideas, technologies and solutions in an organisation. It primarily involves identifying innovation opportunities, assessing their potential value and implementing them effectively. An effective innovation management strategy requires the creation of an environment that encourages creativity and collaboration internally and externally. Furthermore, flexibility is also key in the context of innovation management, as it enables an organisation to adapt quickly to changing market conditions and technological progress. It should be emphasised that effective innovation management increases an organisation's competitiveness by driving long-term growth and ensuring its ability to survive and thrive in an increasingly dynamic marketplace.

Within the framework of innovation management, a key issue is researchers' understanding of the innovation phenomenon itself. In the literature, a universal definition of the term has not been developed (Tohidi, Jabbari, 2012; Stenberg, 2017; Taylor, 2017; Kogabayev, Maziliauskas, 2017). The term is treated very broadly by researchers representing various disciplines. An analysis of the literature on the subject allows one to conclude that innovation can be seen primarily as an idea (Flett, 1998), the primary purpose of which is to solve existing problems (Kanter, 1995). It is also worth noting that innovation is commonly considered as the introduction of a new product, technology, or solution or a significant improvement of an existing one (Pahl et al., 2007; Kotsemir et al., 2013; Oslo Manual, 2018). In this context, it should be emphasised that innovations today are created based on cooperation between actors representing different sectors. Thus, they create added value for diverse stakeholder groups (Huczek, 2015; Wanicki, 2016; Zupok, 2017; Kowalski, 2020).

The issue of innovation is extremely important in the context of organisational resilience. Similar to the concept of innovation, no uniform definition of organisational resilience has been adopted in the literature (Linnenluecke, 2017). The concept is mainly treated by researchers from a social, psychological and strategic management perspective. Lengnick-Hall et al. (2011) defined organisational resilience as the ability of an organisation to create adequate responses adapted to a given situation and to take transformational action to take advantage of unexpected disruptions that may negatively affect the survival of the entity (Lengnick-Hall et al., 2011). Organisational resilience is also understood in terms of the ability of individuals, groups and organisations to absorb the stresses arising from the challenges they encounter. The aim of such activities is to return to assumed levels of functioning and to learn and grow, making actors stronger than before (Stephens et al., 2013). It is important to emphasise that organisational resilience is key to adapting to a changing global marketplace and coping with short-term disruptions such as natural disasters, cyber-attacks, physical threats or supply chain issues (Organisational Resilience: Good Practice Guide, 2024).

Innovation in the context of rapid and often unpredictable change enables companies to adapt faster to market changes, increase their operational flexibility. The implementation of new technologies, e.g. related to automation, digitisation, artificial intelligence (AI), increases organisational efficiency and flexibility, which in turn translates into increased organisational resilience to emerging changes, threats. The introduction of these technologies in the area of innovation process management, enables a faster response to disruptions in the supply chain or emerging new regulations. Indeed, innovation process management is related to the use of appropriate methods and tools aimed at initiating and consolidating innovative and creative attitudes (Brojak-Trzaskowska, 2014). The literature underlines the importance of external and internal factors (determinants) affecting the management of innovation processes (Rojek, 2017). Among the external determinants, the following are distinguished the state innovation policy, indirect impact factors (mainly concerning the sphere of science and education) and those related to the sector of activity (Chodyński, 2021). Internal determinants refer to the

organisation's strategy, cooperation with research and development units and financial resources. Appropriate knowledge management, the pursuit of employee development and skills acquisition, and organisational culture are also important (Fraś et al., 2015). Innovation process management mainly consists of deciding, organising and controlling innovation-related activities. These activities are important in the context of effectively and efficiently achieving the company's innovation goals (Brojak-Trzaskowska, 2014).

Of particular importance in building organisational resilience in the context of innovation management is dynamic innovation capability, which, in the face of emerging changes in the environment, contributes to the renewal, integration, reconfiguration of resources (Teece, 2007; Wijekoon, Galahityawe, 2016). The concept of dynamic innovation capability refers to the capabilities managers use to manage innovation in response to the challenges posed to organisations by a dynamic environment (Cheng, Chen, 2013; Helfat, Martin, 2015). In the face of contemporary and dynamic change, among the various organisational capabilities, a special role is attributed to this capability primarily because it facilitates the recognition of change on the one hand and adaptation to it through innovation on the other (Hill, Rothaermel, 2003).

In summary, innovation management plays a significant role in building organisational resilience through increased adaptability of the organisation to changing conditions as well as increased operational flexibility.

4. Factors influencing organisational resilience in the context of innovation management

In building an organisation's resilience, it is important to take a broad view that considers not only internal factors, but also the external environment in which the organisation operates, including the industry. It is therefore important to have a horizontal approach that considers different factors and perspectives and to develop appropriate support mechanisms, e.g. in the form of identifying metrics and responding to them quickly.

Significant factors in innovation management that have an impact on increasing the resilience of an organisation include: the organisation's innovation orientation, innovative organisational culture, knowledge management, human capital, leadership to support innovation, networking with partners, investment in research and development, operational flexibility, risk management.

To build organisational resilience, an innovative organisational orientation, an appropriate innovation strategy and an innovative organisational culture that promotes, among other things, creativity, openness, acceptance of risky initiatives, trust, learning and experimentation are crucial (Tidd, Bessant, 2013; Lewicka, 2012). Organisational culture, which is the foundation of an organisation, should support innovation, i.e. the ability to create and implement

innovations (Sitko-Lutek, 2014; Kraśnicka, Głód, Wronka-Pośpiech, 2016). Such organisations are better prepared to face unexpected challenges and are more resistant to change.

For the effective management of innovation creation and implementation processes, the management of knowledge and organisational learning is important to better prepare organisations to cope with the uncertainty and complexity of the environment (Nonaka, Takeuchi, 1995). Effective knowledge management, which includes the acquisition, collection, sharing and application of knowledge, is key to innovation (Oslo Manual, 2018). Organisations that can effectively manage knowledge, quickly assimilate information and use it in decision-making processes are better prepared to respond quickly to changing conditions and are better able to cope with a dynamic environment.

Strengthening the resilience of an organisation in the context of innovation process management can be achieved by an innovation ecosystem, networking with external partners from the public, scientific and economic sectors (Dolińska, 2005). Such cooperation enables better and faster access to knowledge, new ideas, sources of innovation, markets and technologies, which translates into faster response and adaptation to emerging changes and market opportunities, and better opportunities for growth in a changing environment. This is linked to the concept of open innovation, which targets the acquisition of innovation from various sources, both internal and external facilitating access to new technologies and markets thereby increasing the adaptability of the firm (Chesbrough, 2003).

Building organisational resilience requires a significant commitment from managers, employees, as well as incurring financial resources and creating accurate analyses. A key factor in increasing innovation and organisational resilience is leadership focused on promoting innovation, creativity, openness, inspiring and supporting its employees (Kotter, 1995; Eva, Robin, Sendjaya, van Dierendonck, Liden, 2018). Agile decision-making, people orientation, implementing new initiatives in response to market opportunities, and analysing failed projects or decisions so that organisations learn from their mistakes are also of considerable importance.

To build the long-term resilience of an organisation, continued investment in research and development (R&D) is key. Investment in this area is the foundation of innovation. Companies that systematically invest in R&D are better equipped to launch innovative products and adapt to technological and market changes, thus gaining and maintaining a competitive advantage in a dynamic environment (Chesbrough, 2003).

Operational flexibility allows companies to adapt quickly to changing market conditions. It is of great importance in carrying out innovative activities, managing innovation processes. New technologies, in particular digitisation and automation, can significantly increase the flexibility and efficiency of operational processes (Westerman, Bonnet, McAfee, 2014). Operational flexibility therefore influences both innovation and organisational resilience.

Another factor in building organisational resilience is risk management. Companies must have the ability to identify, assess and manage the risks associated with innovation activities (Hillson, 2003). This allows companies to adapt more quickly to unexpected events, risks that

may occur. This plays an important role in ensuring the sustainability and growth of the organisation.

Building and strengthening organizational resilience also depends on financial and economic factors. By optimizing operations and processes, as well as controlling costs and debt, organizations can create favorable conditions before a crisis occurs. In this context, analyzing the actions taken by competitors is also crucial (Hamidavi et al., 2023).

Considering these factors may enable an organization to better adapt to changes, thereby increasing its resilience.

5. Examples of best practices in innovation management in the context of organizational resilience

As mentioned, building organizational resilience involves adopting a proactive approach, characterized by the ability to adapt skillfully to changing conditions, act with flexibility, and focus on continuous development. Emerging changes and threats compel organizations to enhance their resilience to ensure continued existence and become more competitive. From the perspective of innovation management, organizational culture, investment in human capital, managerial competencies, and the ability to implement innovative solutions can play a significant role in building resilience. However, building organizational resilience does not rely on a single, universal solution. It is crucial to focus on multiple factors and respond quickly to changes. There are numerous examples of companies that, by employing appropriate innovation management practices, increase their resilience to emerging threats, contributing to their growth and success.

One interesting determinant of building strong organizational resilience is organizational culture, which plays a significant role in innovation and its management. An analysis of successful companies reveals that they have developed an organizational culture where innovation is seen as everyone's responsibility and a goal that employees at all levels strive to achieve in their daily work (Bolton, 2013). A noteworthy example of such an organization is Apple. Apple's culture fosters experimentation among scientists and developers, as well as the formation of informal task forces and problem-solving teams. To encourage the pursuit of creative solutions and prompt decision-making, the norms and values emphasize employee decision-making authority and the freedom to find their own solutions. The role of the manager is not to monitor or supervise employees' activities but to act as a facilitator, providing employees with the resources they need to solve problems independently. Formal decision-making procedures are kept to a minimum, while direct communication is the norm within the organization. Effective communication among employees also plays a crucial role, enhancing their engagement and ability to tackle challenges together (Young, 2021). Shared norms, values,

goals, and employee identification with the organization can contribute to strengthening it, ultimately increasing its resilience to potential threats.

Another interesting factor closely related to organizational culture and significantly impacting the building of organizational resilience is investing in human capital. Contrary to popular belief, organizational success is often not determined by the budget allocated to research and development, nor does technology seem to play the most critical role. Research clearly indicates that the most effective innovation strategies are those focusing primarily on people and human capital. These strategies involve attracting, engaging, and motivating key talents in innovation, fostering a culture of innovation by promoting and rewarding entrepreneurship and risk-taking, and developing innovative skills among all employees. This is also supported by studies from Y. Salamzadeh et al. (2013), which show that investing in human capital has a significant impact on staff creativity and innovation (Salamzadeh et al., 2013). A notable example of an organization that invests in human capital is Alphabet (Google), which is distinguished by both its business success and innovation. Alphabet excels in IT solutions, business techniques, experimentation, improvisation, analytical decision-making, co-creation of products, and other unique forms of innovation. The results achieved by the company demonstrate the value of investing in a well-thought-out human resources policy closely aligned with the company's market strategy. The company invests in various training and development programs, offering employees access to a wide range of online courses, workshops, and mentoring programs. The outcome of these efforts is not only high productivity but also innovation and the ability to quickly adapt to changing market conditions. Investing in human capital leads to the diffusion of knowledge and creativity among employees, supporting the company's goals and serving as a crucial foundation for building organizational resilience.

The managerial staff plays a significant role in building organizational resilience. Their role stems from the nature of their work, which is responsible for the overall development of the organization. A key element is their flexibility in action, openness to change, and the development and implementation of contingency plans and procedures that help the organization respond to crises and unforeseen situations (Fernando et al., 2020). This is crucial for maintaining stability and ensuring the survival of the organization in a changing environment. An interesting example of managerial adaptation to changing conditions is Amazon, which ranked third among the most innovative companies in 2023. During the COVID-19 pandemic, Amazon began aggressively hiring to keep up with the surge in online shopping driven by the pandemic. However, since then, the company has started to gradually reduce its workforce as consumers returned to physical stores and its retail business no longer grew as rapidly as in recent years. This situation led the management to make decisions to cut expenses, due to concerns about a recession, rising inflation, and a sharp increase in interest rates. Amazon reduced its warehouse space, paused some experimental projects, and shut down its telehealth service. This example illustrates how management adapts to changing conditions by quickly adjusting processes and structures to new challenges, thereby increasing the organization's resilience to emerging threats.

Another crucial factor in building organizational resilience is an organization's focus on innovation. This involves the ability to adapt business activities to new realities, including the organization of key processes, the functioning of supplier networks, and consumer behavior. Research by Boston Consulting Group shows that organizations that doubled their spending on innovation during economic downturns—seizing the opportunity to invest and strengthen their market position—achieve better long-term results compared to their competitors. An interesting example of a company highly oriented towards innovation is Tesla, which specializes in electric vehicle production. Tesla has become a leader in developing batteries for electric cars and creates hardware and software for autonomous vehicles. Recently, it has also begun expanding into the field of humanoid robots. Its mission is to accelerate the world's transition to sustainable energy. The company's ability to introduce new solutions and adapt to a changing environment has enabled its expansion and established a strong market position.

The concept of open innovation also plays a significant role in increasing organizational resilience. There are many examples of companies successfully implementing innovation management strategies based on open innovation. One such example is Procter & Gamble, which is recognized as a pioneer in adopting this strategy. The company drives innovation not only through internal sources but also through external ones, including collaboration with external partners, thus accelerating the process of bringing innovations to market (Huston, Sakkab, 2006). This strategy enhances organizational resilience by strengthening the company's ability to adapt. Another company employing an open innovation strategy is IBM. IBM implements open innovation by collaborating with research institutions and universities, developing programs that promote the advancement of technologies and enabling adaptation to rapidly changing technological environments and markets (Gartner, 2013). Intel, on the other hand, fosters innovation through collaboration with other organizations within its ecosystem and invests in open innovation via its venture capital unit, Intel Capital, which supports the development of technology startups. This approach provides access to knowledge, new technologies, and markets, thereby increasing the company's resilience and contributing to greater competitiveness.

Another interesting example of a company that implements innovation through an integrated approach to innovation management, knowledge management, and research and development is Nestlé. The company employs a model that combines research and development activities with marketing efforts, allowing for a better understanding of customer needs. This approach contributes to more effective innovation implementation and improved market adaptability while simultaneously reducing the negative impact on the environment. This activity is supported by digital technologies, including artificial intelligence (AI).

The analysis of the examples presented above indicates that organizations focused on innovation not only invest in the development of their employees but also build an organizational culture based on shared norms, values, and effective communication. They are also oriented towards flexibility and rapid adaptation to changing conditions, which

ensures their stable position in an unstable environment. These examples show that effective innovation management—encompassing investments in research and development, fostering an innovative organizational culture, managing knowledge, network collaboration with external partners, and operating within an innovation ecosystem—is crucial for building organizational resilience in a dynamically changing environment.

6. Discussion and summary

Innovation management plays a crucial role in building organizational resilience in the face of dynamic challenges and changes in the modern world. However, building resilience in the context of innovation management requires identifying, understanding, and integrating multiple factors, such as flexibility, investment in research and development, an innovative organizational culture, human capital, innovation-oriented leadership, knowledge management, risk management, network collaboration with partners, and open innovation, among others. Organizations that effectively manage innovation by leveraging their dynamic innovative capabilities are better prepared to handle market challenges and changes. Implementing effective innovation management practices is essential for long-term success and competitiveness in the global market. Examples of analyzed companies, such as Apple, Alphabet, Amazon, Tesla, IBM, Intel, Procter & Gamble, and Nestlé, illustrate how effective innovation management can enable survival in a turbulent environment and rapid adaptation to changing conditions, resulting in higher efficiency and a better competitive position in the market.

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DETERMINANTS OF COMMUNITY INVOLVEMENT: A COMPARISON OF THE MOTIVATING FACTORS OF INDIVIDUAL DONORS IN GENERATIONS X, Y, Z

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Purpose: The purpose of this article is to analyse and compare the motivations that influence decisions to support charitable collections among representatives of Generations X, Y and Z in Polish reality. The study aims to identify the key factors determining involvement in charitable activities and to identify differences in attitudes towards philanthropy between the different age groups.

Design/methodology/approach: The study was conducted using a survey questionnaire aimed at people involved in charitable activities. Data analysis was carried out using descriptive statistics methods, which allowed the results to be evaluated and significant differences to be identified between the different age groups.

Findings: The results indicate that, despite some Generational differences, factors such as an inner conviction of the need to help, a sense of fulfilment from helping and a willingness to support specific people are central to all the groups studied. Differences appear in those having a very high, high, medium and low impact. Full agreement is also found in factors having a negligible influence on respondents' decisions.

Research limitations/implications: The sample is purposive, making it impossible to generalise conclusions to the whole population. In the case of Generation Z, the number of respondents is smaller than in Generations X and Y which may limit a fuller understanding of their perspectives.

Originality/value: The article provides unique insights into the factors that have a key influence on the decision to support charitable collections among representatives of Generations X, Y and Z and the differences in their motivations to participate in charitable collections. The motivators that distinguish each generation can be useful for NGOs that want to reach different age groups with their message.

Keywords: Non-governmental organizations, Non-profit organizations, Fundraising, Individual donors, Generation X, Generation Y, Generation Z.

Category of the paper: Research paper.

Introduction

Non-governmental organisations (NGOs) work to improve the quality of social life by pooling and redistributing resources and providing services (Sargeant, 1999). Critical to the success of their operation are ensuring the financial sustainability of the organisation and the ability to successfully raise funds for projects (Doherty, Murray, 2007; Ferreira et al., 2017; Marciszewska et al., 2024). These organisations face the challenges of limited resources and the constant search for funding for activities with increasing competition for funding in the non-profit market (Ilyas et al., 2020; Robson, Hart, 2021; Schmitz, 2019; Suri, 2009). Support from individual donors is one source of funding for nonprofit organisations that has become increasingly important in recent years (Bekkers, Wiepking, 2011; Srnka et al., 2003). In a crowded marketplace, organisations need to understand the motivations of donors in order to effectively receive and maintain their support (Sneddon et al., 2020). The simultaneous increase in the number of people in need and the popularity of charitable collections leads to the fact that organisations wishing to end their activities successfully need to differentiate themselves from other activities (Ilyas et al., 2020; Robson, Hart, 2021; Schmitz, 2019). In order to convince a donor to give to a particular charity, it is worth asking questions about what motivates people to participate in fundraising and what factors are critical to their decision to donate.

There are publications in the fundraising literature that examine individual donors' motivations and preferences by gender (Woods et al., 2023), income (Neumayr, Handy, 2019), demographics (Robson, Hart, 2021), and values (Sneddon et al., 2020). Generational variation in attitudes towards philanthropy is also one of the issues currently being addressed in the literature. Research on motivations for charitable giving focuses on understanding what factors influence different generations' decisions to give (Florenthal et al., 2020; Florenthal, Awad, 2021; Gorczyca, Hartman, 2017; Konstantinou, Jones, 2022). Authors of fundraising articles emphasise the need to tailor NGO messages to different age groups (Kolhede, Gomez-Arias, 2022). Research in this area is also becoming increasingly important, especially in the context of the rapid development of new technologies and social media, which are changing the way charities reach potential donors (Bhati, McDonnell, 2020). Research shows that Generation X needs a sense of purpose in taking action and is positively collaborative (Lesniewska, Stosik, 2015). Generation Y, according to researchers, can access information quickly, wants to participate in community building, prefers fast communication, and has a need to surround themselves with electronics. For millennials, the internet is a source of knowledge, entertainment and building social relationships (Lesniewska, Stosik, 2015). Other researchers emphasise that the most important thing for Generation Y is social recognition. Attitude and trust in the charity are also important (Graça, Zwick, 2021). Generation Z wants to feel connected to charities and the causes they support but prefers online communication to personal contact and is more likely

to support charities recommended by peers. In addition, it does not want to follow fashion blindly because it cares about the long-term effect of its actions. Social media plays an important role in how Generation X representatives perceive charitable actions and express their commitment. (Konstantinou, Jones, 2022). Generation Z treats the internet as a natural and everyday part of life (Hysa, 2016).

The literature indicates that there are differences between generations in terms of motivation and ways of engaging in charitable activities. As such, further research into generational differences can provide valuable information that will allow charities to better adapt their strategies to meet changing donor expectations. Understanding the motivations of donors is also key to successful charitable campaigns, particularly in the context of generational diversity. Generations X, Y and Z differ not only in terms of age, but also in terms of values, lifestyles, and the ways in which they respond to various external stimuli, such as marketing campaigns or social media advertising. Each of these social groups may have a different approach to philanthropy and different reasons for engaging in charitable activities. Research into these differences can provide valuable information to better understand how to effectively engage different age groups in social giving.

The aim of this paper is to analyse and compare the motivations that influence decisions to support charitable collections among representatives of Generations X, Y and Z. The study aims to identify the key factors that determine involvement in charitable giving and to identify differences in attitudes to philanthropy between different age groups.

Methods

The aim of the research conducted was to understand the motivations that influence decisions to support charitable collections among representatives of Generations X, Y and Z in Polish reality. The study aims to identify the key factors determining involvement in charitable giving and to identify differences in attitudes to philanthropy between different age groups.

The study was carried out using a survey questionnaire, developed by the author of the article, which was addressed to individual donors actively supporting the activities of NGOs in online communities as well as in public collections carried out in traditional ways. A total of 305 correctly filled in questionnaires were received which met the selection criterion that the respondent was active as a donor in online and/or traditional fundraising for an NGO.

The questions included in the questionnaire allowed the evaluation of the phenomena studied and the relationships between them. The analysis of the research results refers to selected parts of the questionnaire:

- Metrics (6 questions, 6 variables).
- Specific questions (22 questions, 22 variables).

In analysing the results obtained, the author focused on descriptive statistics, with particular emphasis on interpreting the percentage frequency of responses and comparing the results among selected groups of respondents. The objectives of the present research are:

1. Identify factors that have a key impact on decisions to support charitable collections among representatives of Generations X, Y and Z in Polish reality.
2. Identify differences in motivations to participate in charitable collections between Generations X, Y and Z in Polish reality.

The following research questions were posed in relation to the research objectives:

1. What factors have a key influence on the decision to support charitable collections among representatives of Generations X, Y and Z in Polish reality?
2. Are there differences in motivations to participate in charitable collections between Generations X, Y and Z in Polish reality?

The study is characterised by certain limitations that affect the extent to which the results obtained can be generalised. Despite the limitations, the study carried out provides valuable preliminary information that can serve as a starting point for further, more in-depth analyses. The results obtained allow potential directions for future research to be formulated.

Results

The study analysed the responses of 305 respondents from three generational groups (Rogozinska-Pawelczyk et al., 2019):

- Generation X - people born between 1965 and 1979.
- Generation Y - people born between 1980 and 1994.
- Generation Z - people born from 1995 onwards.

Due to the discrepancy in the literature regarding the age range of people belonging to a particular generation, this study adopts an approach (Rogozinska-Pawelczyk et al., 2019) that is in line with the economic, political and social conditions of the respondents of the present study (Cichorzewska et al., 2020; Wątroba, 2022).

Table 1 shows the characteristics of the respondents by generational group (Generation X, Generation Y, Generation Z) and various variables such as gender, education, subjective assessment of control over charitable spending, gross monthly income, gross monthly amount donated to charity, number of initiatives supported. This analysis allows for a better understanding of the structure of the research sample.

Table 1.
Results of respondents' answers - section: metrics

Variable	Types of variable	Results for selected groups of respondents			
		The entire study group (n = 305)	Generation X (n = 116)	Generation Y (n = 164)	Generation Z (n = 25)
1. Gender	Female	277	105	150	22
	Male	28	11	14	3
2. Education	Higher	226	93	123	10
	Secondary	68	21	35	12
	Vocational or primary education	11	2	6	3
3. Control over charitable spending	I do not control how much I donate to charity, my contributions are spontaneous	270	101	147	22
	I regularly donate a ring-fenced amount to charity. I do not exceed the ring-fenced amount	35	15	17	3
4. Monthly income (PLN)	2501-4000	108	39	64	5
	below 2500	87	24	45	18
	4001-6000	69	52	32	2
	above 6000	41	18	23	0
5. Average monthly donations to charity (PLN)	51-300	194	82	98	14
	below 50	48	10	29	9
	301-600	39	15	22	2
	above 600	24	9	15	0
6. Number of activities supported at the same time	between 2 and 3	144	61	75	8
	more than 3	105	38	58	9
	only one	56	17	31	8

Source: Own elaboration.

The survey involved 305 respondents, who were divided into three generational groups. Generation Y was the most represented, with 164 people belonging to it, accounting for more than half of all respondents (54%). Generation X comprised 116 people, or 38% of the sample. The smallest group was Generation Z, represented by 25 people, which accounted for 8% of all survey participants. This distribution indicates a diverse representation of respondents in terms of their affiliation with a particular generation and an opportunity to identify more precisely the factors that have a key influence on decisions to support charitable collections and the differences in their perception among representatives of Generations X, Y, Z. The vast majority of the group surveyed were women (277 respondents). Each generation was dominated by women: in Generation X there were 105 women (91%), in Generation Y, 150 women (91%), and in Generation Z, 22 women (88%). The majority of respondents had a university education (226 respondents). In Generation X, there were 93 (80%) and in Generation Y there were 123 (75%). In the case of Generation Z, 10 people (40%) had tertiary education, while 12 (48%) people had secondary education, a relatively high percentage compared to other age groups. The smallest number of respondents had basic vocational or primary education (11 people in the entire study group). The majority of respondents (270 people) declare that their charitable contributions are spontaneous, suggesting a lack of strict control over the spending allocated to charity. This tendency is evident across all generations, with spontaneous contributions declared by 101 people from Generation X, 147 from Generation Y and 22 from Generation Z. Regular control over the amounts donated to charity is declared by only 35 people. The largest

number of respondents (108 people, 35%) earn between PLN 2501 and 4000 per month, with the largest number of people in this income category being in Generation Y (64 people), followed by Generation X (39 people). Income below PLN 2,500 is held by 87 people (29%), including as many as 18 from Generation Z, suggesting that the younger generation has lower incomes. Income between 4001 and 6000 was declared by 69 people, with the highest number of respondents from Generation X (52 people) and the lowest from Generation Z (2 people). Income above PLN 6000 is declared by the least numerous group (41 people). Furthermore, none of the people in Generation Z have the highest level of income. Most respondents (194 people, 64%) donate an amount between PLN 50 and 300 per month to charity. This tendency persists across all generations, with the highest number of people donating an amount in this range being in Generation Y (98 people). Amounts below PLN 50 are contributed by 48 people (16%). Amounts between PLN 301 and 600 were declared by 39 people. Donations of more than PLN 600 are relatively rare (24 people in the entire surveyed group), with not a single respondent from Generation Z declaring to donate such an amount. Among the respondents, people supporting 2 to 3 charitable activities at the same time dominate (144 people, 47%), especially in Generation Y (75 people) and X (61 people). Support for more than three activities at the same time is declared by 105 people (34%), with a predominance of Generation Y (58 people, 35%). In contrast, support for only one initiative is less popular (56 people, 18%).

A detailed analysis of the collected data provides a more comprehensive picture of the structure of the respondent group. Analysis of the data by generation enables a deeper understanding of the phenomenon under study, taking into account potential differences in the factors influencing motivations for supporting charitable collections among people in different age categories.

Table 2 shows the average ratings of respondents from the different generations on their assessment of the factors determining their involvement in charitable activities. The results allow a comparison of the perspectives of Generation X, Generation Y and Generation Z representatives.

Table 2.

Average scores of factors determining involvement in charitable activities for selected groups of respondents

Type of impact	Variable	Average scores for selected groups of respondents			
		The entire study group (n = 305)	Generation X (n = 116)	Generation Y (n = 164)	Generation Z (n = 25)
Key impact	I have an inner conviction to help others	4,76	4,67	4,82	4,84
	I feel fulfilled by helping I get pleasure from helping others.	4,66	4,62	4,69	4,64
	I want to help a particular person	4,58	4,63	4,55	4,60
Very high impact	I help spontaneously	4,41	4,45	4,41	4,28
	The purpose of the collection is important/close to my heart	4,25	4,20	4,27	4,36

Cont. table 2.

High impact	I am persuaded by the description of the charity collection	3,97	4,03	3,96	3,80
	I want to support people/organisations from a specific group	3,94	3,88	3,98	4,04
	I will help someone, someone will help me in the future	3,77	3,56	3,87	4,08
	I saw an advert on social media/internet	3,72	3,59	3,75	4,16
	I can't say no when someone needs help	3,70	3,62	3,71	4,00
	The fundraising target concerns a person/organisation in my local area	3,55	3,79	3,38	3,48
Medium impact	I heard an advertisement in the media and made a spontaneous decision	3,47	3,39	3,51	3,56
	I help because others in my close environment (family, friends) are being helped	3,37	3,30	3,35	3,88
	I want to support a particular area (health, education, culture, ecology, etc.)	3,36	3,52	3,23	3,48
	I was persuaded by someone close to me/family	3,24	3,29	3,16	3,48
	I make new friends, feel I am using my free time appropriately	3,23	3,23	3,16	3,68
	I know the person/organisation for whom the funds are being collected	3,18	3,49	2,96	3,16
Low impact	I am driven by other reasons	2,97	2,88	2,99	3,24
	Helping out is a family tradition	2,89	3,18	2,71	2,64
	I can deduct the donation from my tax	2,60	2,82	2,35	3,16
	Once someone helped me, now I will help someone	2,56	2,80	2,34	2,84
Negligible impact	I help because a well-known person I follow on social media has donated to a particular collection	1,79	1,81	1,74	2,00

Source: Own elaboration.

For the whole group of respondents, as well as for the individual generational groups, the following variables are the most important in the assessment of the factors determining involvement in charitable activities:

- I have an inner conviction that it is important to help others (4.76).
- I feel fulfilled by helping. I feel pleasure from helping others (4.66).
- I want to help a particular person (4.58).
- I help spontaneously (4.41).
- The purpose of the collection is important to me/close to my heart (4.25).

Additionally, for Generation X, the variable is very influential:

- I am persuaded by the description of the charity collection (4.03).

In contrast, for Generation Z, the following variables have a very high impact:

- I saw an advertisement on social media/internet (4.16).
- I will help someone, in the future someone will help me (4.08).
- I want to support people/organisations from a specific group (4.04).
- I can't refuse when someone needs help (4.00).

The findings indicate that there is a clear consensus on the key factors influencing decisions to support charitable collections among representatives of Generations X, Y and Z. While all generations agreed on the key factors determining involvement in charitable giving, differences

emerge in those having a very high, high, medium and low impact. Full agreement also occurs in factors having a negligible impact on respondents' decisions. Results of this type represent an opportunity for NGOs to better understand donor motivations.

Conclusion and discussion

The survey results show that there is a clear consensus on the key factors influencing the decision to support charitable collections among representatives of Generations X, Y and Z. All three generations unanimously rate the inner conviction to help others as the most important factor that motivates them to support fundraising events. The average values obtained for this factor in all groups are very high, with the highest score recorded among Generation Z respondents (4.84). Research presented by other researchers who only analysed Generation Y confirms that intrinsic motivation is moderately and positively related to attitudes towards helping others (Gorczyca & Hartman, 2017). The results presented in this article confirm that for Generations Z and X this factor is also crucial. In the present study, a sense of fulfilment and enjoyment in helping others was also rated as a key factor, with minimal differences between generations. The average values were 4.69 for Generation Y, 4.64 for Generation Z and 4.62 for Generation X. These results show that, irrespective of age, the sense of satisfaction associated with helping others is an important motivator to engage in charitable activities. Interestingly, the desire to help a specific person also scored high across all groups, suggesting that personalising help is important to respondents regardless of generation. The highest average score was obtained in Generation X (4.63).

In the very high impact category, scores for factors such as spontaneous helping and the importance of the purpose of the collection to the donor differ slightly between generations. The results show that Generations X (4.45) and Y (4.41) rate spontaneity higher, while Generation Z shows more emotional involvement when the purpose of the collection is close to them (4.36). This finding is in line with research in which the authors show that Generation Z wants to feel personally connected to charities and the causes they support (Konstantinou, Jones, 2022). In addition, for Generation X, a convincing description of the charity collection is a very important factor (4.03). Generation Z, on the other hand, indicated that social media and online advertising have a very strong influence on their decisions regarding the choice of supported charitable activities (4.16), indicating that this group is more susceptible to campaigns conducted in digital communication channels. This is also confirmed by a study where the authors showed that social media for Generation Z is crucial as a driving channel for donations (Konstantinou & Jones, 2022). Generation Y rated social media and advertising as having a high impact on them (3.75). Generation X, according to this study, is less susceptible to such forms of media (3.59). Researchers who analysed data on Generation Y confirm that

non-profit organisations should use social networks to attract Generation Y to engage and donate monetarily (Florenthal, Awad, 2021). Furthermore, this is highlighted by the fact that NPOs are increasingly using social media to reach out to Generation Y for their donations (Florenthal et al., 2020).

Generation Z rates the support of individuals or organisations from specific groups higher than other generations (4.04). Generation Z is also strongly motivated by the belief that if they help someone, someone will help them in the future (4.08) compared to other generations. Generation Z also indicated that they are mostly unable to refuse when someone needs help (4.00). Generation Z places more importance on opportunities to make new friends and use their free time by participating in collections (3.68), which may reflect the greater social motivation of younger people.

There is a negligible impact across all generational groups in terms of support for charitable causes advertised on social media by celebrities. In all groups, this factor received the lowest values. These results indicate that although celebrities may promote collections, their real impact on their audience's decision to support is limited.

Furthermore, it is noteworthy that there is a predominance of women in the surveyed groups (91% of female respondents in the entire survey group). With regard to education, the majority of respondents have a university degree. The research shows that Generation Y is the most involved in charitable activities, both in terms of the number of initiatives supported and the amounts donated, while Generation Z, although inclined to help, is active to a more limited extent due to its lower income.

Summary

This article defines the key factors determining the involvement in charitable activities of respondents from Generations X, Y, Z in Polish reality and identifies differences in attitudes to philanthropy between different age groups. The results showed that the factors assessed by the respondents that were considered key were the same for all generational groups. The intrinsic belief that one should help others, the feeling of pleasure in helping and the desire to help a specific person are the universal factors linking the values and beliefs of the three generations surveyed. Full agreement is also found in the factor that respondents believe has a negligible impact on decisions to support charitable activities. Differences exist in the factors rated by respondents as having a very high, high, medium or low impact. These factors distinguish the different generations and can be useful for NGOs that want to reach different age groups with their message.

Generation X is very much influenced by the description of a charity collection, the importance of supporting a specific area, or that the person in need of support is from the local area. Less so, but still important, is the aspect of helping as a family tradition. Generation Y is more spontaneous in making decisions under the influence of information heard in the media, and it does not matter much to them whether they know the person or organisation they are helping. Generation Z stands out the most from the other generations. They value supporting specific groups and organisations, as reflected in the very high rating for this factor. For young people of this generation, the belief that helping others creates a certain reciprocity is very important - they hope that their charity will be reciprocated in the future. This is also the generation that has the greatest difficulty in refusing help when it is needed. Additionally, for Generation Z, the social aspects of being involved in charity are important. Participating in collections allows them not only to help others, but also to make new friends and use their free time in a constructive way. Generation Z is therefore strongly motivated towards pro-social activities, driven by both altruistic values and the need to create social bonds. Regardless of generational affiliation, respondents agree on a very high assessment of spontaneous aid and the importance of the purpose of the collection for the donor.

NGOs able to adapt their appeals to the different motivating factors of donors of Generations X, Y and Z can significantly contribute to the effectiveness of their activities. These findings provide an important point of reference for theorists as well as practitioners studying the motivation of donors from different generations. Despite the important findings, this study has some limitations that are worth taking into account when interpreting the results. The sample was purposive and the number of respondents, particularly of the Generation Z age group, was relatively low, which may have limited a fuller understanding of their perspectives. Despite these limitations, the results provide valuable insights into the key drivers of donors' charitable engagement and the differences in attitudes towards philanthropy between different age groups. This study can also provide a starting point for further, more detailed analyses.

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IMPACT OF THE COVID-19 PANDEMIC ON PROJECT MANAGEMENT. RESPONSES, DETERMINANTS, ADAPTATION

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Purpose: The coronavirus pandemic had a significant impact on project management, including the implementation of construction projects. Therefore, a study was conducted to determine what the impact of this situation was on various aspects of project planning, organisation and implementation. It also aimed to identify the key success factors in project management after COVID-19.

Design/methodology/approach: 120 questionnaires were sent to managers directly involved in the project management industry, with particular emphasis on the construction sector. 100 were correctly completed and returned, corresponding to a response rate of 83.3%. Data analysis was carried out using SPSS software version 23.

Conclusion: The survey of project management professionals found that delays caused by COVID-19 constraints were correlated with the cost and timeliness of projects. At the same time, key success factors such as adaptability and flexibility gained importance.

Practical implications: The results obtained have an implementation significance due to the necessity of adapting traditional project management methods to the dynamically changing external environment, as revealed in the conclusions. The recommendations formulated can be a source of knowledge for construction companies and other entities operating in a dynamically changing business environment, as well as for other organisations.

Originality/value: In the face of increasing uncertainty and risks caused by various factors (e.g. epidemics, military aggression, economic crisis, etc.), a flexible approach to project management can be a key success factor not only in the implementation of projects and the building of competitive advantages for companies, but also in the optimisation of public administration.

Keywords: project management, coronavirus pandemic, COVID-19, key success factors, construction industry.

1. Introduction

The COVID-19 pandemic has introduced significant changes in many areas of life, and project management is no exception. The global health crisis has forced organisations to adapt quickly, which in many cases has required a revision of traditional management methods and the search for new solutions. This article attempts to analyse these changes, with a focus on Critical Success Factors (CSF CSF) and innovative project management techniques in the face of a pandemic.

The situation from March 2020 posed challenges of a scale and scope previously unheard of for economic, social and political organisations and public administrations. Managers had to ensure proper coordination between their institutions, which had to function smoothly during successive waves of the pandemic. The new challenges affected areas such as health, education, security, communications, the economy or public service offices. According to the legislation enacted, in order to minimise social contact and limit the increase in coronavirus infection among employees, most people were directed to work remotely (Mańka-Szulik, 2021, p. 20). The pandemic was a time of business uncertainty and economic instability, as reflected by the fact that phrases relating to business suspensions and employee redundancies reached their highest values since search data has been collected by Google Trends (since 2004). In some cases, the scale of the increase in search phrases was unprecedented, reaching 400% more than ever before" (Wolniak, 2020, p. 13). To confirm the research hypotheses, 120 surveys were sent to representatives of the construction sector. The research implemented issues known from the VUCA model into the area of construction affected by the pandemic. The limitation and weakness of the research was the survey questionnaire method. Subsequent studies will use expert interviews.

2. Project management – CSF

The key success factors in projects vary significantly depending on the characteristics of the project and its complexity. Research points to the identification of specific elements that play a key role in successful project management, regardless of the scope or nature of the project (Chawana, Knapp van Bogaert, 2011, p. 369).

Project manager competence: one of the most important success factors is the competence of the project manager. The project manager's skills and experience are key to effectively managing the process and ensuring transparency. The project manager should have the ability to manage a team, make decisions and solve problems, which is essential to deliver the project according to the objectives and schedule (Garrett, Park, Redlener, 2009, p. 142).

Quality of subcontractor services: In the construction industry, the quality of subcontractor services is extremely important. The timeliness and quality of subcontractors have a direct impact on the success of a construction project (Carr et al., 2011, p. 47). Research confirms that working with reliable and highly qualified subcontractors is crucial to achieving the intended results.

Support from top management: Support from the top management of the organisation is also a fundamental factor for success. Top management should provide the necessary resources and be involved in solving project problems, which is particularly important in the face of project difficulties and challenges.

Influence of external factors: Key success factors are also influenced by external project factors. The current pandemic situation is an example of the influence of external factors on the project management process (Wyk, Dahmer, Custy, 2004, p. 259).

The pandemic has affected the time-consuming nature of project management and how delays are dealt with. In an environment where many activities can be halted or delayed depending on government action, understanding and adapting to these external challenges has become crucial to effective project management.

Project management, defined as a comprehensive effort to manage a project effectively, is based on a variety of techniques. These methods support project managers in effectively implementing projects on schedule and on budget (Klum, 2006, p. 902). Project management techniques focus on optimising available resources and on dealing with potential delays and challenges that may arise during project implementation.

One commonly used concept is the Agile method, which introduces flexibility into project management. This methodology, based on an iterative approach, enables projects to adapt to changing conditions and requirements. Research indicates that Agile brings value to organisations by improving supply chain efficiency and integrating feedback into project communication (Atherton, 2007, p. 59). Delivering projects in short iterations (sprints) allows projects to respond to change on an ongoing basis and better adapt to the needs of the organisation. In contrast to the agile approach, classic techniques such as the cascade method (Waterfall) also remain useful. This technique allows project managers to gain a clear overview of project execution, identifying sequences of activities and dependencies that contribute to project success (Balakrishnan et al., 2014, p. 727). Despite its long-term usefulness, the cascade method has its limitations, with the result that project management often requires the use of different techniques within the same project.

Another technique is Critical Path Method management, which identifies key elements of a project and focuses on them to minimise delays. The literature indicates that project managers often use a combination of different techniques, adapting them to the specific needs of the project. This approach increases the visibility and understanding of the project, enabling decisions to be made at each stage of implementation.

3. Project implementation under pandemic conditions. Methodological assumptions of empirical research

As part of the survey, 120 questionnaires were sent to people directly involved in the project management industry, with a particular focus on the construction sector. Of the questionnaires sent out, 100 were correctly completed and returned, corresponding to a response rate of 83.3%. The final number of respondents of 100 was sufficient for a reliable statistical analysis of the impact of the pandemic on project implementation in Poland. SPSS version 23 software, which is widely recognised as one of the most important tools for statistical analysis, will be used to analyse the data in this study. SPSS is highly regarded for its functionality and versatility.

The conduct of the described study was justified by the disruptive impact of the COVID-19 pandemic on project management both in Poland and around the world. The pandemic caused major disruptions to infrastructure projects, leading to delays and, in some cases, even a complete halt to work. This situation undermined the ability to implement many key initiatives that were essential for economic transformation.

The crisis triggered by the COVID-19 pandemic posed an unprecedented challenge for many stakeholders, being an event of global scope with a huge impact on various aspects of socio-economic life. Despite the official end of the pandemic, its effects are still visible, especially in the area of project implementation. Reactions of panic and uncertainty among stakeholders have contributed to numerous delays in the implementation of planned projects, and these delays are having a long-term impact on economies, especially in the construction sector, which plays a key role in many countries.

The cancellation or stoppage of construction projects has had a negative impact on production and employment, forcing managers to identify the causes of delays and develop strategies to manage in unpredictable conditions. The rising cost of delays is forcing project teams to make difficult decisions, such as reducing resources or lowering material quality to fit within budgets and deadlines.

Initial predictions in 2020 were that the situation should improve in 2021 following the introduction of a universal vaccination programme. However, the reality turned out to be more complex due to the volatile pandemic conditions and the fact that a significant part of the population approached vaccination with mistrust, which delayed the achievement of collective immunity. As a result, despite the availability of vaccines, project constraints and disruptions persisted longer than originally anticipated.

Study objectives and research questions

The main objective of the study is to develop a strategy framework on key success factors for project management in the post-pandemic period. In order to achieve this objective, the following specific objectives have been identified:

- A. Identification of project delivery methods in a post COVID-19 environment.
- B. Identify key determinants of project management success in the new post-pandemic reality.
- C. Explore the relevance and impact of key success indicators in project management post COVID-19.

These objectives form the basis for specific research tasks that aim to answer the following research questions:

- Research Question 1 - What project management methods are used in the post-pandemic period?
- Research Question 2 - What are the key factors contributing to success in project management after COVID-19?
- Research Question 3 - To what extent does the post COVID-19 period affect key success indicators in project management?

The aim of the study was to provide precise answers to these questions, contributing to the development of strategies for effective project management in a changed environment after the COVID-19 pandemic.

4. Record of results obtained

The following are the overall statistical results, which were compiled from the survey responses. Each section of the survey corresponds to different issues related to project implementation during the COVID-19 pandemic. The average scores assigned to each of these issues provide insight into how respondents perceived each aspect of the pandemic's impact on projects. These indicators allow an assessment of the importance of each element and its potential impact on project management.

Table 1.
Impact of delays (ID)

Impact of delays	Average
The current pandemic situation has caused delays in ongoing projects.	3.404
The financial impact is an important dimension of delay.	3.768
My company makes its supply chains more flexible because of delays.	3.566
Delays will continue to increase the cost of existing projects.	3.444
Too many delays lead to the cancellation of existing projects.	3.505
Average.	3.537

Table 2.*Key success factors (KSF)*

Key success factors	Average
Flexibility in this environment is a key factor for success.	3.556
Using new and existing IT systems improves business processes.	3.545
Subcontractors are key to project delivery.	3.354
Qualified project managers are becoming increasingly important.	3.292
Companies need to use new techniques to remain effective in the execution and delivery of projects.	3.253
Average.	3.400

Table 3.*Upgrading skills (HR)*

Improving HR skills	Average
There have been significant changes in skills due to the pandemic.	3.636
Companies are focusing on imparting new skills to employees during this time.	3.434
Higher productivity is the goal of upskilling, which is being realised.	3.515
My company does not undertake such investments.	3.474
Upgrading staff skills is only part of the solution, requiring a combination of factors.	3.374
Average.	3.487

Table 4.*Methods used (MU)*

Methods used	Average
Companies are increasingly relying on delayed payments to cope with the situation.	3.404
There is no change to the current project delivery methodology.	3.576
The greater strain on cash flow is causing companies to focus more on cost-cutting.	3.616
Agile project management methods are becoming more common in implementation.	3.556
Technology is being used to reduce the cost of project delivery across the board.	3.475
Average.	3.525

Table 5.*Impact on project implementation (EP)*

Impact on project implementation	Average
Project implementation changed forever after the coronavirus pandemic.	3.515
In the new normal, life without the implementation of information technology will not be possible.	3.455
Lightweight project management methodologies will become standard.	3.566
Key success factors affect project implementation both during and after a coronavirus pandemic.	3.455
Average.	3.497

4.1. Analysis of the data revealed as a result of the implementation of the research programme

Objective 1: Identify effective project delivery methods. Based on the results of the study, it is recommended that companies invest in human resource development and adapt their methods to flexible approaches. Incorporating external factors in a quantitative way into project schedules also proved important.

Objective 2: To identify key success factors in project management post COVID-19. The results of the analysis indicate that the key factors have a significant correlation and play a significant role in project success. The level of correlation confirms the importance of these factors in the context of the changed post-pandemic environment.

Objective 3: To test the significant impact of success indicators on project management after COVID-19. Regression analysis showed that the model is statistically significant, confirming the quantitative relationship and measuring the impact on project implementation. Key success factors such as methods used, impact of delays and human resource development contribute to explain the impact on project implementation during the pandemic.

The impact of delays was one of the key independent variables analysed in the study. It was defined as the effect of project delays occurring, especially in the context of the coronavirus pandemic situation. Faced with the pandemic, most projects, regardless of their size, experienced significant delays. This was due to limitations in the number of available workers on construction sites and bans on construction activities imposed by the governments of many countries, which considered these sites to be high risk areas for the spread of the virus.

Key success factors are those elements that must be met for a project to be successful. While these factors may vary depending on the type of project, research indicates that for construction projects there are several universal key success factors. In particular, adaptability and flexibility in project delivery are often considered essential as they have a significant impact on the overall success of a project. In reality, the impact of these factors is variable and depends on the type of project and the specific business environment in which it is implemented.

The independent variable, which is the impact of the methods used, aims to understand how the techniques used in project implementation have evolved in response to the coronavirus pandemic situation. Traditionally, project implementation has relied on methods such as cascade, which are well suited to stable and predictable business conditions. However, research shows that changing external factors can force significant modifications to these methods.

The study found that it was important for project implementation to understand how developing employees' skills could improve performance and productivity. This was particularly important in the context of changes in the labour market, where the decreasing number of jobs available required employees to be more versatile and adaptable to different roles.

4.2. Application significance of the results of the study

The first suggestion arising from the study concerns the need for project managers to be more flexible in project implementation. Managers should not rely solely on static management methods or base their decisions solely on internal project information. In order to succeed in a dynamically changing business environment, they should actively integrate external information and adapt their approach to changing conditions.

Another application refers to the need to change the project delivery methods normally used. In the current environment, which demands greater flexibility, companies need to adapt their approach to supply chain and project cycle management to achieve more with limited resources. This points to the growing role of information technology, which can bridge the productivity gap and improve decision-making, enabling companies to adapt more effectively to new challenges.

The pandemic had a significant impact on the implementation of construction projects. In particular, project delays caused by pandemic-related constraints were strongly correlated with the cost and timeliness of project delivery. At the same time, key success factors such as adaptability and flexibility have gained in importance, indicating the need to adapt traditional project management methods to the dynamically changing external environment.

The study also found that the project delivery methods used had changed, placing greater emphasis on flexibility and risk management. In the context of human resources, the development of staff skills, especially in terms of flexibility and multitasking, proved crucial to maintaining productivity and efficiency in project implementation in the face of a pandemic.

Based on the results of the research, recommendations were made to project managers and construction companies, focusing on the need to implement flexible project management methods, greater integration of external factors influencing project delivery and investment in staff skills development.

The study obviously encountered some limitations, such as the peculiarities of the construction market in Poland and the variability of the business environment during the pandemic, which may affect the possibility of generalising the results. At the same time, these limitations are an inspiration for further studies on the impact of the pandemic on different economic sectors and on project management in the context of global crises.

5. Conclusion

This article contributes to a better understanding of the impact of the coronavirus pandemic on construction projects in Poland. The results of the research and the recommendations formulated can be a source of knowledge for construction companies and other entities

operating in a dynamically changing business environment, as well as for other organisations. In the face of increasing uncertainty and risk, a flexible approach to project management can be a key success factor not only in implementing projects and building competitive advantage for companies, but also in optimising the functioning of public administration. The VUCA model plays an important role - it is primarily a world of variability, complexity, uncertainty and ambiguity.

Interestingly, globally, the level of organisational development did not affect incidence. For example: the dynamics of COVID-19 cases in smart cities had a low correlation with the level of smart technology adoption, as it was more susceptible to the spread of waves and strains of the virus depending on geographical location (Kuzior et al., 2022, p. 21). This is because in cities, it was the speed of response and relevance to the threat that mattered.

Using the example of the study carried out in Zabrze, it can be seen that a task team set up in the City Hall together with the Department of Crisis Management and Civil Defence coordinated the securing of infrastructure for the isolation of infected persons, the supply of disinfectants, protective and preventive procedures. Together with social assistance, care was organised for those in need. Support was provided to schools that introduced distance learning. Assistance packages were developed and implemented for residents and entrepreneurs doing business in the city, including exemptions, tax breaks and preferential tax rates. Activities were undertaken to activate and integrate residents. All these activities were properly communicated to ensure access to reliable, up-to-date and relevant information distributed through easily accessible mass and social media (Mańka-Szulik, Krawczyk, 2020, p. 414).

Similarly, economic organisations have had to respond adequately to the requirements of production or project implementation processes. Some of the management models developed at that time have been permanently implemented in social and economic reality, such as the execution of tasks via platforms in cyberspace. The use of remote forms of dealing with customers is, moreover, a welcome development. It not only ensures efficiency, high quality and transparency of service, but is also user-friendly. Paradoxically, the Covid-19 pandemic has also translated into an increase in the use of e-government tools by citizens using public services (Kuzior, Mańka-Szulik, Krawczyk, 2021, pp. 269-270). Traditional decision-making processes have been transferred to digital space, which has ensured the continuity of local government, but has generated new challenges. These undeniably relate to ensuring an adequate level of security for the IT tools and systems that support decision-making and other processes carried out by public authorities. This challenge will be with us for years to come, regardless of the impact of the pandemic (Mroczka, 2021, p. 92).

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HUMANITARIAN SUPPLY CHAINS: A PROCESS-ORIENTED APPROACH

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Purpose: The aim of the research was to identify and evaluate logistics processes undertaken in humanitarian supply chains in Poland.

Design/methodology/approach: The research method was CATI (ang. computer-assisted telephone interviewing). The research was conducted throughout Poland in 40 Crisis Management Centers at the provincial and district level.

Findings: It turns out that the surveyed organizations positively assess the procurement process and the recovery process in humanitarian supply chains. The distribution process in the context of its effectiveness is difficult to assess for the surveyed Crisis Management Centers. A small percentage of respondents believe that transport means are ready to quickly and safely deliver aid. There are opinions indicating inappropriate prioritization of transport means and resources, which leads to poor satisfaction of the real needs of the victims. A large percentage of neutral opinions in assessment of warehousing, distribution and location of operational centers, may indicate the occurrence of problems in these processes.

Originality/value: The results of research can be addressed to those involved in public crisis management, both local authorities and public entities as well as blue light organizations and non-governmental organizations involved in humanitarian aid.

Keywords: humanitarian logistics, humanitarian supply chain, crisis situations, crisis management, logistics processes, process management.

Category of the paper: research paper.

1. Introduction

Humanitarian logistics is fundamentally different from the traditional logistics process, as it aims to save lives, provide humanitarian support in the form of medicine, water, food and shelter, and restore society to self-sufficiency (Liu, Xie, 2017). The humanitarian supply chain is the flow of humanitarian aid and information between those affected by a disaster and those providing aid so that as few people as possible die or suffer (Mittal, Obaid, 2023, p. 317). As reported by Daud et al. (2016) the following processes occur in humanitarian supply chains: evacuation of people, delivery of appropriate relief supplies according to the needs of the

affected people, coordination, and prioritization of the use of limited transport resources, and storage and movement of relief goods and equipment. The aforementioned operations are always hampered by logistical problems, inadequate crisis management and sometimes overdonations (Thevenaz, Resodihardjo, 2010). According to Lima, Dávalos Campos and Trierweiler (2022), decision-making and crisis situation control can be supported by process management, which is understood as all the work done to deliver products/services to beneficiaries, its application starts at the strategic level and ends at the operational level. In process management, processes are divided into sub-processes, which must be performed by one or more activities, in turn activities can be broken down into tasks consisting of individual steps (Drejewicz, 2017).

A process map, i.e. a graphical representation of the identified processes (Olkiewicz, 2018, p. 381), can be prepared for all activities undertaken in humanitarian supply chains. Process management assumes that there are always 'opportunities for process improvement, which implies the need for systematic, structured, process analysis, improvement, monitoring, and performance management' (Olkiewicz, 2018, p. 372). Process management is expected to improve emergency planning and response and improve the actions taken in humanitarian supply chains.

Therefore, there is a need to identify and assess the logistics processes undertaken in humanitarian supply chains in Poland. This objective will be achieved by seeking answers to the following research questions:

1. Is the procurement and warehousing process in humanitarian supply chains well-organized?
2. Are the distribution processes implemented in humanitarian supply chains fair and efficient?
3. Are vehicles sufficient and appropriate to deliver aid quickly and safely and appropriately prioritized according to the needs of those affected?
4. Is the reconstruction of infrastructure after a crisis situation being carried out in such a way that the infrastructure is more resilient to future events?

The answer to the above research questions is based on research conducted in 2024 using the CATI method in the Crisis Management Centres in Poland. For clarity of research descriptions, abbreviations have been used throughout the article: for Crisis Management Centres - CMC; for the humanitarian supply chain - HSC.

2. Logistics Processes in Humanitarian Supply Chains

In the case of humanitarian supply chains, often referred to as 'supply chains for life', researchers primarily emphasize the specific and difficult conditions in which these chains are configured and their purpose of saving human life and health (Lupicka, 2011). Many NGOs involved in humanitarian operations, point out that logistics and humanitarian supply chain management are at the core of all humanitarian operations (Lupicka, 2011). Marcinkowski (2019) states that the importance of logistics in emergencies is increasing as the provision of aid to those in need is taking place within international and national streams of material, financial, human and information flows.

The Pan American Health Organization together with the Department of Emergency and Humanitarian Action Sustainable Development and Healthy Environments (2001, pp. 13-14) indicate that the following logistics processes are primarily considered in the humanitarian supply chain:

1. "Procurement - the purpose of the process is to make sure that the organizations involved in the relief effort have the resources necessary to meet the identified needs. This, in turn, requires identifying the sources of supply of these goods and services and how to acquire them.
2. Transport - by which supplies get to where they are needed. The transport strategy must consider not only the means of transport, but also the actual possibilities of getting supplies from A to B, as well as alternative transport for the rapid and safe delivery of relief supplies.
3. Warehousing - an organized, systematic way of storing resources until they are delivered to the final recipients, i.e. the affected persons. Stocks should also be included for unforeseen needs.
4. Distribution - the main objective of the humanitarian supply chain is to deliver aid to affected people. Aid resources should be distributed in a way that is proportionate to existing needs, fair and properly controlled to prevent abuse or waste".

Thus, a humanitarian supply chain can be depicted as a set of processes that are intertwined, and their identification allows for streamlining and increasing their efficiency (Nowosielski, 2009).

Pokusa (2004) points out that the basic premise of process management is to identify processes in terms of the following criteria:

- process time reduction,
- increasing the quality of processes,
- reducing the number of routes along which decision-making and implementation processes take place,
- a reduction in the number of people involved in handling processes,

- process rationalization,
- a reduction in the financial and material resources involved in the processes.

The implementation of the process management concept requires a continuous and structured influence on the processes taking place in the organization, through the use of appropriate concepts, methods, and tools for improving, designing new or reducing processes to fully realize the organization's objectives (Nowosielski, 2009).

Humanitarian supply chain management, in process terms, consists of the creation of organizational and information systems to support the conduct and coordination of preparedness and emergency response activities within the resources available and in an efficient and effective manner (Sienkiewicz-Małyjurek, 2010). Humanitarian supply chain processes are both physical and intangible in nature. They include the objectives and how they are implemented, the preparation of activities, securing infrastructure, knowledge, experience, information, transport and storage, information and communication systems, reporting, as well as activities that enable continuous improvement (Sienkiewicz-Małyjurek, 2010). The aim of the activities carried out in the humanitarian supply chain is to organize the flows of the resources held (necessary at a specific location) in the shortest possible time to minimize the possibility of threats or their consequences (Sienkiewicz-Małyjurek, 2010).

The humanitarian supply chain relies on logistical flows, which are crucial in streamlining and optimizing them. Sienkiewicz-Małyjurek (2014, p. 430) points to three main types of flows in humanitarian supply chains:

- "the flow of people - lifeguards, patrols, intervention groups, rescue formations, social workers, etc.,
- the flow of material resources - rescue equipment, firefighting equipment, preventive measures, portable security, energy equipment and media, heavy rescue equipment, social and humanitarian aid resources (e.g. food, water, clothing, personal hygiene products, cleaning products and substitute light sources, publicly available medicines and dressing materials), etc,
- the flow of information - between command authorities, executive units, security teams and the public; reliable communication of information enables the proper allocation of resources and prevents panic and disruption of ongoing operations".

The success of logistics operations lies in ensuring the synchronization of material flows through the coordination of processes and the appropriate use of resources, and consequently ensuring the availability of relief supplies at the place and time expected by the affected person. Figure 1 shows the logistics processes in the humanitarian supply chain in the context of the phases of crisis management.

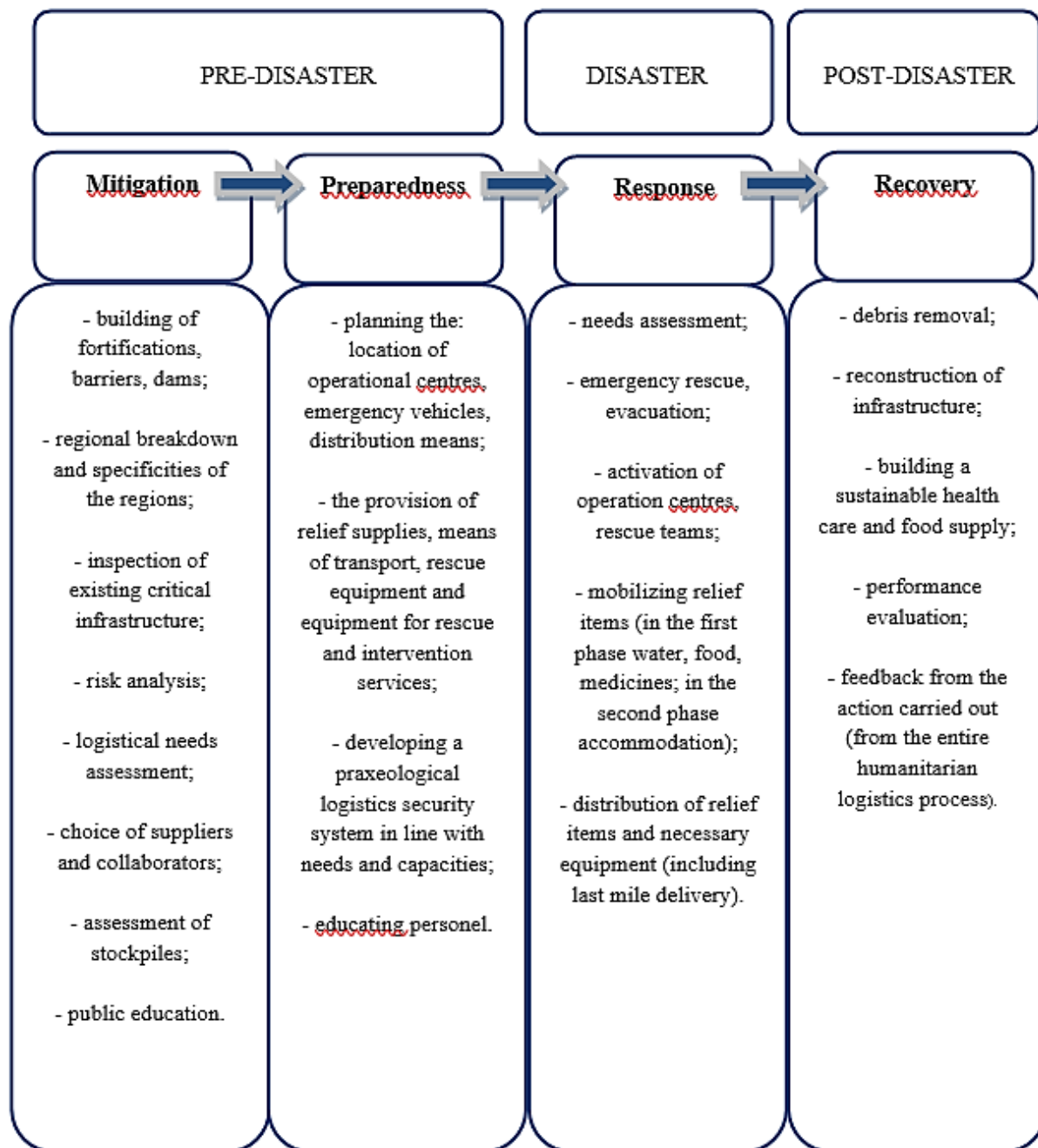


Figure 1. Logistics processes in humanitarian supply chains by phase of emergency management.

Source: adapted from: Duran, Ergun, Keskinocak, Swan, 2013, p. 4.

Managing the humanitarian supply chain requires decision-making at different levels of emergency development. Thus, the humanitarian supply chain is not only about taking action in the face of an emergency, but also before and after an event. The response phase is the most dynamic and characterized by many logistics processes. However, the state of preparedness of an organization before an emergency is equally important, as it defines the quality of operations during an incident. The recovery phase, on the other hand, is needed to restore the standard of living of the affected community; at the same time, the recovery should be implemented in such a way that the affected region is less vulnerable to another disaster after recovery (Piwowarski and Rozwadowski, 2016).

3. Methodology

The aim of the research was to identify and evaluate the logistics processes undertaken in humanitarian supply chains in Poland. An interview was used as the research method. An interview involves obtaining information from the respondent through direct contact with the researcher, which may be in the form of personal contact (personal interview), contact by telephone (telephone interview) or indirect contact (correspondence interview, controlled self-report) (Szreder, 2010, pp. 158-159).

In this paper, telephone interviews were used. The quality of data obtained by the telephone interview technique is as high as during a face-to-face interview, respondents are even more willing to share their opinions over the phone (Szreder, 2010, pp. 161-162). In many cases, a face-to-face interview is difficult or impossible, e.g. due to geographical distance or other specific conditions (Czakon, Glinka, 2021, p. 102).

The research was conducted throughout Poland in 40 Crisis Management Centres at provincial (7 CMC) and district (33 CMC) levels. The respondents were people holding senior positions in their organizations or delegated by their superiors as competent for the research. The sampling technique used is non-probabilistic. This technique is used when the structure of the population is well known and the aim is to gain an initial insight into the issue under study (Miszcza, Walasek, 2013, pp. 101-102). Non-probabilistic techniques are divided into random selection, quota selection, snowball selection and purposive selection (Jablonska, Sobieraj, 2013, p. 34). In this paper, the technique used is judgmental sampling or purposive sampling (Szreder, 2010, p. 56). Purposive selection involves the researcher indicating the population units that should be included in the sample. The sample elements are selected in terms of predetermined criteria. Purposive selection is based on knowledge, experience, or recommendations (Miszcza, Walasek, 2013, pp. 102-103). When building a purposive sample, the researcher selects 'those elements that represent the population well [...] samples are selected so that the study includes individuals who exhibit certain attributes' (Fratczak, Mynarska, 2007, p. 7).

The survey used a 5-point Likert scale, where 1 means 'strongly disagree' and 5 means 'strongly agree'. The Likert scale is used as one of the most commonly used psychometric tools in pedagogical and social research (Joshi, Kale, Chandel and Pal, 2015). The data obtained in the study were subjected to descriptive statistics. The measures used for analysis were the dominant, median, first quartile (Q1), third quartile (Q3) and mean. These measures allowed an objective assessment of the information obtained.

4. Results

Descriptive statistics formed the basis for the interpretation of the research results obtained. Statistical analysis was carried out individually for each issue studied. The results obtained are presented in Tables 1-7. Table 1 presents data of procurement process assessment.

Table 1.
Procurement process in HSC

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
1. Do you think that the procurement process in humanitarian supply chains (HSCs, so-called supply chains for life organised during emergencies and humanitarian aid) is well organised?										
0,00%	2,50%	10,00%	75,00%	10,00%	4	4	4	4	0,55	3,95

Source: own research.

From the data in Table 1, it can be seen that 85% of CMC (total positive responses: 'yes' and 'definitely yes') believe that the procurement process in HSC is well-organized. This is confirmed by the dominant value, which is 4, i.e. a 'yes' response. The standard deviation is low at 0.55, with a mean of 3.95. The 2.5% of CMC rated the HSC procurement process negatively, and 10% had no opinion.

Respondents then referred to the warehousing process at HSC (Table 2).

Table 2.
Warehousing process in HSC

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
2. Do you think that the warehousing process for humanitarian supply chain activities is well organised?										
0,00%	2,50%	47,50%	47,50%	2,50%	3	3,50	4	4	0,59	3,50

Source: own research.

Based on the data in Table 2, it can be concluded that half of the surveyed CMC believe that the warehousing process at HSC is organized correctly. However, almost half of the CMC (47.5%) abstained from giving an opinion in this area and 2.5% of the CMC stated that the warehousing process at HSC is inadequately organized. The dominant value is 4, indicating that 'yes' is the most common answer. The high percentage of undecided respondents and emerging negative opinions may indicate that the warehousing process in HSC is challenging for these units.

This was followed by a consideration of whether the distribution processes in HSC are fair and efficient (Table 3). In organizational and management science, the term efficiency is used, which is sometimes given the meaning of praxeological efficiency (Jashapara, 2006). Efficiency is the relationship between the results achieved, and the resources used (King, 2014). Efficiency means achieving the objectives of an activity in an optimal way, using resources in a rational way (Drucker, 2017).

Table 3.
Distribution process in HSC

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
3. Do you think that distribution processes in humanitarian supply chains are fair and efficient?										
0,00%	0,00%	67,50%	32,50%	0,00%	3	3	4	3	0,47	3,32

Source: own research.

The data presented in Table 3 shows that only one third of the surveyed CMC believe that the distribution process in HSC is fair and efficient, as many as 67.5% abstained from expressing an opinion on this issue.

Next issue examined was the transport means used for humanitarian supply chain operations (Table 4).

Table 4.
Transport means in HSC

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
4. Do you think that vehicles used for humanitarian supply chain activities are sufficient to deliver aid quickly and safely?										
0,00%	5,00%	67,50%	27,50%	0,00%	3	3	4	3	0,53	3,22

Source: own research.

The data in Table 4 shows that the majority of the surveyed CMC are unable to determine whether the transport means used for humanitarian supply chain operations are sufficient to deliver aid quickly and safely. Therefore, 67.5% abstained from giving an opinion in this regard. In contrast, 27.5% believe that the vehicles are adequate for the rapid delivery of aid and 5% of respondents hold the opposite opinion.

Continuing with the analysis of the transport process in HSC, respondents were asked whether transport means and resources are appropriately prioritized according to the needs of the victims (Table 5).

Table 5.
Prioritization of means of transport

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
5. In your opinion, vehicles being appropriately prioritized according to the needs of those affected?										
0,00%	5,00%	52,50%	35,00%	7,50%	3	3	4	3	0,71	3,45

Source: own research.

According to the information presented in Table 5, more than half of the CMC (52.5%) were neutral in indicating whether transport vehicles are appropriately prioritized according to the needs of the victims. In contrast, 42.5% of the CMC identified that vehicles are appropriately prioritized and respond to the needs of the affected, 5% of the CMC believe that vehicles are not appropriately prioritized. The standard deviation is significant at 0.71 with a mean of 3.45.

The recovery process is considered next (Table 6).

Table 6.
Recovery process in HSC

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
6. In your opinion, is the recovery of infrastructure after the crisis being carried out in such a way as to make it more resistant to the future events?										
0,00%	5,00%	22,50%	65,00%	7,50%	3	4	4	4	0,66	3,75

Source: own research.

The data presented in Table 6 shows that the majority of CMC (72.5%) indicate that the reconstruction of infrastructure after a crisis situation is carried out, in such a way that the infrastructure is more resilient to future events. Undecided in the assessment of recovery process was expressed by 22.5% of the CMC, and 5% of the CMC believe that this process is inadequately implemented. The dominant response is 4, i.e. a 'yes' response; and the standard deviation is moderate at 0.66 with a mean of 3.75.

The last question asked for an assessment of the location of operational centres for HSC activities. The results obtained are presented in Table 7.

Table 7.
Location of operational centres for HSC activities

Multiple choice questions [%]					Position measures					
definitely not (1)	not (2)	Neutral/undecided (3)	yes (4)	definitely yes (5)	Q1	Median	Q3	Mode	Standard deviation	Mean
7. Do you think that the location of operational centres for humanitarian supply chain activities is well planned?										
0,00%	2,50%	75,00%	22,50%	0,00%	3	3	3	3	0,46	3,20

Source: own research.

The data in Table 7 shows that 75% of the CMC are unable to assess the appropriateness of the location of operational centres for HSC activities. This high percentage of undecided respondents may be indicative of the problems that exist in these processes, as only 1/5 of the CMC indicate that the location is well planned. In contrast, 2.5% rate the location of the operational centres negatively.

5. Summary

Process management leads to increasing the efficiency of entities through standardization and improving or enhancing access to relevant resources that influence organizational processes (Olkiewicz, 2018). Crisis situations in the 21st century confirm the need for faster resource mobilization. Resource mobilization is an important aspect of response. Resource preparedness ensures a faster and better response (Pramanik, 2021).

Analysing processes in humanitarian supply chains enables their standardization (Saiah, Vega, Kovacs, 2023, p. 241). Process management approaches for emergency response operations carry benefits, i.e. increased transparency, improved collaboration and

communication, promotion of best practices and the use of more efficient and effective processes (Saiah et al., 2023, p. 241).

The surveyed CMC gave a positive assessment of the HSC procurement process. According to Stęplewski (2017, p. 186), the resources for emergency supply are as follows (example municipality, county):

- “material resources of state reserves - food, agricultural products, medicines, medical, sanitary materials;
- material resources from superior authorities - drinking water, medicines and medical, sanitary materials, blankets, clothing;
- material resources from field infrastructure - fuels, food, agricultural products;
- material resources in humanitarian and charitable aid - clothing, blankets, tents, sanitary materials)”.

In the practice of crisis management organisations, scarcity, insufficient availability or poor quality of resources are perceived as a threat, while the certainty of having these resources at the right level and of the right quality is perceived as a manifestation of security (Zawila-Niedźwiecki, 2014, pp. 66-67). Crisis situation creates an urgent need for resources, with the requirements for such resources being diverse and heterogeneous (Yang, Yao, Tian, Jiang, Xing, Yang, Liu, 2023, p. 2). During emergencies, there is a scarcity of resources, such as data and information, inventory, people, technology and transportation, and, in combination with inadequate infrastructure, storage and funding are examples of operational constraints (Maghsoudi, Moshtari, 2021, p. 110; Doan, Shaw, 2019, p. 687).

The warehousing process in HSC divided respondents, with half having a positive view of the process and half having no opinion, and there were also negative views. The warehousing process in HSC includes warehouse location planning, inventory management and distribution, order picking (Mittal, Obaid, 2023, p. 318). The prepositioning of warehouses at the local and regional level should consider location, logistics, costs, government cooperation and aspects of national stability (Mittal, Obaid, 2023, p. 320). Stockpile management, on the other hand, aims to minimize the risk of shortage and to provide the necessary resources to support emergency operations, health care and to maintain essential state functions (Cankaya, Ekici, Özener, 2019). Stockpiles can significantly affect the availability of resources, especially in the initial stages of an emergency response, when there is a high probability of destructions.

The distribution process in the HSC was difficult to evaluate for CMC respondents, with only one-third of CMC respondents believing that the distribution process in the HSC is fair and efficient, with the rest refrained from giving an opinion in this area. Computational optimization, using genetic algorithms, can be used to design socially just resource distribution (Kim, Sutley, 2021, p. 1; Cui, Liu, Tang, Zhu, 2019, pp. 290-294). Optimization is a logical analytical tool to use in this case, as the goal is to strive for fair outcomes (Kim, Sutley, 2021, p. 8). Distribution must respect the principles of norming and limiting, conditional rationing and follow the principle of economy (Kmieciak, 2015; Marjanski, 2015).

During any emergency, chaos ensues, so it is necessary to plan the distribution, as well as to prepare a transport plan for all required emergency and response teams (eGyanKosh, 2007). Establishing optimal distribution routes and identifying damaged distribution networks aims to reduce the suffering of affected communities (Maghfiroh, Hanaoka, 2020, p. 1). The distribution network for responding to hazards and emergencies consists of permanent facilities, temporary facilities and unpredictable disaster areas. The distribution network has more than one channel, and considers multiple available modes of transport, such as air, road, and rail (Zhang, Zhang, Li, Li, Chen, 2023, p. 2). Lee, Ettl and Ghosh (2010) list the following distribution problems when managing HSC:

- "a giant increase in demand at short notice;
- damaged/congested carriageways;
- chaotic demand behaviour (victims);
- failures of infrastructure, such as communication networks;
- short lead times”.

Kumar, Keshav and Zeeshan (2022), in response to the challenges of aid distribution in the smart city, proposed a model that not only dynamically incorporates the details of available resources, but also introduces the priorities of the affected regions with updates of transport route information. Such an integrated optimized model provides an efficient initial distribution schedule and updates it for each subsequent time interval (Kumar et al., 2022). When new demand and resource information becomes available, it may be necessary to redistribute previously delivered relief supplies due to severe shortages in some locations and excess stocks in other areas (Reza, Abbas, Reza, 2021). To send relief items immediately to the site of need after a disaster, an emergency supply site must be selected quickly and a reasonable plan for distribution (Cui et al., 2019).

If resources such as transport means are inappropriately used and sent to the wrong place, then there can be no fair distribution of aid. Only a small percentage of the interviewed CMC believe that transport means are ready to deliver aid quickly and safely, the rest abstained from giving an opinion, and there were some individual voices that openly indicated that vehicles are not suitable to deliver aid efficiently. In the case of the question on prioritizing transport means and resources according to the needs of the affected, it appeared that half of the CMC evaded answering. However, the remaining CMC believe that transport means and resources are properly prioritized, with only 5% of CMC responding negatively, indicating errors in this process.

The recovery process of infrastructure have been assessed positively by most of the CZK. During the reconstruction phase, damage assessment, assistance to the population (health care, rehabilitation, accommodation, psychological support, compensation), restocking and the development of lessons learned take place (Kaak, 2017). Reconstruction is divided into short-term and long-term. Short-term involves restoring vital systems to minimum operational standards. Long-term reconstruction can take many years until the entire affected area is

completely restored (Piwowarski, Rozwadowski, 2016). Recovery aims to restore the previous state of affairs by restoring damaged facilities and areas in such a way that the infrastructure is less vulnerable to another disaster (Krynojewski, 2018).

An example of the mismanaged recovery phase is the 2015 Nepal earthquake. The government delayed the establishment of the National Recovery Authority; due to legal obstacles, the body was only officially established after eight months after earthquake. The delays forced many communities to live in temporary shelters for more than three years. In addition, the landslides damaged the existing transport network, thus making it difficult not only to mobilize the resources needed for recovery, but also to transfer waste (Pradhananga, ElZomor, 2021, p. 15). This example shows that critical transport systems, networks and routes need to be strengthened, and critical infrastructure resilience needs to be pursued.

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THE ROLE OF SERVITIZATION IN BUILDING ORGANISATIONAL RESILIENCE: A META-SYNTHESIS OF CASE STUDIES

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Purpose: This paper aims to investigate the role of servitization in enhancing organisational resilience. By synthesising case studies from various industries, the paper aims to identify the key dimensions of resilience that servitization supports and understand how these dimensions influence an organisation's ability to adapt, remain flexible, and manage risks in dynamic market conditions.

Design/methodology/approach: The paper utilises a meta-synthesis of qualitative case studies as the primary research method. Five case studies were selected from different sectors where servitization strategies have been implemented. The synthesis process involved coding and analyzing the data to identify common patterns and relationships between servitization models and resilience dimensions. The paper integrates theoretical frameworks on organizational resilience and servitization, focusing on adaptability, flexibility, risk management, and collaboration.

Findings: The study found that servitization enhances vital dimensions of organisational resilience, including adaptability, flexibility, modularity, and complexity management. Digitalisation and inter-organisational collaboration were also highlighted as crucial factors that support resilience. The analysis shows that while servitization provides a pathway for increased resilience, it introduces complexity that requires careful management through modular approaches.

Research limitations/implications: The research focuses on case studies within specific sectors, which may limit the generalizability of the findings to other industries. Future research could explore the impact of servitization on resilience in a broader range of contexts and industries. Additionally, the study emphasizes the need for further exploration of how different servitization models affect various resilience dimensions.

Practical implications: The findings provide valuable insights for managers and organisations considering or implementing servitization strategies. By adopting servitized business models, companies can enhance their operational flexibility, manage complexity more effectively, and build long-term resilience. Modular designs allow organisations to manage this complexity, adapting quickly to changing conditions without increasing operational risks.

Social implications: Through its focus on long-term customer relationships and sustainable practices, servitization can positively influence corporate social responsibility by promoting more efficient resource use and innovation.

Originality/value: This paper comprehensively synthesises the relationship between servitization and organisational resilience, highlighting the complexity and adaptability servitization brings to organisations. The value lies in its holistic approach, addressing managers, academics, and policymakers interested in resilience-building strategies in the face of increasing market uncertainties.

Keywords: servitization, organisational resilience, complexity, modularity, flexibility, meta-synthesis.

Category of the paper: Research paper, Case study.

1. Introduction

Modern organisations operate in an environment full of disruptions and challenges resulting from global crises such as the COVID-19 pandemic, climate change, supply chain disruptions, and digital transformation. In the face of these challenges, building organisational resilience, which enables companies to survive and thrive in unpredictable conditions, becomes a critical management element. Organisational resilience, the ability to anticipate, adapt, and recover from disruptions, is becoming a priority in management strategies (Lengnick-Hall et al., 2011; Burnard, Bhamra, 2019). Companies must be prepared not only to respond to crises but also to adapt to long-term changes in market conditions.

In the context of increasing market complexity and dynamics, servitization—the shift from a product sales model to offering integrated product-service solutions—is gaining importance. (Kamal et al., 2020) This transformation increases companies' competitiveness and enhances their ability to cope with disruptions, which can contribute to the growth of organisational resilience. As Rabetino et al. (2017) point out, servitization can positively influence operational flexibility and intra-organizational collaboration. The primary research problem addressed in this article is understanding which dimensions of organisational resilience are supported by servitization and how they influence an organisation's ability to cope with disruptions in dynamically changing market conditions. Although previous studies suggest that servitization may enhance organisational resilience (Rabetino et al., 2017; Reim et al., 2019), further research is needed to identify specific dimensions of this resilience (Li et al., 2022).

The article aims to identify the key dimensions of organisational resilience in the context of different product-service offering models within servitization. The study analyses how these dimensions influence an organisation's ability to adapt, remain flexible, and manage risk and complexity in dynamic market conditions. This approach will help fill the research gap and better understand how servitization can support companies in building organisational resilience, which is particularly important in an unstable business environment.

A meta-synthesis of qualitative case studies was used to achieve the research objective. Five case studies were selected, involving companies from different sectors implementing servitization strategies.

The article is divided into several sections. The theoretical part provides a literature review on the concepts of organisational resilience and servitization. Then, the research methodology is described, including the criteria for selecting case studies and the data analysis procedures. The following section presents the research results, highlighting the relationships between servitization and resilience dimensions. The final section discusses the findings in the context of existing literature and proposes practical implications for companies seeking to enhance their organisational resilience through servitization. The conclusion summarises the study's contributions and outlines directions for future research.

2. Theoretical framework

2.1. Dimensions of organisational resilience

Organizational resilience has become a crucial concept in management, particularly in the face of escalating threats such as natural disasters, financial crises, cyberattacks, and pandemics. It is also closely tied to the ongoing process of digital transformation, which has further underscored the need for adaptability and preparedness in the modern business landscape. This concept refers to an organisation's ability to anticipate, respond to, recover, and learn from adversity (Hepfer, Lawrence, 2022). The literature emphasises that organisational resilience is a multifaceted phenomenon, encompassing various dimensions with distinct foundations and outcomes (Lengnick-Hall et al., 2011; Hosseini et al., 2015; Hepfer, Lawrence, 2022). Adaptability, operational flexibility, risk management, and collaboration determine an organisation's ability to survive and thrive in disruptions.

Adaptability refers to an organisation's ability to dynamically adjust its resources, structures, and strategies in response to changing internal and external conditions. As Karadzic et al. (2012) point out, organisations that can learn from crisis experiences develop their ability to respond more effectively to future threats. On the other hand, operational flexibility is defined as the ability to modify processes and reallocate resources, allowing companies to quickly adapt to operational disruptions (Lengnick-Hall et al., 2011). This flexibility enables organisations to minimise the impact of short-term shocks and maintain operational continuity. Risk management is another dimension of organisational resilience, which involves identifying, assessing, and responding to threats. Resilient organisations actively anticipate risks and implement contingency plans to minimise negative consequences (Chopra, Sodhi, 2014). Effective risk management allows companies to be better prepared for disruptions and recover quickly after a crisis. Internal and external collaboration plays a key role in building organisational resilience. Companies that effectively collaborate within their teams and with external partners are better prepared for disruptions and can efficiently leverage resources available within the collaboration network (Lengnick-Hall et al., 2011).

Understanding and developing these key dimensions of organisational resilience benefits organisations. Companies that are better at anticipating and responding to threats minimise losses and leverage disruptions as opportunities for innovation and growth (Hepfer, Lawrence, 2022). Organisational resilience enables firms to survive and learn from difficult experiences, making them stronger and better prepared for future crises (Essuman et al., 2020). Moreover, organisational resilience provides a competitive advantage, particularly in industries where the costs of disruptions are high, and the ability to maintain operational stability is crucial (DesJardine et al., 2019). Organisations that can strategically adapt to changing market conditions can sustain long-term growth and profitability, even in the face of external shocks (Dewald, Bowen, 2010).

However, achieving organisational resilience comes with challenges. Coordinating different organizational functions and shifting the organizational culture towards greater adaptability and proactive risk management requires commitment and investment (Settembre-Blundo et al., 2021). Additionally, the dynamic and complex business environment demands continuous monitoring of the surroundings and rapid adjustment of operational strategies. (Teece, 2007)

In light of these challenges, it becomes crucial to seek strategies that support the development of various dimensions of organisational resilience. Servitization, through the integration of products and services, can play a significant role in building resilience, particularly in areas such as operational flexibility, modularity, and risk management (Rabetino et al., 2017). The following sections will discuss the role of servitization as a tool supporting organisational resilience.

2.2. Servitization and organisational resilience

Servitization is gaining importance as a strategy for enhancing organisational resilience, particularly in dynamic and uncertain market conditions and during crises such as the COVID-19 pandemic (Li et al., 2022; Bettiol et al., 2023). Servitization integrates product and service offerings to increase customer value by providing more comprehensive solutions (Dwyer, 2008). Companies increasingly recognise that services can generate greater profits than selling products alone, enabling differentiation of offerings and strengthening customer relationships (Vandermerwe, Sánchez-Rada, 1988; Ulaga, Reinartz, 2011). This process combines products, services, self-service, and knowledge, creating holistic solutions tailored to customers' evolving needs. As a result of this approach, businesses focus on providing services, while products become a platform for creating value.

Servitization offers a range of benefits, such as increased revenue, improved profitability, strengthened customer relationships, and enhanced operational efficiency (Rabetino et al., 2017; Reim et al., 2019). However, its implementation comes with numerous challenges, including the need to change organisational culture, develop new competencies, and integrate

products and services into a cohesive offering, which can lead to operational complications (Rabetino et al., 2017; Raddats et al., 2019).

Despite growing interest, research on the impact of servitization on organisational resilience is still in its early stages, and the results suggest that its effects can be both positive and negative, depending on the context. For example, companies with service-based business models demonstrated excellent operational stability in challenging conditions, suggesting that servitization can be a significant stabilizing factor (Zhang, Qi, 2021). On the other hand, other studies indicate the risk of reduced resilience when companies cannot adapt to changing conditions (Nicoletti, Appolloni 2023). The variety of servitization strategies makes their impact on organisational resilience more complex than initially assumed, which calls for further research.

Servitization in the literature is often associated with dimensions such as adaptability, flexibility, complexity management, and risk management, which are key to building organisational resilience. Companies that implement service-based models must quickly adapt to new market conditions and change their organisational culture and approach to resource management (Paiola, 2018; Rapaccini et al., 2023). Despite many benefits, servitisation can increase management complexity, which poses an operational risk if not properly managed (Grubic, 2018).

These diverse outcomes demonstrate the phenomenon's complexity and highlight the need to explore how specific servitization models impact key dimensions of organisational resilience. Rabetino et al. (2017) noted that quickly adapting to market changes and managing complexity and risk is key to company survival in today's unstable business environment. Servitization, as a tool to increase flexibility and innovation, requires further research to understand how different product-service offering models can support organizations in achieving these goals.

Therefore, this article aims to identify the key dimensions of organizational resilience in servitization. In this way, it will deepen the understanding of the role of servitization in building organizational resilience, addressing the urgent research needs highlighted by authors such as Huikkola and Kohtamäki (2018) and Rabetino et al. (2017).

It should be noted that these studies are primarily qualitative, with case studies of companies from various industries and with different product-service offering models dominating. They already provide valuable insights into servitization models and their impact on organisational resilience but in a fragmented way. A meta-synthesis of existing research results can offer valuable insights into how servitization influences organisational resilience.

3. Research Methodology

3.1. Meta-synthesis of qualitative case studies method

Meta-synthesis of qualitative case studies is a research method aimed at integrating and analysing results from several independent case studies to create new theories or develop existing ones (Hoon, 2013). It is crucial in organisational and management research, where case studies are available that already provide knowledge in a given research area but often remain isolated and unconnected. This method combines different perspectives and identifies key relationships that may be overlooked in individual case studies.

The selected method focuses on interpretation rather than aggregation of statistical data, as with traditional quantitative meta-analysis. The key is to identify patterns, relationships, and the significance of results across various case studies while considering the context in which each study is situated.

Methodological rigour is essential in meta-synthesis, as in other research methods. Applying explicit inclusion and exclusion criteria and transparent data coding and analysis methods is crucial to ensure reliable and consistent results. This study follows Hoon's (2013) eight-step process for meta-synthesis. This process includes (1) formulating the research problem, which allows for the precise definition of research questions and inclusion or exclusion criteria for the cases analysed; (2) identifying and collecting relevant case studies related to the research problem; (3) establishing explicit inclusion and exclusion criteria to determine which studies will be included in the analysis; (4) extracting and coding data from the selected studies to create a foundation for analysis; (5) analysing individual cases to identify key variables, patterns, and relationships; (6) synthesising at the overall level, where data from all analysed studies are combined to create a general picture; (7) building theory based on the data synthesis, which may lead to the extension, modification, or creation of new approaches to the topic under study; and (8) discussing the meta-analysis results, including an evaluation of their significance and limitations.

3.2. Research Process

3.2.1. *Formulating the Research Problem – Step 1*

The first step involved precisely defining the research problem and research questions. The key aim of the study was to understand how servitization can support organisational resilience in the context of dynamic market conditions and external disruptions. Specifically, the research question was formulated: What dimensions of organisational resilience can be identified in different product-service offerings?

Formulating the research problem was crucial, as it allowed for establishing the selection criteria for appropriate case studies and determining what data would be needed for the analysis.

3.2.2. Identifying and collecting relevant case studies – Step 2

In the second step, a systematic search for relevant studies was conducted in the Web of Science (WoS) database. This database was chosen due to its broad coverage and reputation among academic databases (Chadegani et al., 2013). Keywords such as "servitization", "case study", "resilience", "adaptability", "flexibility", "innovation", "digitalisation", and "collaboration" were used in the search. Multiple iterative queries were conducted, alternating the main keywords. The search results are presented in Table 1. The table was limited to only those queries where the number of articles was greater than zero. Based on the database search, 192 articles initially matched the specified criteria. Considering each article's title, abstract, and keywords, they were critically analysed before downloading files to verify whether they truly fit the scope of the study. As a result, the number of articles was reduced to 37.

Table 1
Strings used and number of documents identified

No.	Strings used	Number of selected studies
1	(servitiz*) AND ("case study") AND (resilien*)	5
2	(servitiz*) AND ("case study") AND (adapt*)	17
3	(servitiz*) AND ("case study") AND (flexibilit*)	4
4	(servitiz*) AND ("case study") AND (innov*)	157
5	(servitiz*) AND ("case study") AND (risk*)	23
6	(servitiz*) AND ("case study") AND (complexit*)	30
7	(servitiz*) AND ("case study") AND (knowledg* OR learn*)	77
8	(servitiz*) AND ("case study") AND (learn*)	12
9	(servitiz*) AND ("case study") AND (adapt* AND innov*)	10
10	(servitiz*) AND ("case study") AND (adapt* AND complexit*)	3
11	(servitiz*) AND ("case study") AND (flexibilit* AND innov*)	1
12	(servitiz*) AND ("case study") AND (flexibilit* AND complexit*)	1

Note. The table was restricted to only those queries for which the number of articles was greater than zero.

Source: Author's study.

3.2.3. Establishing inclusion and exclusion criteria – Step 3

The 37 selected articles were evaluated based on the established inclusion criteria in the third step. To do this, the articles were read in full and assessed according to the quality of their discussion concerning the following inclusion criteria: 1. Are the case studies described indicative of the service offerings of the entity under study? 2. Whether references to previously identified dimensions of organisational resilience can be found in sections such as the case description, discussion, and/or conclusions; 3. Whether the study used in-depth case studies, aiming to exclude studies that used large samples of case studies (n = 10 or more). In studies with larger samples, authors rely on a few data sources for each case, which does not characterise such research as in-depth case studies. This step narrowed the results to 5 empirical articles, while the remaining 32 were excluded (detailed information on the selected case studies can be found in Table 2).

Table 2.
Details of the studies selected for analysis

Case reference name	Authors	Title of publication	Published by	Number of enterprises
Case 1	Turunen, T., Eloranta, V., Hakanen, E. (2018)	Contemporary perspectives on the strategic role of information in internet of things-driven industrial services	Journal of Business & Industrial Marketing	5
Case 2	Durugbo, C., Erkoyuncu, J.A. (2016)	Mitigating uncertainty for industrial service operations: a multi case study	International Journal of Operations & Production Management	3
Case 3	Fangxu Yan, Shiyuan Yin, Lujie Chen, Fu Jia (2022)	Complexity in a platform-based servitization: a complex adaptability theory perspective	International Journal of Logistics Research and Applications	3
Case 4	Momeni, B., Rapaccini, M., Martinsuo, M. (2024)	Manufacturers managing complexity during the digital servitization journey	Journal of Manufacturing Technology Management	2
Case 5	Rapaccini, M., Paiola, M., Cinquini, L., Giannetti, R. (2023)	Digital servitization journey in small-and medium-sized enterprises: the contribution of knowledge-intensive business firms	Journal of Business & Industrial Marketing	2

Source: Author's study.

3.2.4. Data extraction and coding – Step 4

Data were extracted from the selected five case studies, focusing on the key dimensions of organisational resilience and product-service offering models. An exploratory and inductive approach was adopted. This means that throughout the study, key dimensions were gradually discovered by analysing details related to the listed capabilities of the companies, their strategies, and their outcomes in the respective cases. This approach is often used when the goal is to identify patterns and relationships in the data rather than testing predefined hypotheses. Each case was described, and its data were coded, allowing for the identification of recurring patterns of organisational resilience dimensions and the relationships between product-service offering models and resilience dimensions.

An open coding approach was used, which involved assigning labels (codes) to important text segments in the case descriptions that were significant for the study. For example, if the case description mentioned "flexibility in resource management," this segment was coded as "flexibility." After reviewing, coding, and discovering the initial dimensions, the cases were revisited to check if other dimensions that were not obvious could be added or expanded upon. This process was repeated three times. The results of this stage are presented in the Results section.

3.2.5. Case-level analysis – Step 5

Each of the five cases was thoroughly analysed, allowing for the identification of specific characteristics and resilience dimensions for each case. At this stage, the analysis focused on how the servitization influenced specific dimensions of organisational resilience.

The case analysis provided insights into how product-service offerings support key resilience dimensions. The results of this stage are presented in the Results section.

3.2.6. Data synthesis – Step 6

After analysing each case, data synthesis was conducted to identify general patterns and key conclusions regarding the impact of servitization on organisational resilience. The synthesis allowed for the integration of findings from different cases, providing a more complete picture of the relationship between servitization and the dimensions of organisational resilience. The results of this stage are presented in the Results section.

3.2.7. Theory building – Step 7

Based on the conducted synthesis, theories were formulated regarding the impact of servitization on the dimensions of organisational resilience. The results of this stage are presented in the Results section.

3.2.8. Discussion – Step 8

The final step was to discuss the results in the context of existing literature and identify key implications for companies implementing servitization. The identified dimensions of organisational resilience were compared with existing research.

4. Results

This section presents the findings from steps 4 to 7. Based on the case-level analysis, the identified service offerings and the dimensions of organisational resilience are described (Steps 4 and 5). Next, the obtained results are synthesised by combining the findings from the individual cases (Step 6) with the formulation of theories regarding the impact of servitization on the dimensions of organisational resilience (Step 7).

4.1. Case-level analysis - Step 4 and Step 5

4.1.1. Case 1

The first case analyses companies that provide advanced technology-based services supporting process optimisation and data management in various industrial sectors. They offer solutions such as production process monitoring, building management systems, security system integration, energy efficiency optimisation, and predictive machine maintenance. A common element of their activities is IoT technology, real-time data analytics, and system integration, enabling proactive and efficient resource management.

Their offering is based on a servitization model that combines products (e.g., monitoring equipment) with real-time data analysis services, allowing proactive resource management and problem prediction. Although organisational resilience is not the main focus of the study, the analysed cases reveal key aspects of information management that directly contribute to the company's ability to cope with shocks and disruptions in its operational environment.

The research noted that the analysed entities prioritise access to data rather than control over it. This approach reflects a shift towards greater adaptability, allowing companies to quickly respond to changing market conditions and customer needs. Flexibility in acquiring and utilising data is crucial for coping with disruptions and adapting to unforeseen circumstances. The article underscores the importance of collaboration and data sharing within industrial service networks. This approach fosters mutual connections and shared responsibility, potentially strengthening resilience by distributing risk and creating redundancy in the network. The authors emphasise the pivotal role of continuous learning and knowledge management in the success of the analysed companies. The process of continuous improvement, driven by the analysis of collected data, enables organisations to adapt to new challenges and improve their operations in response to changing market conditions. The authors challenge the traditional approach of viewing data protection as a key source of competitive advantage. Companies can mitigate risk through openness and collaboration in the context of servitization. Although the article does not directly address organisational resilience, its findings suggest that servitization can build resilience through adaptability, collaboration-based networks, continuous learning, and risk mitigation.

4.1.2. Case 2

The article's main aim was to explore how companies in the industrial sector, particularly in the aerospace industry, manage operational uncertainties related to industrial services. The analysis is based on a case study of three large international companies: BAE Systems, Lockheed Martin, and Rolls-Royce, leaders in delivering advanced technologies and service solutions. The study focuses on how these companies manage uncertainty through various product-service offerings, including after-sales agreements, long-term technical support, and product lifecycle management.

Although this article does not directly focus on organisational resilience, it discusses how service offerings help companies manage uncertainties, indirectly impacting their resilience. The cases analysed in the article show that by employing advanced service models based on long-term contracts, these companies ensure operational stability and predictability.

These models offer several key benefits that directly support organisational resilience through 1. financial and operational stability thanks to long-term service agreements like Rolls-Royce's TotalCare®; 2. technological risk management, where Lockheed Martin and BAE Systems provide regular maintenance, upgrades, and repairs of their products through long-term technical support; 3. proactive product lifecycle management, allowing for better planning of technological development, monitoring of equipment wear, and making appropriate

adjustments at the right time; 4. flexibility and adaptability, where remote monitoring and on-demand services enable companies to quickly respond to changing customer needs. Adjusting services to current market and technological challenges allows for greater flexibility and adaptability.

4.1.3. Case 3

The key theme of Case 3 is understanding how service modularity and digitalisation within a digital platform affect system complexity and the organisation's ability to adapt in the face of external disruptions. From the service provider's perspective, Case 3 provides insights into managing complexity and building resilience in the supply chain, directly impacting functional organisational resilience.

The authors analyse how companies like JD.com, Siemens, and Alibaba use digital platforms to manage complexity and build organisational resilience. These companies provide platform-based services supporting various industries. JD.com offers supply chain optimisation, data analysis, and consulting for e-commerce and FMCG. Siemens provides a 3D printing collaboration platform with design and engineering tools. Alibaba integrates sales, finance, and logistics, supporting industrial app developers and manufacturing companies with IoT technology.

The analysis shows these platforms contribute to increased flexibility and adaptability in supply chain disruptions. Service modularity, or the division of the servitization process into smaller, independent modules, allows companies to manage service system complexity better. This enables providers to respond more quickly to changing customer needs and adjust their offerings without adding complexity. Siemens, for example, uses the Additive Manufacturing platform to connect different participants, such as designers, engineers, and OEM suppliers, allowing for efficient and flexible management of the entire production process. The analysed cases prove that IoT, data analytics, and artificial intelligence improve flexibility and responsiveness to disruptions. The authors also noted that by connecting various stakeholders, the platform increases connectivity among participants, leading to a higher degree of internal complexity. This increased complexity, while potentially leading to higher supply chain resilience (SCR) through agile responses, also increases supply chain vulnerability (SCV), making the supply chain more susceptible to disruptions due to denser relationships and greater interdependence.

Ultimately, Case 3 shows that platform-based servitization, while offering numerous benefits, requires careful consideration of the impact of internal complexity on SCR and SCV to achieve optimal adaptive capacity. Case 3 provides evidence that the platform approach to servitization can significantly enhance the organisational resilience of service providers, enabling them to manage complexity better, adapt to market changes, and respond more quickly to supply chain disruptions. Digitalisation and service modularity are key elements of this process.

4.1.4. Case 4

Case 4 examines how manufacturers manage the complexity associated with their digital servitization (DS). Two companies were analysed, which, through the development of service offerings, aimed to monitor installed products in real-time and perform predictive maintenance, streamline production processes, and optimise production efficiency. Research shows that digital servitization, which involves integrating technologies such as IoT, cloud computing, and data analytics, introduces new forms of complexity. The key here is building resilience by absorbing complexity, which means adopting new technologies and adjusting organisational processes. A modular approach to servitization, where service systems are divided into smaller, independent components, allows manufacturing companies to respond more quickly to changes and disruptions. Digital services are created based on data from various sources, allowing companies to predict technical problems and better manage risk. This approach not only increases the flexibility of organisations but also strengthens their resilience to technological disruptions. The companies described in Case 4 benefit from extensive collaboration networks with technology providers, universities, and research partners. This collaboration enables the absorption of external resources and knowledge, helping manufacturing companies better cope with external threats and enhancing their resilience to external disruptions. Digital servitization, based on remote monitoring and data analysis, allows companies to quickly respond to changing customer needs, increasing their resilience to unforeseen changes in demand or technology.

Based on Case 4, it can be concluded that service offerings based on digital servitization significantly impact the organisational resilience of manufacturing companies. Modularity, complexity management, organisational flexibility, and collaboration with technology partners enable companies to respond effectively to changing market and technological conditions, contributing to increased resilience.

4.1.5. Case 5

Case 5 describes how knowledge-intensive business services (KIBS) support small and medium-sized enterprises (SMEs) in digital transformation, particularly servitization. KIBS is essential in managing operational complexity by offering technological (T-KIBS) and professional (P-KIBS) solutions that support SMEs in implementing new technologies and transforming business models. As a result, companies better adapt to changing market conditions, strengthening their resilience.

Organisational flexibility is another key aspect that allows SMEs to adapt to changes quickly. Standardised technologies, such as SaaS platforms, minimise risk and costs, enabling more efficient adaptation. KIBS also supports innovation by providing new knowledge and technologies, allowing SMEs to develop new products and services and enhancing their market competitiveness.

Partnerships with KIBS also allow SMEs to reduce the risk of introducing new technologies by gradually implementing IoT and cloud platforms, reducing operational risk. A modular system approach facilitates operational complexity, optimising production and service processes.

The knowledge and learning processes supported by KIBS enable SMEs to implement innovations faster and adapt to digital transformation. KIBS provides new knowledge resources and helps SMEs integrate and utilise the acquired experience effectively.

In conclusion, KIBS supports SME resilience by helping them manage complexity, increase flexibility, introduce innovations, and minimise risk. This allows for more effective responses to disruptions and crises in a dynamically changing technological and market environment.

4.2. Synthesis of the obtained results - Step 6

Based on the information in the company descriptions and service offerings, several key dimensions of organizational resilience can be distinguished. These dimensions include stability, adaptability, flexibility, modularity, digitalisation, and inter-organizational collaboration.

The first significant dimension is stability, which refers to an organisation's ability to maintain operational and financial balance over time despite changing environmental conditions. (Cheese, 2016) Stable organisations can anticipate future actions, plan resources, and avoid disruptions through long-term service agreements, product lifecycle management, and regular maintenance. Case 2, describing companies such as Rolls-Royce, Lockheed Martin, and BAE Systems, shows that long-term technical support, like Rolls-Royce's TotalCare, allows companies to achieve operational stability and financial predictability. Regular maintenance and lifecycle management enable better technological planning and minimise technological risks.

Another key dimension of resilience is adaptability, understood as an organisation's ability to quickly and effectively adjust its actions, strategies, and processes to changing external conditions, such as new technologies, market changes, or crises. (Karadzic et al., 2013) Adaptability is evident in the analysed cases, particularly in companies like Siemens (Case 1), Alibaba (Case 3), JD.com (Case 4), and KIBS (Case 5). Operating in the integrated solutions model, Siemens effectively implements new digital technologies, such as IoT, to respond to customer needs and market changes in the long term. Operating on a digital platform, Alibaba can transform its infrastructure and services in response to the dynamic demands of the e-commerce market, integrating new technologies and optimising processes. JD.com uses digital tools to monitor product usage in real time, allowing the company to adjust its operational processes and introduce technological improvements that support long-term changes. In turn, KIBS companies, operating in the result-oriented services model, continuously adjust their services to changing technological conditions and the specific needs of their clients, supporting their digital transformation and long-term innovation strategies. In each of these

cases, adaptability is a key factor that enables organisations not only to respond to immediate disruptions but also to make significant strategic changes in response to long-term market challenges, strengthening their organisational resilience.

A frequently observed dimension in the analysed cases was flexibility. It refers to an organisation's ability to immediately adjust its resources, processes, and activities to changing conditions quickly and effectively without disrupting ongoing operations (Roberts, Stockport, 2009). Flexibility involves operational adjustments, such as changing production volumes, reallocating resources, or reorganising processes to meet changing needs or market demands. It is a crucial element in many cases. In Case 3, thanks to an advanced digital infrastructure, the company can instantly scale its resources, change processes, and adjust its offerings in response to fluctuations in demand without disrupting ongoing operations. Similarly, in Case 4 (JD.com), the company can react immediately to changes in usage intensity by monitoring product usage in real time. Case 5 illustrates flexibility in the context of consulting and technological services. KIBS companies can immediately adjust the scope and form of their services due to their expertise and competencies, allowing them to respond flexibly to client needs. These companies rely on intensive expert knowledge, technology, and experience, enabling the rapid transformation of resources and processes in response to a changing environment. Close cooperation with clients allows them to quickly identify changing needs and challenges and immediately adapt to new conditions.

Modularity was the next dimension observed in the cases. Modularity refers to an organisation's ability to divide its processes, products, and services into smaller, manageable components (modules) that can be flexibly adapted and reorganised as needed (Brax et al., 2017). A modular approach reduces operational complexity and increases a company's ability to adapt. It is essential in Case 3, where servitization is based on digital technology, enabling the quick scaling and adaptation of services. Similarly, in Case 1 and Case 4, modularity allows companies to divide processes into smaller, easier-to-manage parts, reducing complexity and increasing adaptability. This allows these companies to easily adjust their services to changing customer needs while minimising the risk of introducing additional complexity.

Digitalisation is another dimension in the analysed cases, understood as integrating modern technologies such as IoT, data analysis, artificial intelligence, and automation (Stawiarska et al., 2021). In Case 1, the company uses digital technologies to monitor machines in real-time, allowing it to predict problems and optimise maintenance, minimising downtime. Similarly, in Case 3, advanced data analysis and artificial intelligence support the dynamic management of logistics and commercial processes, enabling the company to monitor demand changes and optimise supply chains. In Case 4, digitalisation allows for real-time monitoring of product usage by customers, enabling effective management of predictive maintenance and quick adjustment of operational processes. Digitalisation supports resource monitoring, problem prediction, and process optimisation in these cases, increasing operational efficiency and organisational resilience.

The last key dimension is inter-organizational collaboration, an organisation's ability to establish and maintain relationships with external partners, such as suppliers, customers, and technological and strategic partners (Ataee et al., 2011). Servitization relies on integrating products with services, often requiring cooperation with various external entities. The need to consider this dimension arises from several key aspects. Firstly, servitization requires access to advanced technologies and competencies that are not always available within the organisation. Collaboration with technological partners and service providers enables companies to gain easier access to these resources, helping them deliver comprehensive service solutions more quickly and effectively. An example is the company in Case 1, which, in the integrated solutions model, collaborates with partners to provide product servicing and monitoring using digital technologies. This allows the company to offer more advanced services while minimising risks and operational costs. Secondly, servitization carries risks associated with long-term service contracts, equipment maintenance costs, and changing customer needs. Collaboration with external partners allows companies to share these risks. For example, in Case 3, collaboration with external logistics and technology service providers enables the company to manage its infrastructure flexibly, transferring some operational risk to its partners and strengthening its ability to maintain service continuity. Thirdly, collaboration with partners enables companies to understand customer needs better and tailor their services to meet their requirements. In Case 5, consulting and technology firms collaborate with clients and technological partners to deliver services tailored to changing market needs. Through this collaboration, KIBS companies can flexibly adjust the scope and form of their services, sharing knowledge and resources with partners, allowing them to manage better the challenges associated with servitization.

4.3. Theory building based on meta-synthesis – Step 7

In the final step of the meta-synthesis process, we move beyond individual case insights to construct a broader theoretical framework that explains the relationship between servitization and organisational resilience. This involves synthesising the identified dimensions—stability, adaptability, flexibility, modularity, digitalisation, and inter-organizational collaboration—into a cohesive theory that can be generalised across different contexts.

The theory developed here posits that servitization enhances organisational resilience by enabling firms to navigate complex, dynamic environments better. Through servitization, organisations offer products and integrate services that support long-term customer relationships, technological improvements, and operational efficiencies. This integration inherently promotes stability by securing predictable revenue streams and reducing operational risks through long-term contracts and lifecycle management, as seen in companies like Rolls-Royce with its TotalCare program. Stability, a dimension often overlooked in the literature, proves essential in maintaining operational balance, as demonstrated in cases where long-term service agreements reduce disruptions and provide financial predictability.

In addition to stability, modularity emerges as a dimension of resilience that is not frequently highlighted in existing research. Modularity allows organisations to break down their processes and services into smaller, manageable units that can be flexibly reorganised or scaled. This reduces operational complexity and enhances adaptability. For example, companies like Siemens and Alibaba use modular service models to respond quickly to shifting customer needs and market conditions, improving their ability to maintain continuous operations while minimising risks. Modularity not only supports adaptability but also enables companies to maintain stability by reducing the complexity and risks associated with large-scale changes.

Adaptability and flexibility are further bolstered by servitization, where digital tools and modular service offerings allow firms to quickly adjust to changing market conditions and customer needs. As demonstrated by the real-time operational adjustments in cases like Siemens and JD.com, companies can rapidly scale resources and reconfigure processes without disrupting ongoing operations. Thus, flexibility and adaptability become key drivers of organizational resilience, allowing firms to make immediate and long-term strategic adjustments.

Digitisation is another driver of resilience. It provides the technological infrastructure for real-time monitoring, predictive maintenance, and data-driven decision-making, strengthening adaptability and operational stability. This is evident in several cases where advanced digital tools support internal efficiency and external collaboration, ensuring that firms remain resilient in highly volatile environments.

Finally, inter-organizational collaboration is crucial in enhancing resilience by sharing risks and resources with external partners. With its reliance on comprehensive service models, servitization often necessitates partnerships with technology providers, logistics firms, and customers. This leads to an extended network of resilience capabilities, as illustrated by the collaboration strategies employed by companies like Alibaba and KIBS firms.

Thus, the theory derived from this meta-synthesis suggests that servitization is a multifaceted driver of organisational resilience. Stability and modularity, often underexplored in the literature, emerge as key dimensions that complement more commonly discussed aspects such as adaptability and flexibility. These elements work together, promoting stability, adaptability, and collaborative strength by integrating services and digital technologies. This theoretical framework can serve as a basis for further empirical research and practical applications in industries undergoing digital transformation and servitization.

5. Discussion

This study aimed to explore how servitization influences key dimensions of organizational resilience. A meta-synthesis of case studies identified several dimensions of resilience, including adaptability, flexibility, digitalization, inter-organizational collaboration, stability, and modularity. The analysis revealed that servitization enhances these dimensions in various ways, contributing to an organization's capacity to withstand and adapt to disruptions.

Adaptability, a critical dimension of resilience, is significantly bolstered by servitization. According to Baines et al. (2020), servitization enables organizations to make long-term strategic adjustments in response to changing market and technological conditions. Companies adopting integrated solutions models can quickly integrate new technologies, such as IoT, to meet evolving customer demands, demonstrating high adaptability. As Teece (2007) highlights, pivoting and making strategic adjustments are essential for resilience in dynamic environments. Servitization facilitates these adjustments, ensuring companies can continuously evolve and remain competitive.

Flexibility is another dimension supporting servitisation. Lexutt (2020) emphasises the importance of flexibility in managing market volatility. Servitization enables organisations to offer dynamic, customer-centric service models, such as pay-per-use or subscription-based services, allowing them to adjust their offerings in real-time based on fluctuating demand. This operational flexibility ensures that organisations can respond quickly to external changes without disrupting their core functions, making them more resilient to sudden shifts in market conditions or customer needs.

Digitalization is central in servitization, particularly integrating IoT, artificial intelligence, and data analytics into service offerings (Coreynen et al., 2017). Digital tools allow companies to monitor operations in real-time, predict risks, and optimise processes, enhancing adaptability and operational stability. In servitized models, digitalisation supports resilience by enabling companies to anticipate and respond to potential disruptions before they escalate. The ability to continuously optimise service offerings based on real-time data allows organisations to maintain high levels of operational efficiency and resilience, even in highly dynamic environments.

Inter-organizational collaboration is also a key element in enhancing resilience through servitization. Mennens et al. (2018) emphasise that collaboration with external partners allows firms to share resources, reduce risks, and enhance their capacity to manage complex service solutions. This study confirmed that collaboration is crucial in servitization. Partnering with external technology providers and service experts helps companies access new capabilities and distribute risks more effectively, strengthening their overall resilience.

At the same time, stability—a less frequently highlighted aspect in the resilience literature (Hepfer, Lawrence, 2022)—emerged as an essential factor in the context of servitization. As Baines et al. (2009) discuss, long-term service agreements are central to creating stable operational environments. Companies ensure steady revenue streams and long-lasting customer relationships by offering maintenance and lifecycle management. Rolls-Royce's TotalCare program exemplifies stability and helps organisations maintain operational and financial balance, even in volatile environments. This dimension of servitization underscores how companies can depend on predictable operations and recurring contracts, providing a solid foundation for resilience.

Finally, the study highlights the role of modularity, another dimension not always emphasised in resilience discussions. Modularity reduces operational complexity and enhances flexibility and stability, as organisations can adapt their service offerings in real-time without overcomplicating operations. For example, modularity enables companies to scale services based on real-time customer demand, ensuring they can quickly adjust to changing conditions while maintaining efficient operations. Modularity thus plays a dual role in reinforcing flexibility and stability, making it an essential factor in supporting resilience.

In conclusion, this study confirms that servitization enhances multiple dimensions of organisational resilience. While adaptability, flexibility, digitalisation, and collaboration are well-established elements of resilience, the findings underscore the importance of stability and modularity—dimensions less frequently highlighted in the literature. Servitization enables organisations to adapt and respond to disruptions and provides the stability and operational structure necessary to maintain long-term resilience. This holistic approach ensures companies can navigate dynamic environments and thrive amid uncertainties, positioning themselves for sustained success.

6. Conclusion

Through the analysis of multiple case studies, it is evident that servitization, as a strategic approach, provides organisations with the tools and capabilities necessary to navigate and thrive in dynamic, unpredictable environments.

One of the primary findings is the importance of adaptability and flexibility. Servitization allows firms to remain responsive to market fluctuations, technological advancements, and evolving customer needs. By integrating digital technologies and offering flexible service models, organisations can swiftly adjust their offerings and operations, ensuring they remain competitive and resilient in the face of disruption.

The role of digitalisation is also pivotal. Digital tools like IoT, data analytics, and AI are integral to servitized business models, allowing companies to optimise operations, predict risks, and respond proactively. This supports resilience by enhancing adaptability and stability through real-time insights and optimised resource allocation.

Collaboration emerged as another key dimension of resilience. Partnerships with external stakeholders—such as technology providers, service partners, and customers—allow firms to share resources, distribute risks, and innovate more effectively. These partnerships are essential for managing the complexity of servitized offerings and maintaining resilience in volatile markets.

Notably, this study highlights the often underexplored dimensions of stability and modularity. Stability, achieved through long-term service agreements, provides predictable revenue streams and strengthens customer relationships, creating a solid foundation for resilience. Modularity, which allows organisations to break down services into manageable components, enhances flexibility and stability by enabling quick, targeted adjustments without overcomplicating operations.

These findings provide several key takeaways for managers. First, adopting servitization strategies incorporating digitalisation and flexibility is crucial for enhancing organisational resilience. Managers should invest in digital tools to enable real-time monitoring and optimisation of operations, allowing their organisations to respond quickly to disruptions. Furthermore, emphasising collaboration with external partners is essential for expanding the organisation's capabilities and managing risks effectively.

Additionally, the importance of stability through long-term service agreements should not be overlooked. Managers should focus on building stable, long-lasting relationships with customers through tailored service contracts. Finally, adopting a modular approach to service design allows organisations to remain flexible and agile while managing operational complexity. This approach ensures that adjustments can be made efficiently in response to changing customer needs or market conditions, which is vital in a fast-evolving business landscape.

Despite its contributions, this study has some limitations. First, it relies on a meta-synthesis of case studies, meaning the findings are context-specific and may not be readily generalisable across all industries. The case studies analysed here are drawn from specific sectors, such as manufacturing and technology, and the results may differ in other industries with varying degrees of servitization. Additionally, the study focuses on identifying general dimensions of resilience. However, it does not provide detailed insights into how different organisational models (e.g., product-oriented, use-oriented, and result-oriented) might impact these dimensions differently.

Future research could address these limitations by exploring how different product-service offering models influence organisational resilience. Each model, such as product-oriented, use-oriented, or result-oriented services, may affect resilience in distinct ways. During the

study, it became evident that various models have different impacts on dimensions like adaptability, stability, and flexibility, which warrants further investigation. More empirical studies across different industries and contexts would help clarify these dynamics and offer deeper insights into the role of servitization in resilience building.

Additionally, future research should explore how modularity and stability—underexplored dimensions in the current literature—interact with other aspects of servitization to enhance resilience. Researchers could also examine how digitalisation and partner collaboration contribute to long-term organisational resilience in sectors currently underrepresented in servitization studies, such as healthcare, education, and services.

In conclusion, while this study has highlighted the critical dimensions through which servitization enhances resilience, it opens the door for further exploration into the specific mechanisms and models that drive these outcomes. By investigating these aspects more thoroughly, future research can provide managers with more precise strategies for leveraging servitization to build more resilient organisations.

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REGIONAL RESILIENCE: PRO-ECOLOGICAL ATTITUDES OF LUBLIN REGION RESIDENTS

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Purpose: The growing importance of regionalization in the modern world has aroused increasing interest among researchers in regional resilience issues. Residents' behavior plays a crucial role in regionalization's construction, both environmentally, socially, and economically. The article aims to present the results of literature and empirical research on the pro-ecological attitudes of Lublin region's urban and rural residents.

Design/methodology/approach: The research was based on two methods. The analysis and critique literature method allowed to explore the theoretical basis of the topic undertaken and showed the need for research on residents' pro-ecological attitudes. The empirical research was conducted using the diagnostic survey method using the Internet survey technique.

Findings: It was found that the majority of urban and rural residents are ecologically conscious and consider the pro-ecological attitude to be important and necessary. There are slight differences in the extent of ecological activities undertaken by urban and rural residents. Greater environmental awareness is observed among those with higher educational levels.

Research limitations/implications: The research was a pilot study, allowing for the verification of the research problem and checking the research tool. The relevance of the subject matter undertaken and the need for continued research in this area is revealed. It is necessary to clarify the research tool, expand its scope and replicate it on a larger sample.

Practical implications: The main practical effect of the presented research is to confirm that urban and rural residents are taking pro-ecological measures and are aware that their behavior affects the region's environmental status. The information obtained provided a basis for developing recommendations on what local government authorities and organizations working for the sustainable development of regions can undertake to strengthen their resilience.

Social implications: The survey results allow us to assess the extent to which residents understand the relationship between humans and the environment, and whether they think and act ecologically. Confirm the need for systemic measures to strengthen their pro-ecological attitudes.

Originality/value: The article presents the role of residents' pro-ecological attitudes in building regional resilience. Its value is to design a research concept to assess the environmental attitudes of urban and rural residents.

Keywords: regional resilience, sustainable development, pro-ecological attitude.

Category of the paper: Research paper.

1. Introduction

The concept of resilience originated in the 1970s. The term was introduced to the scientific literature by Canadian ecologist Hollings (1973), who defined resilience as the ability of an ecosystem to absorb disturbances and reorganize itself so that it can continue to function in essentially the same form and structure. In subsequent years, resilience issues were addressed by representatives of many other sciences, such as management, economics, psychology, sociology, and urban planning (Masik, 2022). Currently, this concept's assumptions are used in planning sustainable development in the context of global challenges, such as environmental, political, economic and social crises.

The resilience of regions (countries, provinces, cities) means their ability to adapt, survive and even develop in difficult, crisis situations. According to Masik (2022), it is the ability of a region's communities, economy and institutions to withstand, adapt and transform the regional system given internal stresses and external disruptions. When analyzing the resilience of regions, not only current challenges are considered, but also preparation for future unpredictable changes.

The regional resilience concept shares common assumptions with the sustainable development concept. An important aspect of each is ecology. Regions that can effectively maintain healthy ecosystems are better prepared for future environmental challenges and can provide a better life quality for their residents. Environmental care in an era of intensifying climate change should be a priority task in people's and organizations' daily functioning. This is also an obligation under the Polish Constitution and the European Union's environmental policy (Jakubowska, 2008; Szwed, 2022).

Increasing numbers of companies are working by the principles of sustainable development and care for the environment. The Polish population's environmental awareness is also growing. According to the 6th edition of the EKObrometer survey conducted by the SW Research institute, 72% of Poles believe that the current state of the environment is a significant problem (EKObrometr, 2024). Residents' environmental attitudes contribute to the creation of more sustainable and integrated regions, significantly enhancing their ability to cope with various challenges and crises. Concerns about the state of the environment at the place of residence are more often declared by residents of larger cities than in rural areas (Fundacja CBOS, 2020). This research presented here is aimed at a comparative analysis of the pro-ecological attitudes of urban and rural residents in the Lublin region.

2. Residents' pro-ecological attitudes in the concepts of sustainable development and regional resilience

The “sustainable development” concept was defined in 1987 in the World Commission on Environment and Development's Report “Our Common Future” (the Brundtland Report) as a process aimed at satisfying the development aspirations of the current generation, in a way that will enable future generations to realize the same aspirations (UNESCO..., 2024). To achieve this goal, global, integrated action is necessary in three key areas (Figure 1): 1) responsible, long-term economic growth for all nations and communities and the equitable distribution of benefits; 2) conservation of natural resources and the environment; 3) social development (Mieszajkina, 2016).

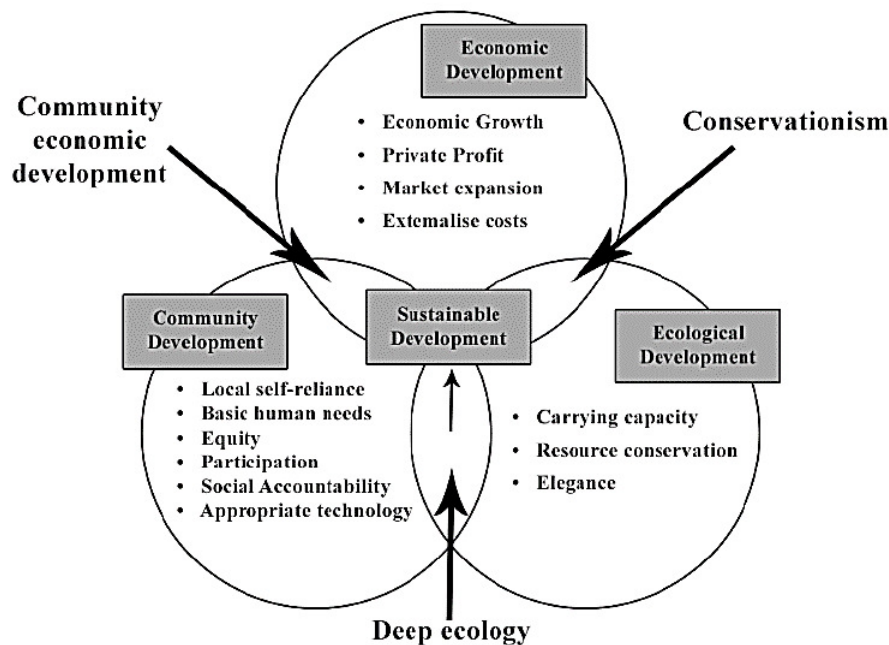


Figure 1. The sustainable development model.

Source: Mieszajkina, 2016, p. 166.

The concept assumes forming the relationship between economic growth and environmental care and life quality in such a way that it does not cause unnecessary, excessive burdens on the environment (Szumski, 2019). Therefore, sustainable development is a specific compromise between the environmental, social and economic needs that determine the well-being of present and future generations (Borys, 2015).

In 2015, 193 leaders of United Nations member countries adopted a document entitled. “Transforming Our World: 2030 Agenda for Sustainable Development” (2024). It contained 17 Sustainable Development Goals and 169 related targets for the world to achieve by 2030. They concern achievements in 5 areas: people, planet, prosperity, peace, partnership (Raczkowska, Mikula, Utzig, 2021). The Agenda emphasizes that global problems, primarily

climate, but also economic and social, are becoming increasingly complex, and cannot be solved at the level of an individual or even a single organization and a single country.

Achieving economic and social goals is largely determined by the state of the environment. Irresponsible human actions are destroying homeostasis mechanisms and causing nature to no longer be a self-regulating system. To achieve a state of equilibrium, it urgently needs human help (Szumski, 2019). The role of the public's ecological awareness, resulting from an understanding of the inextricable link between humans and the environment, is important here. This awareness is the basis for the development of a person willing and able to live in harmony with the natural elements (Perepeczko, 2012).

Ecological activities are also needed to improve the competitiveness, economic performance and resilience of regional units (voivodeships, cities, municipalities). The negative effects of the climate transition are already being experienced around the world. Mitigating and containing climate change is costly and can be somewhat burdensome when considering the multitude of components, processes and interactions occurring within the region's borders. However, this is necessary to provide current and future generations with comparable or better living conditions. The resilience concept is used in the research of phenomena and processes occurring in the territories of different levels of territorial units (Drobniak, 2017). Building regional resilience is a process that requires integrated action at the political, economic and social levels. This holistic approach will overcome existing structural, financial and social constraints (Boyer et al., 2017).

It is necessary to consider each region's specific characteristics, demographic differences, economic structures, geographic context, and environmental and climatic conditions. Activities, positive for the ecosystem of one area, may negatively affect other places or ecosystems. Adequate climate policy is needed, implemented not only at the national level, but also at the level of individual regions (Bronisz, 2024).

The environmental problems highlighted in the concepts of sustainable development and regional resilience require a systemic combination of actions by regional authorities, businesses, but also residents and other stakeholders. Since people have one of the most important roles in building the region's resilience, it is essential to strengthen their environmental awareness. People are the ones who determine the creation, management and maintenance of all regional systems, such as transportation, water and sewage, energy, waste management, etc. (Desouza, Flanery, 2013). Therefore, environmental education is extremely important. According to Sandner (2007), the methods used to teach environmental knowledge do not completely correspond to the needs of societies exposed to increasingly new challenges. The problem of nature education still lacks a holistic approach to ensure a better understanding of the environment.

Achieving sustainable development goals and the regions' resilience is possible provided that pro-ecological attitudes and behaviors of their inhabitants are consolidated. The term "attitude" means "a person's attitude to life or certain phenomena, expressing his views;

also: a way of acting or behaving towards certain phenomena, events or concerning people.” (PWNa, 2024). The term "pro-ecological" means "conducive to maintaining balance in nature" (PWNb, 2024). Therefore, it is possible to consider a pro-ecological attitude as an individual's way of thinking and acting, which manifests itself in respect for the laws of nature, caring for environmental protection and understanding the relationship between humans and nature.

A person who presents a pro-ecological attitude does not avoid all the conveniences of the modern world but can combine them with living in harmony with nature. Is functioning in such a way that the activities undertaken do not cause a destructive impact on the environment (Perepeczko, 2012). It is aware of the consequences of its actions and makes decisions that have the least possible negative environmental impact. Characterized by a certain awareness of both social and environmental issues (Ziernicka-Wojtaszek, 2011). In addition to adequate knowledge of the environment and human behavior, also understands that there is an unbroken bond between humans and nature (Seroka-Stolka, 2012). Therefore, a pro-ecological attitude is not easy to develop, it involves understanding the threat that progressive changes in the environment have on people's livelihoods. The realization of this connection forces people to seek appropriate solutions. Therefore, a pro-ecological attitude encompasses many behaviors that will eventually allow a person to live in harmony with nature. They result from a sense of responsibility for their actions, an awareness of environmental problems and a desire to live a sustainable lifestyle (Perepeczko, 2012).

3. Research methodology

The adopted research procedure included an analysis of the literature on the research topic. This allowed us to pose the following research problem: Do the residents of urban and rural Lublin areas have pro-ecological attitudes and what are their similarities and differences? The empirical research aimed to analyze the pro-ecological attitudes of urban and rural residents in the Lublin region. Five hypotheses were formulated:

1. Residents of both areas consider pro-ecological attitudes to be important and recognize environmental problems in the surrounding area.
2. Urban residents have a higher level of environmental awareness than rural residents.
3. Urban residents take more pro-ecological measures than rural residents.
4. The pro-ecological attitudes of the region's residents are more influenced by factors of an internal nature than by factors of an external nature.
5. People with higher levels of education show more advanced environmental attitudes.

To achieve the research goal, a diagnostic survey method was used, an online survey technique. The research tool was an original survey questionnaire consisting of 12 questions. The first four questions were metrics (gender, age, education, place of residence).

The remaining eight questions were used to verify the research hypotheses. The survey questionnaire was distributed to 200 respondents via the Internet. The sample selection was purposeful. The research was a pilot study, therefore the use of a random mechanism and the preparation of a sampling frame, that is, a list of elements that form the study population, was abandoned. The non-random respondent sampling consisted of their subjective selection by the authors, but the goal was to create a near-representative sample. In cities, people living in single-family homes were invited to participate in the survey to ensure that daily living conditions were comparable to those of rural residents. 169 correctly completed questionnaires were obtained.

Research sample structure:

- urban residents: 49.1%, rural: 50.9%;
- women: 54.4%, men: 45.6%;
- 18-24 year olds: 27.8%; 25-34 years: 10.7%; 35-44 years: 26%; 45-54 years: 8.3%; 55-64 years: 9.5%, over 65 years: 17.7%;
- primary education: 4.7%, secondary: 39.1%, vocational: 13.6%, higher: 42.6%.

4. Research results and analysis

The first survey questions concerned the respondents' pro-ecological attitudes and existing environmental problems in the surroundings.

Table 1 shows how important the pro-ecological attitude is to respondents. The rating was made on a scale from 1 - definitely not important to 5 - very important (here and hereafter N denotes the number of respondents).

Table 1.
The importance of pro-ecological attitude for respondents

Group of respondents	Rating										Weighted average rating
	1		2		3		4		5		
	N	%	N	%	N	%	N	%	N	%	
Total sample (169 people)	2	1.2	7	4.1	13	7.7	69	40.8	78	46.2	4.27
Urban residents (83 people)	0	0.0	3	3.6	4	4.8	35	42.2	41	49.4	4.37
Rural residents (86 people)	2	2.3	4	4.7	9	10.5	34	39.5	37	43.0	4.16

Source: own elaboration.

For 87% of respondents, a pro-ecological attitude is very important (answers 4 and 5). An overwhelming majority of urban (91.6%) and rural (82.5%) respondents confirm the importance of pro-ecological behavior, as evidenced by high weighted average ratings. However, there are noticeable differences between the two groups. More urban residents consider this attitude very important, which may be due to greater environmental awareness, access to education, and environmental problems that are more noticeable in urban areas.

Rural residents, although to a slightly lesser degree, also appreciate the importance of pro-ecological attitudes, which may be related to their daily contact with the environment. Differences may also result from different life priorities or environmental education levels. Therefore, respondents were asked whether they were interested in environmental issues (Table 2). Respondents gave answers on a scale of 1 - not at all interested, 5 - very interested.

Table 2.
Respondents' interest in environmental issues

Group of respondents	Rating										Weighted average rating
	1		2		3		4		5		
	N	%	N	%	N	%	N	%	N	%	
Total sample	13	7.7	18	10.7	57	33.7	48	28.4	33	19.5	3.41
Urban residents	6	7.2	5	6.0	26	31.4	24	28.9	22	26.5	3.61
Rural residents	7	8.1	13	15.1	31	36.1	24	27.9	11	12.8	3.22

Source: own elaboration.

Nearly half of the respondents (47.9%) show a strong interest in ecological topics (ratings of 4 and 5). Regarding this question, there is also an apparent difference between urban (55.4%) and rural (40.7%) residents. This result partly explains the differences in the residents' attitudes of the two groups indicated in the previous question, since people's attitudes are to some extent shaped by the information they have.

Table 3 presents where respondents obtain information about environmental issues. Respondents had the opportunity to indicate more than one answer, therefore the results do not sum to 100%.

Table 3.
Sources of information on ecological issues

Sources of information	Group of respondents					
	Total sample		Urban residents		Rural residents	
	N	%	N	%	N	%
Internet	133	78.7	62	74.7	71	82.6
Social media	83	49.1	40	48.2	43	50.0
Television	72	42.6	40	48.2	32	37.2
Radio	51	30.2	25	30.1	26	30.2
Family/friends	46	27.2	26	31.3	20	23.3
Journals/magazines	43	25.4	26	31.3	17	19.8
School/university	26	15.4	9	10.8	17	19.8

Source: own elaboration.

Regarding the entire sample, the vast majority of people obtain information on ecology from the Internet (78.7%). Following in second place is social media, from which 56.6% of respondents get their information. The least frequently chosen source of ecological information by respondents is journals and magazines, used by 17.1% of respondents.

Subsequently, respondents were asked about the appearance of particular environmental problems where they live (Table 4). The rating was made on a scale from 1 - definitely not present to 5 - definitely present. Here and hereafter, detailed data by rating is presented for the total sample. Only weighted average ratings are given separately for urban and rural residents.

Table 4.*Occurrence of ecological problems in the respondents' place of residence*

Ecological problems	Rating										Weighted average rating		
	1		2		3		4		5		Total sample	City	Village
	N	%	N	%	N	%	N	%	N	%			
Non-ecological consumer behavior	10	5.9	24	14.2	25	14.8	61	36.1	49	29.0	3.68	3.82	3.55
Improper waste management in the region	9	5.3	32	18.9	37	21.9	45	26.6	46	27.2	3.51	3.53	3.42
Climate change	11	6.5	38	22.5	25	14.8	53	31.4	42	24.9	3.46	3.78	3.22
Low use of renewable energy sources	17	10.1	24	14.2	33	19.5	60	35.5	35	20.7	3.43	3.57	3.30
Air pollution	20	11.8	49	29.0	11	6.5	43	25.4	46	27.2	3.27	3.75	2.81
Water pollution	16	9.5	62	36.7	22	13.0	41	24.3	28	16.6	3.02	3.18	2.81
Soil pollution	17	10.1	58	34.3	30	17.8	41	24.3	23	13.6	2.97	3.10	2.85
Lack of green spaces	62	36.7	43	25.4	12	7.1	22	13.0	30	17.8	2.50	3.05	1.97

Source: own elaboration.

The region's residents identified non-ecological consumer behavior as the biggest problem, accounting for 65.1% of them indicating answers 4 and 5. This means that many people around them do not care enough about the environment. More than half of the respondents believe that inadequate waste management in the region, i.e. collection, processing, disposal of waste, is very common. Climate change and the low use of renewable energy sources among the region's residents are also significant concerns. A comparison of the respondents' answers from both areas reveals the intensity of environmental problems is higher in cities than in villages. Higher weighted average ratings for all mentioned problems confirm this.

The analyses conducted confirm hypothesis 1.

To verify hypothesis 2, respondents were asked two questions. In the first, respondents were asked to identify among the twenty proposed activities which are environmentally friendly. Respondents were not informed about the number of environmentally friendly activities or which ones are of this nature. Table 5 presents their responses (grey color indicates non-ecological activities). Respondents could mark more than one answer, so the results do not sum to 100%.

Table 5.*Evaluation of activities belonging to pro-ecological ones*

Activities	Answer: YES					
	Total sample		City		Village	
	N	%	N	%	N	%
Waste segregation by residents	153	90.5	77	92.8	76	88.4
Saving water	129	76.3	68	81.9	61	70.9
Planting trees	122	72.2	63	75.9	59	68.6
Saving electricity	110	65.1	54	65.1	56	65.1
Choosing reusable packaging	104	65.1	56	67.5	48	55.8
Selective waste collection by the municipality	110	61.5	57	68.7	53	61.6
Using public transport	85	50.3	43	51.8	43	50.0
Participation in world cleaning actions	71	42.0	35	42.2	36	41.9
Investments for ecology	77	45.6	42	50.6	35	40.7

Cont. table 5.

Buying organic products	67	39.6	33	39.8	34	39.5
Encouraging friends to take pro-ecological actions	61	36.1	32	38.6	29	33.7
Bringing non-ecological behavior to others' attention	50	29.6	26	31.3	24	27.9
Promoting ecological slogans	45	26.6	27	32.5	18	20.9
Purchase of a hybrid/electric car	32	18.9	18	21.7	14	16.3
Using air transport	20	11.8	10	12.0	10	11.6
Using disposable packaging, dishes, etc.	17	10.1	8	9.6	9	10.5
Using cars and other combustion vehicles	10	5.9	3	3.6	7	8.1
Buying products for storing	5	3.0	1	1.2	4	4.7
Using fertilizers and pesticides	2	1.2	0	0.0	2	2.3
Burning waste	4	2.4	3	3.6	1	1.2

Source: own elaboration.

More than 50% of the region's residents considered activities with numbers 1 through 7 as pro-ecological. It is worth noting that in recent years they have been promoted in the mass media. The vast majority of respondents consider waste segregation as a pro-ecological activity. Slightly fewer respondents include saving water and planting trees. However, each item in the environmental action group was marked more often by urban residents. The listed non-ecological behaviors were considered ecological by a few respondents, with slightly more respondents living in rural areas. Therefore, it can be concluded that the region's residents can distinguish between ecological and non-ecological behavior, and their knowledge is greater for activities about which information is widely available.

The second question concerned the possibility of receiving funding to adapt a household to environmental requirements under specific programs implemented at the national or regional level. Respondents provided answers on a scale: 1 - I don't know anything about this program, 2 - I have heard about it but don't know exactly what it is about, 3 - I know what it is about but I don't use it, 4 - I intend to use it, 5 - I have used or am using it. They are presented in Table 6.

Table 6.

Financing pro-ecological activities in the opinion of respondents

Types of financing	Rating										Weighted average rating		
	1		2		3		4		5		Total sample	City	Village
	N	%	N	%	N	%	N	%	N	%			
For photovoltaic installation	16	9.5	32	18.9	57	33.7	14	8.3	50	29.6	3.30	3.23	3.34
For replacing the furnace	18	10.7	32	18.9	71	42.0	20	11.8	28	16.6	3.05	3.01	3.09
For the purchase of a heat pump	25	14.8	34	20.1	80	47.3	14	8.3	15	8.9	2.75	2.81	2.72
For rainwater tanks	51	30.2	33	19.5	46	27.2	19	11.2	19	11.2	2.52	2.63	2.45
For window replacement	50	29.6	31	18.3	58	34.3	19	11.2	10	5.9	2.44	2.46	2.45
For the purchase of electric cars	60	35.5	42	24.9	58	34.3	7	4.1	1	0.6	2.08	2.28	1.92
For the replacement of window sills	76	45.0	28	16.6	49	29.0	11	6.5	4	2.4	2.03	2.12	1.98

Source: own elaboration.

Most respondents know (answers 3, 4, 5) about the possibility of obtaining all the listed subsidies. Most people (71.6%) claim familiarity with subsidy programs for photovoltaic installation, furnace replacement (70.4%) and heat pump purchase (64.5%). However,

few respondents implemented these solutions in practice. The largest number of residents in the region have used or intend to use subsidies for photovoltaic installation (37.9%), slightly fewer (28.4%) for furnace replacement and only 17.2% for heat pump purchase. It should be noted that these three programs are the most heavily promoted in the mass media, while bringing the most benefits to their consumers and the environment. The least known are subsidy programs for replacing window sills and purchasing electric cars - a significant percentage of respondents (45% and 35.5%, respectively) have no knowledge of them. The region's least popular subsidies are replacing window sills (8.9% of respondents intend to use or have used them) and purchasing electric cars (4.7%). The possibility of replacing window sills and windows is not sufficiently promoted in the mass media, and implementing these measures is accompanied by other costs associated with the building renovation. For electric cars, there is a divergence of opinion - not everyone believes that it is an ecological solution. Despite the subsidies, the purchase costs are quite substantial. Comparing the data for urban and rural areas, it can be noticed that the weighted average ratings for most of the listed urban subsidy programs were higher than for rural areas. The exceptions are subsidies for photovoltaics and furnace replacement, which may be due to additional support for rural residents under rural development programs.

The analysis of respondents' answers to the two questions above does not provide the basis for rejecting hypothesis 2 and confirms that urban residents have a higher level of environmental awareness than rural residents. However, it should be noted that the observed differences are not large.

Hypothesis 3 concerned taking pro-ecological measures by residents of the Lublin region. Table 7 presents respondents' answers given on a scale from 1 - I don't do it at all to 5 - I do it very often.

Table 6.
Respondents' undertaking pro-ecological activities

Activities	Rating										Weighted average rating		
	1		2		3		4		5		Total sample	City	Village
	N	%	N	%	N	%	N	%	N	%			
I segregate waste	5	3.0	3	1.8	20	11.8	39	23.1	102	60.4	4.36	4.46	4.27
I don't waste food	4	2.4	12	7.1	33	19.5	49	29.0	71	42.0	4.01	4.01	4.01
I save water	3	1.8	8	4.7	37	21.9	58	34.3	63	37.3	4.01	4.04	3.98
I choose reusable packaging	16	9.5	7	4.1	30	17.8	52	30.8	64	37.9	3.83	3.94	3.73
I save electricity	10	5.9	10	5.9	44	26.0	44	26.0	61	36.1	3.80	3.83	3.78
I use biomass (e.g. I heat my house with wood)	42	24.9	11	6.5	29	17.2	29	17.2	58	34.3	3.30	2.75	3.85
I use organic products	16	9.5	30	17.8	54	32.0	31	18.3	38	22.5	3.27	3.40	3.16
I use renewable energy sources	54	32.0	15	8.9	17	10.1	27	16.0	56	33.1	3.09	2.99	3.20
I collect rainwater	50	29.6	18	10.7	24	14.2	23	13.6	54	32.0	3.08	2.86	3.31
I plant trees	34	20.1	20	11.8	46	27.2	38	22.5	31	18.3	3.07	3.94	3.14
I use public transport or a bike	40	23.7	25	14.8	38	22.5	26	15.4	40	23.7	3.01	3.35	2.67

Cont. table 6.

I draw others' attention to unecological behavior	39	23.1	26	15.4	48	28.4	30	17.8	26	15.4	2.87	2.92	2.83
I encourage my friends to care for the environment	39	23.1	29	17.2	55	32.5	32	18.9	14	8.3	2.72	2.83	2.62
I promote ecological slogans and activities	60	35.5	32	18.9	37	21.9	25	14.8	15	8.9	2.43	2.63	2.23
I participate in world cleaning actions	59	34.9	39	23.1	41	24.3	18	10.7	12	7.1	2.32	2.37	2.27

Source: own elaboration.

Respondents' two most common pro-ecological activities were separating waste, not wasting food and saving water - weighted average ratings above 4. The high position of the first activity is not surprising, since segregating garbage is the residents' obligation. However, it may be surprising that almost 10% of respondents do not segregate waste or do it occasionally (responses 1 and 2). The second activity - not wasting food - indicates changes in people's shopping attitudes. According to research, in Poland, more than half of wasted food comes from households (Oszczędź sobie..., 2024). The fact that 83.5% of respondents do not waste food is probably due not only to a desire to save money, but also for ethical and environmental reasons and a desire to follow the principles of the Zero Waste concept. Another activity that most respondents (71.6%) perform often or very often is saving water, resulting directly in financial savings. The least frequently practised activities are participating in world cleaning campaigns and promoting environmental slogans and activities - just over a third of respondents have never done this. Such campaigns have been undertaken in Poland for 30 years, including in the Lublin region, with many people participating. Respondents' low involvement may result from a lack of time or insufficient information.

Comparing the respondents' answers, it should be noted that urban residents were much more likely to indicate ratings of 4 and 5 than rural residents. Weighted average ratings are also higher for urban areas for 11 of the 15 pro-ecological measures proposed for evaluation. The exceptions are not wasting food, where the weighted average ratings are the same, and the use of biomass, use of renewable energy sources and rainwater collection, where they are slightly higher for rural areas. Therefore, there is no basis for rejecting hypothesis 3.

Residents were then asked what motivates them to be pro-ecological. Respondents were asked to rate each proposed motivator on a scale from 1 - no impact to 5 - very high impact. The responses are presented in Table 7.

Table 7.
Factors motivating respondents to adopt a pro-ecological attitude

Factors	Rating										Weighted average rating		
	1		2		3		4		5		Total sample	City	Village
	N	%	N	%	N	%	N	%	N	%			
Personal values and beliefs	9	5.3	10	5.9	31	18.3	54	32.0	65	38.5	3.92	4.04	3.81
Ecological awareness	8	4.7	12	7.1	30	17.8	63	37.3	56	33.1	3.87	3.92	3.83
Educational programs	7	4.1	16	9.5	37	21.9	52	30.8	57	33.7	3.81	3.87	3.74
State of the local environment	14	8.3	12	7.1	29	17.2	55	32.5	59	34.9	3.79	3.86	3.72
Available ecological information	12	7.1	14	8.3	37	21.9	61	36.1	45	26.6	3.67	3.82	3.52
Noticeable or anticipated financial benefits	9	5.3	22	13.0	36	21.3	56	33.1	46	27.2	3.64	3.67	3.60
Observed attitudes in the family and environment	18	10.7	15	8.9	35	20.7	52	30.8	49	29.0	3.59	3.59	3.58
Media and social campaigns	16	9.5	19	11.2	34	20.1	55	32.5	45	26.6	3.56	3.66	3.47
Available ecological technologies	19	11.2	15	8.9	40	23.7	59	34.9	36	21.3	3.46	3.40	3.52
Local culture	17	10.1	20	11.8	43	25.4	52	30.8	37	21.9	3.43	3.47	3.38
Available financial subsidies	25	14.8	15	8.9	42	24.9	48	28.4	39	23.1	3.36	3.37	3.37
Government and local programs	23	13.6	25	14.8	46	27.2	46	27.2	29	17.2	3.20	3.31	3.08

Source: own elaboration.

All the factors mentioned in the survey have an impact on building the ecological attitude of the region's residents. They are most motivated by their own values and personal beliefs, with 70.5% of respondents answering 4 and 5, and a weighted average of 3.92. Almost the same result occurs with ecological awareness. Education and information about ecology are quite important in building pro-ecological attitudes. Attitudes such as these also result largely from observing the state of the local environment. It is worrying that financial subsidies and government and local programs are the least likely to activate respondents to be "eco" (weighted average ratings of 3.36 and 3.2, respectively). There are no significant differences between urban and rural residents, although almost all factors affect urban residents slightly more. Among those proposed for evaluation were internal motivators, which derive from personal beliefs and values, and external motivators, based on incentives from the environment. Respondents' answers analysis reveals that internal factors (e.g., values, beliefs, desire for financial benefits) contribute slightly more strongly to building respondents' pro-ecological attitudes than external factors (education, information, ecological programs, etc.). The differences are more noticeable in urban areas. Regarding the entire sample, they are so insignificant that Hypothesis 4 cannot be confirmed with absolute certainty that internal factors are more influential than external ones.

Hypothesis 5 assumed that people with higher education levels showed more advanced pro-ecological attitudes. Table 8 presents data on the frequency of undertaking the environmental activities listed in Table 6 by level of education.

Table 10.*Respondents' undertaking of pro-ecological activities divided by education*

Activities	Weighted average rating			
	Higher	Secondary	Vocational	Elementary
I segregate waste	4.21	3.91	3.78	3.75
I don't waste food	4.58	4.24	4.09	4.25
I save water	4.33	3.82	3.65	3.63
I choose reusable packaging	4.14	3.74	3.35	3.25
I save electricity	4.22	3.61	3.22	3.38
I use biomass (e.g. I heat my house with wood)	3.04	3.44	3.52	3.75
I use organic products	3.61	3.05	2.96	2.88
I use renewable energy sources	2.93	3.32	3.13	2.63
I collect rainwater	3.17	2.97	3.00	2.13
I plant trees	3.06	3.21	2.83	3.13
I use public transport or a bike	3.31	2.85	3.04	2.88
I draw others' attention to unecological behavior	3.03	2.88	2.74	1.75
I encourage my friends to care for the environment	2.96	2.70	2.61	1.50
I promote ecological slogans and activities	2.79	2.23	2.13	1.63
I participate in world cleaning actions	2.63	2.17	2.00	1.75

Source: own elaboration.

People with higher education are more involved practically in all environmental activities. Exceptions include activities such as the use of biomass, the use of renewable energy sources and rainwater collection. However, the validity of the inference for this question is slightly limited, as the survey included 72 people with higher education, 23 with vocational education, 66 with secondary education and only 8 with primary education. Nevertheless, hypothesis 5 can be considered confirmed.

5. Conclusions

Research has revealed that a pro-ecological attitude is important to Lublin region residents. People living in cities and villages are undertaking a variety of pro-ecological activities, which is optimistic concerning the region's environmental protection and resilience. People's attitudes are the result of complex processes and are influenced by factors such as: values and beliefs, information and knowledge, personal experiences, contacts with other people or situations, emotions, social influences, actions of public, economic, and social entities. Internal and external motivators affect the behavior of urban and rural residents with varying degrees of intensity. It's worth considering what can be changed, added, better targeted to support pro-ecological attitudes.

Based on the analysis of respondents' answers, proposals were formulated to strengthen the pro-ecological attitudes of Lublin region residents. Since they depend to the greatest extent on people's values and beliefs and ecological awareness, educational activities should be intensified. Residents need to understand why it is worth taking care of the environment. It is necessary to organize information campaigns, workshops and training on ecology,

environmental protection and sustainable lifestyles for different age groups. Relevant topics can be introduced into the primary and secondary school curriculum through various activities, environmental weeks and competitions can be implemented, students can be involved in developing environmental projects, field trips to local environmental organizations can be organized. It is worthwhile to take advantage of the interesting environmental projects of International Development Norway (Climate protection in Norway..., 2024). Ecological education for adults can take many forms. For professionally active people, educational workshops can be held at workplaces. For the unemployed, such projects could be organized by local government units, local non-government organizations, universities of the third age, cultural centers, schools and universities.

A significant role in developing pro-ecological attitudes comes from various social campaigns promoting, for example, proper segregation of waste, energy and water conservation, reduction of plastic consumption, choosing public transportation or bicycles instead of cars. Initiatives such as conducting regular information campaigns on Facebook, Instagram or TikTok to promote ecological habits and their benefits can be helpful. A way to reach a wide range of people is to engage influencers. Information promoting pro-ecological practices can be conveyed to older people through articles and guides in local newspapers, radio and television spots, leaflets in clinics, offices, etc.

The Institute for the Development of Ecological Thought conducts a variety of projects aimed at implementing sustainable development principles and raising public awareness in this regard. An interesting solution is the ecological calendar, which includes all the popular "ecological days". Its popularization, as well as the organization of relevant events by local authorities and pro-ecological organizations, would help educate and inspire urban and rural residents to take small actions and change their habits to a more pro-ecological one (Instytut Rozwoju Myśli Ekologicznej..., 2024).

Financial incentives, i.e. introducing discounts and subsidies for those who choose environmentally friendly solutions, play an important role in building pro-ecological attitudes. Many such programs are already being implemented. People who participated in the surveys have information on the ongoing programs. However, their motivational impact is not significant. Programs such as "Clean Air," "My Electricity," "My Water" and others have great potential, but their implementation encounters some difficulties, including overly complicated bureaucracy, which delays the implementation of applications and discourages residents from submitting them. Various media campaigns are also being conducted to strengthen the environmental awareness of urban and rural residents. They present ecological problems, the consequences of destroying nature, and prove the necessity of environmental care. However, many experts believe that these campaigns often do not reach a wide enough audience or are not convincing enough to change people's daily habits.

To develop the ecological attitudes of urban and rural residents, there is a need for cooperation between authorities, environmental organizations and associations, business, educational and scientific institutions. Developing ecological awareness effectively for people of different ages is possible by achieving a synergistic effect of interaction between many participants. Each plays an important role, but only coordinated action, based on shared goals and an understanding of the challenges, will enable real change and build more stable, resilient and adaptive communities that can weather crises and thrive despite the challenges that arise.

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DIGITIZATION OF SMALL ENTERPRISES – DIGITAL LEADERSHIP

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Purpose: Ubiquitous digitalization requires the management of companies to develop a special type of leadership - digital leadership. It involves holistically combining human and technological aspects. The article aims to present theoretical and empirical research on digital leadership in small enterprises in their innovation contexts.

Design/methodology/approach: The study is based on two research methods. The first was the literature critique method, the application of which made it possible to develop the methodological assumptions for the research. The second is the diagnostic survey method, a questionnaire technique used to conduct empirical research on a sample of 131 small enterprises. The results made it possible to assess the digital leadership level of the surveyed units regarding their innovation.

Findings: Digital leadership was assumed to consist of activities from three leadership concepts: transactional, transformational and authentic leadership. Research has shown that the digital leadership level in small enterprises is low. Their leaders undertake few actions from each of the three leadership concepts, the worst situation being for transformational leadership. This negatively affects the enterprises' innovation.

Research limitations/implications: The research conducted brought closer the digital leadership issue in small enterprises and allowed verification of the adopted research assumptions. Further research will compare digital leadership levels in enterprises by size, age and industry.

Practical implications: Research has revealed that a low digital leadership level may be responsible for the problems associated with digitizing the operations of small enterprises. Based on them, many recommendations for leaders can be developed.

Originality/value: The survey's originality lies in the development of a concept for assessing the digital leadership level, considering the small business specifics.

Keywords: digitization, small enterprises, digital leadership.

Category of the paper: Research paper.

1. Introduction

Today's organisations and their leaders must operate in a turbulent, non-linear and unpredictable socio-economic environment. Change has become a regular part of everyday business life. Dynamic technology development, ubiquitous digitisation and working in a virtual environment require the permanent development of digital competences by managers and employees of all spheres and levels of management. The challenges of digitisation in today's economy are particularly difficult for small enterprises without sufficient financial, technical, time and competence resources (Mieszajkina, 2020; Mieszajkina, Myśliwiecka, 2022). Their leaders, who are most often business owners, are required to have many skills. In addition to the traditional, business-related aspects, they should learn to manage distributed, remote, multicultural and generationally diverse teams. Increasing expectations both internally and externally require leaders to be highly flexible and able to deal with a variety of leadership situations. All this emphasises the need to master new leadership competences to respond effectively to the challenges of today's digital economy.

The MSME (micro, small and medium-sized enterprises) sector constitutes the overwhelming majority of enterprises in Poland – 99.8%. In the overall structure of Polish enterprises, the share of microenterprises is 97.2%, small enterprises – 2.1%, medium-sized enterprises – 0.6%, large enterprises – 0.2%. Slight fluctuations in this structure have been noted over the last decade. Since 2013, there has been a steady increase in the share of micro and large enterprises. However, the share of small and medium-sized units is declining, with the largest decline in small enterprises (PARP, 2024). Therefore, it is important to consider what exogenous and endogenous barriers small enterprises encounter, which hinder their effective functioning and development.

Globalisation and digitalisation processes are opening up a wide range of opportunities for small enterprises to strengthen and expand their operations. Whether they notice them and use them effectively depends to a large extent on their leaders. Therefore, the presented research aims to assess the level of digital leadership in small enterprises in the context of their innovation.

2. Digital leadership

Burns (1978) wrote almost fifty years ago that leadership is one of the most frequently observed yet most poorly understood phenomena in the world. Although much research has since been conducted to establish its essence, no consistent definition has been developed. Stodgill (1990) stated that there are almost as many different definitions of leadership as there

have been people trying to formulate them. In the digital leadership case, the history of explaining its nature is much shorter.

The term digital leadership refers to leaders taking the right actions to manage the digitisation of an organisation (El Sawy et al., 2016). In general, digital leadership is about holistically combining human and technological aspects, creating a clear vision of how information and communication technologies (ICT) can support the organisation's business goals. In the already quite extensive literature on management in the digital era, various definitions of digital leadership can be found. According to Ordu and Nayr (2021, p. 69), it is “creating an innovative vision by using technology effectively in managerial processes to create a sustainable change culture in the organization”. Zhu et al. (2022, p. 2) define digital leadership as „the leaders’ ability to create a clear and meaningful vision for the digitalization process and the capability to execute strategies to actualize it”. However, Oberer and Erkollar (2018) describe digital leadership as transcending traditional hierarchies, focusing on teamwork, and striving to increase organizational innovation. Tabrizi et al. (2019) emphasize that digital transformation requires leaders to understand its key processes and adapt organizational solutions to them. To develop and implement a digital business model, they need to focus on changing systems, processes, organizational culture, and the mindset of employees. Promsri (2019) believes that digital leadership envisions a shift in the leaders' mindset about connecting people and digital technologies for organizational benefit.

As Kane et al. (2019), emphasize, in times of digital transformation, strong leaders are needed who are not only charismatic visionaries, but who can lead organizations toward digital maturity. Their tasks include finding and attracting talent, motivating employees to continuously learn and step outside their comfort zone. They must be excellent organizers creating conditions for experimentation and cooperation across all boundaries, even remotely. In addition, they should mentor and support employees in difficult situations. The goal that leaders strive for remains unchanged: long-term value growth for the business they lead.

A digital leader must be aware of the latest technological developments; decide which are threats or opportunities; manage their impact on internal processes, products and services; provide employees with the necessary digital knowledge and support them through change and uncertainty (Gilli et al., 2024; Kane et al., 2019). The broad set of competencies that a “traditional” leader should possess is being expanded in the digital age. Among them, the most frequently mentioned are (Avolio et al., 2014; De Neve et al., 2013; Leavy, 2020):

- having the digital knowledge to develop vision and digital business models;
- becoming a role model in finding oneself in the digital reality;
- exerting a positive influence, especially on the attitudes and behaviours of employees who are influenced by digital technologies;
- developing the organization's members' cooperation in the digital environment and their ability to use digital technologies creatively;
- motivating digital behaviour.

Phakamach et al. (2023) believe that a digital leader should have competences in the following areas:

- 1) Communication/Collaboration.
- 2) Vision and Focus.
- 3) Digital Literacy.
- 4) Strategic Thinking/Planning.
- 5) Technology and Innovation.
- 6) Think Critically and Risk-Taking.
- 7) Adaptability and Responsibility.
- 8) Talent Identification.

Summarizing the consideration of digital leadership, it can be said that its essence is not fundamentally different from leadership in “traditional” business. Similarly, it is about strategically using the organization's resources and influencing the behaviour of its members to achieve business goals. The difference involves learning an additional competency: acquiring the knowledge, skills and attitudes necessary to use ICT in responding to endogenous and exogenous changes. Digital transformation of leadership is less related to technical-technological aspects, it is mainly related to strategy, structure, culture, cooperation, employee and stakeholder behaviour. A digital leader doesn't need to understand the intricacies of how technology works, they should focus more on where and how to use it to gain a competitive advantage (Carvalho et al., 2022; Leavy, 2020).

3. Digital leadership model

Many theories have emerged in leadership research and have changed over time. Digitization of business processes creates new approaches to define the essence of leaders' work and their role in the organization. Modern leaders are developing dynamic, flexible leadership styles based on collaboration and the opportunities provided by ICT. Dinh et al. (2014) conducted an extensive qualitative review of 66 leadership theories presented in 10 leading academic publications. Their research indicates that all approaches are interrelated through three macro theories: transactional, transformational and authentic leadership. These findings were used by Prince (2018) to develop a digital leadership research model. She assumed that in the digital age, a leader should flexibly combine three types of leadership, adapting to the situation faced by one's organization (Figure 1).



Figure 1. Complex Digital Leadership Framework.

Source: Prince, 2018.

Transactional leadership involves the leader cooperating with subordinates, clarifying their roles and tasks. Leaders engage in a transactional relationship with members of the organization, which involves mutually setting expectations and possible gratification for task completion. Use a system of rewards and punishments to achieve goals, control, strive to minimize mistakes and prevent undesirable behaviour (Prince, 2018; Bass, Riggio, 2010; Stoner et al., 2011; Yukl, 2013). Transactional leadership assumes that employees' interests can be aligned with those of the organization if they are properly motivated (Hutama et al., 2024; Santosa et al., 2023). Therefore, for transactional leadership to be effective, it is necessary to constantly monitor and meet the evolving needs of subordinates, as well as skilfully influence their behaviour (Czermiński et al., 2001). According to Santosa et al. (2023, p. 2), the relationship between a transactional leader and an employee manifests itself in three situations: „the leader knows what employees want and explains what they will get if their work follows expectations, the leader exchanges the efforts made by employees for rewards, and the leader is responsive to the personal interests of employees as long as those interests are proportional to the value of the work the employee has done”. Therefore, the achievement of the organization's goals mainly depends on the employees' effectiveness in achieving predetermined personal performance goals (Santosa et al., 2023).

The transformational leadership theory involves activating employees, encouraging them to think about the interests of the organization, transcending formal requirements, personal and professional development (Griffin, 2005; Jemielniak, Koźmiński, 2011; Karaszewski et al., 2019; Potocki, 2005; Türk, 2023). Transformational leaders are characterized by charisma, empathy and intellectual stimulation (Makin et al., 2000). They analyse development trends and work proactively to shape the organization's future (Wu, Wang, 2015). They strive for real transformation of the organization by implementing sustainable, self-perpetuating changes that stimulate further growth (Kozioł-Nadolna, 2022; Andoko et al., 2024). Transformational

leaders help employees solve problems, encourage them to look at them from a new perspective. In this way, they motivate members of the organization to undertake creative activities beyond their duties leading to the achievement of the organization's vision (Saleh et al., 2018; Qaradaghi Ahmed, 2024; Andoko et al., 2024; Pradhan Pradhan, 2015).

Authentic leadership is understood as „a vocation to serve and be useful to others through the privileged position that you have” (Calderon-Mafud, Pando-Moreno, 2018, p. 48). Walumbwa et al. (2008) identified five dimensions: self-awareness, relational clarity, cognitive flexibility, self-control, and a high moral compass. The leader sets a good example for subordinates and also helps them achieve authenticity. Is transparent in relationships, open to cooperation, ethical, and moral. In the organization, a climate of compliance is created between beliefs, actions and actual achievements. This encourages the emergence of trust, has a positive effect on improving relationships, increasing productivity, willingness to act creatively and innovatively (Avolio, Gardner, 2005; Baczyńska, 2018; Wong, Cummings, 2009; Sohail, 2024). Authentic leadership is enhanced by transferring new knowledge, creativity, developing innovative ideas and strategic transformation (Sow, Aborbie, 2018; Tung, 2016). Leaders create a climate of compliance between the beliefs, actions and achievements of individual employees, which fosters trust, improves relationships and increases productivity (Avolio, Gardner, 2005; Baczyńska, 2018; Mockało, 2013; Wong, Cummings, 2009).

Analysing the approaches of various authors, Prince concludes that in the digital age, digital leadership consists of activities from all three concepts discussed above: transactional, transformational, and authentic. The model presented in Figure 1 includes pure and mixed spheres. This means that each type of leadership can either exist in its pure form or overlap with one of the others. It also happens that all three types of leadership coexist and overlap. For a leader, this means that he should deepen his competencies resulting from each leadership concept. The principle of the systemic approach should be considered: it is easiest to acquire competences in pure areas, and the most difficult is to create a set of them in a situation where all three concepts are combined (Prince, 2018).

For analysing digital leadership, a holistic approach that considers both technological and human aspects needs to be applied. Schiuma et al. (2021) created a digital leadership compass that shows the key competencies of a digital leader (Figure 2).

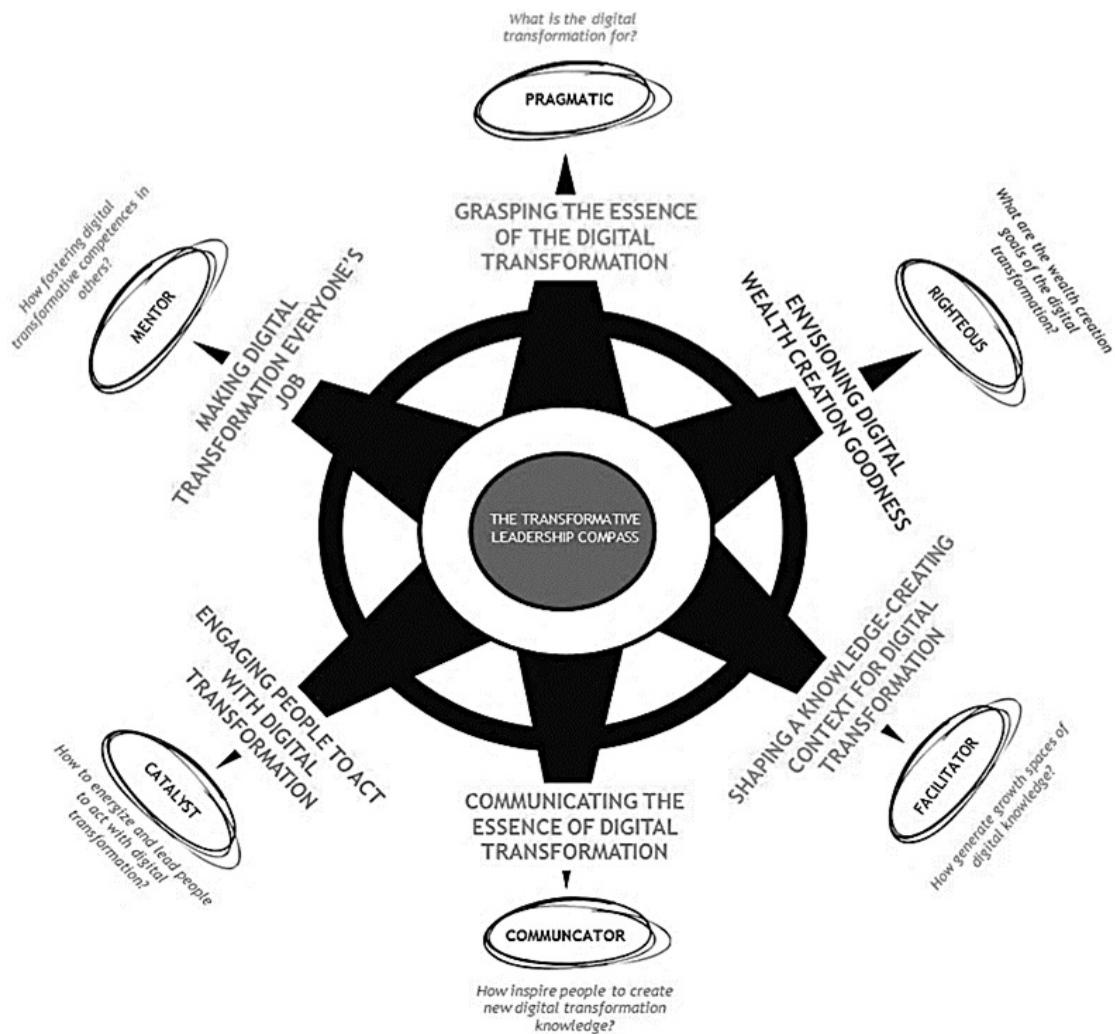


Figure 2. The transformative leadership compass. Complex systems of polygamous holes made from one cluster to several coal deposits.

Source: Schiuma, Schettini, Santarsiero, Carlucci, 2021, p. 127.

The six key competencies that a leader leading an organization through digital transformation should possess are:

1. Grasping the essence of digital transformation – the ability to integrate digital knowledge with business challenges, enabling effective problem solving. The leader understands the purpose of digital transformation and has at least basic technological knowledge.
2. Envisioning digital wealth creation goodness – the ability to make decisions to achieve positive results from digitization, while considering the principles of organizational sustainability.
3. Shaping a knowledge-creating context for digital transformation – the ability to create an environment conducive to acquiring digital knowledge by the organization's employees. Ability to connect virtual and real workplaces and facilitate knowledge exchange.

4. Communicating the essence of digital transformation – the ability to communicate the essence, goals and objectives of digital transformation to employees in an understandable, inspiring way.
5. Engaging people to act with digital transformation – the ability to engage all employees in the organization's digital transformation process and overcome barriers caused by differences in generations, cultures and professional roles.
6. Making digital transformation everyone's job – the ability to promote digital transformation and support the development of employees' digital competencies.

In today's rapidly changing business world, adopting digital leadership is essential for organizations aiming to grow and strengthen their competitive position. This also concerns small enterprises, which often have to balance the demands of digitization with limited resources. This requires their leaders to possess a variety of competencies, including digital.

4. Research Methodology

The research procedure comprised several stages. Firstly, an in-depth analysis of Polish and foreign literature on digital leadership was conducted using the literature criticism method. It was established that research in this area mostly refers to large business organizations. Considering that management processes, including leadership, in small enterprises have distinct characteristics (Mieszajkina, 2018), a perceived research gap has been identified. The following research problem was formulated: whether and to what extent the leadership activities of small enterprise leaders are consistent with the concept of digital leadership and whether they contribute to strengthening the innovativeness of the unit? In the next stage, the research goal was defined: assessing the digital leadership level of small enterprises in their innovation context. The following hypotheses were formulated:

H1: Small enterprise leaders show the least action in transformational leadership, the most in authentic leadership.

H2: The level of digital leadership in small enterprises is low.

H3: Small enterprises with higher levels of digital leadership prove to be more innovative.

The empirical research was conducted using a diagnostic survey method, an online survey technique. The author's questionnaire contained 25 questions, divided into a substantive section (22 questions) and a metric section (3 questions). The survey was conducted on a random sample of 131 enterprises employing between 10 and 49 people. Data were collected using the CAWI method. The survey questions were answered by leaders owning small enterprises. Table 1 presents the structure of the survey sample by number and percentage of the total sample. In this table and the subsequent ones, the following designations are adopted: NO is the total number of respondents; NG is the number of people in each group; N is the number of people who indicated a given answer.

Table 1.
Structure of the research sample

Specification	Total sample NO = 131		Number of people employed in the enterprise							
			10-19 (NG = 36)		20-29 (NG = 40)		30-39 (NG = 30)		40-49 (NG = 25)	
	N	%	N	%	N	%	N	%	N	%
<i>Age of enterprise</i>										
15 years and more	61	46.57	19	52.78	18	45.00	8	26.67	16	64.00
9 - 14 years	40	30.53	8	22.22	12	30.00	12	40.00	8	32.00
3 – 8 years	24	18.32	9	25.00	7	17.50	8	26.67	0	0.0
less than 3 years	6	4.58	0	0.0	3	7.50	2	6.66	1	4.00
<i>Industry</i>										
Production	26	19.85	9	25.00	8	20.00	6	20.00	3	12.00
Trade	26	19.85	7	19.44	6	15.00	7	23.33	6	24.00
Services	70	53.43	16	44.44	22	55.00	17	56.67	15	60.00
Construction	9	6.87	4	11.11	4	10.00	0	0.0	1	4.00

Source: own research.

5. Research results and analysis

Achieving the research objective required determining how to assess the digital leadership level. The Prince model concept was used (Figure 1), combining three macro leadership theories: transactional, transformational and authentic. The original survey instrument from this model could not be used because the survey was conducted on a sample of CEOs of Australian corporations. Leadership in small and large businesses differs significantly in many ways. In small enterprises, leaders are involved not only in establishing a vision and development strategy but also in day-to-day operations. They have direct contact with employees and stakeholders, which facilitates the building of trust relationships and allows them to make quick decisions and respond flexibly to changes. In corporations, leadership is distributed, this function is performed by leaders at different levels of the organizational hierarchy. Corporate CEOs focus on strategic and developmental aspects and have limited contact with employees, making it difficult to form relationships. Significantly less often than in the small business, the organization is identified with the person of its leader.

An in-depth analysis of the transactional (TL), transformational (TFL) and authentic (AL) leadership theories allowed the authors to prepare a survey questionnaire adapted to the specifics of small enterprises. Each of the three leadership types is described by seven questions. Respondents were asked to indicate whether they took the actions specified in the question (1 - yes, 0 - no). This research uses a nominal scale, which allows the set of results to be divided into separate subsets based on having or not having a given characteristic (Encyklopedia Zarządzania, 2024).

To verify hypothesis 1, respondents' answers regarding the undertaking of specific digital leadership activities were analysed. Questions regarding each leadership type, are presented in Table 2. Respondents' answers are presented numerically (N is the number of people who answered YES to the given question) and as a percentage of the total sample.

Table 2.

Activities undertaken by small enterprises leaders in TL, TFL, AL

Type of leadership	Leader's activities	Responses			
		Yes		No	
		N	%	N	%
Transactional Leadership (TL)	TL1: I motivate employees to take action in the field of digitization	19	14.50	112	85.50
	TL2: I encourage employees to strengthen positive attitudes toward digitization	36	27.48	95	72.52
	TL3: I support employees in reporting and implementing their own digital initiatives	63	48.09	68	51.91
	TL4: I provide employees with opportunities to regularly update digital competencies through a formal learning and development program	15	11.45	116	88.55
	TL5: I make employees aware that digital solutions contribute to the company's revenue, which affects their compensation	19	14.50	112	85.50
	TL6: I follow employees' activities related to their digital initiatives	19	14.50	112	85.50
	TL7: I explain to employees what they can expect as a result of expanding their digital competencies	25	19.08	106	80.92
Transformational leadership (TFL)	TFL1: I regularly identify enterprise development opportunities that result from digitalization	46	35.11	85	64.89
	TFL2: I systematically and actively seek and implement product/service innovations based on digital technologies	36	27.48	95	72.52
	TFL3: I actively cooperate with stakeholders in the implementation of digital technologies	15	11.45	116	88.55
	TFL4: I make sure that the enterprise has a coherent strategy based on digital solutions	19	14.50	112	85.50
	TFL5: I prioritize initiatives related to digitalization	18	13.74	113	86.26
	TFL6: I empower employees to experiment with and implement digital initiatives	12	9.16	119	90.84
	TFL7: I aim to digitize most internal processes and interactions with external partners	37	28.24	94	71.76
Authentic leadership (AL)	AL1: I encourage employees to develop and implement digitization ideas	67	51.15	64	48.85
	AL2: I make sure to update and develop digital competencies of employees	42	32.06	89	67.94
	AL3: I systematically analyse and adjust the enterprise business model to take advantage of new digital revenue-generating opportunities	15	11.45	116	88.55
	AL4: I make sure that the enterprise invests in digital technologies in a systematic and planned way	38	29.01	93	70.99
	AL5: I provide employees with the information necessary to increase the effectiveness of their work related to the digital technology use	61	46.56	70	53.44
	AL6: I analyse and update the enterprise's strategy in terms of digitalization of specific areas and activities	42	32.06	89	67.94
	AL7: I constantly analyse and develop the enterprise's presence in the digital space and I create the digital culture of the enterprise	32	24.43	99	75.57

Source: own research.

Table data indicates that few leaders engage in most digital leadership activities. In the case of TL, about half of the respondents support employees in reporting and introducing their digital initiatives (TL3). Nearly a third of them encourage employees to strengthen positive attitudes

toward digitization (TL2). The remaining five questions were answered positively by less than 20% of enterprise owners. The results regarding TFL are even more pessimistic: only slightly more than a third of respondents confirmed having regularly identified enterprise development opportunities that result from digitization (TFL1). Two activities: I systematically and actively seek and implement product/service innovations based on digital technologies (TFL2) and strive to digitize most internal processes and interactions with external partners (TFL7) were confirmed by about 28% of respondents. The remaining 4 activities were declared by approximately 10% of them. Activities regarding AL are confirmed by the majority of respondents. About half of them activate employees to develop and implement digitization ideas (AL1) and provide employees with the information they need to make their work related to the use of digital technologies more efficient (AL5). The remaining activities are declared by about one-third of the leaders, except for activity AL3: I systematically analyse and adjust the enterprise's business model to take advantage of new digital revenue-generating opportunities. Perhaps such a low rating was due to the reference to a business model that enterprises do not have.

Following this, it was summarized how many activities in each type of leadership are undertaken by the leaders of the surveyed enterprises. The summary is presented in Table 3.

Table 3.

Total activities undertaken by small enterprises leaders divided into TL, TFL, AL

Type of leadership	Number of activities undertaken															
	0		1		2		3		4		5		6		7	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Transactional Leadership (TL)	30	22.90	45	34.35	30	22.90	17	12.98	7	5.34	0	0.00	2	1.53	0	0.00
Transformational leadership (TFL)	65	49.62	23	17.56	15	11.45	10	7.63	4	3.05	5	3.82	4	3.05	5	3.82
Authentic leadership (AL)	14	10.69	29	22.14	31	23.66	29	22.14	21	16.03	7	5.34	0	0.00	0	0.00

Source: own research.

None of the respondents engaged in all seven activities listed in the survey for the TL and AL. In the case of the TFL, only 5 such people, but at the same time almost half of the respondents do not undertake any such activities. Lack of activities was reported by the fewest people in the area of AL (14), in the area of TL - 30 people. A summary was made of how many leaders report taking more than half of the actions (4 or more) in each leadership type: TL - 9 people (6.87%), TFL - 18 people (13.74%), AL - 28 people (21.37%). The total number of activities undertaken by all leaders is as follows: TL - 196 (average 1.5); TFL - 183 (average 1.4); AL - 297 (average 2.27). Therefore, hypothesis 1 in part one was rejected: the least action small enterprise leaders show in the area of transactional rather than transformational leadership. Whereas it is accepted in the second part: most activities show in the authentic leadership area.

To verify hypothesis 2, it was verified whether respondents took action in each type of leadership: TL, TFL, AL. The maximum they could mark 21 answers to YES, i.e. score 21 points. Table 4 presents leaders' activity - taking or not taking action - in each leadership type.

Table 4.

The activity of small enterprise leaders regarding TL, TFL, AL

Specification	Number of respondents	
	N	%
Leaders with points in each leadership type	56	42.75
Leaders with 0 points in one leadership type, including:	51	38.93
0 points in TL	6	4.58
0 points in TFL	45	34.35
0 points in AL	0	0.0
Leaders with 0 points in two leadership types, including:	14	10.68
0 points in TL and TFL	10	7.63
0 points in TL and AL	4	3.05
0 points in TFL and AL	0	0.0
Leaders with 0 points in three leadership types	10	7.63

Source: own research.

An analysis of the results presented in the table indicates varying activity levels among small enterprise leaders regarding TL, TFL and AL. Less than half of the respondents (42.75%) implement the full range of leadership activities. Leaders who received 0 in one leadership type account for 38.93% of the total research sample, with the majority (34.35%) not active in the TFL and only 4.58% in the TL. In this group, no one received 0 points in AL. One in ten respondents reported being inactive in two leadership types. Among them, 7.63% are not implementing both TL and TFL activities, another 3.05% are not implementing both TL and AL activities. Leaders who did not obtain points in TFL and AL failed to have them in TL simultaneously. Respondents who do not take action in any of the three leadership types account for 7.63% of respondents. A detailed analysis of the responses revealed an apparent problem with TFL, small enterprise leaders are not prepared to involve their team members in the operation digitization process.

According to the Prince model, digital leadership consists of activities from TL, TFL and AL (21 in total). For further analysis, three digital leadership levels were distinguished: low: 1-7 points, medium: 8-14 points, high: 15-21 points.

Table 5.

Digital leadership level in small enterprises

Specification	Digital leadership level					
	low (1-7 points)		medium (8-14 points)		high (15-21 points)	
	N	%	N	%	N	%
Leaders with points in each leadership type	23	17.56	33	25.19	0	0.0
Leaders with 0 points in one leadership type	48	36.64	3	2.29	0	0.0
Leaders with 0 points in two leadership types	14	10.69	0	0.0	0	0.0
Total	85	64.89	36	27.48	0	0.0

Source: own research.

None of the respondents declared enough activities to rate their digital leadership highly. Less than half of the respondents (42.75%) were active in each leadership type. In this group, 33 leaders reached the medium level, and 23 the low level. The maximum number of points obtained in this group is 13, obtained by 4 leaders. In the group of respondents, who did not show activity in one leadership type, only 3 people obtained a medium level, and 48 - a low level. The maximum number of points in this group is 7, this applies to 6 leaders. In the group of respondents, who did not declare activities in two leadership types, 14 people have a low leadership level.

When analysing the leadership level, it is important to consider the systemic aspect, i.e. the interaction of individual TL, TFL and AL activities. A complete lack of activity in one of the leadership types does not allow for achieving synergy effects. Therefore, there is no reason to reject the hypothesis that digital leadership is not high in small enterprises.

To verify hypothesis 3, respondents' answers regarding their companies' approach to innovation were analysed. Respondents' responses are shown in Table 6. Innovation activities are divided into 5 levels, where level 1 means no innovation, and level 5 means having an innovation-based strategy.

Table 6.
Innovative activities of small enterprises

Activities for introducing innovations		Number of respondents	
Level	Activities	N	%
1	We have not introduced any innovations in the last two years	25	19.08
2	We are technologically ready for innovation, but we are not implementing it due to competence shortages	24	18.32
3	Over the past two years, we have introduced or attempted to introduce innovations	46	35.11
4	Over the past two years, we have been systematically implementing the innovation process	24	18.32
5	For several years now, we have been implementing a strategy based on innovative activities and systematically introducing innovations	12	9.16

Source: own research.

Respondents' analysis of their responses indicates that small enterprises are not very active in innovation. Over the last two years, 37.4% of entities have not introduced any innovations, with almost half of them being technologically ready but lacking competences. The largest group of entrepreneurs (35.11%) claims to be involved in innovation activities, but on an irregular basis. Another 18.32% of respondents are systematically implementing the innovation process, and 9.16% are pursuing a strategy based on constant innovation activities. Thus, almost 63% of enterprises demonstrated some degree of engagement in innovation, while the rest had difficulties in implementing it.

For further analysis, digital leadership levels were compared with small enterprises' innovation levels (Table 7).

Table 7.*Innovation level vs. digital leadership level in small enterprises*

Digital leadership level	Innovation level										Weighted average
	1		2		3		4		5		
	N	%	N	%	N	%	N	%	N	%	
Low: 1-7 points (NG = 85)	15	24.71	22	27.06	36	45.88	10	11.76	2	2.35	2.46
Medium: 8-14 points (NG = 36)	4	11.11	1	2.78	7	19.44	14	38.89	10	27.78	3.69

Source: own research.

In the group of enterprises with low digital leadership levels, the largest number of entities (45.88%) are at the third innovation level, with significantly fewer at the fourth and fifth levels (11.76% and 2.35%). The weighted average innovation rate for this group is 2.46. In enterprises with a medium digital leadership level, most entities present the two highest innovation levels (fourth - 38.89%, fifth - 27.78%). Only 10.87% of them have not introduced innovations in the last two years (first and second innovation levels). The weighted average for this group is 3.69. Therefore, it can be concluded that small enterprises with a higher digital leadership level demonstrate greater innovation, confirming hypothesis 3.

6. Conclusions

The considerations presented in the article on digital leadership confirm that it is essential for organizations willing to survive and thrive in the digital transformation. Digitization is revolutionizing small enterprises and leveling the playing field against larger competitors. Implementing advanced ICT allows small enterprises to cope with limited resources, enable streamlined processes, increase productivity and deepen customer relationships. Consequently, they can respond quicker to environmental changes, strengthen their strategic flexibility, and ultimately deliver greater value to their customers. However, this is achievable, provided small enterprise owners understand the need to digitize their operations and become genuine digital leaders.

Digital leadership, a concept that seemed like a distant future just a few years ago, is now an integral part of everyday business operations. It brings with it tremendous opportunities and at the same time poses enormous challenges, especially in a small business. In enterprises of this size, the owner should skilfully combine the roles of leader and manager, which in a large business are fulfilled by a multi-person management team. To become a digital leader, he needs to enrich his leadership and managerial competencies with a set of various digital competencies.

Polish small enterprises are characterized by relatively low digital activity, and their employees do not have sufficient advanced digital competencies. Therefore, they are not fully exploiting the opportunities provided by ICT (Mieszajkina, Myśliwiecka, 2022). Therefore,

digital leaders are necessary for planning and implementing systematic activities related to operations digitization, strengthening employees' digital skills, and designing a strategy that balances people and technology potentials. Their priority should be the systematic development of a digital learning culture across the enterprise.

The article discusses the digital leadership concept and its key features in the existing literature. The concept of assessing the digital leadership level and the research results conducted on 131 small enterprise units sample are presented. As assumed, the digital leadership level is low: small enterprise leaders take little action regarding transactional, transformational and authentic leadership. Among the owners, none have reached a high level, 27.5% present a medium level, 64.9% a low level, and 7.6% have not shown any digital leadership activity. This is a major obstacle to innovating and orienting the business model towards digital solutions.

The study contributes to the literature on the subject by increasing awareness of the influence of the owner-leader on the success of digitalization of business activity. Although the digitization subject is increasingly appearing in academic journals, there is little research on digital leadership. It is therefore worthwhile to broaden and deepen scientific inquiry related to this topic. It is worth citing here a quote from Marc Benioff at the World Economic Forum in 2016: "Technology is neither good nor bad – it's what you do with it that makes the difference. As in previous eras, new technologies also carry negative consequences. AI and genetic engineering in the wrong hands could alter our future in undesirable ways. For too long we have done our work in isolation, unaware of the effects our innovations have on societies and environment as a whole. As business leaders, government officials, educators and citizens, we need to create a common set of principles and values that take us to the future that we all want together" (Benioff, 2017).

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ECONOMIC RESILIENCE VS. ENTERPRISE ROBUSTNESS: CONCEPTUAL DIFFERENCES AND THEIR IMPORTANCE IN THE FACE OF CRISES

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Purpose: The aim of the article is to theoretically analyze and explain the differences between the concepts of economic resilience and business robustness, as well as the reasons for these differences, and to examine their significance in the face of crises. Specifically, the aim of the paper is to:

- clearly distinguish the concepts of resilience and robustness,
- indicate how both concepts influence the ability of businesses to cope with crises,
- analyze how the methods of measuring resilience and robustness in businesses can contribute to the conflation of these terms,
- propose an exemplary research methodology for business robustness and resilience, depending on their definitional characteristics.

Research problem: What differences and similarities exist in the way resilience and robustness are perceived? How can the application of the same research methods lead to the conflation of these terms? What is their application in the context of crises?

Design/methodology/approach: The objectives of the article were achieved through the application of a literature review method, which includes the analysis of existing studies on the concept of economic resilience and enterprise robustness. The article focuses on presenting the origins of these concepts, comparing their definitions, and analyzing the conceptual differences and their causes. The use of economic resilience and enterprise robustness in the face of crises is also discussed. Additionally, methods for measuring resilience and robustness in enterprises, depending on the definitional characteristics of these concepts, are presented, along with examples of economic indicators that allow their measurement. The theoretical framework of the article is based on an interdisciplinary approach to the concepts of resilience and robustness.

Findings: As a result of the literature analysis, it has been demonstrated that the concepts of economic resilience and enterprise robustness are often used interchangeably, despite having different meanings. The article discusses the conceptual differences and their causes.

Originality/value: The article presents a critical distinction between the concepts of economic resilience and enterprise robustness, which are often confused and incorrectly used as synonyms in the literature, as well as in other non-scientific publications. The article not only describes the differences between these concepts but also analyzes the causes of these differences and their practical significance in relation to the functioning of enterprises during disruptions and crises. Additionally, it offers proposals for economic indicators that can be helpful in measuring resilience and robustness in enterprises. The article is particularly valuable for researchers and

business practitioners who are interested in the functioning of enterprises in the face of crises, as well as in strengthening robustness and resilience in an unstable environment.

Keywords: economic resilience, enterprise robustness, economic crisis.

Category of the paper: literature review, viewpoint.

1. Introduction

In the face of increasingly frequent economic crises, which are an integral part of business operations, and global disruptions such as the COVID-19 pandemic, armed conflicts (e.g., the Russian invasion of Ukraine in February 2022), as well as non-economic crises (e.g., climate change, natural disasters, industrial catastrophes), the ability of enterprises to effectively respond to unexpected events has become a key factor in their long-term survival, and even their sustainability. In addition to surviving the crisis and returning to the pre-disruption state (robustness), increasing importance is placed on factors that enable businesses to adapt to a changing environment and continue developing (resilience).

In the literature, terms such as *economic resilience* and *enterprise robustness* are often mistakenly used as synonyms. However, it is important to emphasize that robustness is just one element of resilience, but not the only one. The aim of this article is to provide a detailed analysis of these two concepts in the context of the functioning and development of businesses in the face of crises and environmental disruptions. The article presents the origins of the concepts of resilience and robustness, as well as their interdisciplinary nature. It identifies the definitional differences between these terms and discusses the causes of these differences. Furthermore, a research methodology based on the definitional characteristics of these concepts is proposed, and the significance of resilience and robustness in the context of crises is highlighted.

This research may serve as a foundation for future academic studies by introducing a new approach to assessing the ability of businesses to survive, adapt, and grow in a turbulent economic environment.

The article consists of six parts. The first part discusses the origins, essence, and definitions of resilience, highlighting its interdisciplinary nature. The second part presents the definitions of economic resilience in enterprises, while the third part addresses the concept of enterprise robustness. The fourth part outlines the conceptual differences between economic resilience and enterprise robustness, as well as their causes. The fifth part describes the significance of economic resilience and robustness in the context of crises. The final part presents the research methodology related to resilience and robustness in enterprises.

2. Origins, essence, and definitions of resilience

The English term *resilience* is derived from the Latin verb *salire*, which can be translated as "to leap," "to rise," and *resilire*, meaning "to jump back" or "to return to a previous state" (Boczkowska, 2019, p. 130). The concept of *resilience* originates from the physical sciences, where it refers to a physical property of solid objects, specifically the ability of an object to regain its original shape after being deformed by an external force (Boczkowska, 2019). The borrowing of this term into social sciences was a result of the lack of an equivalent term that fully captured the essence of the phenomenon (Junik, 2016). In social sciences, the concept of resilience refers to the ability of an individual or social groups to function properly under challenging conditions (Czech-Włodarczyk, 2018). Meanwhile, the literal translation of *resilience* includes terms like "resistance", "flexibility", "elasticity", "springiness", "durability", and "the ability to recover" (Majchrzak, 2020, pp. 33-34). It should be noted that there is no single Polish word that fully conveys the comprehensive meaning of the English term *resilience* (Borucka, Ostaszewski, 2008).

In the 20th century, the idea of *resilience* emerged simultaneously in two fields of science: ecology and psychology (Błąd, 2022). The contemporary interpretation of resilience has been largely shaped by ecology and studies related to the balance and stability of ecosystems (Lucini, 2014, as cited in Stępką, 2021). The term *resilience* was first used in the context of ecological systems by C.S. Holling in 1973 in his work titled *Resilience and Stability of Ecological Systems* (Holling, 1973, as cited in Guzal-Dec, Zwolińska-Ligaj, 2023). C.S. Holling defined resilience as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling, 1973, p. 14). In the ecological approach to resilience, two perspectives can be distinguished. The first approach focuses on the ability of systems to adapt to changes and survive after a shock resulting from external change. The second approach examines resilience in the context of disturbances and the speed of return to the original equilibrium (Annarelli, Nonino, 2016, as cited in Otola, Knop, 2023). C.S. Holling's work laid the foundation for future research on resilience in the ecological dimension and its various applications in other sciences (Piórkowska, 2015). Since then, resilience has spread to scientific disciplines such as psychology, engineering sciences, management sciences, and economics, incorporating a range of subdisciplines (Otola et al., 2024, as cited in Otola, Knop, 2023). It is worth noting that as the concept of resilience has evolved, so has its definition in relation to organizations. More specifically, a resilient organization, including its specific case – the enterprise – can not only survive a crisis but also emerge stronger and grow in the future as a result (Koronis, Ponis, 2018, as cited in Otola, Knop, 2023).

In addition to ecology, the origins of the concept of resilience should also be sought in another discipline – psychology (Majchrzak, 2020). In the psychological context, the concept of resilience has its roots in studies on the development of children and adolescents who grew up in difficult living conditions (Werner, 1994; Garmezy, 1985; Rutter, 1987, as cited in Borucka, Ostaszewski, 2012). Here, the notion of resilience serves as a metaphor for phenomena responsible for the proper psychosocial functioning of children and adolescents, even despite objectively unfavorable life circumstances (Borucka, Ostaszewski, 2012). These phenomena are explained by the concept of resilience, which primarily focuses on explaining processes related to balancing or mitigating adverse conditions (Garmezy, 1985, as cited in Borucka, Ostaszewski, 2012). It is worth noting that the pioneering research on resilience conducted by Garmezy, Werner, and Rutter revolutionized the understanding of this phenomenon – from an individual trait to a complex process in which personality, family, and non-family variables are interconnected in a feedback loop (Boczkowska, 2019). As a result, the literature distinguishes two terms:

- resiliency – a personality trait or a relatively stable resource of an individual,
- resilience – related to the process of effectively overcoming adverse conditions and life events (Ogińska-Bulik, Juczyński, 2011).

The term *resilience* is an interdisciplinary concept. It has multiple meanings and interpretations and is used in various scientific disciplines, such as psychology, medicine, natural sciences (ecology, physics, biology), engineering, economics, management sciences (crisis management, supply chain management, human resource management, strategic management), spatial planning, political and security sciences, public administration, sociology, and pedagogy (Otoła, Knop, 2023; Błasiak, Dybowska, 2021; Stępka, 2021). The interdisciplinary nature of the term resilience and the broad interest of researchers in this concept create a need for the development of scientific research and analyses, expanding both theoretical and practical reflections on the essence and application of resilience, as well as the creation of measurement tools (Kołodziej-Zaleska, Przybyła-Basista, 2018).

Various scientific fields use resilience as a multifaceted approach to studying systems' responses to events that disrupt their functional equilibrium. However, the meaning of resilience remains relatively unclear and imprecise. Indeed, as a hybrid concept, resilience is a conglomerate of descriptive and normative aspects. Moreover, its application is often ambiguous and varies depending on the purpose of its use (Ajili, Slimene, 2021).

Table 1.
Selected Definitions of Resilience in an Interdisciplinary Perspective

No.	Date	Author	Context	Definition
1.	1973	Holling	ecological	„a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables”
2.	2012	Wysocka	psychological	"refers to the processes and mechanisms that promote the proper (positive) functioning of an individual, despite the adversities in their life history, risk factors, vulnerability factors, and realized developmental threats or traumatic experiences, representing a phenomenon of good adjustment — positive adaptation that occurs despite unfavorable developmental conditions" (own translation)
3.	1998	Masten, Coatsworth	psychological	„Resilience also has had varied meanings, but it generally refers to manifested competence in the context of significant challenges to adaptation or development”
4.	2000	Luthar, Cicchetti, Becker	psychological	„Resilience refers to a dynamic process encompassing positive adaptation within the context of significant adversity. Implicit within this notion are two critical conditions: (1) exposure to significant threat or severe adversity; and (2) the achievement of positive adaptation despite major assaults on the developmental proces”
5.	2003	Hamel, Valikangas	organizational	„resilience refers to the capacity to continuous reconstruction”
6.	2003	Starr et al.	organizational	"The ability of an organization to withstand systematic disruptions and adapt to risks in the environment in order to formulate strategies aimed at mitigating the risks of operating in uncertain environmental conditions" (own translation)
7.	2020	Walker	multidisciplinary	„resilience is the ability to cope with shocks and to keep functioning in much the same kind of way. It is a measure of how much an ecosystem, a business, a society can change before it crosses a tipping point into some other kind of state that it then tends to stay in”
8.	2020	Martin, Sunley	multidisciplinary	"The ability of a system (understood, for example, as a state, region, sector, city, company, or local community) to: <ul style="list-style-type: none"> • withstand, • recover, • adapt, • reorganize and reconfigure" (own translation)

Source: based on: (Holling, 1973, p. 14; Wysocka, 2012, p. 288; Masten, Coatsworth, 1998, p. 206; Luthar, Cicchetti, Becker, 2000, p. 543; Bhamra, Dani, Burnard, 2011, p. 5379; Piórkowska, 2015, p. 812; Walker, 2020, p. 10; Drobniak, 2022).

3. Definitions of Economic Resilience in Enterprises

In economics, the concept of resilience is considered in various contexts, including the economy, communities, enterprises, organizations, or business models (Otola, Knop, 2023). Economic resilience can also be studied in areas such as:

- the goal of new macroeconomic policies (e.g., sustainable development),
- microeconomic issues (e.g., supply chains, logistics),
- cities and regions,
- organizations (e.g., crisis management, risk management, corporate social responsibility),
- specific cases of micro, small, and medium-sized enterprises (SMEs) and corporations,
- sectors and industries,
- the workplace (e.g., in relation to managerial traits, education, and skills development),
- healthcare systems,
- the labor market,
- the financial market (Ajili, Slimene, 2021).

The application of resilience in the economic context dates back to the concept of sustainable development (1987), which integrated resilience with the topics of climate change and external shocks (Simme, Martin, 2009). “Since the nineties, global financial institutions such as the International Monetary Fund (IMF, 1996, 2005), the World Bank (WB, 2006), and the Bank for International Settlements (BIS, 2002, 2008), have increasingly incorporated strategies of ‘resilience’ into their logistics of crisis management, financial (de)regulation and development economics” (as cited in Walker, Cooper, 2011). An initiative related to the introduction of the concept of resilience into economic sciences was undertaken in 2006 by Ch. Perrings, who connected it with the concept of sustainable development. According to Perrings, resilience is “the ability of a system to cope with disturbances without losing its functionality. It is the ability to withstand market or environmental shocks without losing the capacity for efficient resource allocation (the functionality of markets and supporting institutions) or the provision of essential basic services (the functionality of the production system)” (own translation, Perrings, 2006, pp. 417-427, as cited in Majchrzak, 2020, p. 34). While considering the origins of the term resilience and its previous interpretations in the economic context, M. Majchrzak argues that resilience should be analyzed as “the robustness, flexibility, and ability for strategic revitalization (regeneration) of an organization in the face of extraordinary threats” (Majchrzak, 2020, p. 35).

Enterprise resilience requires continuous development, robustness to disruptions, and the ability to adapt, create value, and maintain a competitive advantage. It is important to note, however, that a conflict may arise between resilience and agility. Balancing these two competing demands can prove to be a challenging task. The key elements of enterprise resilience include:

- strategic resilience – the ability to continuously develop and create an agile organization,
- operational resilience – the ability to maintain essential operational activities during a crisis,
- financial resilience – the ability to sustain an optimal level of capital and cash flow during a crisis (PwC, 2023).

It is worth emphasizing that resilience is not just a single concept but rather a broader framework for the functioning of enterprises (Majchrzak, 2020). The most important component of enterprise resilience is robustness, which can be defined as "the ability of a company to return to its pre-stress state" (Bishop, Hydoski, 2010, p. 23, as cited in Majchrzak, 2020, p. 35). The robustness of an organization, and in particular a company, can be ensured by four complementary elements:

- risk assessment – it is crucial to identify, classify, and assess risk factors, as well as to develop appropriate strategies for minimizing them,
- risk prevention – appropriate preventive strategies should be implemented with the aim of predicting and eliminating specific threats,
- detection of irregularities based on previously established risk areas, e.g., through periodic audits or continuous monitoring,
- response to irregularities – it is necessary to develop action plans in the event of irregularities to reduce their negative impact on the business entity (Majchrzak, 2020).

The second element of the concept of enterprise resilience is flexibility, which can be defined as "the ability of an organization to adapt to conditions in its environment" (Majchrzak, 2020, p. 35). Given that flexibility is not a clearly defined concept in the literature, it is possible to either attempt to define it or, based on selected literature, continue research into its essence. However, challenges arise in measuring the categories that form the basis of these definitions (a significant portion of flexibility definitions refers to adaptation time and the dynamics of responding to changes, primarily in the environment). An alternative approach is to adopt only a general, fairly broad definition of flexibility, which encompasses various specific aspects. The basis of this approach is to focus on the factors shaping flexibility (Krupski, 2005). Seeking a common denominator across different concepts, flexibility can be understood as the ability of an enterprise to adapt to changing environmental conditions. The term "adapting" is deliberately used as an equivalent to "adjusting" due to the widespread use of the term "adaptiveness" in the English-language literature when describing this phenomenon (Gibson, Ivancevich, Donnelly, 1998, p. 38; Strategor, 1996, p. 277, as cited in Majchrzak, 2020, p. 35). Adaptation can be external – referring to the ability of an enterprise to influence its environment – or internal, relating to the implementation of adaptive changes within the enterprise. Flexibility can refer to various functional areas of the enterprise, such as the use of machinery, labor, material logistics, product assortment, operational activities, development, scale of operations, and the implementation (or modification) of new products (Ziębicki, 2010). Furthermore, flexibility is often analyzed in the context of the "organizational subsystems: financial, informational, production, market, and strategic management" (Krupski, 2008, p. 22, as cited in Ziębicki, 2010, p. 388). It is important to note that each of these areas is assessed according to different criteria (Ziębicki, 2010).

The third component of the concept of enterprise resilience is strategic revitalization (Majchrzak, 2020). Revitalization can be defined as "a change of fundamental character and significant impact on the organization's efficiency, affecting relationships with the environment (customers, suppliers), transformational processes (technology configuration), structures, systems, and routines (decision-making, information, human resources), as well as financial results and individual and organizational behaviors" (Hart, Berger, 1994, as cited in Walas-Trębacz, 2008). Another definition indicates that the process of strategic revitalization can be described as "a shift in the enterprise's direction, which requires a new approach to human resource management and the organization's structure (renewing)" (Nogalski, Marcinkiewicz, 2004, p. 49, as cited in Majchrzak, 2020, p. 34). Consequently, the revitalization process is identified as a strategic change (Floyd, Lane, 2000, p. 155, as cited in Walas-Trębacz, 2008, p. 96). Considering two criteria simultaneously – the continuity (or discontinuity) of changes and the type of changes in the enterprise in relation to changes in the environment – the concept of renewal can be expanded into two situations, namely, strategic turnaround and strategic revitalization. The renewal process occurs in two scenarios: when a strategic gap arises, or when it is anticipated between the enterprise's capabilities and environmental demands. A successfully implemented strategic revitalization should not only result in increased efficiency but also strengthen the enterprise's competitive market position, improve and tighten relationships with customers, introduce organizational structure modifications that support response flexibility, increase the delegation of tasks, responsibilities, and duties, align activities (processes) with customer needs, develop new capabilities and key competencies, enhance the value chain efficiency, and provide other benefits (Walas-Trębacz, 2008). Thus, there are close connections between enterprise robustness, flexibility, and the ability for strategic revitalization (renewal). These three elements together shape the concept of economic resilience in enterprises (Majchrzak, 2020). Figure 1 graphically illustrates the components of the concept of economic resilience in enterprises.

The concept of resilience presented in Figure 1 can be applied to various levels:

- **mega** (*megaeconomic resilience*) – in the context of groups of countries, e.g., the EU or G-20,
- **macro** (*macroeconomic resilience*) – in the context of the economies of specific countries,
- **mezo** (*mezo-economic resilience*) – in the context of regions, sectors, and branches of the economy,
- **micro** (*microeconomic resilience*) – in the context of specific economic units, such as enterprises, financial entities, and households (Majchrzak, 2020).

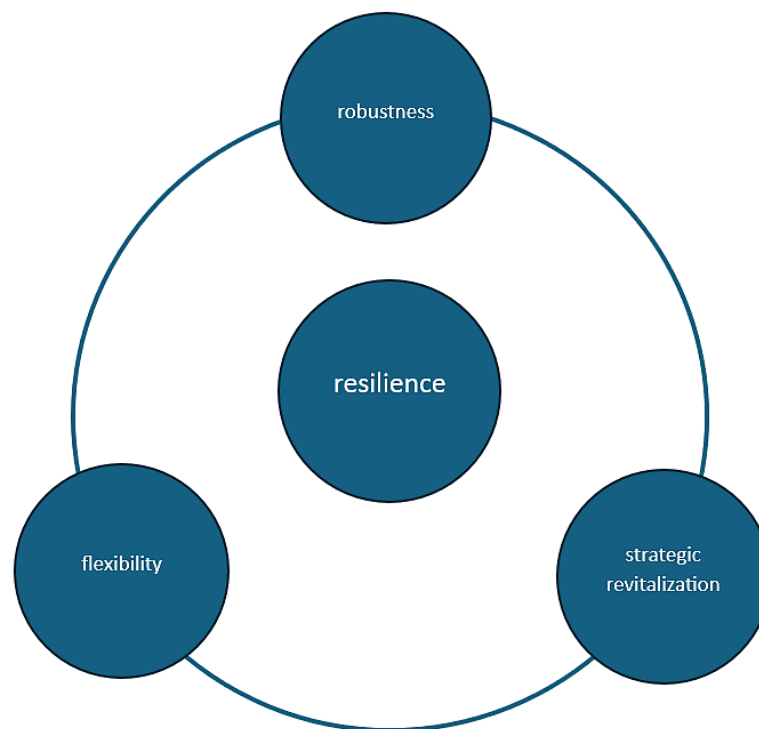


Figure 1. The Concept of Economic Resilience in Enterprises

Source: based on: (Majchrzak, 2020, p. 36).

In this study, the focus of the analysis is specifically on microeconomic resilience in the context of enterprises. Table 2 presents general definitions of economic resilience, followed by more detailed definitions of economic resilience in enterprises.

Table 2.

Sample Definitions of Economic Resilience and Economic Resilience in Enterprises

No.	Date	Author	Context	Definition
1.	2014	Gilly, Kechidi, Talbot	economic	„Double capacity of resistance and adaptation opening the way for new pathways. These pathways indicate the capacity of an organisation to find novel responses to new questions and not simply to reproduce previously used organisational responses”
2.	2012	Biggs, Hall, Stoeckl	economic	„Ability of a system to maintain and adapt its essential structure and function in the face of disturbance while maintaining its identity”
3.	2017	European Commission	economic	„Economic resilience refers to the ability of the country to withstand a shock and recover quickly to potential after it falls into recession. Resilient economic structures herewith prevent that economic shocks have significant and persistent effects on income and employment levels and thus they can reduce economic fluctuations”
4.	2017	Brinkmann et al.	economic	„the capability of an national economy to take preparatory crisis-management measures, mitigate the direct consequences of crises, and adapt to changing circumstances. In this regard, the degree of resilience will be determined by how well the actions and interplay of the political, economic and societal spheres can safeguard the performance of the economy – as measured against the societal objective function – also after a crisis”

Cont. table 2.

5.	2022	Tsiotas	economic	„the capability of an economic system to respond to disturbances (shocks) and is defined about a shock, in terms of either recovering to the previous state of functionality or moving into a new one”
6.	2022	Banaszyk	enterprise	"Resilience is a fundamental competence for effectively responding to significant changes that disrupt the achievement of established plans without falling into prolonged periods of crisis. Resilience should include three main components: productivity, safety, and agility. Productivity refers to the relationship between the volume of goods sold and the amount of resources needed to produce them. Safety, on the other hand, pertains to sanitary protection and stable working conditions. Finally, agility represents the flexibility in adjusting to changing demand requirements" (own translation)"
7.	2021	Ajili, Slimene	enterprise	„Business resilience refers to the ability of companies to emerge from a crisis with the lowest economic and social costs and the ability to better cope with future crises (e.g., infectious diseases, financial shocks, mental changes, digital disruptions, political instability, and social tensions)”
8.	2017	Bogodistov, Wohlgemuth	enterprise	„A resilient enterprise is one that is able to remain in a stable state, maintaining or growing its income and employee numbers despite disturbance”
9.	2009	Moore, Manring,	enterprise	„Capacity of an enterprise to survive, adapt, and grow in face of turbulent change”
10.	2015	Edgeman	enterprise	„Enterprise ability to self-renew through innovation, changing and reinventing itself by adapting its responses to political, social, economic and other competitive shocks or challenges”
11.	2016	Tognazzo, Gubitta, Favaron	organization/ enterprise	„Organization’s capacity to adjust to challenging conditions like environmental shocks and emerge from them strengthened and more resourceful”
12.	2013	Marwa, Milner	enterprise	„Continuously anticipating and adjusting to deep secular trends that can permanently impair the earning power of a core business. It is having the capability to change before the case for change becomes painfully clear”.
13.	2023	Fu et al.	enterprise	„Enterprise resilience is an important indicator reflecting the performance of enterprises during the crisis, reflecting the ability of enterprises to withstand the impact of the external environment and sustainable development”
14.	2011	Walas-Trębacz, Ziarko	enterprise	"The capacity for regeneration (resilience) should be understood as the ability for continuous reconstruction and renewal in terms of strategy and business model. It will not exist in a company if its organizational culture, values, and processes are focused on maintaining the status quo rather than fostering innovation" (own translation)

Source: based on: (Conz, Magnani, 2018, pp. 34-38; European Commission, 2017, p. 2; Brinkmann et al., 2017, p. 11; Tsiotas, 2022, p. 2; Banaszyk, 2022, p. 34; Ajili, Slimene, 2021, p. 3; Fu et al., 2023, p. 4; Walas-Trębacz, Ziarko, 2011, p. 272).

The above reflections on the essence and definitions of economic resilience, and more specifically – enterprise resilience, confirm its multidimensional nature. The analysis of definitions of economic resilience in enterprises, from both Polish and international researchers, indicates several key similarities in their interpretation. Economic resilience in enterprises encompasses not only the ability to survive (which is characteristic of robustness) but also the ability to adapt to challenging environmental conditions and to grow, even in the face of adverse

conditions such as disruptions or crises. Furthermore, resilience also refers to better handling of future shocks and crises. A resilient enterprise, in the face of a crisis, is able not only to overcome difficulties but also to emerge stronger.

The presented definitions (Table 2) highlight several characteristics of economic resilience in enterprises, including the ability to survive, robustness, adaptation, growth (also in the context of sustainable development), flexibility (or agility), the ability to transition to a new functional state (e.g., adapting the enterprise to changing market conditions), productivity, security, as well as the capacity for regeneration and innovation. It is also worth mentioning the ability to improve economic indicators, such as increased income and employment levels, and efficiency in crisis management with minimal costs.

One of the key elements of economic resilience in enterprises is robustness, which makes resilience a broader concept. Economic resilience in enterprises is not limited to surviving a crisis and returning to the pre-disruption state (robustness), but also includes the ability to adapt, undergo strategic revitalization, and continue growing. Thanks to these characteristics, an enterprise can not only overcome a crisis but also strengthen its competitive position in the future.

4. Definitions of Enterprise Robustness

The term "robustness" may originate from Latin (*resistere* – "to stop", "to resist"), late Latin (*resistentia*), or French (*resistance*), with both terms used in the context of "resistance, robustness" (Dictionary of the Polish Language and Foreign Phrases by W. Kopaliński, as cited in Zabłocka-Kluczka, 2012, p. 90). The concept of robustness is interdisciplinary. It can be defined in the context of "living organisms (humans, animals, plants), inanimate objects (e.g., products of human activity), social entities and systems (e.g., nations, regions, organizations, systems)" (Zabłocka-Kluczka, 2012, p. 90). The term is also used in the fields of social and economic sciences (Zabłocka-Kluczka, 2012). In general, robustness is defined in the literature as "the ability to take the necessary actions to minimize the harmful effects of events and to mobilize resources that accelerate the return to equilibrium" (Bishop, Hydoski, 2009, p. 63, as cited in Zabłocka-Kluczka, 2012, p. 91).

One of the approaches to analyzing the robustness of an enterprise during a crisis is to equate it with "the ability of the enterprise to survive for another year after the cessation of the negative stimulus" (own translation, Muller, 2022, p. 72). However, two approaches to analyzing enterprise robustness can be distinguished in the literature. The first is associated with equating robustness with the ability to return to a pre-disruption state. This is the classic understanding of robustness in relation to stability and the ability to maintain basic functions despite disruptions. It is related to endurance against disruptions without the need for radical changes.

The second approach is closer to the concept of resilience, which focuses not only on returning to equilibrium but also on adaptation and further development. Table 3 illustrates the multifaceted approach to organizational and enterprise robustness, which reflects these perspectives.

Table 3.
Definitions of Organizational Robustness and Enterprise Robustness

No.	Date	Author	Context	Definition
1.	2021	Noviarto, Samputra	organizational	„The strength of an organization recovering from or being able to adapt to adverse events”
2.	2017	ISO	organizational	"It is the ability of an organization to absorb and adapt in a changing environment, enabling it to achieve its goals, survive, and grow. Robust organizations can anticipate threats and opportunities and respond to them due to sudden or gradual changes in both the internal and external context" (own translation)
3.	2021	Volkov et al.	economic	„the capacity to withstand or recover from shocks maintaining the core performances and functionalities”
4.	2015	Kramarz	economic (of the supply chain)	"The return of a system to a state of equilibrium in response to disruptions" (own translation)
5.	2004	Anderies et al.	economic	„This concept (robustness) is defined as the capacity of a system to maintain a desired state despite fluctuations in the behaviour of its component parts or its environment”
6.	2019	Accenture	enterprise	"Operational robustness in enterprises is a broad category, encompassing: management, strategy, business services, information security, change management, process initiation, and recovery after a failure" (own translation)
7.	2019	Accenture	enterprise	“A robust enterprise has the ability to recover critical business services after significant, unplanned disruptions. In this way, it protects customers, shareholders, and other stakeholders” (own translation)
8.	2015	Sopińska	enterprise	“The robustness of a company to crises is the ability to sustain continuous growth despite an existing crisis in the macro environment, while simultaneously maintaining current economic performance at a good level" (own translation)
9.	2020	Soliwoda	micro/small enterprises	“A robust micro/small enterprise can be defined as an entity that has not experienced a decline in gross revenues following a catastrophic event” (own translation)
10.	2012	Romanowska	enterprise	“Long-term developmental capacity of a company, while simultaneously maintaining good economic performance despite the existence of a crisis in the economy" (own translation)

Source: based on: (Noviarto, Samputra, 2021, p. 2; Kos, 2023, p. 34; Volkov et al., 2021, p. 6; Kramarz, 2015, p. 183; Mafimisebi, Nkwunonwo, 2015, p. 1108; Soliwoda, 2020, pp. 40-42; Gregorczyk et al., 2016, p. 289; Romanowska, 2012, p. 8).

The definitions of enterprise robustness presented (Table 4) indicate certain discrepancies in defining this concept. On one hand, characteristics of enterprise robustness related to the protection of internal and external stakeholders have been distinguished, which is crucial for the survival of an economic entity in the market. Moreover, maintaining economic and financial indicators at a stable level has been emphasized, which can be reduced to maintaining the system's balance or its ability to return to equilibrium after disturbances while preserving basic

parameters and functions. In this context, a characteristic feature of robustness is the stability of the system in the face of disruptions – an enterprise is capable of maintaining its functionality without the need to adapt to the environment. On the other hand, a dynamic perspective on robustness has also been highlighted, which includes the ability to adapt to changing environments and long-term development despite the presence of a crisis in the economy, a concept typical of resilience. This discrepancy in definitions points to the need for a deeper analysis of the reasons for such a state, as the concepts of robustness and resilience, while related, are distinct concepts.

5. The conceptual differences between economic resilience and the robustness of enterprises and their causes

The concept of resilience in Polish scientific literature is translated in various, often inconsistent ways, such as: "elasticity" (Szwajca, 2014), "psychological elasticity" (Kaczmarek, 2011), "robustness to injury" (Ryś, Trzęsowska-Greszta, 2018), "flexibility" (Ogińska-Bulik, Juczyński, 2011), "personal flexibility" (Uchnast, 1998), but also: resourcefulness, flexibility, pliability, robustness, psychological robustness, robustness to injury, plasticity, durability, resourcefulness, adaptability, or even the Polonized version – "resilience" (Junik, 2011)" (as cited in Boczkowska, 2019, p. 130). However, it should be noted that the aforementioned terms do not fully reflect the English term in a comprehensive manner (Boczkowska, 2019). The term resilience was borrowed from the field of physics, where it is used to describe certain characteristics of physical materials related to returning to their original shape after deformation due to pressure. Nevertheless, what in English-language literature in physics is defined with the single term "resilience," in Polish literature is referred to differently (Junik, 2011) (e.g., elasticity, flexibility, pliability, flexibility, pliancy, durability) (Wikipedia, as cited in Junik, 2011, p. 48). Therefore, many researchers – using physical sciences terminology – do not argue for adopting a specific term and do not refer to the analogy applied for their own research. It is worth noting that such clarification could help eliminate uncertainties related to terminology (Junik, 2011). Additional equivalents of the term resilience, which originally appeared in the psychological interpretation of the phenomenon but are now also used in economic and management sciences, include: "robustness, resourcefulness, the ability to recover strength, the ability to bounce back" (Junik, 2011, p. 48). Therefore, a current issue among resilience researchers and its derivatives remains the lack of consensus regarding scientific terminology. According to W. Junik, the challenge for resilience researchers is to identify which Polish term fully captures its essence. This challenge is also complicated by the lack of scientific discussion on whether it is possible to standardize Polish terminology in this area. One of the negative consequences of this situation is the difficulty in monitoring the academic output in the field of resilience research. It is likely that one of the reasons for the

problem in identifying a clear Polish term that comprehensively reflects the essence of resilience is the lack of consensus among both theorists and practitioners, who conduct research worldwide, regarding what resilience actually is. Some researchers identify it as an individual trait, others as a process, and still others as a specific outcome. In response to this problem, W. Junik proposes the use of the Polonized version of the term (*resilience*). This approach can be helpful in analyzing and searching for literature on the subject, as well as in popularizing knowledge about resilience (Junik, 2011). A similar proposal was also made by M. Stępką, who points out that the Polonized version of resilience is currently the optimal attempt to capture such a complex concept (Stępką, 2021). Another argument supporting the validity of this approach is the fact that it does not narrow the interpretation of the concept of resilience to popular translations, such as "robustness" or "elasticity," which unnecessarily limit its meaning and do not fully capture its internal complexity (Grzegorzewska, 2013, as cited in Stępką, 2021). Meanwhile, M. Boczkowska points out that in order to achieve a clear approach to whether to retain the English term *resilience* or use its Polonized version, empirical research should be conducted (Boczkowska, 2019).

The most likely way to solve the lexical difficulties discussed above is to directly refer to the definition of the term "*resilience*," which can be presented through the lens of four aspects, i.e., the ability of a system (e.g., country, region, sector, city, enterprise, or local community) to:

- robustness, understood as maintaining the most important components of the system and their values – for example: the number of employees, production volume, service diversity, and wage levels – at a stable level, regardless of the type and scale of shocks, disturbances, or disasters that have affected a given country, city, or enterprise;
- recovery, based on restoring the key components of the system and their values in a relatively short period after a shock occurs, e.g., despite an initial collapse caused by the economic crisis, the number of enterprises, jobs, production volume, and wage levels return to their pre-disruption state. Importantly, in the recovery concept, there is no change in the structure of production, technology, or required qualifications, and the system, after the shock, regains its original state and continues to develop;
- adaptation, focused on adapting the system's components to the situation resulting from the shock (the key is the positive adaptation of the existing system elements to the new situation, while maintaining the most important existing activities – for example, adapting educational services to be delivered online during the escalation of the COVID-19 pandemic or transferring previously on-site work to remote work. Adaptation refers to adjusting specific system elements (e.g., changing the way and place of work), but does not cause radical changes to the system itself, meaning that the same educational services are still provided, and the same subjects are taught at universities);

- reorganization and reconfiguration, which are the most complex aspects of resilience, based on the ability to implement a fundamental change in the main components of the system and their values as a result of disruptions – e.g., certain post-industrial cities, which, in response to the sudden closure of traditional industries (mining, metallurgy), successfully created conditions for business activities and jobs in new sectors. This form of resilience is particularly important in the context of the challenges of the energy transition and the shift to a zero-emission economy that will occur in the next decade; acquiring this important ability by countries, cities, sectors, and enterprises will be essential (Martin, Sunley, 2020, as cited in Drobniak, 2022).

All aspects of the term "resilience" are related to the response to difficult conditions; however, this response can take different forms, which is why it is probably more appropriate to use the term "resilience" rather than "robustness", which represents only one of its aspects (Drobniak, 2022). Robustness is usually interpreted as the ability to withstand disruptions without making changes, sometimes characterized as "engineering robustness" (Holling, 1996, as cited in Walker, 2020), which significantly differs from the concept of resilience understood as the ability of a system to change and adapt in response to perturbations and continue to develop. However, some researchers see only a slight difference and, as a result, equate these terms (Levin, Lubchenco 2008, as cited in Walker, 2020). In non-scientific literature, there is an approach that limits the issue of building resilience to making a given system "robust", meaning resistant to change or capable of maintaining its current state despite disruptions. Therefore, it is important to emphasize that this approach reduces the scope and practical dimension of resilience (Walker, 2020).

It is worth noting that the complexity of the modern economic reality in which enterprises operate means that traditional concepts, such as robustness, are no longer sufficient to describe the challenges businesses currently face. For this reason, the term "economic resilience of enterprises" increasingly appears in the literature, which more comprehensively reflects the multidimensional nature of contemporary economic problems and the range of challenges businesses face in order to stay in the market.

The research gap that exists in the literature concerns the interchangeable use of the terms robustness and economic resilience as synonyms. One of the identified reasons for this is the lexical problems related to the word "resilience". However, it should be reiterated that robustness is one element of resilience, but not its only component.

6. The significance of economic resilience and robustness in the face of crises

Resilience is a concept that has gained particular significance in the context of groundbreaking historical events affecting the world, countries, cities, regions, sectors, and enterprises. It is seen as a means of counteracting the negative effects of unexpected and rapid changes, which can lead to the closure of businesses, unemployment, loss of housing, a decrease in GDP, or inflation as a result of natural disasters or improper human activities. In the socio-economic sphere, the concept of resilience encourages reflection among many groups (scientists, economic practitioners, policymakers, local communities) about the reasons why certain countries, cities, regions, or business entities are able to cope with disruptions, turbulence, and crises more effectively than others. This raises another research question: how, for example, can a business be prepared to minimize the negative effects of crises? (Drobniak, 2022).

Crises are economic phenomena that cannot be completely excluded, but their undesirable effects can be reduced. The causes of crises are multidimensional, and their predictability is somewhat limited, which raises the question of how to model economic processes to achieve the highest possible robustness against the effects of crises, or more specifically – how to reduce the losses resulting from a crisis. The recent global economic crisis caused by the COVID-19 pandemic is one example that confirms the unpredictability of crises. Therefore, the literature suggests that the European Union funds allocated for the so-called recovery should focus on transforming the model of the European economy, as well as individual national economies, in terms of building robustness to crises or pandemics. Sectors in which robustness is of particular importance include the medical and pharmaceutical industries, the energy sector, agriculture, the food industry, as well as telecommunications and transportation (Krysiak, 2020). In the context of business activities, it is worth citing the results of an Accenture report analyzing the issue of enterprise robustness (Accenture, 2019, as cited in Soliwoda, p. 40):

- a robust enterprise has the ability to restore key business services after significant, unforeseen disruptions, thus protecting internal and external stakeholders,
- operational robustness of an enterprise is a multidimensional category concerning: management, strategy, business services, data and information protection, change management, process initiation, and recovery after failure,
- providing business services should also be a feature of robustness,
- a key role in shaping operational robustness is played by the human capital of the enterprise (an organizational culture that supports employee engagement in the company's operations),

- managing key risks, including their analysis, minimization, and control, should be a standard part of actions strengthening robustness,
- restructuring activities must be planned and identified in advance, and their implementation should result in building stronger foundations of robustness.

Extreme cases of enterprises affected by the crisis, such as international pioneers (e.g., Nokia or Kodak) and, on the other hand, the exceptional achievements of popular corporations (e.g., Google, Twitter, Facebook), point to the need to identify the characteristics that will determine the vulnerability of businesses to a crisis and its possible consequences, such as insolvency or bankruptcy. Analyzing the characteristics of companies that demonstrate a high level of robustness in crisis situations and difficulties, as well as those that have achieved success, can be helpful (Sochoń, 2017).

It is worth noting that the COVID-19 crisis impacted all businesses, regardless of industry, size, or location. However, scientific research shows that the effects varied depending on factors such as the size of the business or the industry. The manufacturing sector was the hardest hit by the crisis. Meanwhile, industries related to construction, information transfer, IT services, software, healthcare, and social work saw positive effects from the crisis. Additionally, private companies were more negatively impacted by the crisis than public and foreign companies. Regarding company size, small businesses felt the effects of the crisis more than large enterprises (Gu et al., 2020, as cited in Ajili, Slimene, 2021, p. 4).

HSBC (2020, as cited in Ajili, Slimene, 2021, p. 4) identified five key actions used by resilient businesses during the COVID-19 pandemic:

- prioritizing customer needs,
- maintaining good relationships with employees and ensuring their well-being,
- quickly adapting to changes in the environment,
- maintaining an appropriate balance sheet and stable cash flows,
- operating with sustainability principles in mind.

Business management is faced with the challenge of addressing difficulties arising from the immense scale of disruptions, turbulence, and unpredictability of the modern economic environment (PwC, 2023). The years 2020-2022 were a test of the robustness of entities conducting business activities. In March 2020, the World Health Organization declared the COVID-19 pandemic. After overcoming the difficulties caused by the coronavirus pandemic and related health, economic, social, political, educational, and migration crises, businesses began operating in a new reality of threats linked to Russia's invasion of Ukraine, which began in February 2022 (Dębowska, Kłosiewicz-Górecka, Szymańska, Zybertowicz, 2022). Companies must also contend with increased levels of internal complexity and diverse challenges, which amplify the frequency and scale of disruptions. This unrelenting cycle of changes and disruptions is a hallmark of the contemporary global economic environment. By functioning in a reality of permanent crisis, companies undergo significant organizational transformations to adapt to their surroundings, overcome new challenges, and ultimately

emerge stronger from crisis situations, continuing their long-term development. In this context, resilience has become one of the most important strategic goals in the business world (PwC, 2023).

Consequently, the task for all businesses and their internal and external stakeholders is to acquire the ability to function effectively in an economic environment where crises are a constant element. This ability requires acquiring and developing traits that enable maximum efficiency under certain conditions, maintaining a stable market position, and ensuring long-term growth. In the literature, this ability is defined as resilience, which is the key skill of effectively responding to significant changes that disrupt the execution of a planned strategy, while avoiding prolonged crisis situations (Banaszyk, 2021).

When analyzing the significance of economic resilience and robustness in the face of crises, it is also important to refer to their definitions. One definition of economic robustness suggests that it is "the capacity to withstand or recover from shocks while maintaining core performances and functionalities" (Volkov et al., 2021, p. 6). In this sense, the characteristic of business robustness in the context of a crisis is the ability to maintain system stability or recover equilibrium, despite the negative effects of the crisis. On the other hand, one definition of business resilience suggests that it is "the capacity of an enterprise to survive, adapt, and grow in the face of turbulent change" (Moore, Manring, 2009). This definition emphasizes a broader understanding of resilience compared to robustness in the face of a crisis, highlighting not only survival but also the ability to adapt and grow despite the emergence of sudden changes, such as a crisis.

7. Research methodology of resilience and robustness

Economic resilience is a complex phenomenon that generates feedback loops, complicating its direct measurement. However, it seems that this phenomenon can be measured using two indicators:

- risk, which reflects the type and level of threat to the functioning of economic entities,
- positive adaptation, related to specific actions by economic entities that demonstrate effective overcoming of difficulties (Luthar, Zelazo, 2003, pp. 510-549, as cited in Majchrzak, 2020, p. 36).

The ability to measure economic resilience using the aforementioned indicators is largely determined by the predictability and types of threats encountered (Majchrzak, 2020). In the analysis of the resilience concept, a significant methodological gap is highlighted, which exists in the scientific literature on this phenomenon. This gap arises from the fact that there are few scientific publications on this topic. Existing research frequently points to the use of the case study method, particularly in the context of ecological systems (Piórkowska, 2015).

In the literature on the research methodology concerning the resilience concept – in addition to the case study method – other approaches include theory building, surveys, theoretical models (Bhamra, Dani, Burnard, 2011), and indicator analysis (e.g., risk indicators).

M. Romanowska points out that "in the literature, we do not find methods that allow us to measure the robustness of a company against a crisis. Researchers typically limit themselves to identifying the characteristics that an organization robust to a crisis should have (management), or they propose the use of one of the indicators measuring economic condition or the threat of bankruptcy (economics)" (Romanowska, 2012, p. 8). Therefore, in measuring the robustness of a company – just as in the case of economic resilience – it is possible to base the measurement on indicator analysis. By combining these two approaches, one of the possibilities for measuring economic resilience and business robustness may be the application of an appropriate methodology, depending on the definitional characteristics of these concepts. However, it is important to emphasize that this methodology has certain limitations related to the lack of universality, meaning that the method of measurement is shaped by the adopted definitions of resilience and robustness. Thus, the basis for analysis will be the definitional characteristics of these two concepts. An example of research methodology depending on the definitional characteristics of resilience and robustness is presented in Table 4 and Table 5, respectively.

Table 4.

Example of research methodology depending on the definitional characteristics of resilience

Definicja rezyliencji ekonomicznej	"Resilience is the fundamental ability to efficiently respond to significant changes that disrupt the achievement of established plans without falling into prolonged periods of crisis. Resilience should encompass three main components: productivity, security, and agility. Productivity refers to the relationship between the volume of sold production and the amount of resources used to produce it. Security, on the other hand, relates to sanitary protection and stable working conditions. Finally, agility is the flexibility to adapt to changing demand requirements" (own translation) (Banaszyk, 2022, p. 34)	
Definitional characteristics of economic resilience	Quantitative methods, indicator analysis (examples of indicators)	Other methods
Productivity	<ul style="list-style-type: none"> • production per employee indicator, • production per unit of capital indicator, • production per unit of time indicator, • production per unit of material indicator, • labor cost productivity indicator, • asset productivity indicator 	<ul style="list-style-type: none"> • comparative analysis, • case study, • surveys and qualitative interviews, • document and statistical data analysis, • risk assessment
Security	<ul style="list-style-type: none"> • number of reported accidents/incidents, • number of machine breakdowns, • employee turnover rate 	
Agility (flexibility)	<ul style="list-style-type: none"> • time to market for a new product/service, • ability to adapt to changes (e.g., number of changes implemented) 	

Source: own elaboration.

Table 5.

Example of research methodology depending on the definitional characteristics of enterprise robustness

Definition of enterprise robustness	"Maintaining key elements of the system and their values—such as the number of employees, production volume, diversity of service offerings, and wage levels—at a constant level regardless of the nature and scale of shocks, turbulence, or disasters that have affected a given country, city, or enterprise" (own translation) (Drobniak, 2022)	
Definitional characteristics of enterprise robustness	Quantitative methods, indicator analysis (examples of indicators)	Other methods
Maintaining key elements of the system	<ul style="list-style-type: none"> • employee turnover rate, • staff fluctuation rate, • production volume, • average salary level, • percentage share of different types of products/services (all indicators analyzed based on the previous period) 	<ul style="list-style-type: none"> • comparative analysis, • case study, • surveys and qualitative interviews, • document and statistical data analysis, • risk assessment
Stability of key indicator levels	<ul style="list-style-type: none"> • current liquidity ratio, • debt ratio, • market share, • revenue stability ratio, • operating margin, • cash flow ratio (all indicators analyzed based on the previous period) 	

Source: own elaboration.

In the earlier part of the study, potential reasons for the interchangeable use of the terms "resilience" and "robustness" were discussed. It is possible to identify another cause, namely: in some studies, the methods used to measure these two phenomena are similar, which could potentially lead to the incorrect treatment of them as synonyms. In Table 4 and Table 5, an example of research methodology is presented based on the definitional characteristics of resilience and robustness. Among other methods, indicator analysis was used – consistent with one of the research methods for resilience and robustness proposed in the literature. In these tables, it can be observed that similar research methods can be applied to both concepts. This relationship is not universal, as it is determined by the nature and characteristics of the studied definition. However, it is worth noting that another potential reason for equating the terms resilience and robustness could be the use of the same measurement methods. This hypothesis could serve as a starting point for further research into the causes of the conflation of these terms.

8. Conclusion

Resilience is one of the most popular research topics that has been analyzed in relation to the COVID-19 pandemic. The crisis resulting from the coronavirus pandemic likely disrupted the structures and processes related to global governance (Levy, 2021, as cited in Ajili, Slimene, 2021). Moreover, this crisis compelled management and economics researchers to seek new theories and research methodologies. During the pandemic, the organizational culture of enterprises shifted from exploration and creativity toward safety and resilience (Bansal et al., 2021, as cited in Ajili, Slimene, 2021). The literature suggests that the logic of economic efficiency and productivity at both the microeconomic and macroeconomic levels, which dominates organizations and their specific cases – enterprises and societies – should be transformed towards approaches based on the concept of resilience. As a result, this could serve as a form of antidote to the challenges posed by the increasingly unstable and unpredictable socio-economic environment of contemporary enterprises (Ajili, Slimene, 2021).

The aim of the article was achieved through the analysis of scientific literature, economic reports, research findings, and personal observations of the economic reality. The article examines the origins and essence of economic resilience and enterprise robustness, as well as the interdisciplinary nature of these concepts, while highlighting the differences between them and their causes. Attention was drawn to the fact that these differences stem from lexical issues related to the term resilience and the use of similar research methodologies, which may lead to the misidentification of these concepts. It was emphasized that robustness is one of the elements of resilience. Robustness focuses on returning to the pre-crisis state, whereas resilience emphasizes the ability to adapt and grow despite disruptions.

The analysis organized the knowledge about both concepts and indicated ways to distinguish robustness from resilience in enterprises. A sample research methodology for resilience and robustness, based on their definitional characteristics, was also presented. These findings can serve as a foundation for future research on strengthening robustness and resilience in enterprises.

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INFORMATION INEFFICIENCIES IN THE DIGITAL AGE – A CASE STUDY OF THE MUNICIPALITY OF KRAKOW

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Purpose: The research aims to analyze on a selected example the differences in the occurrence of individual types of information inefficiencies in organizations implementing digital solutions. To achieve this goal, it was necessary to identify information inefficiencies occurring in the selected organization (Municipality of Krakow), to identify and evaluate the digital solutions used to eliminate these inefficiencies and to assess the degree of preparation of employees to use them.

Design/methodology/approach: The article in the theoretical part contains a description of the results of the literature review within the framework of the problem undertaken and in the practical part the presentation and discussion of the results of empirical research. The study was conducted using the survey technique (CAWI), and the results of the study results were developed using descriptive statistics.

Findings: The research carried out in the Municipality of Krakow showed the occurrence of all types of information inconveniences, with employees indicating a moderate frequency of their occurrence. The study identified and analyzed digital solutions used to counteract information failures. In this respect, research has shown an insufficient level of their use and high needs in terms of the digital competencies of employees using them.

Research limitations/implications: The limitations of the conducted research mainly relate to their scope, because the surveys were conducted only in selected organizational units of the Office. It would be necessary to develop the undertaken research in the context of expanding the sample, preferably by employees of all organizational units of the City Hall, and in the future to undertake research in other city offices.

Practical implications: Research conducted at the Municipality of Krakow allows us to conclude that the current level of digitization of information understood as a product and process does not allow us to avoid phenomena related to information malfunctions. A comprehensive approach to the digitization of information, a more conscious selection of its tools, and an intensification of employee education in order to improve their digital competencies are suggested.

Social implications: Reducing the incidence of information failure through the introduction of digital information and communication solutions is a practical problem. However, it involves a long and difficult process of introducing digital changes and adapting to them for the people who use them.

Originality/value: The presented research results on the implementation of digital solutions aimed at counteracting information inefficiency in the Municipality of Krakow are part of the current trend of research related to various aspects of the digitization of business in today's world. An important advantage of the research is its unique character both in terms of the research area, which is the City Hall, and the subject of the research.

Keywords: information inefficiencies, public sector, information overload, information ambiguity, information anemia, information retention, information distortion, information infarction.

Category of the paper: Research paper.

1. Introduction

The conditions for the operation of modern organizations related to their functioning in the information environment, in which the number of information sources is constantly increasing, information is becoming more and more diverse, and information streams are becoming more and more intense, making it necessary to use modern digital solutions in the area of information and communication. Changes related to the dynamic development of new digital technologies concern almost all areas of human activity and contribute to better meeting the information needs of both the economy and society.

In the practice of modern information management, which aims to meet information needs, a number of inefficiencies appear relating to both information as a product and information as a process. Their appearance usually results in a decrease in the value and an increase in the cost of information. Such a situation gives rise to specific areas and problems related to the proper selection and processing of the necessary information. An attempt to determine and classify information malfunctions was made in Poland by Z. Martyniak. The author lists the following as typical malfunctions of information products: information overload, ambiguity, and information anemia. On the other hand, the main inefficiencies of the information process are retention, distortion, and information infarction (Martyniak, 2000). A decade later, A. Włodarski supplemented this list by adding inconsistency and inadequate presentation to the inefficiency of the information product, and "memory loss" and lack of feedback to the inefficiency of the information process (Włodarski, 2011).

From a theoretical point of view, the solutions implemented by modern organizations related to the digitization of information (both in the context of the product and the process) should significantly reduce the likelihood of information failures. Correct identification of information needs combined with the use of digital, on-demand, appropriately organized databases reduces both the phenomenon of information anemia and the opposite of information overload. The use of appropriately designed digital information carriers reduces the risk of ambiguity and distortion of information, as does the use of information processing software (e.g. intelligent text translation tools).

The aim of this article is to analyze on a selected example the differences in the occurrence of individual types of information failures in organizations implementing digital solutions.

The article in the theoretical part contains a description of the results of the literature review within the framework of the problem undertaken and in the practical part the presentation and discussion of the results of empirical research. The study was conducted using the survey technique (CAWI), and the results of the study results were developed using descriptive statistics.

2. Information in the digital economy and society

Modern society functions in an era of intense technological changes, which contribute to a profound economic and social transformation. Digitization, understood as the widespread adaptation of Information and Communication Technology (ICT), redefines the traditional ways of working, education, communication, and the daily functioning of individuals. This topic has been discussed by many authors (Kryzhanovskij et al., 2021; Kotarba, 2017; Nevado-Peña et al., 2019; Ali et al., 2020; Alhassan, Adam, 2021; Sherman et al., 2023), who pointed to the importance of the evolution of digital technologies for the development of today's socio-economic system. It is clear that information, which in the 20th century played an auxiliary role in many economic processes, is now the foundation of economic activity. Collected in the form of data (big data), it is used in decision-making processes, designing innovative solutions, and stimulating technological development. New technologies – such as artificial intelligence, cloud, the Internet of Things, autonomous robots, or blockchain – accelerate the process of datafication, i.e. the creation of digital representations of subsequent areas of the real world, intensify networking and foster personalization (Śledziewska, Włoch, 2020). Information has become a strategic resource, key to creating value, and building a competitive advantage in the global market. The process of digitalization affects all sectors of the economy, from industry to public services, as well as society, which is forced to adapt to new forms of interaction and communication. Digital transformation generates significant economic benefits, but it also comes with many challenges. The adoption of digital technologies enables increased operational efficiency, cost reduction, and acceleration of decision-making processes. The digital economy, characterized by an unlimited spatial and temporal flow of information, creates new trade and investment opportunities, enabling global cooperation and access to extensive knowledge resources. Thanks to digital tools, sectors related to big data analysis, artificial intelligence, automation, robotics, and mobile technologies are developing, which further stimulates innovation and increases the competitiveness of the economy. In addition, digitalization fosters sustainable development by supporting the processes of monitoring and optimizing the use of natural resources and reducing pollutant emissions.

As a result, digital technologies contribute to environmental protection, which is one of the priorities of contemporary development strategies at the national and international levels.

Technological changes have an impact on all aspects of social and economic life, especially in the context of the digitization of the economy and the growing role of information. Information, as a strategic resource, has achieved the status of a key factor of economic and social development. The European Union, recognizing the importance of this transformation, has initiated several actions to support Member States in adapting to the digital reality. From the Digital Agenda for Europe to the Digital Decade, these initiatives aim to improve citizens' quality of life by developing digital infrastructure, strengthening digital competencies, and stimulating innovation (Laitsou et al., 2024). The European Union's ambitions in this regard are expressed in the report "eGovernment Benchmark 2020. eGovernment that works for the people" (2020), and as part of the Europe 2020 strategy, which introduced a digital agenda to create a digital single market that supports competitiveness and innovation at regional and international level. Digital transformation plays a key role in the development of modern economies and societies, especially in the context of the increasing role of information as a strategic resource. Digitalization is changing the way citizens and businesses use public services, enabling many of them to be fully implemented online. The European Union puts the pursuit of transparency and accessibility of online services as the foundation of its strategy. The concept of "user-centricity", taking into account the needs and convenience of users, is one of the key directions for the development of digital services. In addition, the implementation of solutions such as eID and eDocuments increases the possibilities of secure and effective identification and authorization of users, which supports the idea of interoperability at the European level and enables the provision of cross-border services. Therefore, it can be concluded that digital transformation is a fundamental aspect of the modern economy and society, exerting a significant impact on various areas of life and work. Advances in information and communication technologies such as cloud computing, artificial intelligence, and the Internet of Things have been a catalyst for global development. The growing importance of digitalization is reflected, among others, in the Digital Economy and Society Index (DESI), which assesses the digital progress of Member States in five main dimensions: connectivity, human capital, use of online services, integration of digital technologies and digital public services, which assesses the degree of digital maturity in EU Member States. Studies show that an increase in DESI values correlates with higher Human Development Index (HDI) scores, suggesting a positive relationship between digital progress and quality of life (Laitsou et al., 2024). The analysis of the DESI reveals significant differences in digital maturity between Member States, highlighting the importance of investment in digital education and infrastructure development. Higher-performing countries, such as Finland and Denmark, invest heavily in human capital and innovation, which has a positive impact on their position in the digital market. For countries with lower scores, actions supporting the development of digital competencies and access to advanced technologies are necessary, which is the basis for

reducing disparities in the level of digitalization and promoting socio-economic cohesion in Europe (Masoura, Malaysia, 2023).

Digital transformation, which is the basis of the modern economy and information society, is associated with the growing importance of access to digital technologies, and digitization is a key element of the modern economy. Its integration with innovation and environmental policies contributes to the achievement of sustainable production goals. Research (Guaita Martínez et al., 2022) They point out that digitalization supports more environmentally friendly solutions in socio-economic structures, responding to the challenges of climate change and the exploitation of natural resources. The information generated and processed by digital management systems is therefore becoming a key strategic asset. They enable the monitoring and optimization of production processes, supporting informed business decisions and promoting innovations, focused on sustainable development. Thus, the role of information in the digital economy is not only operational but also strategic, providing a foundation for creating value and building a competitive advantage, while taking into account economic, ecological, and social aspects. It should be emphasized that although the digital economy currently plays a huge socio-economic role, its importance will continue to grow as generations who cannot imagine a world without the Internet enter the productive age (Moroz, 2017).

Digital transformation directly affects the way society functions. Digitalization processes are shaping communication methods, consumption patterns, and access to cultural and educational resources. The digital society, using services such as e-banking, remote education, e-commerce, or digital access to cultural goods, gains greater autonomy, but at the same time becomes more dependent on technology. While easier access to information creates new development opportunities, it also raises the risk of data overload and pressure to process it properly. In this context, the problem of information asymmetry arises, where access to information and the ability to interpret it become key determinants of social and professional position. On a global scale, digital transformation requires international coordination and cooperation. Due to the multidimensional nature of the digital economy and the complexity of the processes shaping it, it is necessary to develop appropriate regulations and standards to support sustainable development. The European Union, among other things, is emphasizing the twin digital and green transitions to integrate the benefits of digitalization with the need to protect the environment. Setting standards for data protection, AI ethics, digital sovereignty and the sustainable use of technology is a key element of today's development strategies at the European and global level.

3. Information failures and their consequences

As mentioned earlier, information inefficiencies (also referred to as "information diseases") are phenomena relating to both information understood as a product and to information understood as a process, causing several negative consequences for the organization, such as extension of the time of implementation of information and communication processes, higher costs of their implementation, reduction of motivation of their participants, delays in providing information to its users, incorrect or late decisions, reduced motivation of participants in the information process, etc. For this article, the division of information inefficiencies according to Z. Martyniak was used, who (as mentioned in the introduction) lists information overload, ambiguity, and information anemia as typical inefficiencies of information as a product, and retention, distortion and information infarction as the main inefficiencies of the information process (Martyniak, 1997).

Information overload occurs when "a person receives much more information than they can or want to use" (Lesca, Lesca, 1995). Information overload has a negative impact on the quality of decisions made (this applies to the precision of decisions made) and the quality of the decision-making process (manifested as the duration of the decision-making process). In particular, this disability results in a longer time of searching for information, increased costs of its processing, increased inconsistency of information, and reduced user motivation. As the reasons for the occurrence of the phenomenon of information overload, Z. Martyniak cites the imprecise determination of information needs and the lack of positions in the structures of management boards responsible for assessing the usefulness of disseminated information and eliminating useless information. This qualitative defect in information is a measurable quantity. As criteria for assessing information overload, Z. Martyniak proposes the necessity and timeliness of information. The degree to which the criterion of necessity is met can be measured by the share of redundant information in the total volume of information. The measure of timeliness is the share of outdated information in the total volume of information (Martyniak, 1997). Modern digital solutions make it possible to significantly reduce the likelihood of information overload. Starting with the simplest solutions based on e-mail, which is today protected against unwanted and unnecessary information, through data warehouses and cloud data enabling access to information at the time it is needed, to Intranet-based solutions granting employees access to information based on the permissions resulting from the scope of their position.

According to the French researchers cited above, ambiguity of information occurs "when a person can interpret the same information in different ways without being able to determine which interpretation is good" (Lesca, Lesca, 1995). The reasons for this information inefficiency lie in the increasingly common use of abbreviations and jargon and imprecise data reporting (e.g. giving numbers without names). As measures to counteract the ambiguity of information, Lesca cites the following solutions:

- development and use of special dictionaries in the company, containing unambiguous definitions of various types of information,
- introduction of the custom of returning ambiguous information to its sender for verification,
- the use of appropriately adapted information carriers that exclude or at least limit their ambiguity (Lesca, Lesca, 1995).

The criterion for assessing the ambiguity of information may be its unambiguity. The first question that should be asked at this point is: is the information unambiguous? If the answer is affirmative, the quality of the information due to this criterion is unblemished. If the answer is negative, an unambiguous interpretation of the information under investigation should be achieved. Such proceedings are associated with a loss of time and the need to incur costs. The size of these expenditures can be an auxiliary measure in assessing the quality of information as a product. Digital solutions reducing the ambiguity of information include the use of digital versions of the procedures carried out along with dictionaries of terms used within them, the use of appropriately designed digital information carriers (systems for submitting queries, applications, applications, etc.), as well as intelligent tools for translating the text of information.

The concept of information anemia was introduced to the Polish literature on the subject by Z. Martyniak, who contrasts it with information overload. As the cause of informational anemia, the author cites a lack of information, also known as a weakening of the field of vision. The field of view is understood in the literature on information management as a set of information that a company has on a given topic. Informational anemia can occur in several degrees of severity. Its least painful variety is characterized by the fact that the information is relatively rich, but not always up-to-date. The more burdensome form manifests itself in the diversity of information, but scattered and incomplete. Finally, the most severe form of information anemia is characterized by extreme information poverty and leads the company to quasi-blindness (Martyniak, 1997, 2000).

The authors of "Gestion de l'information" consider poor management style to be the main cause of information anemia. Some managers believe that their level of knowledge, skills, and the related "feel" for decision-making situations allow them to make decisions without relying on detailed reports, especially if they are formalized. Without denying the role of intuition in decision-making, it should be said that managerial "intuition" can only be effective to a certain extent. After exceeding them, information anemia occurs, which sooner or later creates troublesome problems for the managerial staff. Other causes of information anemia include excessive fragmentation of tasks in the management process and lack of a comprehensive view of the information held by the company. The criterion for assessing this malfunction is the completeness of information, which either occurs or does not occur. Supplementing the information, as is the case with its unambiguity, requires time and material or financial resources. The total expenditure relativized to a unit of volume can be a measure

of the quality of information (Martyniak, 1997). Digital solutions that can result in the reduction of information anemia include, m.in, digital data sets and sources available to the employee in real time, managerial information systems, and digital internal communication systems between employees (e.g. chat, chatbot).

The information process is often identified with the information production process, which performs the following functions: generating information, gathering information, storing information, transferring information, processing information, sharing information, interpreting information, and using information (Oleński, 2003). Each information process performs all of the above functions. Usually, one or more of them are basic functions, while the others are auxiliary functions. The information process can perform several basic functions. In this case, it is necessary to define a function that is superior to the others, i.e. to establish a hierarchy of basic functions. In socio-economic systems, we are dealing with the functional specialization of information processes, consisting of the fact that these processes specialize in the implementation of one or several specific functions. The functions in the implementation of which a given information process is specialized determine the scope of information and the ways of its representation, methods, organization, technology, and economic principles of this process. In the economy, many information processes are interrelated and complement each other. They are usually specialized in one or more functions and make up the so-called information system.

The information process may show several inefficiencies affecting the quality of its implementation. The basic information malfunctions understood as the Lesc process include: information retention, information distortion, and information infarction.

Based on research conducted in the eighties of the twentieth century by specialists in the field of information management of the Siemens concern, it was found that in this company 95% of the duration of information processes is the time of information retention. This means that only 5% is the time associated with their processing and use (Potocki, 1990). Similar results were also obtained in national surveys on the implementation of administrative procedures in local administration institutions¹ (Czekaj, Teczke, 1998). The time of backlog therefore significantly extends the time of the entire information process. Shortening the time of detention, and thus at the same time the time of implementation of the entire information process, is of particular importance in the situation of mass implementation (as is the case in information economies). The reasons for information backlog can be varied. One of the most serious is the so-called information overload, which is particularly dangerous at those points of the information process that are equipped with decision-making powers. Another reason for information retention in information processes is their excessive fragmentation. In such a case, incompleteness of information found in one of the organizational units results in the need for

¹ These studies have shown that the share of information retention time in the entire cycle of the information process is about 70%.

another unit to supplement it, which not only incurs additional costs but also extends the time of backlog. This quality defect can and should be evaluated. The criterion for assessing the quality of the information in this case is the so-called information patency, measured by the ratio of the sum of the dwell times to the total time of the process, expressed in relative numbers.

Information retention can be eliminated by the appropriate design of information processes. In the digital era, you can use numerous tools to support business process management based on the BPMS process management paradigm, offering functionalities for modeling, analysis, simulation, and evaluation of processes (e.g. ARIS or Adonis).

Information distortion is understood as a situation in which two or more people interpret the same information in different ways. Information distortion is therefore a more complex variation concerning information as a product of information ambiguity. Its reasons in this case are identical to the reasons for the ambiguity of the information product. Distortion can also be a conscious or unconscious deformation of information during its flow in the information process. In this case, it is caused by the modification of the meaning of the information transmitted in the process between one circulating point and another. The assessment of the distortion of the information process can be carried out analogously to the assessment of the ambiguity of information as a product, except that in this case, the criterion is the unambiguity of the information (Czekaj, 2000). Digital solutions to reduce information distortion include digital versions of the procedures carried out with dictionaries of the terms used within them, digital document templates with explanations of the rules for their completion, online training covering the implementation of procedures, and filling in documents.

An information infarction occurs when the flow of information does not keep up with logistical flows. For example, when information related to the ordered physical product reaches its recipient after the delivery date. It turns out that at a time when systems such as just in time or zero stock are more and more commonly used, information very often does not keep up with logistics flows (Information management..., 2000). The reasons for this phenomenon are seen in the lack of integration of three factors within the information process: human, technical and organizational. The criterion for assessing the diffusion of information may be delays in the transmission or reception of information. A sufficient evaluative procedure is the gradation of delays (insignificant, significant, significant, large, and very large). Simple, digital solutions to reduce the possibility of information infarction are methods of direct communication such as e-mail, instant messaging, chats, and mobile telephony. More complicated, but also more effective solutions include methods of modeling and analysis of business processes (e.g. the already mentioned ARIS or Adonis).

4. The Municipality of Krakow as an area of research

An important premise for the democratic exercise of power in local government units is the active participation of the local community in public life (Wojciechowski et al., 2014). The City Hall is a public administration unit operating at the local level, responsible for the management and implementation of administrative tasks within a given city. It is a local government body acting based on the provisions of the Act on Municipal Self-Government or other legal acts regulating the functioning of the city. The City Hall, functioning as an organizational unit of local government administration at the local level, is established to carry out public tasks of a local nature, aimed at meeting the needs and expectations of the local community (Grzebyk et al., 2019). The basic functions of the City Hall include the management of municipal affairs, the provision of administrative services for citizens on current issues, and the organization of cultural events and events. The Municipality of Krakow is the central administrative unit responsible for managing the affairs of the municipality of Krakow. The basic legal acts defining the system, organization, principles of operation, and competencies of local government bodies are:

- Constitution of the Republic of Poland of 2 April 1997.
- Act of 8 March 1990 on Municipal Self-Government.
- Act of 5 June 1998 on Poviats Self-Government.
- Act of 5 January 2011 – Electoral Code.
- Act of 27 August 2009 on Public Finance.
- Act of 11 September 2019 – Public Procurement Law.

The basic task of the City Hall is to implement the resolutions of the Krakow City Council and to ensure the effective functioning of public services provided to residents. The Office is headed by the Mayor of Krakow. The organizational structure of the Municipality of Krakow is complex and includes 39 administrative units, including departments, offices, and other organizational units specializing in various areas of city management. The City Hall is indicated as the central decision-making body in the structure of local authorities, because its employees, including directors of various levels and specialists managing local affairs, establish various types of regulations. As Grzebyk points out (2017) within the City Hall there is usually a division of staff into two main groups. The first group consists of senior managers who create the conceptual and information basis for strategic decisions and implement the policy established and approved by the city authorities. The second group consists of staff responsible for performing administrative functions of a routine nature, which mainly concern the service of citizens and the provision of public services.

The scope of activities of the Municipality of Krakow is wide and includes the management of the city's finances, including budget planning and implementation and obtaining external funds; spatial planning through the development of local spatial development plans;

maintenance of infrastructure and transport, including road maintenance, development of public transport and investments in transport infrastructure; environmental protection through pro-ecological activities, management of urban greenery and implementation of programs aimed at improving air quality; promoting culture and tourism through the protection and promotion of cultural heritage, the organization of cultural events and the support of tourism initiatives; as well as education and sport, supervising the functioning of educational institutions, supporting sports initiatives and implementing programs aimed at the development of physical culture among residents.

The Municipality of Krakow provides administrative services to residents, such as civil registration covering births, marriages, and deaths; issuing identity documents, including ID cards and driving licenses; servicing entrepreneurs by registering a business, issuing permits, and providing information and support; Registration matters, such as check-in and check-out; and implementation of social programs, including social benefits, support for families, seniors and people with disabilities. As part of initiatives and projects, the Municipality of Krakow is involved in numerous activities aimed at the sustainable development of the city and improving the quality of life of its residents. Such initiatives include "Smart City" programs, involving the implementation of modern information and communication technologies in city management; environmental programs promoting renewable energy sources, reducing greenhouse gas emissions and increasing energy efficiency; development of infrastructure through investments in the road network, public transport, cycling infrastructure, and public space; and supporting entrepreneurship by creating business incubators, economic zones and programs supporting innovation and development of the SME sector.

The Municipality of Krakow places great emphasis on transparency and dialogue with residents, which is achieved by organizing public consultations, enabling the participation of residents in the decision-making process regarding key issues of the city's development; use of digital platforms, such as e-office and mobile applications, enabling access to administrative services and reporting problems and suggestions; running residents' service offices available in various parts of the city, ensuring direct contact with officials and obtaining the necessary information; and organizing information and educational campaigns aimed at informing about planned investments, changes in the functioning of the city and promoting pro-social and pro-ecological attitudes.

5. Research Methodology

The research carried out at the Municipality of Krakow involved 245 employees from organizational units that in the past reported the most problems related to broadly understood information and communication. The surveyed units included:

- Entrepreneurship and Innovation Department.
- Department of Vehicle and Driver Records.
- Department of Spatial Planning.
- Department of Administrative Enforcement and Debt Collection.
- Investment Planning and Monitoring Strategy Department.
- Department of Education.
- Department of Social Communication.
- Department of Tourism.
- Department of Municipal Economy and Climate.

The survey was conducted using the survey technique (CAWI) in the days from September 30 to October 14, 2024. Its main objective was to identify and analyze information inefficiencies that occur in the information and communication processes of the City Hall despite their partial (and in some cases complete) digitization. The research was to answer the following questions:

1. Does the digitization (total or partial) of processes in the area of information and communication eliminate the phenomenon of information inefficiencies?
2. Does the Office implement digital solutions to eliminate or reduce information inefficiencies?
3. What digital solutions are used to eliminate or reduce information inefficiencies by the Office?
4. Do the employees of the Office have digital competencies enabling the use of their digital tools to eliminate or reduce information inefficiencies?

The above questions allowed us to specify the following research hypotheses:

H1. The digitization of information and communication processes reduces, but does not eliminate, the phenomenon of information deficiencies.

H2. A significant reduction in the risk of information inefficiencies is possible thanks to the use of appropriate digital solutions as part of information and communication processes.

H3. The persistence of the phenomenon of information inefficiencies despite the digitization of processes results from inadequate digital competencies of employees.

To verify the H1 hypothesis, the questions contained in 3 parts of the questionnaire were used: the first part assessing the occurrence of information inefficiencies in the Municipality of Krakow, the second part analyzing the level of digitization of the City Hall, and the detailed digital solutions used, and the third part characterizing the level of digital competence of the City Hall employees.

To verify the H2 hypothesis, questions from the second part of the survey were used on the level of digitization of the Office and the detailed digital solutions used.

To verify the H3 hypothesis, the answers to the questions from the third part of the survey on the digital competencies of the Office's employees were used.

6. Analysis and discussion of research results

The first part of the questionnaire contained questions allowing for the identification of four basic information inefficiencies appearing at work: information overload (heart attack), ambiguity (distortion) of information, information anemia, and information retention. Respondents had the option of answering using a five-point Likert scale, where a score of 1 meant "definitely not" and a score of 5 meant "definitely yes". Assuming grade 3 as a "moderate" frequency of symptoms of information overload, it can be concluded that employees of the surveyed organizational units of the Municipality of Krakow encounter this phenomenon relatively rarely (Table 1). The study shows that the employees of the City Hall most often encounter the phenomenon of duplication of the same information by sending it from different sources (e.g. the same message sent to employees from more than one e-mail box). The average response to the question about the occurrence of this form of information overload was 3.39. Other forms of overload occur slightly less frequently, according to the respondents. Reaching an employee with a lot of information at the same time received an average score of 2.84. Slightly less, i.e. 2.80, was obtained for the phenomenon of reaching the employee with information unnecessary from the point of view of the activities carried out by him. Very close to the answer "rather not" was the question about reaching employees important for the performance of their duties too early (2.32).

Table 1.

Answers to questions related to information overload and information infarction

Question	Number of responses	Average response	Standard deviation
Do you receive unnecessary information from point 1 in the course of the performance of employee tasks? To see the tasks being carried out?	245	2,80	1,17
Does it happen that as part of my duties, I receive such a large amount of information at the same time that you are not able to effectively do it?	245	2,84	1,21
Does it happen that the same information related to your work reaches you from several sources at the same time?	245	3,39	1,23
Does it happen that information reaches you too early and you have to come back to it after a long time?	245	2,32	1,07

Source: own study.

The next block in the survey consisted of questions relating to the phenomenon of information ambiguity (distortion). In this respect, the respondents indicated that it is more common for them to receive information that is difficult to interpret due to the way it is formulated. This form of ambiguity is most often caused by linguistic errors made by the senders of information. The average assessment of this form of ambiguity by the surveyed employees was 3.16, which indicates moderate admission. The possibility of receiving mutually exclusive information from various sources was ranked lower, here the average score was 2.71. In the block of questions devoted to the ambiguity of information, there was also a question to

which respondents could answer "yes" or "no". It was a question about whether they encounter information in languages other than Polish as part of the performance of their duties. Of the 245 people in the survey, 93 answered yes and the remaining 152 denied such events. Then, 93 people who answered affirmatively were asked whether the need to use information in a language other than Polish was a problem for them. It turned out that for the majority of respondents (58 people) this is not a problem. 35 people were of the opposite opinion. It can therefore be concluded that this form of information ambiguity is less common, and even if it does occur, it is not a problem for most respondents (Table 2).

Table 2.

Answers to questions related to ambiguity and distortion of information

Question	Number of responses	Average response	Standard deviation
Does it happen that as part of the performance of your duties/tasks, you receive information that is difficult to interpret?	245	3,16	1,13
Does it happen that as part of the performance of your duties, you receive mutually contradictory (mutually exclusive) information?	245	2,71	1,18

Source: own study.

In the further part of the survey, the respondents answered questions devoted to the phenomenon of information anemia. The results of the survey indicate a similar probability of events consisting of failure to perform obligations due to the lack of necessary information (2.82), making an incorrect decision as a result of the lack of necessary information (2.88), and delaying the decision as a result of the lack of necessary information (2.86). It should be noted that all three scores did not exceed the value of 3 (Table 3).

Table 3.

Answers to questions related to information anemia/information deficiency

Question	Number of responses	Average response	Standard deviation
Is there a risk of failure to perform employee tasks due to the lack of necessary information?	245	2,82	1,20
Does it happen that during the performance of employee tasks, there is a risk of making a wrong decision as a result of the lack of information?	245	2,88	1,12
Does it happen that as a result of the lack of information, you make late decisions?	245	2,86	1,20

Source: own study.

The last block of questions relating to information inadequacies concerned the phenomenon of information retention. Respondents were asked about the possibility of one of two events: the retention of information important for the performance of their duties by other positions and the retention of information needed by other positions. An interesting fact about the answers to these questions is that when asked about the possibility of storing information needed by other employees, the respondents answered that such situations do not occur (average 2.01). On the other hand, in the opposite situation, i.e. when they kept information needed by other employees, the average response was higher (3.11), which should be interpreted as a moderate occurrence of such events (Table 4).

Table 4.*Answers to questions related to information backlog*

Question	Number of responses	Average response	Standard deviation
Are there cases where the information you need is held by other positions?	245	3,11	1,25
Does it happen that for some reason you are forced to keep information, despite knowing that someone else is waiting for it?	245	2,01	1,16

Source: own study.

The conclusion from this part of the survey is the moderate occurrence of all types of information inefficiencies in the Municipality of Krakow.

Another element of the research was the analysis of the level of digitization of the Office and the detailed solutions used to reduce the phenomenon of information inefficiency. The respondents could answer the questions posed in this block using the five-point Likert scale, already known from the part devoted to information disabilities. The use of digital information resources necessary for the performance of tasks by the Office was rated the highest (average 3.49) and the availability of procedures and instructions enabled the use of these resources (3.36). The functioning of the electronic information and communication system in the Office was rated slightly lower (3.30) and the specific digital tools used within it (3.16). The respondents rated the level of implementation of digital work organization solutions the lowest (2.96). Answers to this question were submitted in Table 5.

Table 5.*Digital solutions to eliminate or reduce information inefficiencies*

Question	Number of responses	Average response	Standard deviation
Does the Office have implemented digital solutions in the area of information and communication?	245	3,16	1,02
Does the Office have implemented digital solutions in the area of work organization?	245	2,96	1,09
Has the Office implemented an electronic information and communication system?	245	3,30	1,10
Does the Office have digital, integrated information resources needed to perform employee tasks?	245	3,49	0,99
Are there procedures and instructions for managing digital information assets in the Office?	245	3,36	0,96
Are there any electronic solutions in the Office to reduce the amount of incoming unnecessary information?	245	2,99	1,15

Source: own study.

Subsequently, the respondents were asked about the use of detailed digital solutions supporting information and communication processes and reducing the risk of information deficiencies. In the question about closed answers, respondents were asked to indicate those digital solutions that they use daily as part of their duties. Respondents could choose more than one correct answer to this question. The answers show that in addition to such a common and currently constituting minimum standard in the field of information and communication processes as e-mail (used by 96.31% of respondents), the Office mainly uses inward-facing

solutions such as the Intranet (95.49% of respondents), the electronic document circulation system dedicated to the work of the Office (76.64%) and the internal electronic communication system based on MS Teams software (65.98%). The remaining solutions are indicated by less than 40% of the surveyed employees (Table 6).

Table 6.

Digital solutions used by employees to support information and communication processes

Digital support for information and communication processes	Number of responses	Response rate
Intranet	233	95,49
Internal electronic communication system (MS Teams, Zoom, chat)	161	65,98
Dedicated electronic document workflow system	187	76,64
Electronic system for submitting applications and comments	7	2,87
E-mail	235	96,31
Virtual teams	17	6,97
Access to external, dedicated databases	54	22,13
Access to the office's internal digital assets	88	36,07
Access to digital versions of administrative procedures	83	34,02

Source: own study.

The obtained answers to general questions concerning the areas of implementation of digital solutions along with answers to specific questions about specific forms of implemented solutions in this area allow us to confirm the H2 hypothesis.

The last block of questions used in the survey concerned the assessment of the level of digital competencies of the Office's employees necessary for the proper use of the tools supporting information and communication processes. It contained three questions with the possibility of answering in the previously presented five-point Likert scale. On this basis, the respondents assessed the degree of digital competence of the Office's employees, the availability of training to improve digital competencies, and the support by the management of employee initiatives aimed at developing digital competencies. The results show that the Office still has a long way to go in terms of digital competencies. Respondents rated their level of digital competence at 2.93, which is below the "moderate" level (Table 7). The level of motivation of employees to develop digital competencies on the part of the management was rated even lower (2.80). According to the respondents, training for employees in the development of their digital competencies is at a relatively satisfactory level (3.10).

Table 7.

Digital competencies of employees

Question	Number of responses	Average response	Standard deviation
Do the employees of the Office have sufficient digital competencies?	245	2,93	1,04
Does the Office provide training for employees in digital competencies?	245	3,10	1,10
Does the management of the Office actively motivate employees to develop digital competencies?	245	2,80	1,13

Source: own study.

The analysis of answers to questions about employees' digital competencies allowed us to confirm the H3 hypothesis. Despite the use of digital solutions by the Office, some of them may not be available to employees as a result of their insufficient digital competencies.

The answers to the questions contained in the three parts of the survey show that the Municipality of Krakow has digital solutions that reduce the risk of information inefficiencies. At the same time, the employees of the Office encounter these phenomena. An analysis of the areas of implementation and the detailed digital solutions implemented and used shows that they are not always used by all employees. According to the respondents, the assessment of the digital competencies of the Office's employees was also quite low. To conclude – the implementation of digital solutions itself reduces to some extent but does not eliminate information malfunctions, which allows us to confirm the H1 hypothesis.

The analysis of the literature on the subject indicates that research related to the digitization of public administration offices and the context of information inefficiency was the area of research by various authors. Erkkilä (2020) addresses the issues of access to information and transparency of the functioning of public institutions in the digital era. The author analyzes transparency as a mechanism for building public trust, indicating that access to information about the activities of public institutions can affect the level of citizens' trust in state authorities. At the same time, it emphasizes the complexity of this relationship, which is not always unambiguously positive. The impact of digitization on access to information is indicated, highlighting the possibility of increasing transparency through technologies, but also the challenges associated with it are emphasized. Digitalization is seen in the context of global pressure for transparency and the resulting tensions between transparency and privacy. Information is also considered to be a key resource, the proper management of which determines the effectiveness of public institutions. B. Hysa (2012) points out that the excess of data and problems related to its proper selection and processing can interfere with the decision-making process, which in turn has a negative impact on the efficiency of the organization. The author's considerations are focused on the issue of information quality in the decision-making processes of public administration. Analyzing the importance of information as a key resource in public institutions, he emphasizes that its quality has a direct impact on the effectiveness and accuracy of decisions made. Particular attention is paid to the attributes of information quality, such as timeliness, reliability, completeness, and availability, which are necessary to ensure the proper functioning of offices. The research presented in the cited article reveals similar challenges related to information overload, which can complicate the decision-making process and lead to information overload. The author emphasizes that maintaining high-quality information requires systemic management methods, including the implementation of procedures and instructions based on quality standards and the use of technical safeguards in information systems. In addition, it points to the key role of employee competencies, where training is important in the process of ensuring the quality of information. As part of the study, the author also described the most commonly used methods to improve the quality of

information in public administration, such as electronic document workflow, information security systems, and practices related to regular data updates. The results of the research suggest that appropriate information quality management is not only a matter of technology but also requires the involvement of employees and the application of consistent quality standards within the organization, which is consistent with the general conclusions of this article. A similar scope of considerations also appeared in the report "Digitization of City Offices" presenting the results of a study conducted by the Institute of Urban and Regional Development, which indicates the importance of effective information management as one of the basic factors affecting the quality of public services and the effectiveness of decision-making processes. A detailed analysis of the level of advancement of digitization processes showed that even though 84% of offices use electronic document management systems (EDMS), only 25% of them treat EDMS as the primary method of documenting cases. The use of advanced e-services and electronic document circulation is not fully optimized, especially in smaller offices, which results in a limited possibility of complete transfer of administrative processes to digital forms. The survey also revealed that the lack of a coherent digitization policy and insufficient competence of employees in the use of digital tools hurt the efficiency of the implementation of e-services and exacerbate problems related to information overload (Miazga et al., 2022). The conclusions presented in the report are in line with the results of the study and are consistent with the beliefs of the authors of these considerations that digitization without systemic support and an appropriate level of employee competence may lead to a situation in which information problems, such as excess data or difficulties with their proper processing, are only intensified. The lack of implementation of a well-thought-out digitization strategy and the development of digital qualifications of civil servants is a common problem in many city offices, which in practice limits the effectiveness of digital information management and makes it difficult to improve public services. A broad analysis of this issue is also presented in the article "The Impact of Digitalization in the Public Sector: A Systematic Literature Review" (Fischer et al., 2021). The text presents an analysis of the impact of digitalization in the public sector through a systematic review of empirical research from the last decade. The authors point out that despite the potential of information technology to improve administrative processes, research on the real impact of digitalization is relatively scarce and usually focuses on short-term effects. The review includes 93 studies on digitalization in various areas, such as e-government, open governance, and the digitalization of internal processes. The authors point to the need to increase interdisciplinarity in research on the digitization of public administration, especially through the integration of results relating to different dimensions of public value. In addition, they point to the lack of research on the internal effects of digitization, which suggests the need to examine the impact of technology on administrative employees and organizational structures. It can be assumed that the results of the study presented in this article meet the articulated expectations, paying attention not only to utilitarian and instrumental values, especially in the context of the provision of public services but also to the internal effects

of digitization and to the study of the impact of the technology used on public administration employees. A very interesting look at the changes taking place in innovation, including digital, of public administration offices was presented by A. Wodecka-Hyjek (2023) who pointed out that the processes in which public organizations become similar to the organization of the business sector are expression of a rational strategy based on the assumptions of modern concepts of public management. Such imitation and its key features are revealed in the implementation of management methods in public organizations, often directly taken from the practices of enterprises. It also seems that institutional isomorphism, undoubtedly dominant among public organizations in recent decades, is the result of a certain pressure to increase the rationality, effectiveness, and efficiency of the functioning of the public sector. These conclusions prompt the authors to continue their research, because the pressure to improve the efficiency of offices will continue to increase, and the only way to reduce it is the continuous implementation of solutions to reduce the level of digital inefficiencies.

7. Conclusions

Information has always accompanied the management processes of organizations, but it has never been as valued as it is today. The contemporary reality is dominated by information and technologies used to acquire, process, and transmit it. Information becomes the most valuable of any organization's strategic assets. At the same time, it is a unique resource and cannot be replaced by other resources: it supports various processes, enables communication between employees and management, increases employee knowledge, helps to make decisions, and facilitates contact with the environment. Increasingly easy ways of producing and supplying it also generate certain risks. On the one hand, the amount of information provided far exceeds the capacity to process it, on the other hand, it is increasingly difficult to find the information that is needed in a given situation in the mass of information reaching people. Another problem is that the quality of the information provided is getting worse, so the quality of decisions made on its basis is also at risk. The existing methods of information management, based on the exchange of paper documents containing specific information, are becoming inefficient, imprecise, and difficult to implement. Their place is taken by methods of electronic exchange of information and data. Digitization in information and communication processes is one of the main directions in which modern information management is developing. Digital solutions allow for the management of large sets of information while maintaining its usability and quality, understood as the degree of adaptation to the needs and requirements of the user. Information inefficiencies identified almost thirty years ago, as research indicates, still occur in modern reality, causing several negative effects on both the economy and society. The digitization of information, both as a product and a process, is today one of the most

effective ways to counteract these inefficiencies. Technologies referred to as ICT or information and communication (ICT) have revolutionized the entire modern world and influenced the way we work, the economy, and the functioning of enterprises and people. The development of modern organizations today is closely related to the use of this type of solution. Of course, for them to work, many conditions must be met, such as m.in, their adaptation to the conditions of operation of a specific organization, or the appropriate competencies of employees related to their use.

The research on the impact of the implementation of digital solutions in the field of information and communication management has certain limitations, resulting primarily from the limited range (the surveys were conducted only among selected organizational units of the Municipality of Krakow). Therefore, these results cannot be generalized, and their analysis should be critical. Next, the research should be expanded in the context of expanding the sample, preferably by employees of all departments of the Municipality of Krakow. It would be interesting to diversify the study not only depending on the faculties but also to confront the results obtained by extending the study to other public sector institutions.

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ENERGY AWARENESS OF MANUFACTURING COMPANIES IN PURCHASING AND USING CLOUD COMPUTING SERVICES

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Purpose: The use of cloud services grows rapidly, due in part to the development of Industry 4.0 concept and massive use of new artificial intelligence applications. It should be noted that this involves significantly increased electricity consumption. This increase is mainly concentrated in data centers, but the understanding energy efficiency practices on user sides is also necessary.

Design/methodology/approach: The research problem of the article was the assessing the level of managers awareness in manufacturing companies regarding the energy consumption of cloud computing services. As a first step literature study was performed out on the importance of carrying out energy efficiency measures and practices, especially related to the development of cloud computing services. The empirical part of the study was based on a quantitative method, the opinions of 300 IT managers were collected using a questionnaire designed for this purpose (the Cronbach's alpha 0.957).

Findings: The overall of the importance of the investigated energy efficiency practices is low and their perception slightly varies according to the size of the organization.

Research limitations/implications: Only a few selected from wide range of practices were surveyed restricted to the area of purchasing and IT management. Managers' opinions were questioned, the research did not include documents (e.g. procurement documents) to confirm opinions.

Practical implications: The future introduction of the obligation to conduct an energy audit in medium and small organisations can raise awareness of the need for energy management in the procurement and use of IT services. It should be motivated and supported by activities carried out by governmental and social organisations.

Social implications: Increasing awareness and action related to energy management in the purchase and IT services management has a positive impact on the environment, especially while their massive use.

Originality/value: The article points out the need for organizations to raise awareness of the environmental impact of using cloud computing services in the area of energy efficiency and consumption. This is important both for organizations and for the bodies responsible for stimulating sustainable development activities.

Keywords: energy efficiency, Cloud Computing, energy awareness, manufacturing companies, resilience.

Category of the paper: research paper.

1. Introduction

The resilience of energy systems is important for the energy management of organizations as it ensures the stability of fuel and energy supply, which is fundamental for the functioning of the economy and society. Resilience, or the ability of a system to resist disruptions, refers to the ability to withstand disruptions due to technical failures, weather phenomena, catastrophes and intentional actions, e.g. cyber-attacks (Xu et al., 2023). Resilience is achieved by ensuring the ability to adapt to disruptions and the ability to adjust to changing conditions.

Resilience is not considered in Polish crisis management and critical infrastructure protection legislation with the exception of the National Programme for the Protection of Critical Infrastructure (RCB, 2023). Resilience has been considered in cyber security legislation. The issue of resilience is addressed by EU regulation. The Directive on the Resilience of Critical Entities defines resilience as ‘the ability of a critical entity to prevent, protect against, respond to, resist, mitigate and absorb an incident and to adapt and recover from an incident’ (EU, 2022). The document details the framework and elements for building and enhancing the resilience of critical entities (Wróbel, 2022, p. 169). Corporate energy management from an organizational resilience perspective takes two perspectives - the first is to optimize resources towards delivering energy efficiency to the organization. The growing demand for energy can be a serious threat to the environment and lead to problems in the field of energy security. As the literature shows, energy efficiency is considered the best solution, beneficial from the point of view of energy cost savings, but also sustainable development.

The second perspective is based on the assumptions underlying Corporate Social Responsibility for organizations that use energy - the company consciously chooses and buys environmentally friendly products, saves common resources that are limited in amount as a result of wider access to knowledge or new resources, in order to seek the most innovative solutions for the benefit of society and the environment, the customer, when choosing products, may pay attention to whether the entity undertakes socially responsible actions and freely select products and services according to the criterion of whether the company meets its expectations. The potential of energy management (EM) varies depending on company-specific characteristics such as size, energy intensity, and type of production. In the case of manufacturing companies, there is a large untapped market potential in the form of services that provide a promising market solution for improving energy efficiency. But, not only do production processes have an impact on the level of energy consumption, the level of use of information and communication technologies is becoming increasingly important. The concept of Industry 4.0 contributes to increased energy consumption through the increased use of IT services, related to technologies such as Big Data, Digital Twins, Artificial Intelligence. Nevertheless it is possible to indicate the degree of energy maturity of the company in terms of EM. Energy management maturity models allow organizations to assess their level of maturity

against a predefined set of parameters, enabling benchmarking and continuous improvement (Finnerty et al., 2017). The implementation of the chosen energy management maturity model, inherently identifies good practice and provides a progression path from the lowest to the highest level of maturity, which corresponds to the improvement effect of adopting a strategy and implementing energy efficiency measures (Pamula, 2021). The literature indicates several trends proposing EM assessment models, which differ in terms of approach, objectives, perspective and level of detail. Trianni (et al., 2019) distinguished four such trends. The first is a simple system for checking the fact of a non-system, without using metrics defining its maturity and effectiveness, as indicated by the ISO 50001 standard. The starting point of the second trend is the systemic perspective indicating the need to determine the level of maturity of the required steps in order to establish the system as such. The third trend focuses on matrices proposing assessment models that take into account a detailed list of activities, while none of them defines the critical factors on which the assessment is based. In turn, the fourth shows detailed characteristics of the energy management system, but does not indicate the factors for obtaining a comprehensive overview of EM activities. Trianni et al. (2019) proposed an innovative energy management assessment model based on a novel characterization of energy management practices. The model describes 58 practices based on the literature review. Following this model the energy practice in this paper is defined as “an energy management practice is a technique, method, procedure, routine or rule adopted at a precise stage of the industrial energy management setting in order to achieve the company’s energy efficiency objectives. It acts on technological, non-technological, or of support aspects, by improving the energy performance directly or indirectly in a specific area of the company” (Trianni et al., 2019). The Authors proposed 8 attributes of energy management practices. They have also categorized the types of energy management distinguishing the following types/areas: technology related, non-technology related, administrative, energy-performance related, informative, procurement, staff-related, support, engineering financial and managerial.

One of the important practices in the field of EE is conducting an energy audit. In Poland the Energy Efficiency Act of 20 May 2016 (Dz.U. 2021 r., poz. 2166) imposes an obligation on an entrepreneur within the meaning of the Act of 6 March 2018. Entrepreneurs' Law (Dz.U. z 2021 r., poz. 162), with the exception of a micro-entrepreneur, small or medium-sized entrepreneur, an obligation to carry out an energy audit of the enterprise every four years or to have one carried out. Therefore, this law applies to large entities, such as those that employed an average of at least 250 employees per year or achieved an annual net turnover from the sale of goods, products and services and financial operations exceeding the PLN equivalent of EUR 50 million and the total assets of its balance sheet as at the end of one of those years exceeded the PLN equivalent of EUR 43 million. (see Information from the President of the Energy Regulatory Office No. 46/2016). The Law on Special Solutions for the Protection of Electricity Consumers in 2023 (Dz.U. z 2022 r., poz. 2127), which came into force on 18 October 2022, required managers of public finance sector units (PSUs) to take measures

aimed at reducing electricity consumption by 10 per cent. The intention behind the introduction of this regulation was to realise higher standards of energy efficiency improvements in the public sector and to strengthen measures that translate into a stabilised electricity market. An obligation to take measures to reduce by 10% the total electricity consumption of occupied buildings (or parts of buildings) and of the technical equipment, installations and vehicles used is incumbent on all entities that are public sector bodies.

Cloud Computing and energy consumption

Cloud computing has become a powerful, versatile and widely used technology that offers users reliable, customizable and adaptive computing environments (Islam et al., 2023). Many companies use infrastructure solutions and applications, which these are hosted on large systems and storage infrastructures located around the world. The increase in demand services in the cloud, it is necessary to develop extensive data centers, which significantly increases electricity consumption (Masanet et al., 2020). The fast growth of cloud computing over the past years is seen as trigger for digital transformation (Al-Rwaidan et al., 2023), but on the other hand it has a strong environmental consequences. Since cloud computing shifts energy consumption dynamics between providers and users (Bharany et al., 2022) the understanding energy efficiency practices on both sides is necessary. From the provider site (Astsatryan et al., 2017) the optimization of energy consumption can be achieved by consolidating resources based on real-time usage, using efficient networks, and taking into account the thermal conditions of nodes and computing devices. In the literature, one can find a number of solutions that could be applied to minimize energy consumption in large data centers using various machine learning techniques, heuristics, metaheuristics and statistical methods (Karimi-Mamaghan et al., 2022; Juan et al., 2023). A comparative analysis of such models was done by Panwar et al. (2022) and (Long et al., 2022) who also discuss data center energy efficiency evaluation metrics, as well as their benefits and drawbacks, so that users could select the most relevant metrics. Katal et al. (2022) discusses the challenges, concerns, and requirements that cloud data centers and organizations need to understand, along with various factors and case studies that influence the adoption of environmentally sustainable cloud practices.

Park et al. (2023) conducted research on the energy efficiency impacts of cloud computing from the user's perspective. They introduced a new industry-level measure of cloud computing based on IT services in the cloud. Using data from the U.S. economy between 1997 and 2017, the study revealed that cloud-based IT services significantly enhance users' energy efficiency, especially since the wide commercialization of cloud computing. The results indicated that this impact varies across different cloud service models, and the intensity of internal IT equipment. Specifically, software as a service (SaaS) was linked to improvements in overall energy efficiency, while infrastructure as a service (IaaS) was mainly associated with increased electricity efficiency in industries with heavy IT equipment usage. Additionally, SaaS contributed to more energy-efficient production, whereas IaaS primarily helped reduce energy consumption in IT infrastructure.

2. Method

The main research question of the study was *How important for manufacturing companies is the analysis of energy consumption of cloud computing services?*

The adopted solution method was the use of a quantitative method. The opinions of IT managers were collected using a survey tool.

Data collection and research sample analysis

The data used in this study were collected in 2023 through a quantitative survey, as part of ongoing research on the spread of cloud computing (CC) solutions in Polish manufacturing companies. The survey respondents were either IT managers (*Chief Information Officer – CIOs*) or, in the case of small enterprises, company owners responsible for implementing IT solutions. This selection of respondents ensured that they had knowledge about the IT services used in the company as well as the methods of their purchase and use. The survey was conducted using the CATI (Computer-Assisted Telephone Interviewing) method, targeting manufacturing companies with headquarters or production facilities in Poland. A professional agency, selected through a request-for-quotation process, administered the questionnaires.

The sample consisted of randomly selected manufacturing companies registered in the REGON database of Polish businesses. The companies were categorized by size based on the number of employees: micro (0-9), small (10-49), medium (50-249), and large (over 250). In addition to company size, data on the year of establishment was collected. Companies were drawn by REGON number, and approximately 88% of the sample was used (there was no need for subsequent draw), and the random selection process continued until either the survey was completed or the company declined to participate. The collected data was analyzed, with 300 records determined to be relevant for further examination. These records represented companies of various sizes (micro 12.33%, small 42.33%, medium 29.33%, and large 16.00%) located in Poland. It must be noticed that small and medium companies dominated in the group. Detailed information is provided in table 1 below.

Table 1.

The structure of the surveyed firms

Company Size	Micro	Small	Medium	Large
records	37	127	88	48
percentage	12,33	42,33	29,33	16

Source: own compilation.

In order to find an answer to the research question, a survey questionnaire was prepared. The study covered 7 selected practices related to the purchase of IT infrastructure and services and, as well as IT service management. In the survey, respondents were asked to rate the extent to which their organization considers the practices studied to be important. A ranking scale

from level 1 unimportant to level 5 very important was used to assess each practice. The research in this article focuses only on selected practices. The studied practices can be assigned to areas defined in the model proposed by Triani et al. (2019). Table 2 presents the practices that were investigated and operationalized into variables, the comment column indicates a reference to the practices defined in the model proposed by Triani et al. (2019) - the practices studied were grouped into two areas Procurement and IT Management/Informative. The first four of the best practices studied refer to the supplier selection process, while the next three refer to the use and management of already available IT services.

Table 2.
Investigated practices

Area	Variable	Best practice description	Comments
Procurement	BP1	Each component of the physical infrastructure necessary for CC is subject to an energy assessment and approved by the body responsible for energy management	Practice 2 Adoption of adequate investment criteria of energy efficiency investment. Practice 3 Adoption of energy performance contracting for energy-efficiency investments. Practice 23 Energy efficient procurement of equipment, direct and indirect materials.
	BP2	Only the purchase of infrastructure equipment with significant energy consumption is subject to an energy assessment and approved by the body responsible for energy management	
	BP3	The selection of the cloud service provider takes into account its approach and measures of reducing the impact on the environment	
	BP4	Applications are selected, marked as Energy-aware software programming	
IT Management/ Informative	BP5	Actions are carried out to increase the efficiency of the existing software	Practice 13 Documentation and record management regarding energy use. Practice 38 Measurement of energy use. Practice 40 Monitoring and evaluation of energy performance. Practice 43 Optimize energy procurement based on energy data. Practice 57 Reporting of energy performance
	BP6	Optimization tools for cloud computing (cloud native) are used	
	BP7	Tools for monitoring the operation of IT services related to performance and load balancing are used	

Source: own assumptions.

3. Findings and Analysis

To check the internal consistency or reliability of a scale or measurement instrument as the first step Cronbach's alpha test was performed. The Cronbach's alpha value obtained was 0.957, indicating a high level of consistency between the scale items and showed that variables were highly correlated (in all cases $R > 0.8$). This suggests that the questionnaire used in the study was reliable and valid for measuring the energy awareness of manufacturing companies. Performed principal component analysis showed all correlation statistically significant ($> 0,7$)

with determinant 0,001, KMO value 0.945 (taking into account significance $< 0,001$). It was also found that one component was responsible of 79% of variance. Table 3 presents descriptive statistics. The Mean value for all investigated practices were similar and vary from 2,27 to 2,47), the median for each practice awareness was equal 2. Figure 1 and table 4 presents detailed data for each practices.

Table 3.

Descriptive statistics and PCA results

Area	Variable	Mean	Standard deviation	Communalities Extraction
Procurement	BP1	2,37	1,388	0,728
	BP2	2,43	1,375	0,745
	BP3	2,38	1,461	0,814
	BP4	2,27	1,370	0,800
IT Management/Informative	BP5	2,47	1,516	0,821
	BP6	2,37	1,416	0,859
	BP7	2,37	1,379	0,813

Source: own compilation.

The differences in the assessment of the perceived importance of the practices studied were not very large. For more than 40% of the companies, none of the investigated practices was important. More than 50% demonstrates some type of awareness. The level of importance varies slightly for each practice. The respondents rated the most important practice BP2 (*Only the purchase of infrastructure equipment with significant energy consumption is subject to an energy assessment and approved by the body responsible for energy management*). It concerns the purchase of equipment with significant energy consumption. Therefore, it may indicate a greater focus on a single large action than supervision of purchases of services used 'en masse', in which only this 'en masse' use constitutes significant use of energy. On the other hand, the respondents considered the least important practice BP3 (*the selection of the cloud service provider takes into account its approach and measures of reducing the impact on the environment*) that indicates actions aimed at transferring activities in this area to business partners. 15% of respondents pointed out practice 5 (*Actions are carried out to increase the efficiency of the existing software*) as very important that allow to conclude that existing software was audited in some way, and some actions were taken to improve energy efficiency of IT services. At the same time, it should be noted that only 7% of companies indicated practices BP1 (*Each component of the physical infrastructure necessary for CC is subject to an energy assessment and approved by the body responsible for energy management*) and BP4 (*Applications are selected, marked as Energy-aware software programming*) as very important, which may indicate greater involvement in searching for energy efficiency in already possessed application and hardware resources.

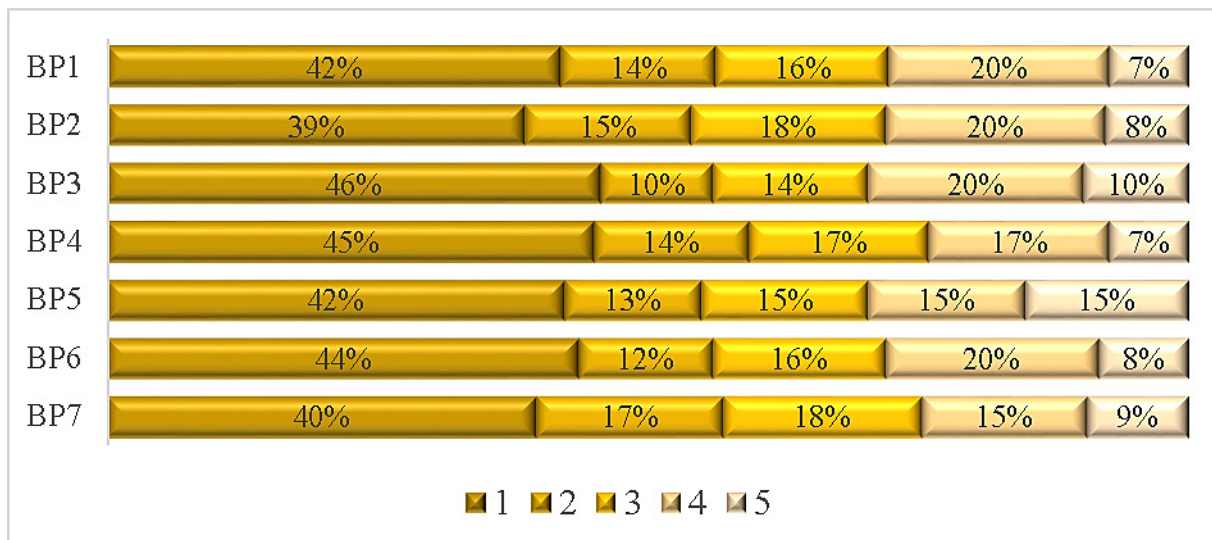


Figure 1. Assessment of investigated practices (ranking scale from level 1 unimportant to level 5 very important).

Source: own compilation.

Taking into account the presented results it can be concluded that analysis of energy consumption of cloud computing services but the awareness is low and not sufficient taking into account the energy crisis and the growing trend of using IT services.

Table 4.

Assessment of the practices

Area	Best Practice	Assessment				
		1 unimportant	2	3	4	5 very important
Procurement	BP1	42,0%	14,3%	16,0%	20,3%	7,3%
	BP2	38,7%	15,3%	18,0%	20,3%	7,7%
	BP3	45,7%	10,3%	14,3%	20,0%	9,7%
	BP4	45,0%	14,3%	16,7%	16,7%	7,3%
IT Management/ Informative	BP5	42,3%	12,7%	15,3%	14,7%	15,0%
	BP6	43,7%	12,3%	16,0%	19,7%	8,3%
	BP7	39,7%	17,3%	18,3%	15,3%	9,3%

Source: own compilation.

The next stage of the research process was to examine the impact of company size on the perception of the importance of analysis of energy consumption of cloud computing services. A statistically significant difference ($p \leq 0.001$) was found after applying the Kruskal-Wallis test. In particular, pairwise comparisons showed a significant difference between all pairs except micro to small and medium to large companies. The new constructs were calculated as a mean value of all variables (MeanTotal), mean value of variable BP1 to BP4 representing best practices in purchasing processes (MeanPrct), mean value of BP5 to BP6 representing best practices in IT management (MeanITMng). The data was not normally distributed so non parametric test were used for further investigation. The statistical relationships between the composite variables MeanTotal, MeanPrct MeanITMng were calculated and statistically significant correlations were confirmed for variables.

Table 5.

Average assessment of the procurement & IT Management practices according to company size

	All	Procurement	IT Management/Informative
Total	2,38	2,36	2,10
micro	1,53	1,53	1,66
small	2,08	2,07	1,97
medium	2,88	2,82	2,40
large	2,90	2,93	2,22

Source: own compilation.

Table 5 and Figure 2 present detailed results. For small, medium and large companies practices related to the of Procurement of IT services were considered slightly more important than those related to Management/Informative area.

Figure 2 present the comparison of the average assessment of the importance investigated practices by micro, small, medium and large enterprises. The highest rating was given by medium-sized and large enterprises, the lowest by micro companies. Micro-enterprises rated the practice BP6 (*Optimization tools for cloud computing (cloud native) are used*) as the highest and BP4 (*Applications are selected, marked as Energy-aware software programming*) as the lowest, while small companies rated BP2 (*Only the purchase of infrastructure equipment with significant energy consumption is subject to an energy assessment and approved by the body responsible for energy management*) at the highest and BP3 (*The selection of the cloud service provider takes into account its approach and measures of reducing the impact on the environment*) at the lowest, medium-sized companies rated BP5 (*Actions are carried out to increase the efficiency of the existing software*) at the highest and BP 4 (*Applications are selected, marked as Energy-aware software programming*) at the lowest, and large companies rated it BP5 (*Actions are carried out to increase the efficiency of the existing software*) at the highest and BP6 (*Optimization tools for cloud computing (cloud native) are used*) at the lowest.

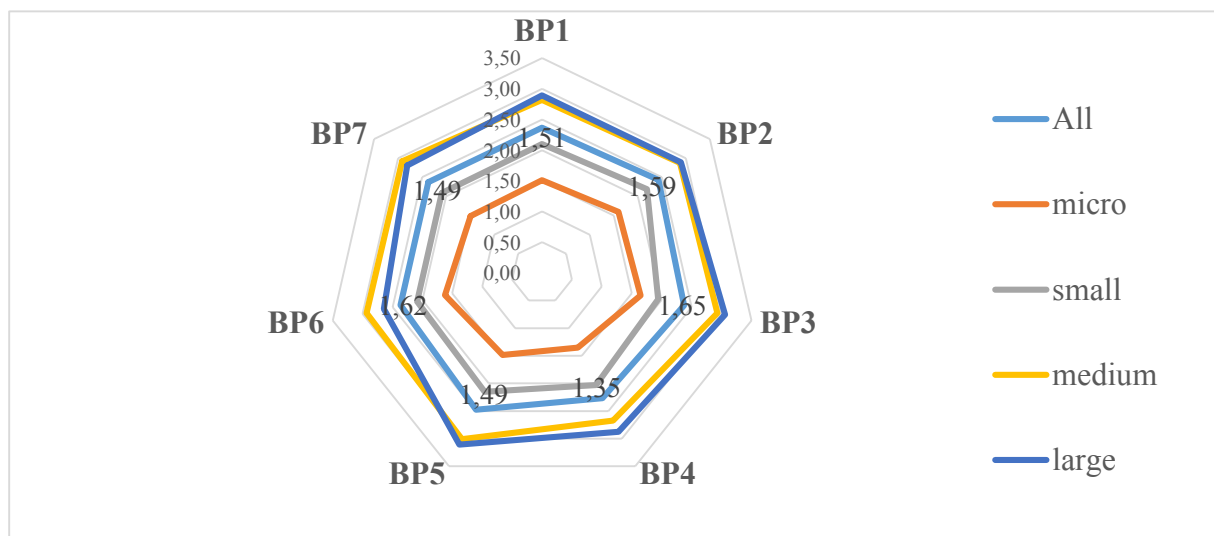


Figure 2. Mean value of the best practices assessment by micro, small, medium and large companies.

Source: own compilation.

4. Discussion and conclusion

The overall of the perception of the importance of the investigated practices is low and it varies according to the size of the organization. The low importance rating level of the surveyed micro and small enterprises may indicate that there is no interest in all researched practices services and problems in relation to their use at the time the research was conducted. These organizations (micro and small) usually do not perceive need to use IT resource management systems, however, access to digital services and cloud manufacturing seems to be a way such organizations will function in the near future (Gharibvand et al., 2024). The results of the survey indicate that medium and large companies show a greater recognition of energy awareness.

Our society's increasing dependence on critical computer systems means that even short periods of downtime can result in significant financial losses and, in some cases, even put human lives at risk. A key challenge is to handle the business continuity of companies, enabling them to return to operation quickly after a disaster (Wood et al. 2010). Optimized use of IT services, including cloud computing services, is a condition for business continuity, which is using these services increasingly intensive. The disaster-recovery mechanisms in clouds are cheaper than the traditional ones and is also more convenient and user friendly (Wood et al., 2010). In principle, cloud computing has the potential to become an energy-efficient technology (e.g. for ICT), as some academics say (Berl et al., 2010) provided that the potential for its significant energy savings, which has so far been focused on hardware aspects, can be fully referenced to system operation and network aspects.

On the other hand, the Cloud is associated with high energy consumption (Mastelic et al., 2014) In 2020, energy demand in the data centre domain was predicted to increase to 5% of global energy production by 2025 (Deepika, Prakash, 2020). Such alarming figures call for a rethink of an organisation's energy efficiency. However, the analysis of the current state is required, before introducing any changes. This article analyses the perception of cloud computing services and the awareness of manufacturing companies regarding energy consumption. The results obtained in the study conducted by Trainni et al. (2019) indicated increasing the attention on the purchase activities in terms of energy procurement optimization, however, these studies did not concern the use of IT services.

Mandatory audits of large companies and reporting by public entities make them consider extending this approach to other companies. An analysis of these mandatory documents indicate comparison of current state to future one with higher concern to energy efficiency. Basic suggestion extracted from these documents are monitoring electricity consumption and investing in more energy-efficient equipment. As the paper discuss the best practices conducting an energy audit in medium and small organizations can be suggested as important practice to be applied as it can raise awareness of the need for energy management in the

procurement and use of IT services. Currently only large companies in Poland are obliged to have an energy audit every four years. Other organizations are the subject neither to audits nor to reporting. For this reason, there are no documents available on the basis of which conclusions can be drawn about the behaviour of companies – whether the purchase decision is based only on the price of the equipment, or perhaps also on energy intensity and other factors (e.g. availability of spare parts).

This research paper has also some limitations. General limitation comes from perception-based study coming from the nature of the method. The opinions of managers were examined, but the research did not cover the documents due to a lack of access to them. For the procurement area it could have been data obtained from the study of historical documents, like contracts with suppliers that could possibly show a real way what actions would have been taken by organizations in this area. Data from ITSM systems could be helpful while accessing current activities performed by IT staff. As only the opinions were investigated it must be noticed that respondents were IT managers in case of the procurement managers were asked it could have possibly reflect other issues, undiscussed in this paper. The reason for this is the way medium and large manufacturing companies operate where the user of the equipment does not make the purchase himself. A person who needs a certain infrastructure places an order with the relevant unit, where orders and purchases are made, often in bulk. IT managers make purchases according to their knowledge of the needs of the employees and the quality of the equipment, adjusting them to the financial possibilities of the company. The limitation that also indicates the need for further research is examining only 7 selected practices were surveyed considering 2 areas Purchasing and IT management/Informative areas. Also this research did not cover the purpose of IT-service usage – whether it is devoted strictly to support production processes, or to services supporting administrative activities.

The use of cloud services will show an increasing trend (Katal et al., 2023). The development of AI contributes significantly to this and manufacturing companies will have to look for energy savings not only in the manufacturing process itself. IT services are performed by compute-intensive servers within huge data centres, but it is the final users who decide on the intensity of their use. At the moment, only the European Union has planned measures to regulate this consumption. Given the ever-increasing population of our planet, the greenhouse effect and energy derived from non-renewable sources, this is another important point in the public discussion requiring a decision at the highest level.

Further research could focus on more specific practices, those that have the greatest effect while generating the lowest possible cost – this mapping of first steps can support small and medium-sized companies to implement best practices to reduce energy consumption and support company resilience related to energy market volatility. Further in-depth research and analysis of individual energy efficiency practices should also be included in energy audit schemes and carried out to determine their potential and possible impact on company welfare.

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MODELS OF SHARED MOBILITY IN THE SILESIAN-ZAGŁĘBIE METROPOLIS – RESEARCH RESULTS

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Purpose: The article focuses on understanding the complexity of shared mobility activities, using a variety of perspectives and insights provided by existing publications and citizen opinions.

Design/methodology/approach: In article an attempt is made to examine the opinions of residents of the Upper Silesian Metropolis on shared mobility models, their use and limitations (survey research).

Findings: In this paper, we show the Upper Silesian Metropolis (GZM) are implementing various actions in line with the latest global trends, introducing a number of changes in urban mobility. They are mainly based on the promotion of the concept of sharing public transport services. The presented paper is an attempt to look at shared mobility from the perspective of the beneficiary/stakeholder, i.e., a person who uses shared mobility models.

Practical implications: The results of the conducted research indicate that despite many undertaken activities bringing positive effects, the Metropolis still faces many challenges identified as limitations in the use of urban mobility.

Social implications: The article identifies the limitations of using shared mobility, and the proposal of GZM residents can be used to improve existing solutions and develop cities.

Originality/value: The publication of research results may constitute valuable material for the future activities in the field of promoting the idea of sustainable development in cities. Shows, how it transforms traditional urban transport because it has the potential to move towards social, environmental and economic efficiency through the use of technology, which enables the transition to a climate-neutral economy and zero-emission transport a may constitute valuable material for city authorities for future decision-making processes.

Keywords: shared mobility, metropolis, city logistics, city bike, e-scooters, carsharing.

Category of the paper: Research paper, Case study.

1. Introduction

More than 70% of EU citizens live in urban areas, which generate 23% of all greenhouse gas emissions from transport. Therefore, in recent years, several initiatives have been undertaken to change this unfavorable trend. Cities are taking a number of actions in line with the latest global trends, introducing a number of changes. They are mainly based on the dissemination of the concept of sharing public transport services. They are based on three pillars, i.e., sharing economy, urban mobility and ecology, while determining a new area called shared mobility. Activities implemented in this area are related, on the one hand, to mobility in cities (paying attention to air pollution, congestion, accessibility, safety), and on the other hand, to promoting an increase in the share of sustainable means of transport (public transport, active mobility).

It is observed that shared mobility has recently become a very popular issue. Interest in the issue of shared mobility has intensified over the last decade- approximately 5.2 thousand papers have been published. Scientific works in this field, most of them concerned social sciences, economics and management. There have been many domestic and foreign publications (Wright, 2021; Benevolo, 2016; Le Vine, 2015; Raviv, 2016), in which different authors and decision – makers present different approaches to the term shared mobility itself, its advantages and disadvantages.

Nevertheless, the most frequently undertaken problems include urban mobility (Kiba-Janiak, Witkowski, 2019), the impact of the urban mobility management tools used on environmental efficiency (Arsenio, Martens, 2016; Pisoni, Christidis, 2019), the role of public transport in balancing urban mobility (Snatos, Behrendt, 2010), smart city solutions (Lyons, 2018).

Previous publications present the tasks of shared mobility from the point of view of cities and the successes of their rulers. However, there are no publications that discuss the issues of shared mobility from the point of view of the end user – beneficiary, thus revealing a research gap.

Therefore, the article consciously ignores broad theoretical considerations on shared mobility (Płaczek, 2023), focusing on an attempt to examine opinions of residents on shared mobility models in the Silesian-Zagłębie Metropolis (GZM). For this purpose, the following research questions are formulated:

- what is the knowledge of shared mobility models among GZM residents,
- what limits the use of SM,
- what activities would encourage the use of SM.

The conclusions drawn from the research may constitute valuable material for future decision – making processes, showing beneficiaries, on the one hand, that for cities shared mobility is a real alternative to reducing social and environmental costs and improving the quality of life,

and on the other hand, that their opinions and suggestions for implementations are valid and are implemented.

2. Shared mobility

In the literature, there is not a single, universal definition of shared mobility (SM). In English it is called Sharing Mobility or Shared Mobility. In foreign literature it is defined as sharing (shared use of) a vehicle, bicycle or other means of transport. The UK government defines SM as a model that is based on shared ownership or use of a vehicle enabled by digital platforms (Wright, Castellanos, Grant-Muller, 2021, p. 326). On the other hand, the American organization SAE International describes it as the shared use of a vehicle, motorcycle, scooter, bicycle or other means of transport, providing short-term access to them when required (Wright, Castellanos, Grant-Muller, 2021, p. 326). It is more difficult to find a definition of shared mobility in Polish literature. Polish authors refer to Swedish researchers B. Nansubug and Ch. Kowalkowski. They describe shared mobility as a system based on the shared use of means of transport by passengers in order to meet temporary transport needs without transferring ownership right from the service provider to the customer (Kuźma, Połom, Żukowska, 2022, p. 8). Just like the SAE organization, they emphasize the short-term nature of the SM service. In practice, shared mobility means the shared use of vehicles such as bicycles, scooters, cars, scooters, etc. It is perceived as an innovative transport strategy that provides users with short-term access to a means of transport without the need to own a vehicle (Saheen et al., 2016, p. 120).

Shared mobility is often incorrectly replaced by the term shared transport. Transport means the movement of people, goods or information from point A to point B (Kumemer, 2023, p. 36). The word mobility is a broader concept. It is related to movement, i.e., travelling (Szołtysek, 2011, p. 5). Three types of mobility are identified: virtual mobility (e.g., telework), social mobility (e.g., promotion or social degradation) and spatial mobility, i.e., physical movement (Ciastoń-Ciulkin, 2016, p. 4). Spatial mobility is about reaching a specific destination using various available resources, which is why it is characterized by high multimodality. To meet the diverse needs of users, shared mobility includes various models of transport-related services. Fig. 1 shows examples of services provided as part of shared mobility.

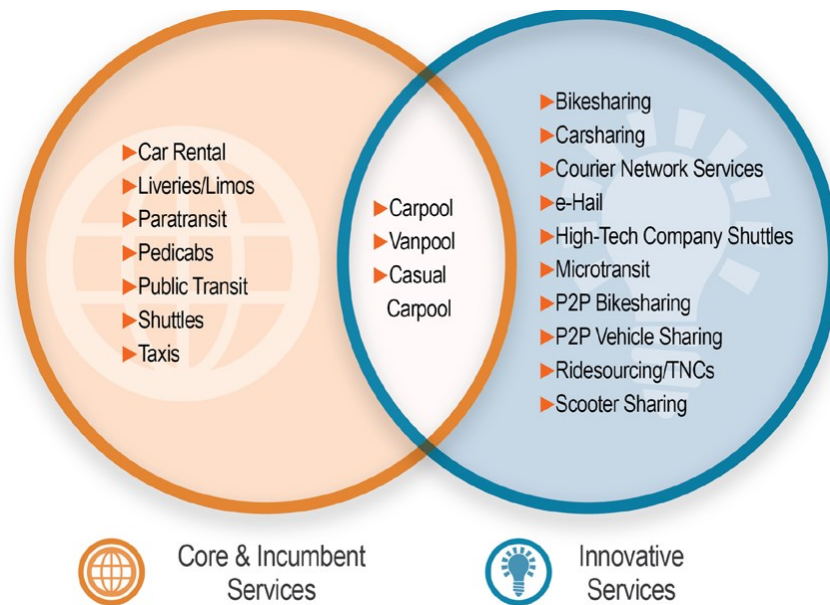


Figure 1. Services provided as part of shared mobility.

Source: Shaheen, Cohen, Zohdy, 2016, p. 10.

Traditional models of shared mobility include taxis, limousines, stationary car rental companies and public transport. With the development of technology, new innovative services have emerged, including micromobility: non-station (or area) carsharing, city bikes, a system of urban electric scooters, e-hail and ridesourcing. B2C and B2B models prevail in shared mobility, where companies provide vehicles to consumers and companies for a specified period of time for a fee.

Generally, services provided within shared mobility can be divided into five groups: 1) membership-based self-service models, 2) P2P self-service models, 3) non-membership self-service models, 4) for-hire service models, and 5) mass transit systems (Table 1). Sequential models (used by one user and then another, e.g., bikesharing and carsharing) and concurrent models (shared by many people at the same time, e.g., microtransit, carpooling, ridesplitting) are also distinguished among shared services (Transportation Research Board, 2015).

Table 1.

Models of shared mobility services

Shared Mobility Service Models				
Membership-Based Self-Service Models	Peer-to-Peer Self-Service Models	Non-Membership Self-Service Models	For-Hire Service Models	Mass Transit Systems
<ul style="list-style-type: none"> • Bikesharing • Carsharing • Carpooling • On-Demand Ridesharing • Scooter Sharing • Vanpooling 	<ul style="list-style-type: none"> • Bikesharing • Carsharing 	<ul style="list-style-type: none"> • Bikesharing • Car Rental • Casual Carpooling 	<ul style="list-style-type: none"> • Courier Network Services (CNS) • Liveries/Limousines/Pedicabs • Ridesourcing/TNCs • Taxis/E-Hail 	<ul style="list-style-type: none"> • Public Transportation • Micro and Alternative Transit Services (including Microtransit, Paratransit, and Shuttles)

Source: Shaheen, Cohen, Zohdy, 2016, p. 10.

Shared mobility is changing our thinking in a tangible way. Shared mobility service models enable efficient movement around the city; they constitute an alternative to private vehicles, reduce the problem of traffic jams and lack of parking spaces, while being an attractive complement to public transport. The advantages of shared mobility determine its main goal, which is to implement the assumptions of sustainable development, i.e., reducing road congestion, air pollution, noise and improving the quality of urban spaces, limiting the space occupied by private cars on the one hand, and creating transport systems that meet the needs of all users on the other hand (Wright et al., 2021, p. 327). The continued use of vehicles that pollute the environment such as carpooling and carsharing is a negative aspect of shared mobility forms. The convenience and flexibility of these forms increases the risk that travelers will more often use these means of transport instead of choosing more environmentally friendly public transport, walking or cycling.

It is certain that the development of the idea of shared mobility, in all its forms, will finally result in a decrease in the number of cars, a decrease in emissions of harmful exhaust fumes and a significant decrease in traffic intensity in city centers.

3. Towards the Metropolis

The first step to creating the Metropolis was the creation of the Upper Silesian Metropolitan in 2006, which included the fourteen largest cities of the Silesian conurbation (<https://metropoliagzm.pl/>). On July 1, 2017, the association was transformed into the Upper Silesian-Zagłębie Metropolis. It became fully operational on January 1, 2018 (Zuzańska-Żyśko, Sitek, 2018, p. 68). GZM covers an area of 2553 km² (approximately 21% of the area of the Silesian Voivodeship). The seat and central center of GZM is Katowice, because it is characterized by the highest concentration of metropolitan functions and has a strong position as an economic and cultural center (Dz.U. 2022, poz 1709). The executive body of GZM is the Metropolis Management Board. The area of agglomeration is distinguished in the Silesian Voivodeship by its high population density, development intensity, extensive road infrastructure network, public transport connections and large daily migration of residents between the cities of the agglomeration (Dolnicki, Majchaj, 2017, p. 75). GZM currently consists of forty – one communes, including:

- 13 cities with county rights: Katowice, Mysłowice, Tychy, Sosnowiec, Dąbrowa Górnicza, Ruda Śląska, Świętochłowice, Chorzów, Siemianowice Śląskie, Piekary Śląskie, Bytom, Zabrze, Gliwice,
- 13 urban communes: Mikołów, Łaziska Górne, Knurów, Imielin, Łęczyny, Bieruń, Pyskowice, Czeladź, Będzin, Sławków, Wojkowice, Radzionków, Tarnowskie Góry,
- 2 urban – rural communes: Sośnicowice, Siewierz,

- 13 rural communes: Rudziniec, Pilchowice, Gierałtowice, Wiry, Kobiór, Bojszowy, Chełm Śląski, Psary, Bobrowniki, Mierzęcice, Ożarówice, Świerklaniec, Zbroślawice (<http://infogzm>).

Conventionally, GZM is divided into five subregions: Bytom, Gliwice, Katowice, Sosnowiec and Tychy.

The Metropolis undertakes many initiatives to improve transport and the mobility of residents within the GZM area. In 2021, it published the „Sustainable public transport plan for the area of the Upper Silesian-Zagłębie Metropolis and the communes with which an agreement was concluded on entrusting the Upper Silesian-Zagłębie Metropolis, with the municipalities` own task, i.e. acting as an organizer of public collective transport” in which it presented the directions and goals development of public transport and mobility policy, including shared mobility (<https://bip.metropoliagzm.pl>) and the document „Good Mobility”. Both studies were intermediate stages in the creation of the „Sustainable Urban Mobility Plan” (SUMP) of GZM. The aim of the mobility plan was to present proposals for actions, investments and modifications that could improve the mobility of residents so that they would waste less time commuting (<https://www.metropoliatzm.pl>). Unlike a transport plan, an urban mobility plan focuses on people and the better use of existing urban resources, not their expansion (<https://umtychy.pl>). The Sustainable Urban Mobility Plan provides for various types of pilots of innovative services and the development of the Mobility as a Service concept (<https://metropoliagzm.pl>).

4. Shared mobility in GZM

The first and oldest shering option in GZM is ridesharing. It has been unofficially present in the GZM area for many years in the form of shared rides, for example to work, study or vacation. So far, no system or dedicated platform for ridesharing users has been created in Upper Silesian-Zagłębie Metropolis. Residents use platforms with national reach (mieszkamyrazem.pl or bytheway.pl) or international platforms (Blablacar). The second form of shared mobility in GZM is carsharing. There are three carsharing operators in the Metropolis: Traficar, Panek and eCar. The carsharing service has so far developed in large cities of the Metropolis, in particular in Katowice, where all operators are present. Although you can drive the vehicle in other GZM communes, renting and returning the car is only possible in designated operator zones. Another sharing option available in GZM is the city bike system, which initially functioned as a classic bike rental in Katowice. In 2015, the first self-service stations were introduced (<https://www.katowice.eu>). In the following years, city bike systems were created in the following communes: Sosnowiec, Siemianowice Śląskie, Tychy, Gliwice, Chorzów and Czeladź. City bikes can be ridden in urban –rural and rural communes, but rental and return is

possible in communes where there are stations. The desire to improve the quality of life of residents and the desire to popularize bicycles as a healthy means of transport prompted the metropolitan authorities to expand and integrate systems so that every resident of GZM could use bicycles in a larger area and on the same terms (<https://metropoliagzm.pl>). The final stage of integration is the creation of the Metropolitan Public Bicycle Rental System (MSWRP) in GZM. The new system will enable the use of bicycles in each commune using one application and for the same tariff. The metropolis plans to create 940 stations located on average every 350-400 meters with over 8000 bicycles available all year round (<https://metropoliagzm.pl>). Additionally, it will be possible to rent bicycles with electric support for a long time, the so-called e-bikes. The final form of shared mobility is electric scooters. They appeared in GZM in 2019 along with the dynamic development of urban electric scooters in Poland and Europe. Currently, there are 5 operators in the Metropolis: 3 foreign operators: Lime, Bolt, Tier and 2 Polish operators: Roles and Blink.ee.city. Operators currently operate only in the cities of the Metropolis, and the rental and return of scooters takes place only in a stationless system.

5. Research methodology

The aim of the study¹ was to recognize opinions about shared mobility solutions in the Silesian-Zagłębie Metropolis. The survey was conducted in the last week of April 2023 among adult residents of GZM. A total of 112 respondents participated in the survey, including 2 surveys that were invalidated because the respondents did not live in the GZM area.

The study involved 45% of men and 55% of women of various age groups. The largest percentage (57% of respondents) were people aged 18-25 (Generation Z), mostly pupils and students. The second largest group were Millennials (or Generation Y) aged 26 to 35, constituting 26% of all the respondents, whereas Generation X, i.e., people aged 36 to 50, was represented by 11% of the respondents. The fewest responses were obtained from older generations. 5% represented people aged 51-65, and 1% those aged 66+.

Respondents participating in the survey lived in 25 of the 41 existing GZM communes (Fig. 2).

¹ The study was conducted as part of a diploma thesis.



Figure 2. Representatives of the research group by GZM communes.

Source: own study.

Among the respondents, 77% of people live in core communes and 23% in outer communes. Most respondents (32%) live in Katowice city commune and other urban communes and counties: Tarnowskie Góry (7%), Tychy (6%), Zabrze (6%), Gliwice (6%), Sosnowiec (5%) and Ruda Śląska (5%). These are the communes with the highest level of urbanization, where the largest number of workplaces, universities and schools are located. These communes are where most residents settle or move around every day for work, education and consumption purposes.

Based on the respondents' particulars, it can be assumed that the average survey respondent is a young person aged 18 to 25, living in a large city, for example Katowice.

6. Research results

Promoting slogans related to sustainable development brings the expected results. We are observing how current behaviors of the society are slowly changing. Shared mobility models are widely known to society. Among the researched shared mobility solutions, carsharing is the

least known (Fig. 3). 24% of respondents do not know this model (most of them are young women, aged 18-25).

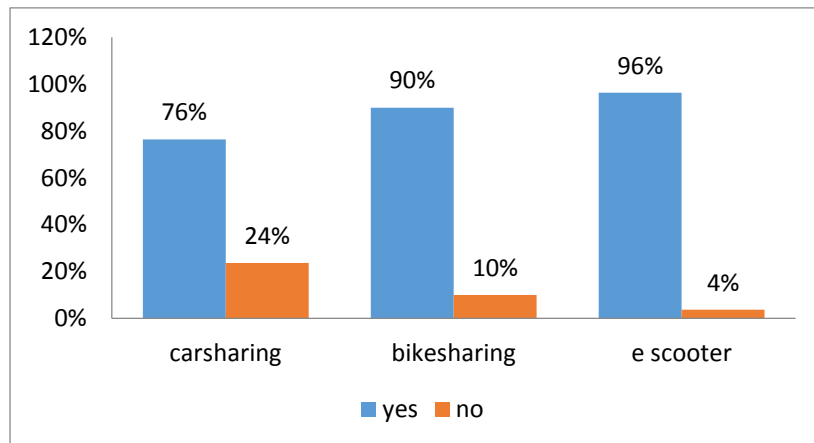


Figure 3. Knowledge of shared mobility models among GZM residents.

Source: Own study.

Urban electric scooters are the most famous model. 96% of respondents know them. Even though this model appeared the latest, it became really popular very quickly. Many people also riding private scooters can be seen on streets in the cities. City bikes also enjoy considerable popularity among respondents (90%).

Due to the presence of these sharing models in GZM, respondents were asked about the frequency of their use. Residents could select one of four answers: never, 1-2 times a month, several times a month, or once a week or more often. Respondents' answers by individual sharing models are presented in Fig. 4.

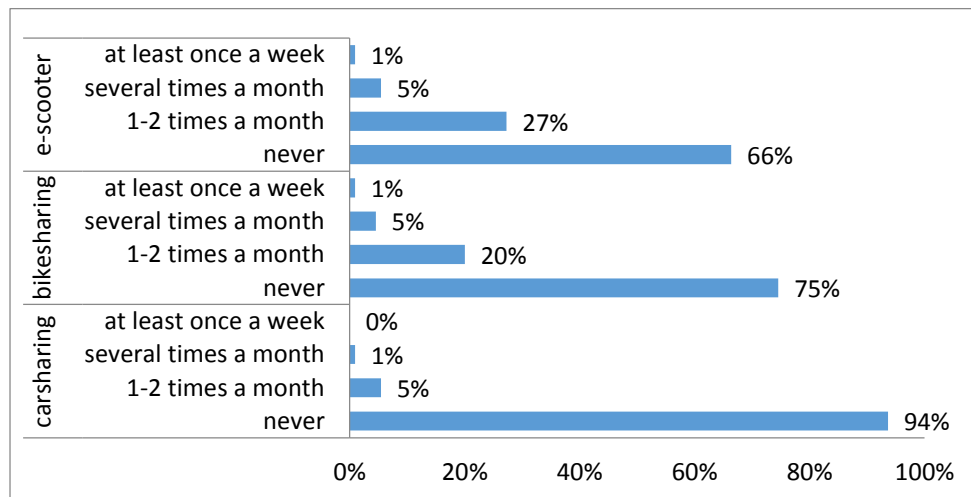


Figure 4. Frequency of use of shared mobility models.

Source: Own study.

Even though residents know sharing models, they rarely use them. Only 6% of respondents use carsharing (the least of all models). Among the users, 86% use carsharing at most 1-2 times a month, and 14% several times a month. Nobody uses carsharing more than once a week. 25% of respondents use city bikes which are in the second place. In the group of users,

79% use bikes 1-2 times a month, 18% - several times a month, and 3% - at least once a week. City scooters are the most frequently used means (34%). 81% of respondents use them 1-2 times a month, 16% - several times a month, and 3% - at least once a week. Figure 5 shows the use of sharing models by gender and age.

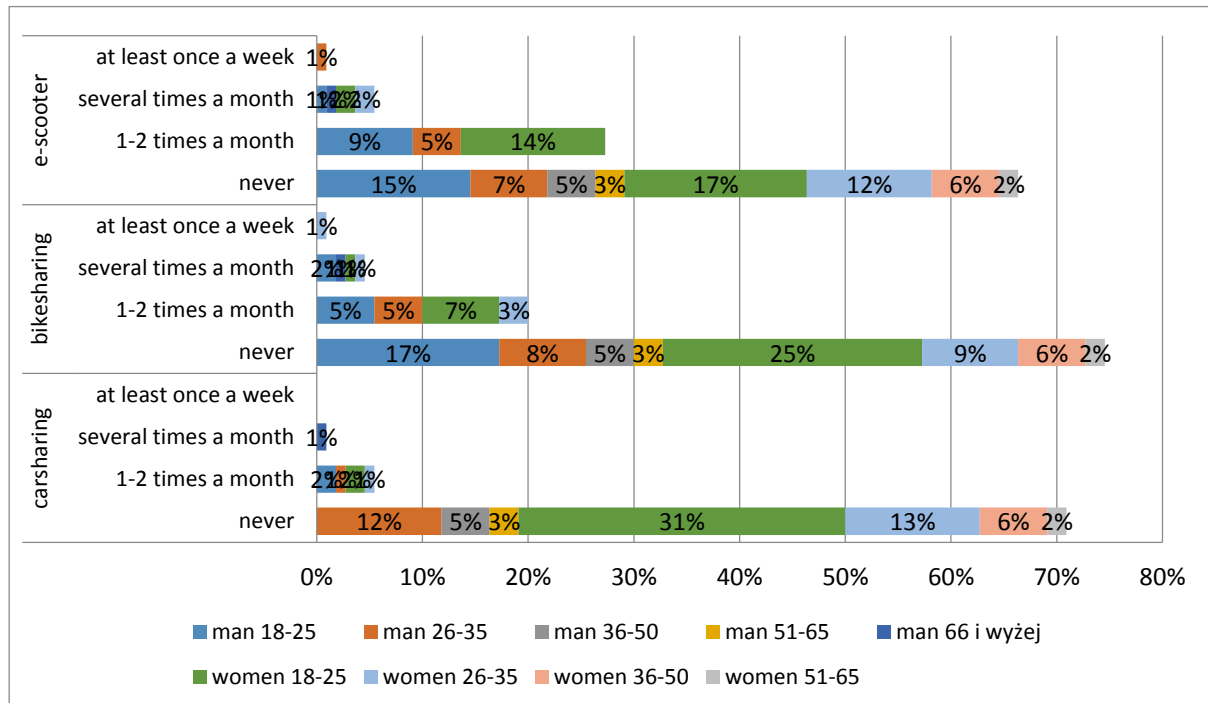


Figure 5. Use of shared mobility models by gender and age.

Source: Own study.

Shared mobility models (carsharing, ridesharing, e-scooter) are mainly used by generations Z and Y (people up to 35 years of age), regardless of gender, who have smartphones and know how to use mobile applications on a daily basis. These are people who usually have a driving license but do not own a car (for financial or ecological reasons). The vast majority of people using carsharing, bikesharing and e-scooters (over 85%) come from the core municipalities, and the remaining percentage come from the outer municipalities. This is related to the availability of entities offering this type of services and their infrastructure (cars, bicycle stations, e-scooters). In the case of carsharing in external communes, it is possible to rent a car only at the airport in Pyrzowice, and city bikes operate only in one external commune (in Czeladź). Bicycle stations in external areas are to be developed only after the Metropolitan Bicycle is created. For older people, the use of shared mobility models is associated with a considerable risk of health problems and lack of skills in using the applications.

The low level of use of all sharing models among residents of external communes is caused by the inability to rent and return vehicles in their commune. Regardless of whether the model operates in an area or station system, residents can use them only when they are in the zone of their operation, i.e., in the core municipalities. For this reason, sharing models are not

an alternative to motorized individual mobility for residents of outer municipalities, nor do they even complement public transport in last-mile transportation.

Respondents were asked to rate each sharing model using a 5-point Likert scale (where: 5 means very good, 4 means good, 3 means average, 2 means bad, 1 means no opinion). The obtained results are presented in Figure 6.

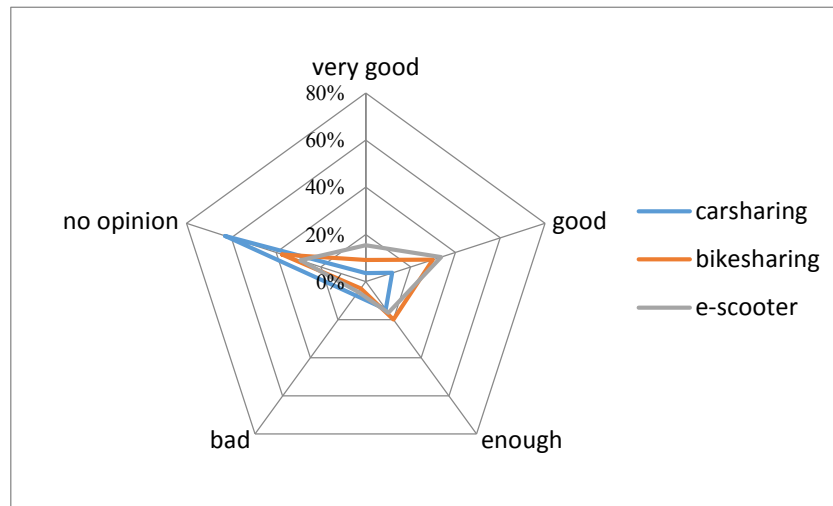


Figure 6. Evaluation of sharing models.

Source: Own study.

The overall assessment of shared mobility models is not positive. The vast majority of respondents have no opinion on this subject. The high rate of obtained responses, i.e., carsharing 63%, bikesharing 37%, e-scooter 29%, is affected by the fact that that respondents do not use the particular mobility sharing models (see Fig. 4).

Respondents most often use ridesharing and e-scooters, which is why they are highly rated. Respondents rate urban electric scooters the best. They were rated very good and good by 49% of respondents and sufficiently by 16%, whereas ridesharing was rated very good and good by 39% and sufficiently by 20%.

To understand the reasons for the low rate of use of sharing models, respondents were asked to indicate the obstacles that discourage residents from using them. The respondents could mark on the scale, at each obstacle, the extent to which they agreed with it by selecting the answers: definitely no, probably no, I don't know, probably yes, definitely not (Fig. 7).

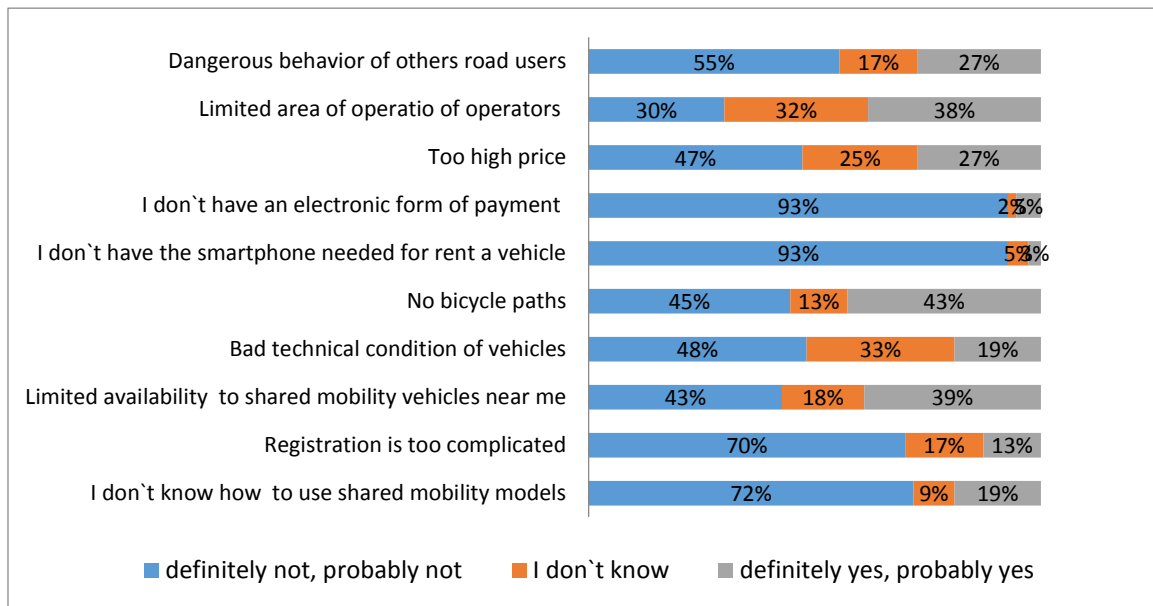


Figure 7. Obstacles to using sharing models in the GZM area.

Source: Own study.

Based on Figure 7, it can be concluded that the main reasons why residents do not use shared vehicles include:

- lack of extensive infrastructure. 43% of residents believe that there are not enough bicycle paths in GZM on which they can safely ride a rented bike or scooter;
- limited accessibility to vehicles nearby (39%) and the associated limited operating area of operators (38%). Residents of external communes face the problem of the lack of shared mobility offers in their area and the area of operation limited only to larger cities of the Metropolis;
- too high price (27%);
- fear of dangerous behavior of other road users (27%);
- the technical condition of the vehicles is poor - broken brakes, discharged batteries in scooters (19%). This answer had the highest percentage of "I don't know" answers (33%). The low percentage of users means that respondents are not aware of the technical condition of the vehicles.

For the considerable majority (93%), the lack of a smartphone and electronic payment method is not an obstacle to using sharing models. For the majority (70%), registering in the application is not too complicated.

The respondents (3% of respondents) also added their suggestions for obstacles, including:

- they prefer to travel by public transport or on foot, which allows for saving time and avoiding the problem of parking vehicles;
- sparse location of vehicles, i.e., too long distances from/to the rental point;

- they emphasized once again that the models only operate in large cities of the Metropolis, and mobility in small GZM towns is poorly developed, which makes it difficult for residents to get to larger cities;
- undeveloped infrastructure and a large number of renovations in the city (roads, bicycle routes, sidewalks) hampers moving around the Metropolis;
- in the case of city bikes, the constantly changing contractor, which forces the use of new applications is another difficulty. Additionally, there are often no bikes available for rent at stations. It was emphasized once again that bicycles and scooters are not respected by people and are often damaged and abandoned in places where they should not be left;
- there was also an opinion that the Metropolis prioritizes car traffic, which makes it difficult to use other means of transport. Less than 3% of respondents are not interested in learning about sharing models due to the lack of time, lack of need or because they use their own vehicle.

In order for the Metropolis to implement actions to increase the percentage of people using sharing models, respondents were asked to indicate solutions that could encourage residents to use sharing options (Fig. 8).

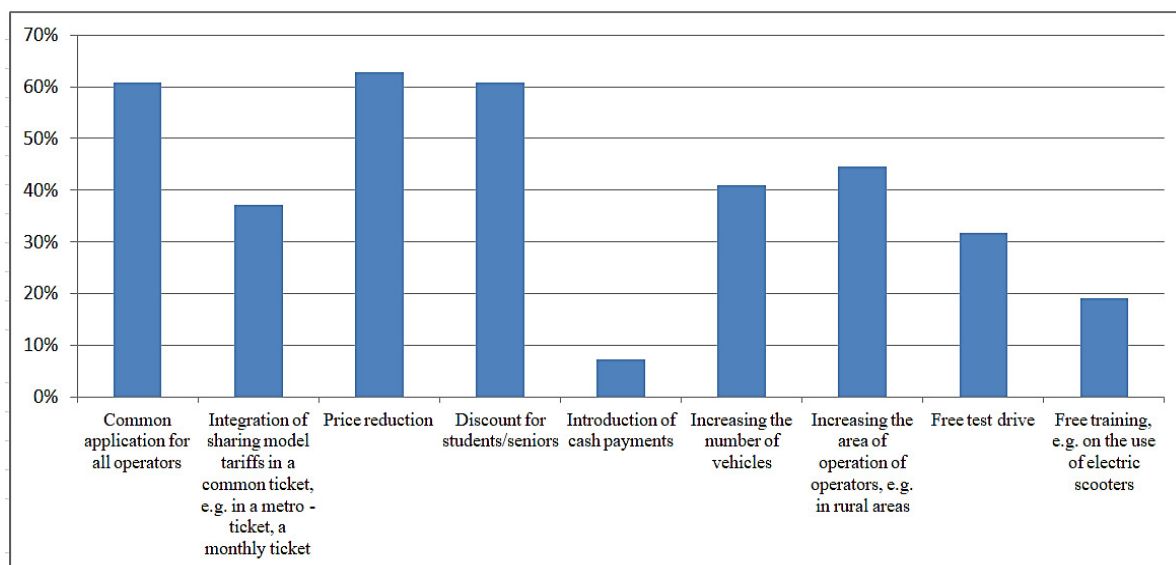


Figure 8. Solutions encouraging the use of sharing models in the GZM area (% of responses).

Source: Own study.

Most respondents indicate the need to make decisions related to price reductions (63%) and the introduction of discounts for students/seniors (61%) (these groups usually have lower incomes). Also, 61% of respondents supported the idea of creating a common application of Mobility as a Service model, which would consolidate the models of all available operators. Respondents support all activities aimed at integrating all sharing models to make their registration, reservation and payment more transparent and as simple as possible. Users would not have to install a separate application for each operator. 37% of respondents were in favor

of integrating tariffs of all sharing models into a common ticket. Further suggestions supported by respondents included increasing the operators' area of operation (45%) and increasing the vehicle fleet (41%), so that the offer was available throughout the entire GZM. Residents expect greater flexibility in the use of vehicles and the possibility of renting and giving them to each commune of the Metropolis. 19% of respondents supported the idea of free training in the use of sharing models so that users learn to use them properly and the level of road safety is higher. The introduction of cash as a form of payment was supported by 7% of respondents.

7. Conclusions

In recent years, a trend related to sustainable development in transport has been noticeable. Cities are implementing a number of actions consistent with the latest global trends, introducing a number of changes in urban mobility. They are mainly based on the promotion of the concept of sharing public transport services. For cities, shared mobility is a real alternative to reduce social and environmental costs and improve the efficiency of movement.

The results of the survey conducted among the inhabitants of the Silesian-Zagłębie Metropolis are difficult to explicitly assess as positive. In the field of shared mobility, there is a large disproportion between the core communes, where the offer is large, and the outer communes, where the offer is limited, or even scant. There are many service providers in large cities, yet the percentage of users is very low. The reason for this is the limited area of operation and lack of flexibility when travelling. As sharing models are operated by private operators (apart from city bike), the Metropolis cannot decide on its own in which area the models will operate. To solve the problem of disproportions, the Metropolis should try to negotiate with the operators and encourage them to expand their area of operation to cover the entire GZM area. When offering transport services, the Metropolis should be perceived as a whole, and not only focus on larger centers/cities.

To increase the percentage of users of sharing models in core municipalities, integration of models is needed to make their operation simpler and more transparent. Creating a common application for all sharing models is one of such solutions. Another problem is the too high price for using the models. The price for using vehicles could be reduced, for example, by creating common tariffs and introducing discounts for students/seniors. The use of sharing models also requires appropriate measures to ensure the safety of users on the street, and thus the construction of bicycle paths and more frequent vehicle servicing to eliminate defective vehicles. A part of the GZM population is still not familiar with sharing models, therefore it is recommended to take steps to inform residents about the way in which the models work, for example through free training.

Shared mobility as an element of the Metropolis's transport system is a source of change for current behaviors of the society. It transforms traditional urban transport because it has the potential to move towards social, environmental and economic efficiency through the use of technology, which enables the transition to a climate-neutral economy and zero-emission transport.

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LEADERSHIP IN IT PROJECTS: A CASE STUDY FROM POLISH COMPANY

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Purpose: The main goal of the study was to investigate the potential of servant leadership in increasing the effectiveness of IT project teams and to assess its impact on organizational culture. In addition, an analysis of leadership styles was conducted according to Hersey and Blanchard's situational model.

Design/methodology/approach: In-depth interviews were used to assess the potential of servant leadership in the IT industry, which were conducted among 5 leaders from the IT industry, while the analysis of leadership styles was conducted based on the LEAD-Self questionnaires developed by Hersey and Blanchard. The Benedictine model of management was included as an additional ethical context.

Findings: research results indicate that servant leadership has an impact on increasing the effectiveness of project teams and organizational culture. This is because it allows the project goals to harmonize with the needs of the participants, creating a symbiotic arrangement conducive to the development of both the team and the project. In addition, the LEAD-Self questionnaire shows that the dominant primary style, which the survey of leaders uses most often, is a supportive style.

Practical implications: Implications for organizations and leaders are given in the publication. The most important of them is to promote a supportive style among leaders that fosters effective and aligned project teams, as well as to implement proven leadership models, such as servant leadership, that incorporate ethical and moral values into project management.

Originality/value: The publication addresses the issue of servant leadership in IT project management and additionally considers the situational approach in this context. By doing so, it influences the expansion of knowledge in the field of human resource management in project management and emphasizes the importance of the moral and ethical dimensions of leadership in combination with the situational approach, which constitutes the originality of the study.

Keywords: leadership in project management, servant leadership, situational leadership, IT projects, benedictine model.

Category of the paper: research paper.

1. Introduction

The dynamic and constantly changing environment of IT projects makes it necessary for managers to not only interpret the changing needs of the market, but also to anticipate future technological trends. Moreover, IT projects are considered difficult ventures because they exhibit characteristics that distinguish them from other projects and increase the likelihood of failure (Khan et al., 2024). For example, it is necessary here for the project team to constantly respond to emerging needs in a timely manner and to work in interdisciplinary teams (Podgórska, 2022). This poses unique challenges for leaders in shaping effective project teams and building a supportive organizational culture. In this context, servant leadership, which focuses on team support and development, is a promising solution. The implication is that servant leadership integrates ethical and moral principles with management practices, supporting effective coping with change and technological challenges. The importance of this form of leadership also stems from the growing awareness of the importance of ethics in management. Also of interest in this context is the ability to flexibly adapt leadership style, which, as Hersey and Blanchard (2013) point out, should be tailored to the level of readiness and maturity of the team, allowing leaders to effectively manage teams in different project situations. Additionally, project managers' understanding of their own leadership style and the ability to predict team member's readiness to work are key in guiding people and projects (Kerzner, 2006; Podgórska, Detko, 2023).

The specifics of working in project teams, especially in the IT industry with agile approaches, include a number of key aspects that affect the effectiveness of project execution. Among some of the most important issues related to project success, the skills of the team and the ability of its members to self-organize are mentioned here. It also points to issues of how the agile approach fits into the corporate culture, for example, in terms of planning, reporting, hierarchical structures and just leadership. Additionally, the challenges of managing projects using agile approaches included: high capacity requirement of the users for testing, limited communication of large and distributed teams and more time and budget required in case of iterative development (Thesing et al., 2021).

Taking this into account, the main goal of the article was to explore the servant leadership potential in increasing the IT project teams effectiveness and to assess its impact on organizational culture. In addition, an analysis of leadership styles was conducted in accordance with Hersey and Blanchard's (2013) situational model. In order to achieve the aim of the research, the following three research questions were asked, i.e.:

1. What competencies should a modern IT project leader possess?
2. What characteristics should an IT project leader avoid?
3. What leadership style is dominant in contemporary IT project leaders?

2. Theoretical background

2.1. Competencies of a leader in IT project management

The evolution of project management has affected the role of the leader in shaping organizational culture, especially in the context of complex IT projects. The traditional approach, in which the leader mainly played the role of a manager focused on processes and tools, has evolved into a leadership style that places more emphasis on interpersonal aspects and teamwork. Moreover, in the digital age, where IT projects are becoming increasingly complex, leaders must not only manage resources and processes, but also inspire and motivate their teams. An effective IT project leader is not just a formal position, but first and foremost embodies the attitude of a natural leader who can inspire and motivate a team to action. With his charisma, commitment and ability to build relationships, he guides the team through the complexities of the project, supporting them at every stage and striving for mutual success (Podgórska, Juda, 2018; Podgórska, 2022; Podgórska, Detko, 2023).

A project leader, according to Blanchard and Broadwell (2019), should be the incarnation of servant leadership, focusing on the human dimension of management and shaping a culture that supports innovation and collaboration. Project management, therefore, requires a holistic approach that considers all these elements in a coherent way, which is the essence of effective leadership in IT projects and building the desired organizational culture.

In the PMBoK (2021) standard, the role of the project leader equated with the project manager is multidimensional. The standard describes the project leader as the person responsible for achieving project goals. For a better understanding of this role, the PMBoK project manager's responsibilities are broken down into specific areas pertaining to the various functions that occur in a project. In PRINCE2 (2019), on the other hand, one can see an emphasis on managing projects in controlled environments with a strong emphasis on the division of roles, management of project milestones, and regular reporting. In this approach, the manager focuses on executing the project according to the established framework, ensuring that all processes are followed and the project is delivered efficiently, on schedule and on budget. In the agile approach - Scrum, the competencies of a leader include a wide range of qualities and skills. Among the most important are the ability to make decisions, the ability to resolve conflicts, effective communication, and the ability to inspire and motivate team members. A leader should also have in-depth subject matter expertise in the area of the ongoing project and experience in project management. In addition, the ability to adapt to changing conditions and be innovative are essential in a dynamic project environment. Ultimately, the role of the leader is not only to manage, but also to build a cohesive and effective organizational culture that fosters long-term success (Schwaber, Sutherland, 2013).

An analysis of various methodological approaches to project management indicates that today's leader should combine technical competence with interpersonal skills, and emphasizes the role of the leader both in the context of supervision and coordination, as well as in ethical and communication aspects. It can also be concluded that the key qualities of an IT project leader are the ability to inspire and motivate the team, effective communication, conflict resolution and decision-making skills. Flexibility and adaptability in a dynamically changing environment are also important. The leader should promote a culture of continuous learning and innovation, while ensuring the development and well-being of team members.

2.2. Servant leadership in project management

The concept of servant leadership was created by Greenleaf (2013) in the 1970s and assumed that a leader first serves and then leads. It is based on key principles of ethical and effective leadership aimed at transforming organizations and societies. The application of servant leadership in practice shows that it not only supports the development of individuals, but also contributes to the achievement of the organization's strategic goals. Long-term benefits include the development of organizational culture, the individual development of employees and a reduction in staff turnover (Greenleaf Center for Servant Leadership). This is supported, for example, by Ehrhart's (2004) research, which indicates that servant leadership can improve organizational effectiveness and support employee development, and plays a key role in increasing leader, employee and customer satisfaction. Moreover, research by Wu et al. (2021) indicates that servant leaders are able to bring out servant behavior, especially among subordinates who are strongly focused on self-interest.

Spears (2004) identified ten key characteristics of servant leadership: (1) listening, enabling effective communication and understanding of team needs, (2) empathy: allowing leaders to understand the emotions and needs of their employees, (3) healing, referring to helping the team return to full team effectiveness after conflicts and stressful situations, (4) awareness regarding both one's own emotions and those of the environment, (5) persuasion, used to build consensus and support cooperation, (6) conceptualization, allowing leaders to think creatively and visionarily, (7) foresight enabling proactive planning and risk minimization (8) stewardship concerning responsible management of resources, taking care of technology, people and information with long-term benefits in mind, (9) commitment to the growth of people meaning investing in the skills and competencies, and (10) building community in and around the team and project supports collaboration, knowledge sharing and mutual support, which is critical to project success. Barbuto and Wheeler (2006) also identified five key factors that define servant leadership: (1) altruistic calling, (2) emotional understanding, (3) persuasive planning, (4) wisdom, and (5) efficient organizational management. The authors combined these elements to create a harmonious organizational culture that promotes efficiency and consistency in operations.

The collaboration of the above researchers emphasizes that the aforementioned factors are fundamental to building effective and sustainable teams. Their work, combined with Ehrhart's (2004) research, provides a comprehensive picture of how servant leadership can transform organizations, leading to better performance and increased commitment from all team members.

In conclusion, it can be pointed out that in order for the above activities to bring lasting benefits to an organization, it is crucial for a leader to have the right social competencies. Flexibility, adaptability, initiative, leadership skills, the ability to build trust, and verbal fluency are essential for successful project team management.

3. Methods

The in-depth analysis and critique of the literature conducted in the first part of the study allowed for the development and adaptation of research tools. Leadership in project management was studied based on Greenleaf's (2013) concept of servant leadership and Blanchard and Hersey's (2013) concept of situational leadership. The integration of these two approaches allowed the leadership style to be flexibly adapted to the needs of the team. In addition, the analyses included Bombala's (2010) servant leadership perspective, which showed the importance of deep interpersonal relationships as a foundation for effective leadership, and the Benedictine model as an ethical context.

The study used qualitative research using free-form interviewing as a research method, which aimed not only to capture the complexity and dynamics of servant leadership, but also to understand its impact on the effectiveness of project teams. This approach enabled in-depth analysis, which is essential for drawing conclusions and developing recommendations to improve project management practices in the IT industry. In order to create a conducive atmosphere for conversation and to be fully attuned to the interviewee, interviews were conducted in the form of meetings from which notes were taken. In one case, the interview was conducted via the Microsoft Teams application. In addition to the in-depth interview, the study also used a tool to measure leadership styles - the LEAD-Self¹ (1993), which leaders were given after the free-form interview. The questionnaire was designed to assess the effectiveness and adaptability of leaders' leadership styles in various situations. It consists of 12 scenarios that leaders may encounter in their work. Each scenario offers four alternative actions (A, B, C, D), from which the respondent must choose the one that best suits his leadership style.

¹ Leader Effectiveness and Adaptability Description - Self Assessment.

The selection of the sample for the study was justified by the availability and kindness of the respondents, who agreed to devote sufficient time and attention to the interviews. Professional relationships, built by one of the authors of the paper with the respondents over many years and in various projects, provided deep insight into their experiences and perspectives. All of the interviewees work in information technology-related companies, serving as project team managers, making it possible to assess their approaches to leadership. Each leader has unique experiences and approaches to leadership, allowing for a wide range of opinions on the subject. Due to the diversity of roles and the context of the IT industry, the research sample is representative and allows for a comprehensive understanding of project management leadership.

The research included five project team leaders with diverse perspectives on IT project management. The surveyed group included: two Sales Directors, responsible for sales strategy and customer relationship management, one Creative Director, who leads the creative department and overseeing creative and innovative processes, one Product Manager, managing product development and coordinating activities between different departments, and one Project Manager, responsible for implementing projects according to schedule and budget and coordinating the work of project teams. As for the age of the respondents, two of them were in the 30 to 39 age group. This age group represents mature leaders who are in the dynamic stage of their careers and have significant experience in project management. The 40 to 49 age group also included two leaders. Leaders in this age group are characterized by extensive professional experience, which may translate into a more established and mature approach to leadership. The under-30 age group included one leader. This leader brings a younger perspective, which may be important for understanding new trends and approaches in managing project teams in IT. The age group over 50 had no participants, which may indicate the dominance of younger leaders in the IT industry. All leaders surveyed have a university degree (four leaders have a master's degree, and one leader has a part-time university degree). As for the experience of the surveyed leaders, 1 person had experience of 1 to 3 years, one person had experience of 3 to 5 years, and the largest number, 3 leaders, declared experience of 5 to 10 years. None of the surveyed leaders had experience of less than 1 year or more than 10 years. In terms of management certifications, one respondent held a PRINCE2 Foundation certificate, another held a PRINCE2 Foundation and a Prince2 Practitioner certificate, while two respondents held an MBA, indicating advanced management education. Only one respondent had no certification at all.

4. Results

Analysis of the respondents' statements shows that the management style of most of them approaches the concept of *servant leadership*. Respondents emphasize the importance of supporting and developing the skills of team members, which is a key element of servant leadership. Their focus on team development indicates their willingness to serve others and build strong, integrated project teams:

- *Respondent 1*: Encourages participation in training and offers mentoring.
- *Respondent 2*: Regular *feedback* sessions and *coaching*.
- *Respondent 3*: Enables in-house projects.
- *Respondent 4*: Organizes internal training and supports self-study.
- *Respondent 5*: Encourages training and supports implementation of own projects.

In addition, empathy and the ability to support the team is valued, which also fits in with the principles of *servant leadership*:

- *Respondent 2*: Emphasizes empathy and flexibility.
- *Respondent 5*: Values empathy, listening and supporting the team.

The analysis of the statements also shows that respondents strive to build positive and supportive relationships with the team:

- *Respondent 1*: Builds trust and inspires the team.
- *Respondent 2*: Stresses open communication and relationship building.
- *Respondent 3*: Involves the team in decision-making.
- *Respondent 4*: Regular meetings and feedback foster better relationships.
- *Respondent 5*: *Cares* for the team's well-being and gives them freedom of action.

Moreover, the analysis of the statements shows that the respondents' management style has a significant impact on the organizational culture:

- *Respondent 1*: His inspiring management style positively influences the team's motivation and innovation.
- *Respondent 2*: His flexible style allows the team to work effectively in different situations, which promotes the adaptability of the organization.
- *Respondent 3*: A participative management style leads to better team collaboration and commitment, which builds a positive organizational culture.
- *Respondent 4*: A transactional management style helps achieve goals and maintain discipline, which affects organizational effectiveness.
- *Respondent 5*: His supportive and submissive approach, giving the team freedom, positively influences the motivation and creativity of the team, although it can sometimes lead to a lack of structure.

Taking into account the respondents' answers, the competencies that a leader should possess were distinguished, as detailed in Table 1.

Table 1.*Competencies of an ideal leader in IT projects according to respondents*

Competencies	Description	Respondent's comments
Inspiring	Motivates and inspires the team to achieve high performance	Respondent 1: Focuses on inspiring and motivating the team, resulting in high performance.
Empathetic and flexible	He is able to adapt to different situations and needs of the team.	Respondent 2: His flexibility allows the team to work effectively in different situations.
Visionary and determined	Has vision and the ability to solve problems and make decisions.	Respondent 3: Stresses the importance of vision, determination and problem-solving skills.
Communicative	Communicate effectively with the team, both formally and informally.	Respondent 4: Highlights regular meetings and <i>feedback</i> , which promotes better communication.
Supportive	Promotes the development and well-being of team members.	Respondent 5: Focuses on supporting the team and giving them space to act.

Source: own elaboration.

Respondents also pointed out characteristics that an IT project leader should not have. These included lack of empathy, authoritarian and controlling, or inflexible. A detailed description of the survey responses is presented in Table 2.

Table 2.*Negative characteristics of a leader in IT projects according to respondents*

Characteristics	Description	Respondent's comments
Authoritarian and controlling	Imposes his opinion and does not give the team freedom.	Respondent 5: He described his first leader as authoritarian, which taught him that such a style does not foster good relationships and motivation in the team.
Lacking empathy	Unable to understand and support his team.	Respondent 3: He noted that a leader's lack of empathy leads to low morale and higher employee turnover.
Inflexible	Fails to adapt to changing conditions and team needs.	Respondent 2: Indicated that a leader who is not flexible is often unable to respond effectively to changing project demands, leading to delays and frustration for the team.

Source: own elaboration.

In addition, the results from the LEAD-Self questionnaire indicate that the dominant primary style that the surveyed leaders use most often is a supportive style (B - low level of directive, high level of support). The second most frequent choice is the directive style (A - high level of directive, low level of support). Coaching style (C - high level of directive, high level of support) and delegating style (D - low level of directive, low level of support) are not used by respondents.

5. Discussion

The article posed three research questions. The first question referred to the competencies that a modern IT project leader should possess. The second was related to the characteristics that an IT project leader should avoid, and the third referred to the leadership styles that dominate modern IT project leaders.

Answering the first question, it can be indicated that on the basis of in-depth interviews, key servant leadership competencies were defined that can influence the effectiveness of IT project teams. These include empathy, the ability to listen and support the development of team members. These competencies foster trust and cooperation within the team, which directly translates into higher project performance. The research also found that IT project leaders need to have adaptive competencies, flexibility, communication skills, risk and conflict management, and technical skills in order to effectively manage teams in dynamically changing market and technological conditions. This is also emphasized in previous studies (e.g. Blanchard, Broadwell, 2019). Traditional management, often task-oriented, is characterized by less flexibility and treating employees more objectively.

Regarding the second research question, it should be noted that a modern IT project leader should not impose his opinion on team members and allow them to act freely. Moreover, if a leader is not flexible, he or she is often unable to respond effectively to changing project requirements, leading to delays and frustration for the team. It should also be pointed out that a leader's lack of empathy leads to low morale and higher employee turnover. Indeed, leadership based on empathy and support fosters an open and supportive organizational culture, which in turn increases project effectiveness. These findings are consistent with reports by other researchers (e.g. Ehrhart, 2004; Spears, 2004).

Answering the third research question, it is important to point out that a supportive style, characterized by high levels of support and low levels of directiveness, is conducive to building trust and cooperation within the project team. Moreover, practices such as regular training and mentoring are key to the ongoing development of leaders' competencies, confirming the benefits of applying servant leadership to IT project management. However, the implementation of servant leadership faces challenges and barriers, including the need to make a conscious decision to adopt this perspective and overcome resistance to change and difficulties in adapting to new management methods.

6. Conclusion

This article contributes to the literature on project management in the field of human resource management and from the perspective of organizations implementing IT projects. Moreover, it assesses the potential of servant leadership in the context of IT project management, showing how ethical and moral principles can support effective management in the technology industry. In practice, the article responds to the needs of companies by showing how servant leadership harmonizes the goals of the project with the needs of the participants, creating a symbiotic arrangement conducive to the development of both the team and the project. The findings also served to define the following recommendations.

As for the organization, the following recommendations are proposed: (1) it should be a priority for the organization to promote the concept of servant leadership, focusing on serving the team, developing team members and creating a healthy and ethical organizational culture (2) it is crucial to promote a supportive (B) style, characterized by low levels of directive and high levels of support, among its leaders, as this style fosters the creation of effective project teams in line with the servant leadership concept, (3) it is necessary to invest in the ongoing development of leaders by offering training programs, courses and certification opportunities. Leaders should be encouraged to regularly participate in professional development programs and benefit from mentoring and coaching, (4) organizations should also invest in developing leaders' competencies in IT project management, especially in terms of adaptability and flexibility in the face of changing market and technological conditions, (5) it is important for organizations to invest in new technologies that support the technical aspects of management and contribute to the development of an organizational culture that promotes innovation, collaboration and a strategic approach to management. Artificial intelligence-supported tools improve communication and coordination within teams, enabling leaders to quickly monitor progress, identify problems and make decisions. In turn, the automation of administrative processes saves time that can be spent on integrating teams, training and building a strong organizational culture.

Implementing servant leadership brings numerous benefits not only to the organization itself, but also to its stakeholders, including customers and employees' families. Effective implementation of servant leadership can bring long-term benefits, contributing to building a healthy, ethical and innovative organizational culture that supports employee development and the achievement of the organization's strategic goals.

The results of this study can serve as a valuable resource for promoting the concept of servant leadership among leaders and for companies seeking to increase organizational maturity. The findings and recommendations presented can support leaders in developing core competencies and implementing ethical and effective management practices that foster trust, collaboration and effectiveness in IT project teams.

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LEGAL LIABILITY OF AN ORGANISATION USING ARTIFICIAL INTELLIGENCE

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Purpose: an analysis of the impact of artificial intelligence on organisations, with a particular focus on the legal liability associated with the use of AI-based tools.

Design/methodology/approach: legal and qualitative analysis of AI's impact on organizations, focusing on general principles of civil law and regulatory frameworks like the AI Act. The paper adopts a formal-dogmatic method of interpreting legal texts and case-study approach, examining specific instances of AI use, and covers theoretical aspects of liability, data privacy, intellectual property etc.

Findings: the analysis reveals that while AI greatly enhances efficiency and innovation, it also introduces complex legal risks, particularly concerning data privacy, liability, and intellectual property. In many cases, existing rules and laws may be adequate to deal with potential infringements using AI. The EU legislation being implemented provides for new specific obligations for AI operators complementing existing spheres of legal liability. Due to the legal uncertainty, organisational managers have to balance efficiency and accountability.

Originality/value: an analysis of the impact of artificial intelligence (AI) on the legal liability of organisations, particularly in the context of civil and administrative law (within EU). The paper highlights AI as a key tool in organisations, but also identifies legal risks due to the lack of national legislation specific to AI. It is intended for decision-makers implementing AI within organisations.

Keywords: legal liability, artificial intelligence, organizations liability.

Category of the paper: research paper.

1. Introduction

Artificial intelligence (AI) has rapidly become the technology backbone of many modern organisations, revolutionising various aspects of business conduct and decision-making. Its importance is underlined by its ability to increase productivity, innovation, and competitive advantage across industries (Holmström, 2022). However, this technological phenomenon carries a number of potential risks. Fundamentally, this is because it is not an 'entity' that thinks and rationalises its 'decisions', it acts in a way that is delineated by its creator but not necessarily

fully anticipated and controlled by him, autonomously adapting to new situations in many situations (Yampolskiy, 2024). As such, it can be an agent of damage and harm to other entities, especially private individuals, and thus the question arises as to who and what legal liability is incurred in this respect.

Even though AI has been accompanying humanity in practical terms for several years now, the issue of legal liability is still unsolved. There are also relatively few scientific studies on this topic, and journalistic and popular science texts predominate. A frequent feature of legal provisions is their lack of relevance to new technological phenomena due to the slow reaction of legislators. This raises the problem of the multiplicity of interpretations and approaches in situations not explicitly resolved by the norms. The aim of this article is therefore to identify the areas and scope of liability of an organisation using artificial intelligence algorithms. The paper is a prelude to further in-depth research into legal liability within specific branches of law based on analyses of legal acts and court judgments. These are few for the time being, but the regulation of this area, which is new to the legal system and the judiciary, is certainly to be expected in the future. Further considerations are based on the interpretation of general principles of law and an attempt to juxtapose them with possible infringements in connection with the application of AI but without reference to the content of specific state laws and acts. The whole is complemented by a general overview of the proposals and framework regulations adopted in the European Union, which are the first in the world to attempt to create a catalogue of the obligations of AI operators and the consequences of failing to comply with them. Therefore, the formal-dogmatic method, typical of the legal sciences, will be applied here. The above remarks lead one to conclude that such an analysis is needed and can be a valuable resource for organisational managers, and this article aims to contribute to this.

2. The concept and relevance of AI for modern organisations

The term ‘artificial intelligence’ has still not arrived at a uniform, universally accepted definition. In general, it is a field of computer science that studies methods and software that enable machines to perceive their environment and use knowledge and intelligence to take actions that maximise their chances of achieving specific goals (Russel, Norvig, 2021). Attempts to determine the meaning of the term have been made since the mid-20th century with varying degrees of intensity, depending on the various approaches and levels of technological development (Kumalski, 2022). It is not the purpose of this paper to present various definitions of the term AI; a broad overview of these is presented by Russel and Norvig (2021). For this thesis, it can be assumed that AI is an information system that suggests solutions to the problems posed to it based on data collected by it (machine learning), analysed, logically processed along the lines of human reasoning, and presented to the user in a comprehensible

(natural language) and desirable form (text, image, sound, et al.). Implementing such a system can refer to an application accessible through a computing device, as well as being a component of a self-functioning machine, such as an autonomous vehicle.

The pioneer to mention a 'thinking machine' is believed to have been Alan Turing (1950), while the term 'Artificial Intelligence' was coined by John McCarthy (Aziz, 2023). In the mid-twentieth century, the construction of such machines was only a matter of futurology. In recent years, however, AI has reignited people's minds. Thanks to the gigantic amount of data stored in the memories of computers and global access to them via the Internet, as well as the enormous computing power of modern processors, it has become possible and obvious to create tools with which humans can somehow make use of these unimaginable resources in an efficient, synthetic, but also economical way considering, for example, the time and cost of information processing. Computer systems today are no longer simple programs performing automated, obvious, and relatively simple (but still useful) tasks. AI can successfully serve and is already being used in many areas of life, e.g. content generation in the creative and entertainment industries, electronic diagnosis of human diseases or malfunctions in machines, air or sea traffic control, automatic assessment of the creditworthiness of borrowers, in education, customer service, and these are just some examples of ever-evolving applications. Undoubtedly, artificial intelligence also plays an increasingly important role in modern organisations, influencing various aspects of business operations, decision-making, and strategic planning.

One of the most profound impacts of artificial intelligence is its ability to automate routine tasks, thereby increasing operational efficiency. AI-enabled tools and systems can fulfil a variety of functions, from customer service chatbots to robotic process automation for repetitive office tasks such as data retrieval, form filling and so on. By automating repetitive and basic duties, an organisation can direct employees' attention to other strategic, innovative and more rewarding endeavours, ultimately increasing productivity and reducing operational costs (Davenport et al., 2023; Morandini et al., 2023; Lukan, 2024).

In the age of big data, artificial intelligence plays a key role in transforming raw information into useful information. Advanced algorithms can analyse huge data sets to identify patterns, trends and anomalies that a human would not be able to access on their own. This capability enables companies to make more informed choices, optimise business processes and predict trends with greater accuracy (Duan et al., 2019). For example, AI-based predictive analytics can help companies predict customer needs and behaviour or build strategies (Law, 2024).

AI is a key driver of innovation in contemporary organisations. Using artificial intelligence, companies can develop new products, offerings and business models. It is enough to pay attention to the services that have long been available on the market using complex, intelligent algorithms. For example, artificial intelligence is influencing the automotive industry through the increasing autonomy of the vehicle and the 'smart' sensors operating within it (Rudkovska, 2023); the services offered by various providers to recognise products, objects or places from photos, voice assistants, tools using generative AI, et al. (Uzialko, 2024).

Algorithms are revolutionising the way businesses interact with their customers. With artificial intelligence-based, self-updating customer relationship management (CRM) tools, organisations can anticipate customer needs and expectations. A. Uzialko (2024) gives the example of a service from a certain bank that notifies a borrower to pay the next instalment when the borrower is near a branch of that bank. Taking this a step further, organisations can respond to queries in real time because, available 24/7, chatbots and virtual assistants can provide information and assistance more and more efficiently and effectively, increasing customer satisfaction and loyalty. What's more, artificial intelligence can analyse customer comments and sentiments to improve its products and services, to profile its audience and provide them with products that best fit their preferences (e.g. music and movie recommendations from streaming services).

Artificial intelligence is undeniably a transformative force in today's organisations. Its ability to increase operational efficiency, support data-driven decision-making, foster innovation and improve the customer experience, and ultimately gain competitive advantage, makes it an essential tool for companies across industries. The business benefits seem enormous, but companies also face legal challenges. The use of AI in business, like any other tool, involves potential infringement of the interests of others, e.g. personal rights, privacy or personal data; it is a threat of formal errors, e.g. in accounting records; and finally, it is a possible tort of criminal law. Awareness of the areas of legal liability and limitations in the use of AI is essential to ensure that business does not suffer the negative consequences of possible illegal actions, including loss of customer trust.

3. Legal liability of the organisation

The legal system generally distinguishes three basic types of liability: civil, administrative and criminal. There are also other forms of liability, such as labour, disciplinary or statutory, but these are variations of the aforementioned categories. Each entails specific sanctions: civil and administrative usually result in the payment of a sum of money as compensation (which has a compensatory rather than a punitive function) or an administrative fine, while criminal may lead to a criminal penalty, such as imprisonment. The latter, however, is individual in nature and thus applies to a specific person, e.g. a manager for a crime committed. Although many national legislations provide for the institution of liability of a collective entity, the conduct of criminal proceedings is most often linked to the prior conviction of a specific individual. In contrast, the liability of the organisation itself is reduced to a financial sanction covered by its assets. For this reason, the issue of criminal liability will be disregarded in the remainder of this paper. Although it is worth emphasising that in various

situations of AI use, typically civil law claims against an organisation may be accompanied by criminal charges against individual individuals associated with the organisation.

3.1. Civil liability

Civil liability relates to the sphere of legal relations between private civil law entities, i.e. natural persons, legal persons or other organisational entities that are not legal persons but to which the law has granted legal subjectivity. It should be noted that each of these types of entities can be identified with an organisation, depending on the legal form adopted by its creator. Civil liability can be either tortious, i.e. related to the commission of a tort, or contractual concerning the non-performance or improper performance of a contract.

The emergence of civil liability in tort is the result of three cumulative conditions being met. Firstly, the occurrence of conduct, i.e. the act or omission of the entity that led to the damage. In the context of AI, one can point to, for example, the machine learning stage, when an algorithm extracts data from sources protected by, for example, copyright. Another example relates to the generation of sound or images that may infringe someone's physical or auditory image. Secondly, the occurrence of damage, i.e. harm to legally protected goods and interests, which may be material (property, the extent of which can be expressed economically, e.g. plagiarism, accident involving an autonomous vehicle, errors in the financial system) or immaterial (non-material, affecting the goods and interests of the victim but not translating into the victim's property, e.g. violation of personal rights, privacy, discrimination, generation of false information). Thirdly and finally, there must be a causal link between the event and the damage, as liability is only incurred for the normal consequences of the act or omission from which the damage arose. The attribution of liability for damages is, of course, possible concerning the one to whom fault can be attributed. In most cases, it is irrelevant whether the fault is intentional (intention to cause damage or harm) or unintentional (lack of intention, carelessness of action). Instead, what is relevant is whether the act in question is unlawful, i.e. whether it violates the applicable legislation and, in some legislations, also the principles of social co-existence. Such an assessment is usually made by the court at trial, but regardless of this, the aggrieved party always has the right to lodge a claim against the perpetrator. In the context of the use of artificial intelligence, it would therefore have to be verified whether the effect of its action is indeed an unlawful act under the relevant legislation and, if so, whether someone can be attributed fault. If this cannot be done, no one will be held legally responsible, even if the damage occurred.

3.2. Administrative liability

Another type of liability is administrative liability, which stems from administrative laws that regulate the relationship between public authorities and other subjects of the law. This branch of law is highly dependent on the political and legal system adopted in a given national legislation, specific local rules or traditions. It is, therefore, difficult to identify

a catalogue of principles of legal liability in this area that would be universally applicable. Another difficulty is that there is no unambiguous set of rules defining sanctions for violations of administrative law due to the vastness and diversity of the scope of regulation, for example, covering tax law, environmental law, social welfare and others.

In contrast, it can be said that administrative liability is mainly repressive in nature, and its purpose is to compel the performance of administrative duties. It is objective in nature, which means that it does not depend on the intentional or unintentional fault of the perpetrator unless the provision so indicates. The breach of the provision itself is decisive. Sanctions for violations of administrative law can be both monetary and non-monetary. Financial sanctions include various types of administrative fines and fees. Non-financial sanctions, on the other hand, may include obligations of specific behaviour, such as an order to demolish a building or stop the operation of an establishment.

4. Areas of liability for the use of AI

4.1. Areas of potential infringements

The possibilities outlined at the beginning of this thesis, offered to organisations by the use of artificial intelligence, show that it is undoubtedly a phenomenon that will develop and will become increasingly widespread. At the same time, it seems necessary to identify areas where there could potentially be breaches of existing law. It might be wrong to believe that a specific technological innovation is something unprecedented and unique, that it completely escapes the existing legal rules that have not kept up with technological progress. It's because it turns out that we are dealing with virtually the same consequences indicated in the legislation, i.e. the occurrence of certain events or behaviour resulting in damage or harm. However, it is achieved using a new tool, in this case artificial intelligence, but this, from the point of view of existing legal provisions, should be irrelevant in many cases. Therefore, it is possible to identify various legally regulated areas in which infringements caused by the use of artificial intelligence systems may occur.

First of all, it is worth mentioning human personal rights in its broadest sense. These are collectively accepted in a given culture, non-material values relating to a person's physical and mental integrity, dignity and position in society (Radwański, 2007; Bojanowski, 2023). These can include such universal values as health, freedom, dignity, good name, privacy or image. It is not difficult to imagine threats to personal goods when they come into contact with systems equipped with artificial intelligence algorithms.

A related example of personal rights is certainly the issue of IT system processing of sets of information about individuals - personal data and sensitive information concerning health, sexual orientation, political opinions or religion. The source of such data may be social media, where users build a profile by filling it with information about themselves, photos, statements and others. A source of valuable information may be a bot with which the user 'talks' as if it were a human being. The data collected in this way serves a variety of needs for different organisations, ranging from the typically business-related, e.g. to address marketing messages, to criminal purposes for fraud, phishing, impersonation or the spread of hate speech. In the EU, personal data is subject to protection requirements under the GDPR regardless of how it is collected, processed or stored. Compliance with EU regulations requires controllers of personal data to demonstrate the necessity and appropriateness of the extent of data collected, while AI systems need vast amounts of data to operate and grow. In addition, it is necessary to inform the data owner of the purposes and means of data processing, as well as to obtain their consent to the processing. Meanwhile, the functioning of an AI system, the level of complexity of the actions it takes and the results it produces may not be predictable or even comprehensible to the controller itself. There is also no certainty that AI will only use the information for the purpose assumed by the controller. Therefore, precise and complete information for the data owner, and consequently his consent expressed with full awareness, may be difficult to achieve (Chalubinska-Jentkiewicz, Nowikowska, 2022). In this context, it is worth mentioning the complaint of the organisation NOYB against OpenAI to the Austrian data protection authority regarding the inability of the ChatGPT algorithm (OpenAI's product) to correct the data collected on the person represented by the complainant. OpenAI was unable to comply with the obligations imposed on it by the GDPR (requesting deletion or correction of data), and an inspection procedure was initiated as a result of this breach (NOYB, 2024).

The need to comply with the requirements of GDPR is only the beginning of the problems that may arise in relation to AI processing of information about individuals. There may be doubts related to possible errors in profiling these individuals. It may result in making the wrong decision regarding specific characteristics or abilities of a given person, e.g. in the recruitment process (Czajkowski, Stroińska, 2023), whereby allegations of discrimination and bias become possible. Going further, the privacy of data subjects should be a concern. It may be that artificial intelligence tools infer sensitive information, such as political views or health status, from seemingly innocuous and unrelated data. This was demonstrated by the example of Cambridge Analytica, which, by running millions of inconspicuous personality quizzes on Facebook, created a campaign of personalised election ads ahead of the 2016 US presidential election (Sullivan, 2023).

Also linked to privacy and personal rights is, of course, the issue of a person's image, which is usually an image of a face, voice or other features by which that person can be identified. Generative AI can create both a realistic image and voice of a person, whether actually existing or completely invented. In the former case, the algorithm 'learns' the

appearance, behaviour, facial expressions and intonation of a particular person from available photos and audio and video recordings. At this point, it is worth recalling the high-profile case in which actress Scarlett Johansson accused OpenAI that its new voice assistant sounds strikingly similar to her voice. It should be noted that the artist had previously rejected the offer to lend her voice. The company argued that the voice belonged to another actress, but the assistant was eventually switched off (Milmo, 2024). When an algorithm creates an image of a non-existent person, it does so using collections of facial images of people who actually exist. For example, IBM used nearly one million photos from Flickr, a popular photo-sharing platform, to train its facial recognition software without the explicit consent of the people in the photographs. The company argued that the photos were publicly available, but it should be noted that the photos were originally shared on Flickr for a different purpose (Sullivan, 2023).

Another area of consideration for AI legal liability is its use in the field of intellectual property. In creative and inventive activities, the possibilities of AI are extraordinary and innumerable: from suggesting creative ideas, to proposing forms and main elements of content to generating ready-made and attention-grabbing unique images, films, musical, literary works or computer programs. However, both in the context of copyright and invention law, certain doubts arise, which will only be indicated here. Firstly, the question of the novelty of the creative effect - AI tools, for the time being, do not create entirely new ideas on their own, but only support human creativity (Bieser, 2022). Algorithms generate their realisations based on analysed, ubiquitously available ready-made creations, many of which have probably been created by humans in a creative process and are covered by exclusive rights. This raises the issue of whether such exploitation should be regarded as an encroachment on the exclusive rights of creators, publishers and producers and, therefore, as infringement, or whether it can be likened to a human information acquisition or technological process and covered by an appropriately worded statutory licence (Torrance, Tomlinson, 2023; Geiger, Iaia, 2024). Within the framework of European Union law, it has been accepted that the exploitation of intellectual property for the purposes of machine learning (text and data mining) may be prohibited by express reservation by the right holder. However, in the absence of such a reservation, it is allowed as one of the forms of permitted use without having to obtain a separate authorisation (Art. 4 DSM, 2019).

Secondly, whether the creations generated by AI can be protected by exclusive rights (i.e. whether they constitute works within the meaning of copyright law or whether they can be patentable inventions) and, if so, who will be their possessor: the AI, its creator or the prompting person. In this respect, the laws of most countries make it clear that the rights holder can only be a human being. However, it is not always clear how to treat the situation where generative AI contributes to the creative or inventive process, whether this contribution is minimal or significant. In the US, for example, it is excluded to include artificial intelligence as a co-inventor (Vidal, 2024). EU and UK law regulate it in the same way, while on the other hand, the Canadian Intellectual Property Office has recently listed the DABUS application as

an inventor in a patent document (Di Piano, 2024). In conclusion, current legislation does not allow to prejudge with certainty the status of intellectual property created by AI. Arguably, the general premise of this branch of law of creative human involvement in the process should be used. The extent of this involvement should be decisive for the granting of protection, and where it is minimal or non-existent, the generated product should be considered part of the public domain. However, the evidentiary process can be extremely difficult here, as it will rely heavily on the declarations of the entity interested in protection. Thus, the use of such creations of uncertain status by others, will be risky and may expose them to legal liability.

In the context of accountability for the use of AI, the issue of access to and use of information certainly cannot be overlooked. The use of AI-based tools in market analysis and economic forecasting can serve as an example here. Patterns and relationships identified by the algorithm may generate benefits, but suggesting them, basing future investment decisions and advice on them, is undoubtedly a risk. This is because even inferring future trends from historical data by AI is a risk. Here, the algorithm may generate misleading forecasts without taking into account unexpected political events, economic crises, and natural disasters (Rane et al., 2024). At the same time, the tool user would have no insight into how it arrived at its recommendations (the ‘black box’), whether it relied on erroneous data, or confabulated, resulting in misinterpretations and wrong decisions (Yalamati, 2023). The question of legal liability in this regard would primarily concern the breach of contractual obligations and the triggering of disciplinary clauses and contractual penalties for material damage caused. The above considerations are also not difficult to apply *per analogiam* to the advice given by lawyers, doctors or tax advisers. In the case of these professions, not only contractual liability will come into play, but also disciplinary liability within their professional organisations.

Staying on the subject of information and artificial intelligence, the problem of disinformation using fake news, deepfake etc. cannot be overlooked. The motivation for their use is economic or political gain, or the intention to deceive or harm another person or business. The multitude and ease of use of available AI tools for modifying statements using someone else's voice, adjusting lip movements to it, generating videos with other people's images, and generating misleading opinions and assessments about competitors – these are just some of the examples of applications of artificial intelligence algorithms. The basis for legal liability in this respect will be sought in the provisions of civil law on the protection of personal rights, as already mentioned above, in relation to infringements of reputation, dignity, privacy or image. However, we should also mention that e.g. in Polish law, criminal provisions provide for the offences of defamation and insult, generally prosecuted by private prosecution.

4.2. The issue of the subject of liability

When considering issues of legal liability arising from the use of artificial intelligence, we are first confronted with the momentous problem of determining who is liable. In the case of existing algorithms, this has not really been a dilemma, as liability could, in principle,

be attributed to the person who used the computer program or device in question, or alternatively to the manufacturer of the software if the resulting damage was caused by its errors. However, the situation is somewhat different when dealing with algorithms that operate completely or largely autonomously and independently of human oversight (the ‘black box’ principle); it is not fully known what effect new data fed into such a system has on it; the source codes of the algorithms are generally legally protected and rather secret. Consequently, accountability is somewhat diluted.

Liability cannot be attributed to artificial intelligence, given the aforementioned aspect of guilt, which, after all, can only be attributed to humans. After all, neither the machine nor the software controlling it has legal subjectivity. It is also difficult to accept that no one is responsible for the damage or harm caused, as is the case with so-called force majeure or damage caused by wild animals. Attention should, therefore, be directed at the artificial intelligence operator providing both the tool and the infrastructure for potential violations. In some jurisdictions, the legitimacy of claims could be sought in product liability laws (strict liability), although in this respect, Polish law, for example, only provides for the physical form of such a product, which obviously excludes artificial intelligence. The problem was noticed by the European Union authorities, who, as a result of several years of work, adopted Regulation 2024/1689, commonly referred to as the AI Act. The regulations do not cover the private use of AI by individuals but are primarily aimed at those who create and market such systems in the EU, i.e. providers, importers and distributors. In addition to them, deployers, i.e. organisations implementing and using AI systems in practice in their business operations, are also identified.

The aim of the regulation is, on the one hand, to provide clear guidelines for creators to develop their solutions and, on the other hand, to guarantee individuals an adequate level of protection of their rights (Stawicka, 2024). AI systems are classified into four categories of risk levels: unacceptable (prohibited creation and use), high, limited and minimal (none). The highest risk level relates to AI used to capture extremely sensitive data, and therefore, any processing of health, biometric, opinion or behavioural data will be prohibited. Systems with a lower level of risk are allowed, albeit subject to regulatory requirements. For adopters, it will be mandatory to implement appropriate technical and organisational measures to use AI systems in accordance with their instructions; to keep automatically generated logs of AI systems, if under control, for a certain period of time; to carry out an assessment of the impact on fundamental rights by adopters of high-risk AI systems, especially when providing essential public services, before using them for the first time. This protection is to be further strengthened by the transparency of generative AI models, i.e. the need for them to meet certain standards before they are marketed. Violations of the Regulation by obliged entities will result in fines of up to €35 million and, if the violator is a company, up to 7% of its annual global turnover (Rytel, 2024).

Independently of the AI Act, legislative solutions for civil liability are also in the pipeline in the EU. They are to concern non-contractual claims leaving aside contractual liability, where the general principles of freedom of contract remain sufficient. They aim to harmonise, using a directive, the rather diverse national regulations in this area, which are not conducive to the development of the common market (Skibińska, 2022). Liability is to be borne by the operators, i.e. the persons designing the system or entering data into it, who have control over it, which translates into a level of risk for those using it. More specifically, a presumption of operator fault would be introduced for damage caused by high-risk AI. The defendant, on the other hand, would have to rebut this presumption to avoid consequences such as compensation. In terms of the concepts used, the provisions of the Directive are intended to refer to the AI Act, so that an operator is to be understood as both the one who creates the algorithm, markets it and the one who uses tools based on it.

4.3. The need for balance

As artificial intelligence becomes increasingly integrated into business operations, companies face the challenge of balancing the benefits of these tools with the responsibility and legality of data use. Striking this balance is critical for maintaining trust, avoiding legal complications, and unlocking AI's potential responsibly. Businesses should understand and comply with regulations – staying informed about laws and other industry-specific regulations is essential. Companies should establish a robust data governance framework to ensure compliance, incorporating privacy-by-design principles to make privacy an integral part of AI development. Another issue is the ethical acquisition and use of data and the need for transparency. The data should be collected with informed, explicit consent, ensuring users understand how their data will be used. Appropriate security measures concerning privacy should also be ensured. To ensure AI systems remain trustworthy, companies should regularly audit algorithms for compliance, accuracy, and bias. Maintaining detailed logs of data usage and processing ensures accountability while verifying that third-party tools meet ethical and legal standards is equally important. Moreover, employees must be trained on data privacy laws, ethical AI principles, and best practices for handling sensitive information. Cultivating a culture that prioritizes ethical responsibility ensures alignment across the organization. Navigating the complexities of data protection laws and ethical AI use is challenging. Consulting legal experts ensures compliance, while working with ethics consultants helps align AI initiatives with societal values and expectations. By implementing these strategies, businesses can successfully balance the innovative capabilities of AI with the responsibility and legality of data use. This approach not only ensures regulatory compliance but also builds trust among stakeholders, creating a foundation for long-term success.

5. Conclusion

This paper is intended as an introduction to an in-depth study of AI liability based on the provisions of various branches of law. The analysis presented here is necessarily cursory and overview-based. At the same time, it is useful in identifying areas and potential problems and in helping to select provisions that may be applicable in specific cases, thus providing a valuable resource for the organisation's managers.

From the above analysis, it is clear that the development of artificial intelligence undoubtedly opens up an extremely wide range of opportunities for organisations, with its ability to automate processes, analyse large sets of data, contribute to innovation, efficiency and gain competitive advantage. But it also poses legal liability challenges concerning privacy, personal data, intellectual property or the generation of disinformation. These and other areas of responsibility have been identified as crucial.

Secondly, the adoption of legislation such as the AI Act in the EU is a first step towards regulating the AI market, aiming not only to formulate principles of responsibility for the creation and use of tools, but also to protect the rights of individuals. However, it is important to bear in mind that, despite the Regulation coming into force in mid-2024, it requires implementation in EU member states, and this is expected to take place over the next two years. Some provisions have an even longer *vacatio legis* of 36 months. The directive on civil liability, on the other hand, is still at the drafting stage.

And finally, for the time being, it is only possible to anticipate how these regulations will be applied, what impact they will have on organisations – those providing and those deploying, and what stage of development artificial intelligence itself will be at in two years. Until then, infringements of others' rights caused by the use of AI systems must be treated in the same way as they happen when they occur in other situations, according to current laws and rules. Ultimately, organisations will have to balance efficiency with accountability.

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MEDICAL FACILITY MANAGEMENT IN THE CONTEXT OF THE COORDINATED MEDICINE MODEL – RESEARCH ASSUMPTIONS

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Purpose: The main purpose of the paper is to present research assumptions on the issues of the coordinated medicine model and the management of a medical facility. Due to the comprehensiveness of the topic, the paper is another part of the publication series.

Design/methodology/approach: The paper is based on a theoretical analysis and literature review.

Findings: The paper describes the main research assumptions.

Research limitations/implications: The content presented here provides an introduction to undertaking research on the coordinated medicine model.

Practical implications: The considerations presented and references to international experience provide a basis for further research to identify possible impacts on improving the availability and quality of health service provision in Poland.

Social implications: Undertaking research based on the theoretical assumptions of the model described should improve the health of the population and make more rational use of resources to improve access to services.

Originality/value: The paper is primarily addressed to health care managers, as well as economists and government employees dealing with management issues in health care and public health.

Keywords: management, quality management, coordinated medicine, treatment facility, healthcare system.

Category of the paper: General review.

1. Introduction

This paper is a development of the research issue undertaken by the author (Skowron, 2023). Currently, changes have been initiated in Poland with the aim of creating a public payer financing system for health services provided as part of comprehensive care. Attempts of this type of action, with currently unknown results, may be: comprehensive care for women and children, combining invasive cardiology and orthopaedic services with rehabilitation,

or the announced projects for reform of psychiatric care. However, the above changes in the way funding is provided are limited in scope and focus on particular health problems of limited patient groups. They do not, however, solve the fundamental problems facing health care in Poland, such as: limiting the negative effects of civilisation diseases, ensuring continuous preventive care for entire local populations, transferring diagnostic, therapeutic and rehabilitation competencies to the lowest effective level of care, control and optimisation of costs. These challenges can only be met by a far-reaching change in the delivery process in ambulatory healthcare (Skowron, 2023).

The starting point for undertaking the research is the results of NIK (Najwyższa Izba Kontroli – Supreme Audit Office) audits, carried out periodically in recent years, which indicate the need for urgent changes, both in terms of financing and organisation of the health care system. The system is not patient-friendly, does not ensure efficient use of public funds, and creates problems for the managers of health care entities and the staff employed in them. There are five main areas of research undertaken (NIK, 2019):

- organisation and resources,
- system funding,
- availability of benefits,
- rights and patient safety,
- system's information resources.

Of course, the research problems indicated above are very general and only show the most important problems to be solved in the health care system, which in turn is necessary to ensure that citizens utilise their constitutional right to health care. One such direction could be precisely the introduction of a well-designed model of coordinated medicine.

The impairments mentioned above will form the basis for the Author's research in this area.

Therefore, the main research problem of the research undertaken relates to the identification of the coordinated care pathways used and the associated management models of medical facilities and the evaluation of their effectiveness, i.e. to determine the extent to which these models support the achievement of their statutory and strategic objectives. This problem is to be verified on a representative research sample and provide answers to the following questions:

- Are the different pathways of coordinated care being used in health units?
- What are the opportunities and constraints in managing coordinated care?
- Is it possible to assess the effectiveness of the management approaches used in medical facilities in terms of achieving their statutory and strategic objectives in the context of integrated care?
- Is it possible to identify an effective method of governance for the coordinated medicine model?

- Does the use of the coordinated medicine model improve the quality of healthcare?
- Does managing a treatment facility in the context of coordinated care optimise costs?
- Does the use of coordinated medicine pathways improve communication between specialists and patients and affect patient and medical staff satisfaction?
- Can technologies supporting coordinated medicine be identified?
- Can and how can the management of coordinated medicine affect equity in access to medical care as well as public health?

Co-ordinated medicine aims to create a more integrated and efficient healthcare system, and the research planned in this area can contribute to new and better solutions for treatment, organisation of care and health policy.

2. Research model

For the purposes of the research objectives pursued, a research model was developed (Figure 1), in which the following types of study variables were distinguished.

Dependent variables – relating to the effectiveness of the management of a medical facility in the context of the coordinated medicine model, classified in the dimensions of organisation and resources, system financing, availability of services, patient rights and safety and information resources of the system.

Independent variables – describing management in the coordinated medicine model, determined by the following criteria: flexibility of staffing, availability of human resources, freedom of decision-making regarding subcontractors, the way in which services are financed and the rules for billing the payer.

Variables of the background – these are constituted by the legal norms of the relevant coordinated medicine pathways, the specifics of the health sector in Poland, the conditions of operation of treatment facilities and the balance of human resources in the existing organisational and legal conditions.

Catalysing variables – depicting individual characteristics influencing the management of the coordinated medicine model: size of the organisational unit under study, activity profile, number of employees and founding body.

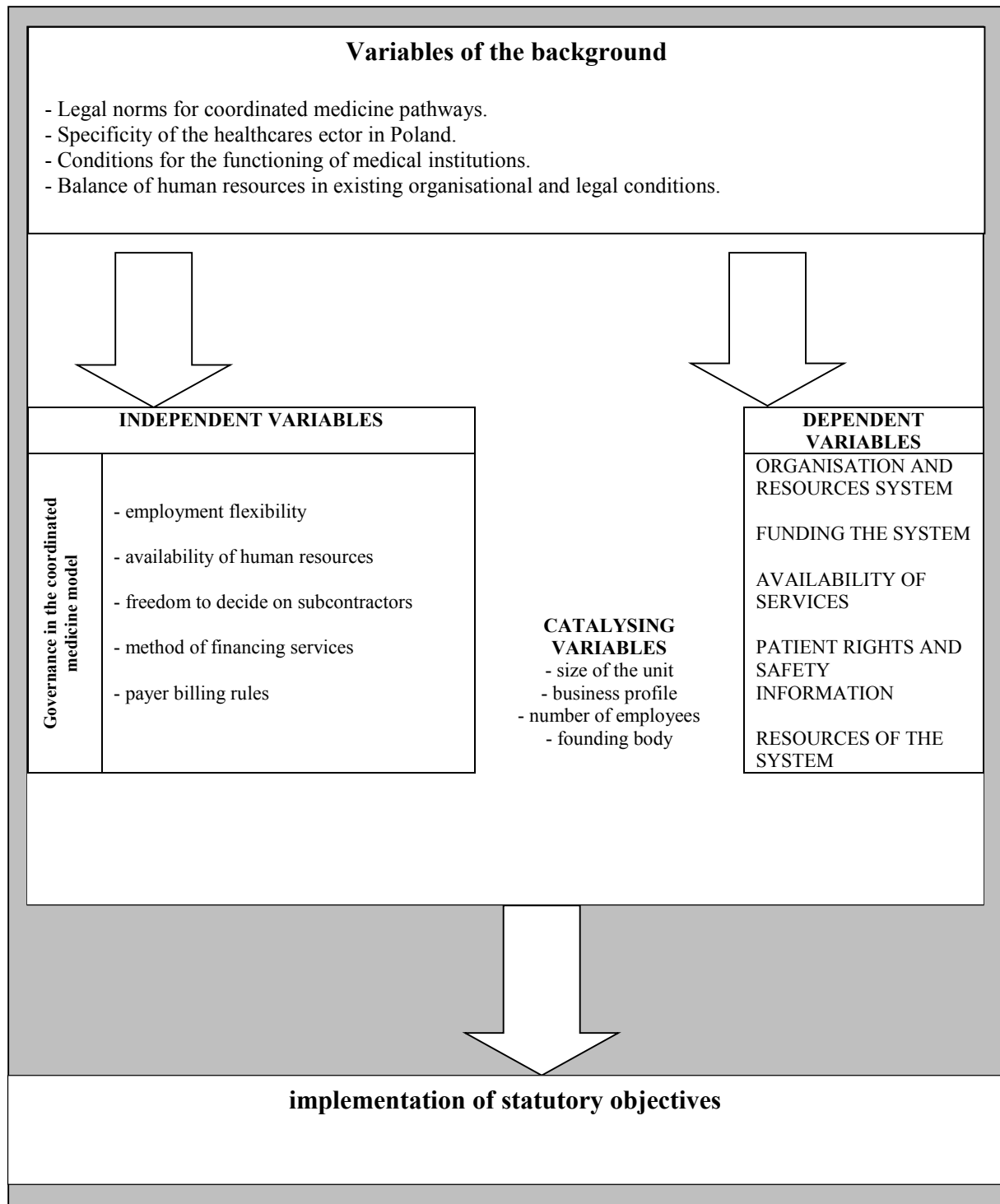


Figure 1. Research model.

Source: own work.

It should be noted that the multidimensionality and multifaceted nature of issues concerning the specificity of the functioning of health care units in Poland, is extremely complex. Hence, the developed research model can be elaborated and expanded in any way, thus creating an opportunity for further research development in this area.

3. Organisation of research

The starting point for the projected research is the transformations taking place in Polish legal norms with regard to the possibility of managing a health care unit in an alternative model of coordinated care pathways and the resulting problem of human resource balance. Both of these premises condition the functioning and implementation of the statutory goals of health care units. On this basis, the research procedure was designed, which is presented above, while the course of the conducted research (procedure, areas and methods) is illustrated in Figure 2.

The scope of the study was determined by the stated aims of the work and includes:

- identification of possible pathways for coordinated care and management options in this context in medical facilities,
- collection of data necessary to evaluate and compare the effectiveness of the management methods identified,
- identification of the main barriers limiting the effectiveness of governance in the context of the coordinated medicine model,
- identification of actions that could reduce or remove the identified barriers,
- verification of the thesis and research hypotheses set out in the paper.

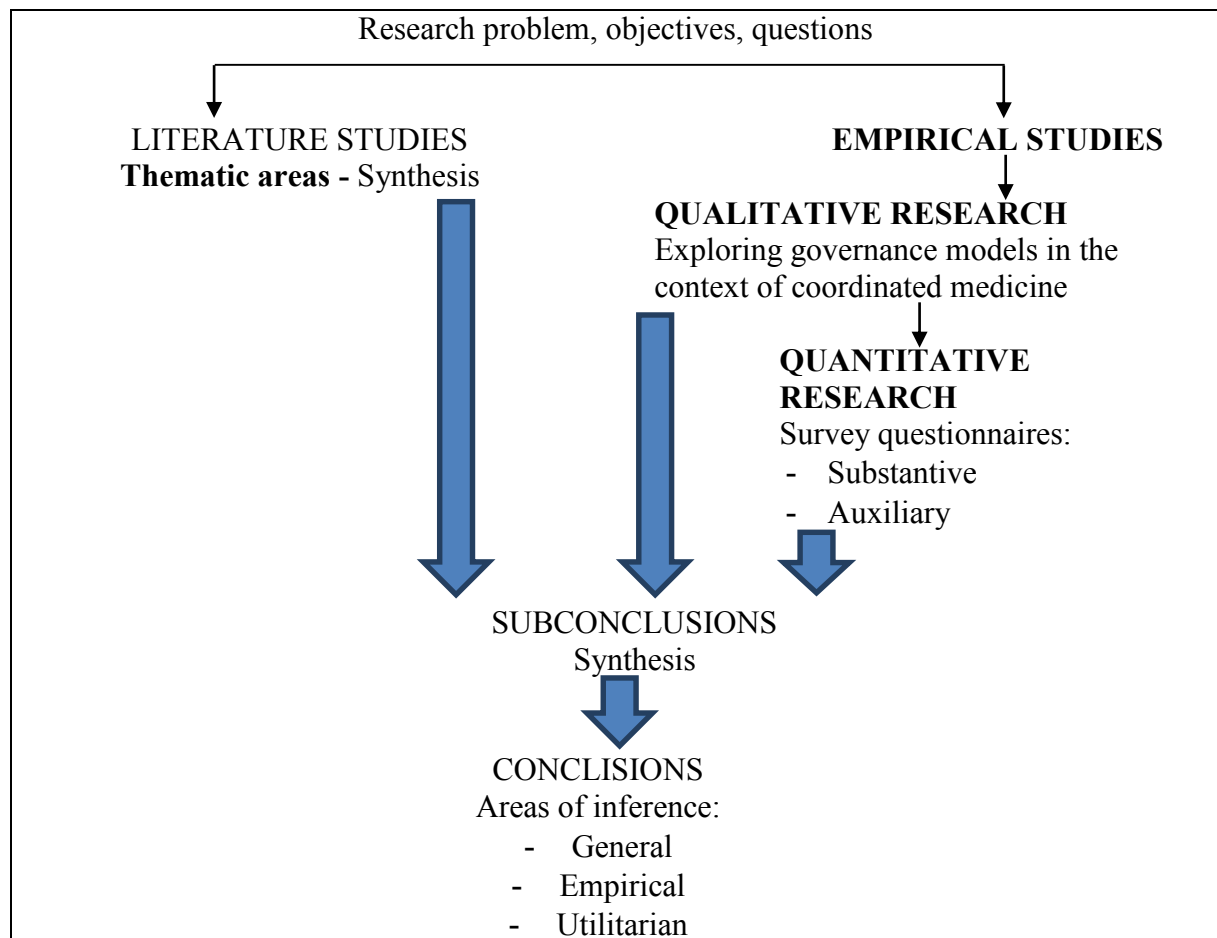


Figure 2. Survey procedure. Source: own work.

3.1. Qualitative research – the first stage of empirical research

The first stage of the research, which is a qualitative research phase that forms the basis for further (quantitative) research, is planned for the second half of 2025.

Qualitative research applied at this stage will allow us to look at the issues through the eyes of the respondents, see the phenomenon, explore it, get to the mechanisms behind it and determine the views of the employees of the units under study (Churchill, 2002; Michna, 2009). They will serve as a source of inspiration for the creation of a quantitative tool, which is important especially in the case of a 'fresh' research topic such as the one addressed in this paper. The methods that will be used in this stage of the research are:

- casual interview,
- participatory observation,
- analysis of legal acts and internal documents.

The aim of this stage of the research will be to observe whether specific management methods are used in the context of the coordinated care model in individual medical facilities, with particular reference to public hospitals (city and provincial hospitals), multi-specialist outpatient clinics and other publicly funded entities, and whether they can be adapted and applied for the management of other units. To this end, a research tool will be created in the form of a taxonomy matrix, by means of which the management method of the coordinated medicine model used in a given unit will be determined.

3.2. Quantitative research – second phase of empirical research

Quantitative research involves questionnaire surveys conducted on relatively large samples of respondents, most often representative of the target population, using statistical and mathematical methods for sample selection and calculation of results. They involve the collection of data, gathered from respondents by means of forms - questionnaire surveys and interviews. A certain number of respondents, selected according to the rules of statistics, answer the questions contained in the questionnaires. On the basis of the data collected in this way, it is possible to answer the question "how many" – approximately – people in the surveyed population know e.g. a given brand, have watched an advertising film, use a product, own a certain item, etc.? They thus make it possible to establish how often various opinions and facts occur in a given population. Quantitative research is used when on the basis of the results obtained on a given sample, conclusions are drawn about a certain population, larger than the sample under study (e.g. the population of the general adult population of Poland, the population of consumers of a specific product category, the population of housewives aged 18-35, etc.). Inference from the results of quantitative research is subject to the principles of mathematical statistics. It usually makes it possible not only to obtain certain numerical estimates for the general population, but also to determine the statistical error that these estimates are subject to. With regard to the survey population, quantitative surveys can be

divided into consumer surveys, in which individuals or households are surveyed, business-to-business surveys, in which business entities (companies) are surveyed, and distribution surveys covering commercial and service establishments (shops, wholesalers, bank branches, etc.).

3.3. Research tool

The management pathways identified in the first stage of the research in the context of coordinated medicine should confirm the feasibility and necessity of further research aimed at assessing the effectiveness of management in individual organisational units. In this stage, a set of two surveys will be used, consisting of a self-administered survey questionnaire (substantive) to investigate the effectiveness of a particular management pathway and a self-administered survey questionnaire (auxiliary) to investigate motivational factors, complementing this stage of the research.

In both the first and second research tools, statements will be used, requiring responses graded on a Likert scale that allows respondents to indicate their attitude to each statement in terms of: "strongly agree", "rather agree", "no opinion", "rather disagree", "strongly disagree" (Oppenheim, 2004).

3.4. Statistical verification of the survey instrument

Before proceeding with the research, it will be necessary to verify the research tool for reliability. For this purpose, the Cronbach's reliability test will be used. This is a coefficient for a summary scale whose items can be measured on any ordinal scale. Its form is as follows:

$$\alpha = \frac{k}{k-1} \left[1 - \frac{\sum_{j=1}^k S^2(x_j)}{S^2(x_s)} \right] \quad (1)$$

where:

$S^2(x_j)$ is the variance of a single variable,

$S^2(x_s)$ is the variance of the synthetic (aggregate) variable,

k – number of questions forming the synthetic variable.

This coefficient indicates how much of the variance of the summary scale is the variance of the true value of that scale. A value of zero means that the individual scale items do not measure the true score, but only generate random error. As a result, there is a lack of correlation between the items of the summated scale. In studies, the reliability of the measurement tools used should exceed 0.7, some authors report a range (0.6-0.8). The values of the Cronbach reliability test for the individual modules of the research tool - the content-related questionnaire and the auxiliary questionnaire - are presented below.

3.5. Test sample

A survey - both qualitative and quantitative – is planned among the staff of the Society of Healthcare Managers (STOMOZ). Its history dates back to 1991. In that year, the first graduates of the Postgraduate Study of Health Economics, which was organised and headed by Dr Katarzyna Tymowska, left the University of Warsaw. They decided to found the Association of Health Care Managers.

The first President of the STOMOZ General Board was Józef Tazbir – Director of the M. Kopernik Provincial Specialist Hospital in Łódź, who was succeeded for successive terms by Marek Wojtowicz – then Director of the Specialist Hospital in Lubartów, later Medical Director and Chief Executive Officer of the Specialist Hospital in Puławy, Director of the Lubelskie and Mazovian Provincial Branches of the National Health Fund (transition to work in the National Health Fund, in accordance with the statutory requirements of STOMOZ, was the reason for his resignation from the position of President). The next president of the General Board was Jarosław Kozera, then his place was taken by Danuta Tarka – the director of treatment at the Provincial Complex Hospital in Płock. Subsequently, Małgorzata Majer – Director of the Wł. Biegański Provincial Specialist Hospital in Łódź – took over as President, and since 2016 the General Meeting has entrusted the leadership of the Association to Iwona Mazur – Director of the Day Psychiatry and Speech Disorders Centre for Children and Adolescents in Wrocław. Since 2021, the President of the General Assembly has been Dariusz Rajczyk – President of the Management Board of Centrum Medyczne SILESIA Sp. z o.o. Hospital in Zabrze.

The Association of Health Care Managers is the oldest organisation in Poland that brings together managers involved in the management of health care institutions. From its ranks come many ministers, deputy ministers, central and local government officials who are responsible for the organisation of health care in Poland.

Today, STOMOZ supports decision-makers with its experience and knowledge, actively participates in the creation of legislation, in consultations with representatives of the Ministry of Health and the National Health Fund. It provides opinions on legal acts concerning the health care environment, supports managers in improving their professional competences, and participates in international educational projects. STOMOZ is an apolitical, professional organisation and upholds the interests of both patients, the healthcare system and managers – the people who are responsible in hospitals, clinics and medical companies for implementing statutory solutions.

The specific objectives of the Association are (www.stomoz.pl):

- ensuring high professional qualifications and moral standards and to protect the dignity and professional ethics of healthcare managers,
- integration of those in managerial roles in healthcare and those interested in the processes of management, organisation and economics in healthcare,

- working towards the dissemination of effective and efficient methods of healthcare management,
- initiating and taking action to improve the legislation governing healthcare,
- initiating and promoting research and solutions for modern healthcare management methods,
- cooperation with national and international organisations dealing with management, organisational and economic processes in healthcare,
- dissemination abroad of Polish experience in management, organisation and economics in health care.

The above objectives are achieved in particular through:

- dissemination of knowledge on organisation, management and health economics, effective and efficient management methods and organisational solutions, through courses, seminars, congresses, conferences and other forms of training, including e-training,
- provision of legal and other assistance to the members of the Association in matters relating to the achievement of the Association's objectives,
- promoting professional ethics and adherence to the norms of coexistence in the Association with the involvement of the collegiate judiciary,
- giving an opinion on draft legislation governing healthcare,
- submitting opinions, proposals and draft changes to the authorities for the efficient, effective and socially acceptable functioning of health care,
- cooperation with national and foreign associations, organisations and other institutions,
- cooperation with the competent authorities and institutions in the development of teaching and training methods and programmes in the field of organisation, management and health economics.

The association pursues its objectives in accordance with the applicable law, especially the Associations Act and its statutes.

3.6. Possible further lines of statistical analysis

Depending on the course of the research and the results obtained, further statistical verification of the data obtained will take place. In particular, the following statistical analyses will be used (Pawłowski, 1976; Gatnar, 1998; Domański, 1979, 1980; Ferguson, Takane, 1997):

- factor analysis,
- Keiser-Meyer-Olkin statistic,
- analysis of variance,
- Newman-Keulustest,
- Kruskal-Wallis test,
- Shapiro-Wilk test,

- Brown-Forsyth test,
- Mann-Whitney U test,

The selected statistical analysis tools proposed above should play a key role in the research being designed, as they will enable accurate interpretation of the data and the drawing of key conclusions based on the information collected. Here is the main importance of statistical analysis in scientific research.

4. Conclusion

Coordinated care can be a solution to the problems of Polish health care. It will not only improve the quality of patient care, but also increase its effectiveness. At the moment, the issue of introducing such a model of health care system management faces many challenges, which may hinder its introduction or discourage further expansion to new groups of patients. When deciding on such a management model, it should be emphasised that a prerequisite for this model is information sharing, so it is important to connect different IT systems (or build new dedicated solutions) – doctors must have full information about their patients (both administrative and medical data) delivered in a timely and usable manner. Finances and economic pressures on healthcare systems can also be a significant impediment to integrative care projects. It takes several years to implement a project and a short-term approach to efficiency gains can overshadow the benefits of long-term, systematic improvements. Another major challenge is overcoming a lack of understanding on the part of the patient and physician about the needs of the evolving system. Integrated care prioritises the needs of the patient, focusing on managing health with the help of information and assistive technologies. It is also worth bearing in mind that the governance model under discussion raises concerns for both doctors (due to a change in the way funding is directed – there is a greater focus on the outcome of treatment rather than the delivery of the service itself, as in the traditional model) and other system staff working with the doctor (there is an issue of independence and subordination of individuals and processes within the redefined model). In addition to the above challenges, there are also issues of different types of integration (coordination) and differences in the priorities of different groups caring for the patient, e.g. medical staff or social workers, who have their own standards and regulations.

Conducting research on the management of a medical facility in the context of the coordinated medicine model requires a multidisciplinary approach that encompasses both the clinical, economic and organisational aspects of the entire healthcare setting.

The research assumptions presented in the above paper are only a prelude to further publications by the author in this area. At present, the research design is outlined. Further conclusions and directions of statistical analyses will be contoured after obtaining data from surveys conducted in the STOMOZ Association.

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MOTIVATION IN PROJECT TEAM MANAGEMENT

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Purpose: The purpose undertaken in this article is to present the results of a research study in the field of motivation, aimed at identifying the factors of greatest importance to project team members in project management.

Design/methodology/approach: The paper uses a diagnostic survey method and a survey questionnaire as a research tool. The survey questionnaire used for the research was prepared on the basis of a critical analysis of the literature (domestic and foreign) on motivation, motivation systems and motivating factors of project team members. The research was conducted on a group of 176 project team members.

Findings: The results of the research contained in the article provide answers to the formulated three research questions.

Originality/value: The paper has a cognitive value for the development of knowledge, learning and quality in the field of motivation factors of project teams.

Keywords: motivation, motivational factors, project team.

Category of the paper: research paper.

1. Introduction

Motivation plays a key role in the success of a project team. Motivated team members show greater productivity, creativity and commitment to achieving project goals. There are a number of different methods of motivation that can be used to increase the level of motivation in a project team. However, due to the varying individual characteristics of team members, there is no universal motivation strategy that will work in every case.

Therefore, when managing a project team, it is very important to use different types of motivation solutions, especially well-chosen motivation tools. The key to effective motivation is the proper adjustment of these tools to the specifics of the company and the needs of the project team members, which is possible by identifying the factors that motivate them.

The aim of the research undertaken in this article is to identify the motivational factors that improve the effectiveness of project team members. It will be achieved by achieving the set research objectives and obtaining answers to the research questions posed. Based on the analysis of the literature, a research tool, i.e. a questionnaire, will be developed to conduct the survey.

2. Literature analysis

2.1. Motivating the project team

Interest in the issue of motivation leads to numerous attempts to explain this complex process. Motivation is generally understood as a set of factors that stimulate individuals to take specific actions. These motives, which give rise to human behaviour, may include needs, desires, values or goals. It is these intrinsic motivators that influence an individual's decisions, prompting them to act. The literature often emphasises that motivation is not a uniform phenomenon - it can be shaped by many factors, such as personal experiences, culture, life circumstances or individual goals.

A key aspect of management is the motivation of employees who are the company's most valuable resource. As Kopertyńska (Kopertyńska, 2009) notes, motivation is a process aimed at managing human capital, which plays a decisive role in the achievement of organisational goals.

In turn, Reykowski (Reykowski, 1979) describes motivation as a set of incentives that guide an individual's actions, while Koźmiński and Piotrkowski (Koźmiński, Piotrkowski, 2007) point out that motivation is a readiness to act resulting from personal preferences and goals.

In the context of teamwork, adequate motivation is a key success factor. As Schermerhorn (Schermerhorn, 2008) points out, motivation shapes the intensity and sustainability of employee engagement.

One popular definition of motivation is that of Deci and Ryan (Deci, Ryan, 1985), who see it as a process of self-determination in which an individual seeks to satisfy his or her intrinsic needs, such as autonomy, competence and relationships with others. Within this theory of self-determination, motivation is the result of both intrinsic striving and external influences, with the fulfilment of psychological needs being the key driver for action.

Motivation in a project environment requires a flexible approach that takes into account a variety of incentives, both tangible and intangible (Czerska, 2001). Koontz and Wehrich (Koontz, Wehrich, 1984) define motivation as a process that starts with the feeling of needs and ends with the satisfaction of those needs, leading to goal-oriented action. For this reason, proper management of motivation in a project team can significantly increase work efficiency and commitment, which directly affects project success.

2.2. Factors having the greatest impact on motivating the project team

Based on the literature review, several main factors can be identified that have a significant impact on project team motivation. Motivation is a complex process that can take different forms depending on the individual needs and goals of the project team members. The process is based on a number of key motivational factors, which can be divided into those related to financial and intangible factors.

Tangible motivators

Salary-related motivators such as wages, bonuses and monetary rewards have traditionally been some of the most effective ways of motivating employees. Armstrong and Taylor emphasise that salary is one of the most important aspects that influence motivation, especially in the short term. Their research indicates that the transparency of the salary system and the linking of financial rewards to performance are crucial to employee satisfaction (Armstrong, Taylor, 2014).

It is worth noting that, according to Shields et al. (Shields et al., 2015), bonus and bonus systems are only effective if they are linked to measurable outcomes. Project teams with clearly defined goals can more easily be motivated by variable salary elements.

Borkowska (Borkowska, 2006) adds that salary motivators also act as tools for employment stabilisation, providing a sense of security and satisfaction for employees, which influences their loyalty and commitment. In addition, Adams (Adams, 1965) points out in his equity theory that an important element of financial motivation is the fairness of pay. Employees who feel that they are fairly rewarded compared to others show higher levels of commitment.

Intangible motivators

However, contemporary research indicates that salary alone is not sufficient to maintain high levels of motivation over the long term. Pink (Pink, 2009) argues that people are more motivated by intangible factors such as autonomy, recognition and a sense of meaning. Autonomy, especially in project teams where team members have the ability to make decisions for themselves, is one of the most important factors in increasing engagement.

Grant (Grant, 2013) adds that social relationships and a collaborative culture are important motivators in project teams. Collaboration, mutual help and positive feedback can significantly increase the motivation of team members, especially in long-term projects.

Self-determination theory, developed by Deci and Ryan (Deci, Ryan, 1985) also points to the importance of satisfying psychological needs such as autonomy, competence and interpersonal relationships. The authors emphasise that these intangible aspects of work are crucial to maintaining long-term commitment.

Hackman and Oldham (Hackman, Oldham, 1976) in their theory of job characteristics point out that task variety, autonomy and feedback are key factors influencing intrinsic motivation. In project teams, where creativity and innovation are important, the opportunity to develop competence and receive regular feedback plays an important role in sustaining high levels of motivation.

Individualising motivation

In the literature, the need for an individualised approach to motivating employees is increasingly emphasised. Cerasoli, Nicklin and Ford (Cerasoli, Nicklin, Ford, 2014) demonstrate that a combination of intrinsic and extrinsic incentives produces the best results in terms of work engagement. However, a key challenge for leaders is to understand which factors are most important to individual team members.

Bakker and Leiter (Bakker, Leiter, 2010) emphasise that regular conversations with employees about their expectations and goals allow leaders to customise motivational strategies. This approach enables stronger relationships and higher levels of commitment to be built, ultimately resulting in better team performance.

Based on an analysis of the literature, it can be concluded that effective motivation of a project team is based on a balanced approach, combining both tangible and intangible factors. Contemporary research, indicates that while salary can be an effective short-term incentive, long-term employee engagement requires that employees' intrinsic needs such as autonomy, competence development and interpersonal relationships are met. Leaders who are able to tailor motivational strategies individually, taking these needs into account, achieve greater effectiveness and commitment within the team, which translates into the success of ongoing projects.

3. Research methodology

The objective undertaken in this paper is to present the results of the research carried out in the field of motivation, aimed at identifying the factors that matter most to project team members in project management. The main objective will be achieved through the following sub-objectives:

- C1. To clarify the concept of motivation and its importance in project team management.
- C2. To identify the factors that motivate project team members.
- C3. To identify the ranking of motivating factors of project team members.
- C4. To identify the ranking of motivating factors of project team members according to the characteristics of the respondent.

The realization of the presented sub-objectives took place in the course of answering the following research questions:

1. What is motivation and what is its importance in project team management?
2. What are the factors for motivating project team members?
3. Which factors motivate project team members the most?

In order to find answers to the research questions posed, which were directed at identifying the factors that have the greatest impact on motivating project team members, a diagnostic survey method and a research tool, namely a survey questionnaire, were used. The survey questionnaire prepared for the research was developed on the basis of a critical analysis of national and international literature. The research used non-random sampling - the snowball method, meaning that participants were selected by contacting individuals who then recommended others with similar characteristics. The research was conducted using Google Forms, a survey tool that is part of G Suite.

The survey questionnaire developed for the research consisted of two parts. The first part included 5 metric questions. The second part of the survey questionnaire included 6 closed questions to answer the question of which (among those identified from the critical analysis of the literature) motivational factors are most important to project team members.

The survey was conducted between 11.03 and 11.04.2024.

Statistical methods such as arithmetic mean, median, percentage were used to analyse the survey results obtained.

4. Survey results

The survey questionnaire was sent to 236 respondents. A total of 176 respondents took part in the survey, including 116 project team members and 60 project managers. Assuming a maximum error of 5%, the fraction size is 0.5, while the confidence level is 95% and the sample is therefore considered sufficient.

The respondents in the survey were university graduates (40%), with half of the project team members (58 people) having a secondary education, and project managers (72%, i.e. 43 people), having a university degree. When analysing the respondents' experience with projects, 33% of them had worked on projects for more than 1 year. Only 11 % of respondents (i.e. 25 people) had worked on projects for more than 8 years, with 19 people being project managers. The majority, i.e. 37%, of respondents had worked on less than 6 projects. Respondents to the survey carried out projects in the industrial, manufacturing (39%), marketing, advertising (21%) and service, consulting sectors (15%).

Based on a critical analysis of the literature, the following motivational factors were listed as being the most important for successful project delivery, i.e.: salary, financial rewards, training and professional development, flexible working hours, team relations and communication, and working conditions and standards. These factors, were rated by respondents on a scale of 1 to 5, where 1 was the lowest possible rating and 5 the highest.

The results obtained from the survey allowed for the development of a ranking of factors influencing the motivation and demotivation of project team members. The ranking represents the importance of the motivating factors for the total respondents taking part in the research. It allows us to identify the factors that have the greatest impact on motivating and demotivating project team members.

Specifically, the factors with the greatest impact on the motivation of project team members include (in order of greatest importance):

1. Salary.
2. Positive working atmosphere.
3. Working conditions and standards.
4. Financial rewards.
5. Training and professional development.
6. Flexible working hours.

In particular, the factors having the greatest demotivating effect on project team members include (in order of greatest importance):

1. Conflict within the team.
2. Lack of recognition and rewards for contributions.
3. Lack of clearly defined procedures.
4. Problem with internal communication.
5. Mismatch between tasks and skills.
6. Monotony of tasks.

The results of the survey conducted among project team members clearly indicate that the key factors motivating them to work are, above all, salary and a good working atmosphere. The practice of such measures contributes to an increase in commitment and an improvement in the effectiveness of implemented projects. On the other hand, conflicts within the team and a lack of recognition for one's contribution are factors that worsen the level of motivation thus negatively affecting the project. The project managers participating in the survey indicated that motivational measures should be tailored to the individual needs of project team members. In addition, all project managers highly appreciated the impact of the motivation level on the effectiveness of the project implementation. Therefore, it is important to bear in mind the need for an individual approach to managing motivation in project teams, taking into account the diversity of staff perspectives and needs.

5. Ranking of factors influencing the motivation of project team members

It should be noted that the ranking presented in the earlier chapter is generalised. Hence, it was considered worthwhile to additionally analyse the obtained results in terms of the respondents' characteristics, in particular: a) the role they perform in the project team, b) the time they perform the indicated role, c) the number of projects in which they participated, d) the sector in which they implemented projects.

1. Factors having the greatest impact on motivating project team members, depending on the role they play in the project team.

176 respondents took part in the survey, with the largest number of respondents in the role of project team member, i.e. 66%, and the role of project manager in 34% of respondents. Respondents, regardless of their role in the project team, both project team members (63%) and project managers (52%) identified salary as the factor most influencing motivation and thus affecting successful project delivery. In last place in the ranking of motivational factors, among both project team members' and project managers' evaluations, are training and professional development. This was indicated by 18 project managers and 40 project team members. As far as the rest of the ranking notes are concerned, they vary. For project team members, financial rewards are an important factor in motivating the team - ranking second, while for project managers this factor is ranked fifth to last. Analysing the ranking of motivational factors by project managers, it can be seen that factors such as working conditions, positive atmosphere and flexible working hours significantly influence team motivation.

A ranking of the factors having the greatest impact on motivation according to the ratings of project team members and project managers is included in Table 1.

Table 1.

Summary ranking of factors having the greatest impact on motivating project team members, according to their role in the project team

Ranking of motivation factors according to their role in the project team	
project team member	project manager
Salary	Salary
Financial rewards	Working conditions and standards
Flexible working hours	Positive working atmosphere
Positive working atmosphere	Flexible working hours
Working conditions and standards	Financial rewards
Training and professional development	Training and professional development

Source: own elaboration based on survey results.

2. Factors which have the greatest influence on the motivation of project team members, depending on the length of time they have held the indicated role in the project team.

Most respondents indicated that they have been in a project team member or project manager role for less than 1 year (33%, i.e. 77 respondents). On the other hand, 25 respondents (11%) indicated that they have been in the role of project team member or project manager for more than 8 years. Comparing the ranking of motivation factors made by respondents

depending on experience (time of involvement in projects), it can be noted that people with the least and the most experience in project management indicated salary, followed by a positive working atmosphere as important factors influencing the motivation of the project team. In last place in the ranking, they indicated training and professional development. It is interesting to note that for people who have been involved in projects for 1-8 years, salary is not the most important factor influencing motivation. For these people, factors such as working conditions, a positive atmosphere and flexible working hours are important.

The ranking of factors having the greatest impact on motivation according to the duration of the indicated role in the project team is shown in Table 2.

Table 2.

Summary ranking of factors having the greatest impact on motivating project team members according to the length of time in the designated role in the project team

Ranking of motivation factors according to the duration of the indicated role in the project team				
less than 1 year	1-3 years	3 -5 years	5-8 years	more than 8 years
Salary	Conditions and working standards	Positive working atmosphere	Flexible working hours	Salary
Positive working atmosphere	Salary	Training and professional development	Salary	Positive working atmosphere
Conditions and working standards	Positive working atmosphere	Flexible working hours	Positive working atmosphere	Flexible working hours
Flexible working hours	Training and professional development	Salary	Conditions and working standards	Conditions and working standards
Financial rewards	Flexible working hours	Conditions and working standards	Financial rewards	Financial rewards
Training and professional development	Financial rewards	Financial rewards	Training and professional development	Training and professional development

Source: own elaboration based on survey results.

3. Factors having the greatest impact on motivating project team members, according to the number of projects they have participated in.

Most respondents had taken part in less than 5 projects in the last year (37%). 18% of respondents indicated that they had taken part in 11-20 projects in the last year and 11% of respondents had taken part in 5-10 projects. 9% of respondents had taken part in more than 20 projects in the last year. The factors that have the greatest impact on the motivation of the project team according to the respondents' assessments depending on the number of projects they have participated in varies (is shown in Table 3). For those who have participated in fewer than 5 projects, the most important motivational factors are a positive working atmosphere, salary, working conditions and standards. They ranked training and professional development last. Similarly, those who participated in more than 20 projects as well as those who participated in between 11 and 20 projects indicated the same. Salary as an important motivation factor was indicated by respondents with 5-10 projects as well as over 20 projects. From this ranking it is interesting to note that financial rewards are not an important factor influencing motivation, ranking 5th and 6th.

Table 3.

Summary ranking of factors having the greatest influence on the motivation of project team members according to the number of projects in which they participated

Ranking of motivation factors according to the number of projects in which they participated			
Less than 5 projects	5-10 projects	11-20 projects	Over 20 projects
Positive working atmosphere	Salary	Flexible working hours	Salary
Salary	Positive working atmosphere	Working conditions and standards	Positive working atmosphere
Working conditions and standards	Working conditions and standards	Positive working atmosphere	Flexible working hours
Flexible working hours	Training and professional development	Salary	Working conditions and standards
Financial rewards	Flexible working hours	Financial rewards	Financial rewards
Training and professional development	Financial rewards	Training and professional development	Training and professional development

Source: own elaboration based on survey results.

4. Factors most influential in motivating project team members, according to the sector in which they carried out projects.

The largest number of respondents who took part in the survey carried out projects in industry/manufacturing, i.e. 39% (92 respondents). 21% of respondents participated in projects in marketing/advertising and 15% in services/consulting. Factors significantly influencing the motivation of project teams implementing projects in industry/manufacturing as well as services/consulting are salary, a positive working atmosphere and working conditions and standards. For project teams in the marketing/advertising sector, the most important factors for motivation are flexible working hours, a positive working atmosphere and working conditions and standards. Salary and financial rewards do not have such a significant impact.

A ranking of the factors having the greatest impact on motivation according to the sector in which they carried out projects in Table 4.

Table 4.

Ranking of factors having the greatest impact on motivating project team members depending on the sector in which they carried out projects

Ranking of motivation factors according to the sector in which they carried out projects		
Marketing/Advertising	Industry/Manufacturing	Services/Consulting
Flexible working hours	Salary	Salary
Positive working atmosphere	Positive working atmosphere	Positive working atmosphere
Working conditions and standards	Working conditions and standards	Working conditions and standards
Training and professional development	Flexible working hours	Financial rewards
Salary	Financial rewards	Training and professional development
Financial rewards	Training and professional development	Flexible working hours

Source: own elaboration based on survey results.

The research carried out gathered important information on what motivates project teams to achieve project goals. The analysis of the collected data made it possible to identify the factors that should be paid attention to when aiming to motivate project teams effectively.

6. Conclusion

Nowadays, employees are described as a valuable asset of a company, who, through their engagement, influence the company's competitive advantage. The literature on workplace motivation closely examines the theoretical aspects that focus on understanding the various factors that influence employee engagement. These studies seek to establish how both intrinsic and extrinsic factors shape employee motivation, taking into account both individual predispositions and the influence of the work environment. Despite the abundance of literature on motivation, it is possible to notice gaps in the studies with regard to the motivation of project team managers in particular. Theoretical knowledge is often not applied to real-life work situations, and practice is often based on intuition or experience instead of a scientific basis. Therefore, the use of different types of motivation solutions and well-chosen motivation tools is very important in project team management. In order to select motivation tools appropriately, it is necessary to identify the factors that motivate the project team, and these can vary depending on the specific characteristics of the company as well as its employees.

Therefore, survey research was undertaken to find out the various factors on motivation in the context of project teams. Through the collection of empirical data and the analysis of survey results aiming to identify the specific mechanisms that underlie the motivation of project team members and the ways in which these mechanisms can be put into practice in the process of managing these teams.

The research results presented in this article show that motivation plays a key role in project team management, which in turn allows project success to be achieved. The research has identified the factors that have the greatest impact on the motivation of project teams. Motivation factors in terms of their importance to project team members include: salary, positive working atmosphere, working conditions and standards, financial rewards, training and professional development, and flexible working hours. In addition, the article presents rankings of the importance of motivating factors in terms of respondents' characteristics, in particular: the role they play in the project team, the length of time they have played the indicated role, the number of completed projects in which they have participated and the sector in which they have carried out projects.

The conclusions of the survey are relevant to human resource management practice. By implementing motivational strategies based on the collected data, team managers can more effectively support and mobilise their employees to achieve common project goals. In addition, the identified motivational factors can provide a starting point for the development of personalised motivational strategies tailored to specific teams and projects.

On the basis of the research carried out, i.e. the literature analysis and the analysis of the results obtained, the following suggestions can be identified to increase the level of motivation among project teams contributing to improved efficiency. Suggestions include: guaranteeing adequate salary, building a positive working atmosphere, resolving conflicts, regular feedback, ensuring working conditions and standards and rewarding high performance.

The research presented in the artikel contributes to broadening the theoretical understanding of motivation in the workplace, but also to providing practical guidance for managers and project team leaders to help in improving the effectiveness of teamwork.

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INTERNAL ENVIRONMENT FOR PROJECT MANAGEMENT IN CITY AND COUNTY COUNCILS IN POLAND

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Purpose: The aim of the article is to assess the internal project management environment in municipal and district offices in Poland.

Design/methodology/approach: Based on the literature analysis, the paper develops a research tool to conduct a survey on a group of 200 city and district offices in Poland.

Findings: Based on the research conducted, the factors of the internal environment of project management in the studied local government organisations were identified.

The work is of cognitive value for the development of knowledge, learning and quality in project environment management in local government organisations.

Keywords: project environment, project management.

Category of the paper: research paper.

1. Introduction

The need to streamline the work process to increase productivity and efficiency in project management is ever-present. Individual organisations strive to provide the right environment so that projects can be completed within time and financial constraints.

The project management process takes place in an organisational environment that is characterised by certain company- or organisation-specific features. These characteristics reflect the organisation's state of readiness for project implementation and primarily relate to the enterprise's system architecture (including organisational structure, internal procedures, communication systems, etc.), organisational culture and social potential (Pachura, 2016). This system directly influences the project implementation and project management process.

The literature points to tools that streamline the project management process while creating a certain project management environment. Their purpose is to ensure that all elements of the project, such as the project manager and his team, can interact and work with access to project information. The effect of this is to provide a favourable environment so that people work together to achieve a common goal.

This paper will examine the internal project environment and its role in project management in city and county offices in Poland. In particular, the factors of the project's internal environment that can affect project implementation will be analysed.

2. Internal project management environment factors

Environmental characteristics have a significant impact on all aspects of management, including project management (Ochieng et al., 2013). Project management as a management concept deals with creating a favourable environment so that people work together to achieve a common goal (Reis, Ribeiro, 2022).

The project environment is defined as 'the set of phenomena, processes, institutions, groups and individuals - both external and internal - that are affected by and influence the project' (Trocki, 2013; Trocki, Grucza, 2009). The environment can therefore be understood as the setting in which a project is created and implemented, which is why the project environment is often referred to as the project context or project environment. This environment includes the actors and objects of the project (Grucza, 2019).

The relevance of the project environment in the PRINCE2 methodology is encapsulated in the definition of a project, where a project is '(...) a management environment created to deliver one or more business products according to the specific requirements of the business' (Office of Government Commerce, 2005, p. 7). Furthermore, in the PRINCE2 methodology, the approach to the project environment is embodied in the principle (princippium) that states adaptation to the conditions in which the project is implemented and the role of the Steering Committee.

The project context in the International Project Management Association (IPMA) standard is reflected in the contextual skills of the project manager. The project manager's contextual competencies cover areas such as the role of project management in permanent organisational structures and the interrelationship of project management and the organisation's business administration (SPMP, 2009, p. 30).

The effective implementation of a project requires considering the strong influence of various elements constituting the project environment, such as: processes, events, activities, as well as organisations, teams, individuals, which have a mutual relationship with the project.

The project environment so understood can be divided into external and internal (Grucza, 2019), i.e.:

- a) the external project environment includes:
 - the project macro-environment (further, global) indirectly affecting the project, e.g.: social, technological, political, economic, natural environment,
 - the proximate environment directly affecting the project, e.g.: suppliers and competitors, customers, regulators.
- b) the internal project environment includes:
 - the intra-organisational project environment, which is formed, among others, by the supervisory and managerial bodies of the project organisation, its management and line and functional staff, experts, employee representations,
 - the intra-project environment, which comprises: the project steering committee, project management, project management teams, administrative and technical support teams, specialists, consultants.

Similarly, Sarah Burner (Burner, 2024) divides key project environment factors into two categories: internal and external. Internal project environment factors consist of elements within the organisation and are mostly under direct control, these include, but are not limited to: employees, team dynamics, project management software, assets and resources, culture and organisational structure, which can be easily shaped through internal policies or decisions. External factors that are out of our control but can affect project performance include but are not limited to: changes in political power or regulatory compliance in a jurisdiction.

The Project Management Institute (PMI) standard indicates the positive or negative impact of the project environment on projects. According to the standard, there are two categories of impact, i.e.: business environmental factors and organisational process assets.

Business environment factors are conditions ‘that influence, constrain or direct the projects that are beyond the control of the project team’. These factors include internal and external factors (Table 1).

Tabela 1.

Factors in the project management enviro

Factors in the project management enviro	
Internal environmental factors of the business	External environmental factors of the business
Organisational culture, structure and supervision	Market conditions
Geographical dispersion of facilities and resources	Impact and social and cultural issues
Infrastructure	Legal restrictions
Software	Commercial databases
Availability of resources	Research
Staff capacity	Government or industry standards
	Financial considerations
	Physical elements of the environment

Source: PMBOK Guide, 2019.

Organisational process assets are factors internal to the organisation that have an impact on project management. These factors can be divided into two categories:

- Processes, policies and procedures for carrying out project work.
- Organisational knowledge bases for storing and granting access to information.

The analysis of the project environment is also addressed in project maturity studies of organisations. In this context, the project environment is understood as the organisation's organisational structures, management system, awareness of the importance of project management, stakeholder management and support of the organisation's management, procedures to support project management (Spalek, 2013, p. 41).

Both the organisational process assets and the project environment defined for the project maturity study indicate the factors that influence project management in an organisation. It is these factors that are worth examining to answer the question of the state of the project management environment in an organisation.

It is the environment in which a project is implemented that determines the methods and tools used to implement it, and ultimately influences its ultimate success (Swietoniowska, 2015). Projects are launched and implemented in a dynamic environment. The bidirectionality of the project-environment interaction should also be noted, i.e. the project throughout its cycle is created and influenced by the environment, but also influences it.

Managing the project environment in local government organisations requires a different approach compared to the private sector. This is related to the specific characteristics of the public sector. This makes public projects characterised by certain features that distinguish them from private projects. As Wirick writes (Wirick, 2009, p. 8) public projects:

- are implemented in an environment that may contain elements of political struggle,
- are carried out in organisations that have little project experience,
- most often have to be implemented within existing staff resources,
- require the interaction of individuals outside the project team,
- are often implemented in an environment with different objectives and expecting different results,
- involve different stakeholders with different expectations,
- are managed within the constraints imposed by administrative rules, cumbersome procedures and policies.

All these circumstances make it unjustifiable to automatically, unreflectively transfer solutions developed in private organisations to public organisations.

The project context in public sector organisations undoubtedly contains elements of political gamesmanship, but these belong to the environmental factors of the activity, i.e. the conditions affecting the projects that are beyond the control of the project team.

Considering the above considerations, the internal factors of the project management environment were divided into four categories, viz:

- 1) the project team,
- 2) project management procedures, tools and techniques,
- 3) knowledge base,
- 4) organisational culture and structure.

For the purpose of the research conducted, internal project management environment factors were identified in each category (Table 2).

Table 2.
Internal factors of the project management environment

Internal factors of the project management environment	
Project team	Z1. Provision of competent people for project management. Z2. Project managers effectively manage project stakeholders. Z3. Project managers are willing to share knowledge and experience. Z4. Project team members are willing to share knowledge and experience gained during projects.
Project management procedures, tools and techniques	P1. A formal appraisal system is in place to measure the level of competence of those involved in project planning and implementation. P2. Project management is used as an avenue to achieve strategic objectives. P3. Common terminology associated with project management. P4. Defined tools and techniques for project management. P5. Defined processes for initiating, planning, executing, monitoring, controlling and closing a project. P6. Defined project stakeholder management process.
Knowledge base	B1. There is a system for collecting and sharing data on completed projects. B2. There is an awareness of the importance of knowledge in effective project management. B3. Knowledge and experiences from completed projects are collected and stored. B4. Knowledge and experience from completed projects is applied to subsequent projects. B5. Project experience is documented. B6. A system is in place to support project knowledge management.
Culture and organisational structure	K1. Adapt project management processes to the needs of individual projects. K2. Organisational structure aligned to support project management. K3. Separation of project management organisational unit. K4. There is an awareness of the importance and value of project management.

Source: own elaboration.

3. Research methodology

To preparing the article, a research mode of procedure was adopted in line with the methodological principles applicable in the management sciences. The research mode consists of the following stages: formulation of the research problem and research questions, analysis of the collected empirical material and formulation of conclusions.

The internal environment of the project consists of, among others, the organisation's management, the employees concerned, the project manager and the other members of the project team, as well as the organisation's values, its mission, adopted strategy, procedures, its culture or organisational structure. The project is also implemented in a broader context in which, among others, suppliers, competitors, public institutions, local government, trade unions, and, in the case of projects with social impact, residents or community organisations, etc. must be considered.

In this context, the paper will examine the internal project environment and its role in project management in city and county offices in Poland. In particular, the internal factors of the project management environment will be analysed, which have been identified and grouped into four categories (presented in Chapter 2). The main objective will be achieved by finding answers to the following research questions:

Q1. Is the project environment managed in city and county offices in Poland?

Q2. Is there a relationship between internal project management environment factors?

A diagnostic survey method and a research tool, the survey questionnaire, were used to find answers to the research questions posed, which were directed at identifying internal environmental factors. The survey questionnaire prepared for the research was developed based on a critical analysis of national and international literature. The survey questionnaire contained a metric, and 20 questions graded on a scale from 1 to 5, where 1 means no such factor and 5 means the factor is always present.

The research was conducted among Polish local government organisations selected by the authors. The research allowed data to be collected from 200 organisations, i.e. 55 county offices and 145 town halls. Data was collected using the CAWI (Computer-Assisted Web Interview) method.

The research was carried out among competent local government officials, most of whom were employees of offices with seniority of more than 16 years and higher education.

4. Research findings

As a result of the empirical research, data were obtained to determine the actual situation regarding the assessment of the internal factors of the project management environment in city and county offices in Poland. Basic descriptive statistics were calculated for the factors studied: mean, median and standard deviation (Table 3).

Table 3.

Descriptive statistics on internal project management factors in municipal and district offices in Poland

Category	Factor	Average for individual factors	Median	Standard deviation	Average
Project team	Z1	4,40	4,00	0,62	4,13
	Z2	3,89	4,00	0,86	
	Z3	4,15	4,00	0,69	
	Z4	4,09	4,0	0,74	
Project management procedures, tools and techniques	P1	3,66	4,0	1,08	3,60
	P2	3,78	4,0	0,94	
	P3	3,53	4,0	1,07	
	P4	3,57	4,0	1,07	
	P5	3,70	4,0	1,11	
	P6	3,43	4,0	1,06	
Knowledge base	B1	3,87	4,0	0,94	3,80
	B2	4,05	4,0	0,87	
	B3	4,08	4,0	0,92	
	B4	4,32	4,0	0,73	
	B5	3,78	4,0	1,01	
	B6	2,73	3,0	1,23	
Culture and organisational structure	K1	4,04	4,0	0,79	3,71
	K2	3,84	4,0	0,95	
	K3	3,12	3,0	1,54	
	K4	3,83	4,0	0,97	

Source: own elaboration.

The lowest averages for individual internal factors of the project management environment in the surveyed organisations are in the category of project management procedures, tools and techniques. The average for this category is 3.60 and is the lowest among the surveyed categories. This means that in many organisations there are shortfalls in common terminology, tools and techniques, project management processes, as well as the application of rules for appointing people to a project and measuring the level of competence of these people. And yet these shortfalls will have an impact on the factors in the other categories. Thus, it can be assumed that the factors included in the category of project management procedures, tools and techniques are correlated with each other and are correlated with the factors in the other categories.

To examine the relationship between the internal factors of the project management environment, the rho-Spearman correlation testing method was used

The rho-Spearman correlation coefficient can take values in the range $\{-1,1\}$. A positive sign at the value of the coefficient indicates that an increase in the value of one variable defines an increase in the value of the other variable, while a negative sign at the value of the correlation coefficient means that an increase in the value of one variable defines a decrease in the value of the other variable. The strength of the correlation between variables is expressed by the absolute value of the correlation coefficient, with a value of 0 indicating no correlation and a value of 1 indicating perfect correlation, with an interval interpretation most adopted (Pulaska-Turyna, 2005):

- Correlation very weak for values between 0 and 0.2.
- Weak correlation for values between 0.2 and 0.4.
- Moderate correlation for values between 0.4 and 0.6.
- High correlation for values between 0.6 and 0.8.
- Correlation very high for values between 0.8 and 1.0.

In this study, a significance level of 0.05 was used. If the significance level p is less than 0.05, the relationship between the variables should be considered significant.

The study showed that there are high and moderate positive values of the correlation coefficient between the internal factors of the project management environment, which means that an increase in the value of one variable defines an increase in the value of the other variable. For all the correlations tested, the significance level p is less than 0.05, which allows us to consider that the relationship between the variables is statistically significant (Table 4).

The obtained correlation results occurring between the internal factors of the project management environment in the category of procedures, tools and techniques indicate high and positive values of the correlation coefficient. The highest value of the correlation coefficient in the studied category concerns the factor P4 which is strongly correlated with the factor P5, the correlation value is 0.86. This means that offices that have defined tools and techniques for project management also have processes in place for project initiation, planning, implementation, monitoring, control and closure. High positive values of the correlation coefficient also apply to P3 with factors: P4-0.78 and P5-0.75. Public organisations that have ensured the use of common project management terminology also have project management tools, techniques and processes in place. It is worth noting that a high positive correlation ascends between the internal project management environment factors from the project team category and the internal project management environment factors from the knowledge base category. High correlation values apply to factor Z2 with factors: B2-0.66; B3-0.63; B4-0.65 and B5-0.60. Thus, it can be said that the effectiveness of project stakeholder management is influenced by the awareness of the importance of knowledge in effective project management, as well as the documentation of project experiences and the collection, storage and use of knowledge and experience from completed projects.

High correlation values apply to factor Z3 and Z4 with factors B3, B4, B5, confirming that project managers and project team members sharing knowledge and experience contribute to the fact that knowledge and experience from completed projects was accumulated and used in subsequent projects.

Table 4.
Correlation results between internal project management environment factors

		Z1	Z2	Z3	Z4	P1	P2	P3	P4	P5	P6	B1	B2	B3	B4	B5	B6	K1	K2	K3	K4
Z1	R	NaN	0.50	0.49	0.47	0.45	0.39	0.39	0.40	0.38	0.40	0.35	0.47	0.39	0.50	0.37	0.23	0.47	0.43	NaN	0.40
	p	1	1	3,19E-13	2,27E-12	3,82E-11	8,02E-09	8,28E-09	3,68E-09	4,40E-08	3,96E-09	3,94E-07	1,40E-12	1,30E-08	6,12E-14	5,01E-08	0,00094	2,77E-12	2,54E-10	0,25732	5,63E-09
Z2	R	0.50	NaN	0.63	0.63	0.46	0.55	0.50	0.52	0.58	0.51	0.66	0.63	0.65	0.60	0.41	0.67	0.52	0.34	0.62	
	p	3,00E-14	1	1,49E-23	1,71E-23	1,30E-11	1,98E-17	3,16E-14	3,75E-15	1,54E-17	4,82E-19	2,30E-14	3,08E-26	6,28E-24	5,38E-25	8,55E-21	2,35E-09	4,27E-27	2,37E-15	6,54E-07	4,66E-23
Z3	R	0.49	0.63	NaN	0.85	0.35	0.47	0.46	0.45	0.47	0.45	0.39	0.56	0.62	0.68	0.61	0.28	0.47	0.51	0.33	0.58
	p	3,19E-13	1,49E-23	1	1,87E-57	3,69E-07	3,29E-12	5,24E-12	1,34E-11	1,23E-12	2,27E-11	1,60E-08	5,65E-18	1,34E-22	1,05E-28	5,42E-22	7,05E-05	1,59E-12	1,36E-14	1,57E-06	2,41E-19
Z4	R	0.47	0.63	0.85	NaN	0.36	0.49	0.41	0.45	0.43	0.46	0.42	0.58	0.59	0.65	0.63	0.27	0.48	0.55	0.32	0.58
	p	2,27E-12	1,71E-23	1,87E-57	1	1,28E-07	2,54E-13	2,17E-09	1,58E-11	1,67E-10	1,05E-11	7,31E-10	2,92E-19	5,82E-20	1,27E-25	9,48E-24	9,02E-05	9,94E-13	6,15E-17	4,05E-06	3,71E-19
P1	R	0.45	0.46	0.35	0.36	NaN	0.34	0.47	0.45	0.40	0.51	0.34	0.39	0.35	0.42	0.40	0.34	0.39	0.38	0.14	0.37
	p	3,82E-11	1,30E-11	3,69E-07	1,28E-07	1	9,75E-07	2,26E-12	1,85E-11	4,10E-09	7,41E-15	8,18E-07	7,33E-09	5,59E-07	6,76E-10	4,47E-09	1,15E-06	1,55E-08	3,59E-08	0,04552	4,84E-08
P2	R	0.39	0.55	0.47	0.49	0.34	NaN	0.45	0.54	0.50	0.50	0.40	0.65	0.52	0.47	0.47	0.41	0.56	0.66	0.39	0.69
	p	8,02E-09	1,98E-17	3,29E-12	2,54E-13	9,75E-07	1	2,09E-11	1,88E-16	3,68E-14	6,64E-14	4,03E-09	1,62E-25	5,26E-15	1,25E-12	3,27E-12	1,61E-09	1,13E-17	6,71E-26	7,86E-09	1,18E-29
P3	R	0.39	0.50	0.46	0.41	0.47	0.45	NaN	0.78	0.75	0.59	0.48	0.50	0.52	0.50	0.43	0.46	0.52	0.34	0.44	
	p	8,28E-09	3,16E-14	5,24E-12	2,17E-09	2,26E-12	2,09E-11	1	1,34E-42	1,14E-37	2,16E-20	6,57E-13	7,06E-14	1,95E-15	6,05E-14	2,65E-15	2,46E-10	6,74E-12	1,62E-15	9,73E-07	1,09E-10
P4	R	0.40	0.52	0.45	0.45	0.45	0.54	0.78	NaN	0.86	0.70	0.54	0.49	0.53	0.49	0.53	0.43	0.53	0.60	0.36	0.49
	p	3,68E-09	3,75E-15	1,34E-11	1,58E-11	1,85E-11	1,88E-16	1,34E-42	1	2,07E-58	7,42E-31	2,29E-16	1,10E-13	4,39E-16	2,18E-13	5,12E-16	1,68E-10	1,31E-15	6,81E-21	1,91E-07	2,12E-13
P5	R	0.38	0.55	0.47	0.43	0.40	0.50	0.75	0.86	NaN	0.66	0.53	0.46	0.56	0.52	0.50	0.41	0.48	0.57	0.39	0.45
	p	4,40E-08	1,54E-17	1,23E-12	1,67E-10	4,10E-09	3,68E-14	1,14E-37	2,07E-58	1	1,25E-26	4,03E-16	4,28E-12	9,10E-18	3,11E-15	6,70E-14	1,18E-09	4,40E-13	2,35E-18	1,14E-08	2,04E-11
P6	R	0.40	0.58	0.45	0.46	0.51	0.50	0.59	0.70	0.66	NaN	0.57	0.49	0.52	0.45	0.54	0.51	0.57	0.55	0.32	0.47
	p	3,96E-09	4,82E-19	2,27E-11	1,05E-11	7,41E-15	6,64E-14	2,16E-20	7,42E-31	1,25E-26	1	9,77E-19	9,80E-14	4,06E-15	1,66E-11	2,12E-16	2,17E-14	6,34E-19	4,63E-17	4,50E-06	3,52E-12
B1	R	0.35	0.51	0.39	0.42	0.34	0.40	0.48	0.54	0.53	0.57	NaN	0.48	0.58	0.57	0.53	0.37	0.51	0.44	0.20	0.48
	p	3,94E-07	2,30E-14	1,60E-08	7,31E-10	8,18E-07	4,03E-09	6,57E-13	2,29E-16	4,03E-16	9,77E-19	1	3,61E-13	2,03E-19	1,22E-18	5,02E-16	1,04E-07	6,61E-15	5,20E-11	0,00493	5,66E-13
B2	R	0.47	0.66	0.56	0.58	0.39	0.65	0.50	0.49	0.46	0.49	0.48	NaN	0.66	0.56	0.61	0.43	0.61	0.56	0.23	0.70
	p	1,40E-12	3,08E-26	5,65E-18	2,92E-19	7,33E-09	1,62E-25	7,06E-14	1,10E-13	4,28E-12	9,80E-14	3,61E-13	1	2,94E-26	7,09E-18	3,79E-22	2,53E-10	1,38E-21	1,35E-17	0,00101	4,10E-31
B3	R	0.39	0.63	0.62	0.59	0.35	0.52	0.52	0.53	0.56	0.52	0.58	0.66	NaN	0.71	0.66	0.35	0.50	0.52	0.26	0.59
	p	1,30E-08	6,28E-24	1,34E-22	5,82E-20	5,59E-07	5,26E-15	1,95E-15	4,39E-16	9,10E-18	4,06E-15	2,03E-19	2,94E-26	1	3,44E-32	3,42E-26	3,93E-07	3,38E-14	2,50E-15	0,00017	3,06E-20
B4	R	0.50	0.65	0.68	0.65	0.42	0.47	0.50	0.49	0.52	0.45	0.57	0.56	0.71	NaN	0.59	0.21	0.57	0.56	0.29	0.52
	p	6,12E-14	5,38E-25	1,05E-28	1,27E-25	6,76E-10	1,25E-12	6,05E-14	2,18E-13	3,11E-15	1,66E-11	1,22E-18	7,09E-18	3,44E-32	1	2,02E-20	0,00298	8,02E-19	2,94E-18	3,91E-05	2,35E-15
K1	R	0.37	0.60	0.61	0.63	0.40	0.47	0.52	0.53	0.50	0.54	0.53	0.61	0.66	0.59	NaN	0.48	0.55	0.56	0.31	0.60
	p	5,01E-08	8,55E-21	5,42E-22	9,48E-24	4,47E-09	3,27E-12	2,65E-15	5,12E-16	6,70E-14	2,12E-16	5,02E-16	3,79E-22	3,42E-26	2,02E-20	1	1,04E-12	3,70E-17	8,93E-18	7,82E-06	2,79E-21
K2	R	0.23	0.41	0.28	0.27	0.34	0.41	0.43	0.43	0.41	0.51	0.37	0.43	0.35	0.21	0.48	NaN	0.36	0.38	0.29	0.48
	p	0,000944424	2,35E-09	7,05E-05	9,02E-05	1,15E-06	1,61E-09	2,46E-10	1,68E-10	1,18E-09	2,17E-14	1,04E-07	2,53E-10	3,93E-07	0,00298	1,04E-12	1	1,50E-07	2,57E-08	3,20E-05	5,30E-13
K3	R	0.47	0.67	0.47	0.48	0.39	0.56	0.46	0.53	0.48	0.57	0.51	0.61	0.50	0.57	0.55	0.36	NaN	0.67	0.33	0.60
	p	2,77E-12	4,27E-27	1,59E-12	9,94E-13	1,55E-08	1,13E-17	6,74E-12	1,31E-15	4,40E-13	6,34E-19	6,61E-15	1,38E-21	3,38E-14	8,02E-19	3,70E-17	1,50E-07	1	6,73E-28	1,55E-06	1,30E-20
K4	R	0.43	0.52	0.51	0.55	0.38	0.66	0.52	0.60	0.57	0.55	0.44	0.56	0.52	0.56	0.56	0.38	0.67	NaN	0.51	0.59
	p	5,63E-09	4,66E-23	2,41E-19	3,71E-19	4,84E-08	1,18E-29	1,09E-10	2,12E-13	2,04E-11	3,52E-12	5,66E-13	4,10E-31	3,06E-20	2,35E-15	2,79E-21	5,30E-13	1,30E-20	8,76E-20	4,97E-08	1

Source: own elaboration.

Internal project environment factors in the category of procedures, tools and techniques correlate with organisational culture and structure. The highest correlation values relate to factor P2 with factors K2-0.66 and K4-0.69. On this basis, it can be concluded that organisations that use project management as a route to achieving strategic goals are aware of the importance and value of project management and therefore adapt the organisational structure to support project management.

5. Summary

The article assesses the internal project management environment in municipal and district offices in Poland. Based on literature research, four categories of internal project management environment factors were specified, i.e. 1) project team, 2) project management procedures, tools and techniques, 3) knowledge base, 4) organisational culture and structure.

In order to find answers to the research, questions posed in the article, which were aimed at analysing the internal factors of the project management environment, a questionnaire survey was conducted among 200 randomly selected city and county offices in Poland.

The results obtained suggest that city and county offices in Poland manage the project environment. The highest average scores were given to internal project management environment factors in the project team category, and the lowest average scores were given to factors in the project management procedures, tools and techniques category.

The research conducted showed (answering the second research question) that there are correlations between the internal factors of the project management environment. When examining each internal environment factor with the others, it can be seen that positive, moderate and high correlation coefficient values are most often observed, which means that an increase in the value of one variable defines an increase in the value of the other variable. In addition, there are high positive correlations between the internal project management environment factors from the project team category and the internal project management environment factors from the knowledge base category, and between the internal project management environment factors from the procedures, tools and techniques category and the internal project management environment factors from the organisational culture and structure category.

In the organisations surveyed, project management is used as an avenue to achieve strategic goals and thus there is an awareness of the importance of knowledge in effective project management. In these organisations, project managers effectively manage project stakeholders by adapting project management processes to the needs of individual projects and appreciate the importance of knowledge in effective project management, where knowledge and experience from completed projects is accumulated used in subsequent projects.

The results of the research show that the analysed local government organisations, while having defined tools and techniques for project management, also have an organisational structure tailored to support project management and use project management as a route to achieving strategic goals.

The results of the research show that organisations should strive to develop individual internal project environment management factors, as this will allow the development of other project environment management factors. As Randall Englund and Robert J. Graham write, senior managers play the biggest role in this area. They are the ones who ultimately create the environment that supports projects. The way senior managers define, structure and act in relation to projects has a significant impact on the success or failure of those projects, and consequently on the success or failure of the organisation (Englund, Graham, 2019).

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LOGISTICS INFRASTRUCTURE MANAGEMENT OF MASS ART AND ENTERTAINMENT EVENTS

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Purpose: This article aims to present the management processes of various logistics infrastructure areas crucial for organizing mass events. It seeks to develop "good practices" for effectively managing the logistical infrastructure of large-scale gatherings.

Design/methodology/approach: The research method used to gather data on the infrastructural aspects of organizing mass events involved an analysis of literature, supported by field observations. The research material also includes internal documents and data collected through open, semi-structured direct interviews with organizers of mass events.

Findings: Managing the modern logistics infrastructure of mass events is a comprehensive process that necessitates meticulous planning, coordination, and control of activities related to transport, storage, distribution, and technical services. This ensures the effective achievement of the event's organizational objectives.

Practical implications: In the management of logistics infrastructure for mass artistic and entertainment events, several good practices have been identified. Effective logistics management for large artistic and entertainment events relies on system integration, flexibility, clear communication with participants, and ongoing activity monitoring. Key trends include leveraging modern technologies in planning and prioritizing sustainability to reduce environmental impact.

Originality/value: This article highlights the importance of managing logistics infrastructure for mass artistic and entertainment events, focusing on maintaining public order, ensuring participant safety, and adapting to changing conditions.

Keywords: mass event, mass gathering, infrastructure, logistic infrastructure, management.

Category of the paper: research paper.

1. Introduction

The logistics infrastructure of mass art and entertainment events forms the backbone of their successful execution, enabling the seamless integration of diverse elements such as crowd accommodation, technical systems, and security measures. These events, characterized by their socio-technical complexity and high public visibility, demand an infrastructure capable of

ensuring participant safety, satisfaction, and environmental sustainability. The critical role of logistics infrastructure lies in its ability to adapt to dynamic conditions, coordinate diverse functions, and support the core objectives of these events (Szymonik, 2011).

The importance of logistics infrastructure is emphasized by the growing scale and complexity associated with contemporary large-scale events. As Getz and Page (2007) argue, infrastructure is a fundamental component of event planning frameworks, while Wincenty-Bosy (2014) highlights its importance in addressing participant needs and ensuring public safety. Environmental considerations further elevate the importance of robust infrastructure, with studies by Cerezo-Esteve et al. (2022), Müller (2015), and Mancini (2023) emphasizing sustainability in large-scale event logistics. Effective infrastructure management, particularly for crowd control and safety, has been explored by Feliciani et al. (2022) and Kanaujiya and Tiwari (2022), who underscore its role in minimizing risks. Johansson et al. (2012) add that public health during mass gatherings is heavily dependent on the quality and resilience of logistical systems. Additionally, Richards and Palmer (2010) explore how event logistics play a strategic role in urban revitalization and cultural management, emphasizing the alignment of logistics with broader societal goals.

Despite these insights, the specific challenges of managing logistics infrastructure for mass art and entertainment events remain underexplored. Such events often involve unique infrastructural requirements, including specialized staging, sound, and lighting systems, alongside innovative security and crowd management solutions.

This article seeks to bridge this gap by exploring the interdisciplinary processes essential for managing logistics infrastructure in mass art and entertainment events. It highlights the importance of aligning infrastructural systems with participant satisfaction, operational efficiency, and compliance, offering insights into optimizing event logistics in a rapidly evolving landscape.

2. Characteristics of mass art and entertainment events

Mass events are a fundamental aspect of human life, significantly contributing to the development and preservation of cultural foundations. They are unique endeavors, enabling the building of social ties, which being part of the cultural heritage, reflect the distinctiveness of a community.

The analysis of historical sources proves that the first recorded ceremonies and celebrations took place more than 60.000 years ago (Berridge, 2020), with the development of civilization, their nature has successively evolved, leading to the development of a modern classification of mass events, taking into account two main criteria: the purpose of their organisation, listing eleven "functions", such as key events connected to the cause, to the audience and to the

participants; and the form, suggesting the existence of twenty-three different forms, including festivals, parades, religious, visual and sports events (Getz, Page, 2007).

According to Getz and Page (2007), a mass artistic and entertainment event is a large-scale, organized gathering designed to showcase artistic, cultural, or entertainment performances and experiences to a broad audience. These events are characterized by their significant scale, involving extensive logistical planning, infrastructure, and coordination to ensure the seamless delivery of unique and memorable experiences. They often serve multiple purposes, including cultural enrichment, community engagement, economic stimulation, and the promotion of artistic expression, while catering to diverse audiences in a shared social setting.

Due to the fact that the entertainment industry is subject to constant modification, adapting to changing market conditions, table 1 distinguishes a number of features of contemporary art and entertainment events.

Table 1.
Features of modern mass art and entertainment events

Item	Characteristics
Diversity of art forms	The bounty of art forms presented at mass events includes music, theater, performance, dance, as well as visual and circus arts. The amount of artistic fields creates unique experiences, contributing to the broadening of society's cultural horizons.
Social integration and educational impact	Mass art and entertainment events act as social catalysts, integrating local communities and attracting participants from diverse backgrounds. These events also seem to impact intellectual development, encouraging participants to reflect on and discuss art, culture or important social issues, fostering integration through the exchange of ideas.
Economic impact	Mass events generate significant economic revenues. In addition to revenue from the sale of tickets, gadgets and other accompanying services, the organisation of such events contributes to the development of local businesses, catering, hospitality and tourism infrastructure, all the while increasing the number of jobs in the market.
Use of technology	Modern mass events use advanced special effects and stage technologies, such as 3D mapping, laser shows, holograms, and drones to create spectacles not only at the stage level, but also over the heads of the audience, representing an innovative approach to shaping the space and atmosphere of the event. The use of VR allows participants to be transported into entirely new virtual worlds, opening up the possibility of interacting with artistic installations or performances in ways that would not be possible in traditional settings. Specially designed mobile apps offer personalized experiences, allowing access to event schedules, a site map or interactive game elements. The use of IoT allows for the creation of smart event spaces, including smart entry gates, exhibit elements or participant tracking, contributing to more efficient event management.
Digital experience sharing	Contemporary mass art and entertainment events, show a close relationship with the emerging digital community. Social media platforms, such as Instagram, Facebook, and Twitter, enable near instantaneous sharing of experiences and visuals, creating a dynamic flow of content, extending the impact of an event beyond its physical boundaries. The development of live streaming allows people outside the event area to remotely participate in the event, resulting in its global accessibility. Through hashtags and dedicated groups on social media platforms, attendees form virtual communities, enabling the exchange of opinions, discussions and the establishment of relationships, while providing a source of feedback for organisers. The digital community is thus not just a documenting, but also an actively shaping force, enriching the experience of mass arts and entertainment events and contributing to their global visibility and relevance.

Cont. table 1.

Emphasis on sustainability and CSR	More and more arts and entertainment events are emphasizing environmental goals, implementing practices such as recycling, reducing plastic consumption and using renewable energy sources, leading to minimizing the event's environmental footprint. The organisers undertake charitable activities, promoting sustainability and engaging in local initiatives. To support the local culture and economy, arts and entertainment events engage regional artists, artisans and suppliers. This contributes to the growth of the local creative and economic sector.
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Source: own elaboration.

The organisation of this type of event entails the need to ensure the comfort and safety of its participants, granted by the availability of infrastructure for supplies, services fulfilling basic needs, maintenance and repair, order and security services, as well as communication, focusing, among other things, on the proper organisation of pedestrian and vehicular traffic and the appropriate deployment of the distribution points network.

3. Logistics infrastructure for mass events

3.1. Universal mass event infrastructure

Logistics infrastructure serves as the essential physical and operational framework for events. Getz and Page (2007) define event infrastructure as encompassing all physical and operational systems necessary to support an event, including venues, transportation networks, utilities, and support services, emphasizing that infrastructure is not merely a logistical convenience but a determinant of an event's feasibility, scale, and impact on its surroundings. Therefore, the logistics infrastructure of mass events is a collection of all kinds of technical means (mobile and stationary) necessary for the proper implementation of tasks related to the planning and supervision of the proper course of such events, with particular emphasis on the security requirements (Kulinska, Rut, Pytel, 2014).

A prominent feature of the logistics infrastructure is its diversity due to the distinctiveness of each event. However, it has been demonstrated that there is a number of relatively constant components, subject only to minor modifications depending on the nature of the event. M. Wincenty-Bosy (2014) distinguished the following components of the logistics infrastructure of mass events:

- stage or show arena (including seats for the audience),
- commercial and gastronomic zone,
- technical and sanitary facilities (utility and social rooms, warehouses, dressing rooms; information and technical support systems, etc.),
- parking lots,
- communications infrastructure,
- communication and evacuation routes,
- organising office.

The primary venue for hosting a mass event is the stage or performance arena, a key component of the service infrastructure that substantially influences the overall audience experience. Kronenburg (2013), providing comfort and safety not only for the audience, but also for those creating the event, such as presenters, singers and actors. The proper location of the stage meeting technical standards provides the audience with the possibility of uninterrupted observation of the events taking place on it, while preventing the intrusion of undesirable persons.

In the opinion of participants, the success of a given event is often significantly influenced by the organisation of the catering area, ensuring the safe preparation and supply of food and water (WHO, 2015), as well as the shopping and entertainment area (Silvers, 2012), which both complement the offer of the mass event. Among the stands located there, potential children's gatherings and alcohol outlets are the most noteworthy. Setting their locations should take into account the requirement for separation of these areas, which is subject to the highest control by the organiser.

Technical and sanitary facilities enable the proper operation and service of the mass event area and its participants, through the provision of social and sanitary and hygienic spaces and equipment. It is also often associated with the need to provide access to maintenance and repair infrastructure, including properly equipped warehouses and the designation of an area to be developed by the machinery park, which is a collection of machinery and equipment that allows the proper progression and security of the event. Sanitary facilities, in turn, guarantee the availability of a number of public toilets, according to the expected attendance, and the ability to dispose of liquid and solid waste generated at the place and time of the mass event (Johansson et al., 2012).

Another element of the logistics infrastructure is the parking lot. There is a requirement for the organiser to designate parking areas when they are not included in the facility plans or to indicate the closest location to them, allowing the audience arriving in vehicles to participate in a given event. Their accurate location is crucial for the proper technical maintenance of events and is an important factor in the perception of a given event by the audience.

Mass events often cause changes in the volume of traffic in the area surrounding the mass event, therefore, its proper adjustment and communication with the city infrastructure, taking into account the location of bus stops and the frequency of public transport is one of the most important infrastructural requirements for the organisation of mass events.

A separate element of the infrastructure are properly marked routes that allow conflict-free and collision-free movement of the people and technical equipment and devices, as well as all kinds of communication and evacuation routes, the course of which is determined bearing in mind the location of medical and information points, thus ensuring adequate safety conditions for all participants of a given event (Struniawski, 2024).

An extremely important role is also played by the organising office, which performs an informational function in relation to a number of stakeholders of the mass event, using a specific communication technique that makes it possible to ensure the fluidity and reliability of the information flow (Nelson, 2008). It is the place for coordinating all the activities carried out at a given event, including the audiovisual recording of its progression. It cooperates with the security coordinator and units and institutions shaping the security system of the mass event, forming part of the infrastructure of law enforcement and security services.

The above elements are an integral part of the logistics infrastructure of mass events, occurring both in the case of artistic and entertainment events, such as music or film festivals, as well as sports events, including football matches. Its other components display a diverse nature determined by the distinctive features of a particular show.

3.2. Logistical infrastructure of an arts and entertainment event based on the example of a concert

Among mass events requiring specific infrastructure, concerts ought to be mentioned, defined as artistic events following a specific musical program which stand in need of the use of appropriate technical equipment (MNE). The parameters of the apparatuses used depend on the individual requirements of the artists, which are stated in the so-called riders, including both technical elements and guidelines related to the equipment of dressing rooms and accompanying elements.

The first part of the document in question contains a detailed description of the artist's requirements relating directly to the dimensions and positioning of the stage; the preferred sound system, including loudspeakers and amplifiers; and lighting, taking into account the specification of the necessary lighting apparatuses and their placement. In addition to the guidelines for the technological solutions used, the technical rider provides information on the so-called backline, which is a graphical presentation of all kinds of musical instruments and equipment, along with a detailed definition of their positions in a way that allows the stage space to be properly arranged. In addition, the document presents a series of guidelines describing the specifications of the monitor system, both individual (in-ear) and stage monitors, used during the concert; and allows the specification of additional preferences relating directly to the equipment, the provision of which is the responsibility of the organiser (Szary, 2014).

While the technical components of the rider revolve around the proper preparation of the venue for the physical realization of the concert, ensuring the proper progression of the show, the dressing room guidelines allow for the proper development of the part of the event facility intended exclusively for artists and staff, taking into account a number of preferences regarding the characteristics and room equipment dedicated to members of the team. In addition, the content of the document often obliges the organiser to provide artists with accommodation of a certain standard and in a preferred location.

The logistical infrastructure of mass events and the technical parameters specified in the riders complement each other, effectively running a given event and shaping the level of satisfaction of its spectators. Organisational practice shows that over time systems are created to support the organisation of mass events, introducing modern solutions not only at the infrastructural level, but relating to the entire process of planning and conducting a specific event.

4. Management of logistics infrastructure of mass art and entertainment events

4.1. Literature review

The management of logistics infrastructure for mass art and entertainment events is an intricate and multifaceted process that forms the backbone of successful event execution. These events, characterized by their large-scale participation and dynamic nature, require seamless integration of planning, coordination, and real-time adaptability. Logistics infrastructure encompasses the physical and operational systems necessary to support all activities related to transportation, storage, distribution, technical maintenance, crowd flow, and safety. The ultimate goal is to ensure the event runs smoothly while prioritizing participant satisfaction, safety, and sustainability. Drawing upon the collective insights of scholars such as Müller (2015), Getz and Page (2007), Cerezo-Estevé et al. (2022), and others, this synthesis explores the critical components and challenges in the management of logistics infrastructure for such events.

A critical initial step in managing logistics infrastructure is the comprehensive analysis of logistical requirements, which forms the foundation for effective planning and execution. This involves identifying the specific requirements of the event, including transportation systems, participant movement patterns, and high-density areas. Accurate assessment is essential to address variables such as crowd flow, the number of attendees, and the physical characteristics of the venue (Müller, 2015; Gong et al., 2020). This includes understanding the dynamics of participant behavior, using tools such as crowd modeling and social data analytics to predict movement patterns and areas prone to congestion (Gong et al., 2020). These insights enable organizers to design efficient layouts that mitigate risks and optimize resource allocation.

Getz and Page (2007) emphasize the long-term implications of infrastructure investments for recurring events, advocating for the integration of infrastructure planning into urban development strategies to ensure that facilities such as roads, parking, and utilities serve both the event and the local community. This perspective underscores the dual purpose of permanent infrastructure, which facilitates event operations while providing lasting benefits to host cities.

In contrast, Kanaujiya and Tiwari (2022), in their study of the Kumbh Mela, focus on the deployment of temporary infrastructure, such as tent cities and short-term bridges, to accommodate millions of participants in a time-bound setting. While temporary infrastructure allows for flexibility and scalability to meet specific event demands, it lacks the permanence and broader community utility emphasized by Getz and Page. These differing approaches reveal the varied infrastructural needs of mass events, highlighting the importance of tailoring solutions to event-specific contexts. Whether permanent or temporary, both models underline the necessity of meticulous planning, coordination, and adaptability to ensure safety and operational efficiency.

The infrastructure supporting mass events must cater to several layers of participant needs, from functional and logistical to experiential and emotional. Space planning plays a pivotal role in ensuring the smooth operation of these events. Strategic zoning is necessary to identify and designate areas for entrances, exits, recreational zones, food service areas, main performance stages, and medical facilities (NAS Nik Him et al., 2018). Effective spatial design ensures that participants can move seamlessly between different areas while minimizing bottlenecks (Struniawski, 2024). Clearly marked routes, efficient signage, and designated pathways for both pedestrians and vehicles are crucial components of this process (Johansson et al., 2012). In large-scale gatherings, spatial layouts also serve aesthetic and experiential purposes, particularly in artistic and entertainment events where ambiance contributes significantly to participant satisfaction (Getz, Page, 2007). These elements, combined with well-organized seating arrangements, viewing zones, and accessibility features, enhance the overall experience and ensure that the infrastructure meets the diverse needs of attendees.

Transportation infrastructure is another cornerstone of logistics management. Events of significant scale require detailed planning of transportation routes, parking facilities, public transit systems, and pedestrian pathways to ensure efficient and safe access to the venue. Transportation planning also extends to the movement of technical equipment, supplies, and staff to and from the event site. Effective coordination between event organizers, municipal authorities, and transport providers is essential to avoid congestion and ensure the timely arrival of resources (Kanaujiya, Tiwari, 2022). Large events often necessitate temporary adjustments to existing transport systems, such as rerouting public transit, providing shuttle services, and creating dedicated access routes for vehicles. Additionally, the increasing focus on sustainability in logistics planning calls for eco-friendly transportation solutions, such as low-emission vehicles, bicycle parking stations, and walkable access points to reduce the environmental footprint of events (Cerezo-Esteve et al., 2022; Ballarano et al., 2022).

Safety and emergency management are integral to the logistics infrastructure of mass events. The scale and density of participants in these events create potential risks, necessitating robust safety protocols and real-time monitoring systems. Evacuation planning is a fundamental aspect of safety management, requiring detailed maps of exit routes, assembly points, and crowd control mechanisms (Marsella, Sciarretta, 2018). Emergency services, including

medical teams, fire departments, and law enforcement, must be strategically deployed to address incidents swiftly and effectively. Surveillance systems, such as CCTV and drone monitoring, are increasingly used to observe crowd behavior and identify risks in real time (Silvers, 2012). The integration of predictive tools, such as scenario modeling and risk assessment software, enhances the ability of organizers to anticipate and mitigate emergencies. For instance, these tools can simulate crowd movements and predict areas of potential congestion, enabling preemptive action to prevent accidents (Patel et al., 2016).

The logistical demands of real-time operations during mass events are equally critical. Dynamic distribution of materials, such as food, merchandise, and supplies, requires sophisticated inventory management systems to ensure availability at all points of need. Distribution hubs must be strategically located within the event site to minimize delays and disruptions (Silvers, O'Toole, 2020). This is particularly important for catering and retail operations, where participant satisfaction depends on quick and efficient service. Additionally, real-time logistical adjustments may be required to address unforeseen challenges, such as supply shortages or equipment malfunctions. Advanced technologies, including real-time tracking systems and mobile communication networks, facilitate efficient management of resources and coordination among teams (Gong et al., 2020).

Environmental sustainability is an emerging priority in the logistics management of mass art and entertainment events. These events often generate significant waste, consume large amounts of energy, and place substantial demands on local infrastructure. Sustainable practices, such as renewable energy integration, waste management systems, and eco-friendly materials, are increasingly being adopted to minimize environmental impact (Cerezo-Esteve et al., 2022; Mancini, 2023). Organizers are also encouraged to promote sustainable behaviors among participants, such as using public transit, recycling, and reducing single-use plastics. Sustainable logistics not only align with global environmental goals but also enhance the reputation of events and attract environmentally conscious audiences (Getz, Page, 2007).

The role of technology in logistics infrastructure management cannot be overstated. Emerging technologies, such as artificial intelligence (AI), the Internet of Things (IoT), and big data analytics, are transforming the way logistics are planned and executed (Gong et al., 2020). AI-powered tools enable organizers to analyze large datasets, optimize resource allocation, and predict potential disruptions. IoT devices, such as sensors and wearable technology, provide real-time data on crowd density, environmental conditions, and equipment status. Social media analytics offer insights into participant sentiment and behavior, enabling organizers to make informed decisions during the event (Silvers, 2012). These technological advancements are reshaping the landscape of logistics infrastructure management, making it more efficient, adaptable, and responsive to the needs of modern events.

The coordination and collaboration among stakeholders represent another essential aspect of logistics infrastructure management. Successful events require seamless coordination between organizers, venue operators, local authorities, transportation agencies, and emergency

services. Stakeholder mapping and integrated planning committees facilitate communication and alignment of objectives among all parties involved (Getz, Page, 2007). This collaborative approach ensures that logistical systems are robust and capable of addressing the diverse challenges posed by mass events. It also fosters a sense of shared responsibility, enhancing the overall efficiency and resilience of the event infrastructure.

In conclusion, the management of logistics infrastructure for mass art and entertainment events is a complex but indispensable aspect of event planning. It integrates multiple components, including pre-event analysis, space planning, transportation, safety, real-time operations, and sustainability. The collective insights from scientific studies underline the importance of holistic planning, technological innovation, and stakeholder collaboration in achieving successful outcomes. As mass events continue to grow in scale and complexity, the adoption of advanced practices and sustainable solutions will become increasingly critical. By addressing these challenges proactively, event organizers can create infrastructure systems that are not only efficient and safe but also aligned with the evolving expectations of participants and the broader goals of sustainability and social responsibility.

4.2. Own research

The management of logistics infrastructure for mass events is a comprehensive process, involving the planning, coordination and control of all activities related to transportation, storage, distribution and technical maintenance, determining of the success of the show. It is a multi-stage, complex process, requiring the coordination of a number of activities at each stage of organising a given event, from the development of the initial plan to the ultimate completion of the event.

The first step, carried out as part of the management of logistics infrastructure for mass events, is therefore a thorough analysis of the event's logistical needs (Müller, 2015), which includes, among other things, planning the direction of participants' movement, taking into account safety issues and the possible population flow, includes the identification of the main entry and exit points, movement routes of participants, and areas characterized by the highest population density during the event (Gong et al., 2020). The analysis also takes into account the needs for transportation of necessary materials, technical equipment, or catering supplies. This requires identifying available transportation means, transportation routes, and delivery schedules. Transported materials sometimes undergo warehousing processes, forcing the need for adequate storage space, storage conditions, and ways to organise and manage inventory. A key aspect then is to ensure the safety and security of supplies, with the goal of protecting them from theft, pests, weather conditions and fire hazards (Getz, Page, 2007). In addition, an analysis of the logistical needs of mass events is followed by recognizing a number of requirements for catering and sanitary facilities and technical services, including sound systems, lighting, monitoring systems and audiovisual equipment, while taking into account the needs of technical personnel and the availability of necessary external services.

The aforementioned activities show a direct connection to the next stage of logistics infrastructure management for mass events, centered around space planning (NAS Nik Him et. al., 2018), in a way that allows for the smooth flow of people and goods, involving the identification of key areas such as the entrance and exit area, recreational and food service areas, the main stage, and sanitary and medical facilities. The challenge for organisers is constantly to arrange the aforementioned areas in such a way as to ensure the smooth flow of participants between the various zones of a mass event (Getz, Page, 2007). These movements take place on the basis of specific routes, suitable for both pedestrian and vehicular traffic. The provision of clearly marked routes and appropriate road signs is key to guaranteeing the safety of event participants. This safety is also granted by the presence of evacuation zones, access to fire extinguishers and first aid kits, as well as emergency service patrols, whose posts are deployed based on estimated movements and areas with the highest population density. As part of space planning, it is also necessary to properly deploy technical infrastructure, such as sound systems, lighting, and monitoring systems.

The management of logistics infrastructure for mass events also takes into account a number of measures to guarantee the area's transportation accessibility by analyzing the facilities prepared for participants, such as public transportation, parking lots (including parking spaces designated for the disabled), bicycle stations, or dedicated transportation lines to get to the event site. Transportation planning also includes designing transportation routes, based on the event's location, road accessibility and expected peak traffic hours, to ensure the smooth flow of vehicles and minimize traffic congestion (Kanaujiya, Tiwari, 2022), as well as coordinating the delivery of materials and technical equipment well in advance, allowing the facility to be prepared for a mass event.

The activities carried out as part of the management of the logistics infrastructure of mass events also include a set of activities aimed at the distribution of materials, taking place, often in real time, in a number of distribution points (used for catering, sales, or information) located in strategic parts of the facility (Silvers, O'Toole, 2020; Silvers, 2012). The efficiency of resource allocation during a mass event depends on effective inventory management, which limits stock fluctuations at specific points of the distribution network. This involves planning supplies based on estimated demand, which in turn is based on population density in different parts of the facility.

Infrastructural issues are also addressed when preparing an evacuation plan, identifying potential risks related to the logistics of the mass event (including technical failures and transportation inconveniences), enabling the establishment of evacuation routes, assembly points, and procedures related to crowd control (Marsella, Sciarretta, 2018). Indeed, the protection of life, health, and property of the participants, employees, and all persons associated with a mass event, implemented through, among other things, monitoring and responding to potential threats, plays a fundamental role during mass events. These activities require the cooperation of many teams, involving the logistics team, emergency services, police,

medical personnel, technical service providers and other entities responsible for the safety and comfort of event participants. This cooperation enables the coordination of a range of activities in real time, while maintaining a high degree of flexibility manifested in a readiness to adapt to changing environmental conditions.

The management of the logistics infrastructure for mass events is a key element in the organisation and conduct of such events, requiring a precise analysis of logistical needs, space planning, coordination of activities of various teams, and continuous monitoring and response to changing conditions. With the proper management of the logistics infrastructure of mass events, it is possible to ensure the safety, comfort and satisfaction of participants and the effective achievement of the organisational goals of the event.

5. Discussion

The management of logistics infrastructure for mass art and entertainment events is an intricate process, drawing on both theoretical insights and practical applications. A detailed comparison of the literature review and original research reveals areas of convergence in foundational practices but also significant differences in the depth and breadth of their focus. These differences highlight gaps, emerging priorities, and the diversity of approaches to logistics infrastructure management across contexts.

Both the literature and the original research emphasize the importance of pre-event planning as the cornerstone of effective logistics management. The original research highlights logistical needs assessment, focusing on participant movement, transportation of materials, and the identification of high-density areas as critical components. Similarly, Müller (2015) and Gong et al. (2020) stress the significance of mapping crowd flow patterns and anticipating potential bottlenecks. However, while the original research concentrates on immediate logistical needs, the literature extends this perspective by incorporating predictive tools and data analytics to simulate crowd behavior and plan for dynamic conditions (Gong et al., 2020). This distinction underscores a methodological difference: the original research provides practical, on-ground strategies, whereas the literature emphasizes the integration of advanced technologies for forecasting and adaptability.

A striking difference emerges in the discussion of infrastructure longevity. The original research predominantly addresses short-term logistical requirements, such as temporary routes, storage, and warehousing, to meet the immediate needs of a single event. In contrast, Getz and Page (2007) advocate for a long-term view, emphasizing the integration of infrastructure planning into urban development strategies. Permanent infrastructure, they argue, serves not only the event but also the local community, creating lasting benefits. This long-term perspective is notably absent in the original research, which focuses on event-specific solutions.

Conversely, the study by Kanaujiya and Tiwari (2022) on the Kumbh Mela complements the original research by showcasing the scalability and adaptability of temporary infrastructure, such as tent cities and short-term bridges, to accommodate large crowds. This divergence between permanent and temporary infrastructure highlights the varied demands of different event contexts, where flexibility and permanence offer distinct advantages.

Space planning is a shared focus in both the literature and the original research, but their approaches diverge significantly. The original research emphasizes practical spatial zoning, such as identifying areas for entrances, exits, and essential services, and ensuring smooth participant flow. This aligns with the work of NAS Nik Him et al. (2018), who stress the importance of minimizing congestion through clear zoning and designated pathways. However, the literature, particularly Getz and Page (2007), extends the discussion to include the aesthetic and experiential dimensions of space planning, especially for artistic events where ambiance plays a pivotal role in participant satisfaction. While the original research provides a functional blueprint for space design, the literature's broader perspective suggests that logistics infrastructure can contribute not only to operational efficiency but also to the overall participant experience, a dimension underexplored in the original findings.

Transportation planning is another area of significant difference. Both the literature and the original research agree on the importance of efficient transportation routes, public transit integration, and parking facilities. However, while the original research focuses on coordinating deliveries and managing traffic flow, the literature adds a layer of sustainability. Cerezo-Esteve et al. (2022) and Ballarano et al. (2022) emphasize the adoption of eco-friendly transportation solutions, such as low-emission vehicles and bicycle parking stations, to reduce the environmental footprint of events. This sustainability perspective is largely absent in the original research, which prioritizes operational efficiency over environmental considerations. The literature's focus on sustainability reflects a growing global priority that event organizers must increasingly address to align with broader environmental goals and participant expectations.

Safety and emergency management are critical areas where the literature and original research converge but with varying degrees of depth. The original research emphasizes evacuation planning, deployment of emergency services, and the use of monitoring systems to manage risks during events. These findings align with the work of Marsella and Sciarretta (2018) and Patel et al. (2016), who highlight the importance of risk assessment and scenario modeling. However, the literature further explores advanced safety technologies, such as predictive analytics, drone surveillance, and wearable devices, which are absent from the original research. These tools provide real-time data and improve emergency preparedness, offering a proactive approach to safety management that is underrepresented in the practical strategies of the original findings.

The role of technology in logistics infrastructure management illustrates a significant divergence. While the original research acknowledges the use of monitoring systems, it does not delve into the transformative potential of emerging technologies. In contrast, the literature emphasizes the integration of artificial intelligence (AI), the Internet of Things (IoT), and big data analytics in optimizing logistics processes. Gong et al. (2020) demonstrate how social media analytics can provide real-time insights into crowd behavior, enabling dynamic adjustments to logistical plans. Silvers (2012) also highlights the potential of IoT devices for tracking resources and monitoring environmental conditions. This technological dimension, which significantly enhances adaptability and efficiency, remains a largely untapped area in the original research, pointing to an opportunity for further development.

Environmental sustainability is another domain where the literature offers insights that are less prominent in the original research. While the original findings focus on logistical efficiency, the literature places increasing emphasis on sustainable practices, such as renewable energy integration, waste reduction, and participant engagement in eco-friendly behaviors (Cerezo-Esteve et al., 2022). Getz and Page (2007) advocate for a “triple bottom line” approach, balancing economic, social, and environmental considerations in logistics management. The absence of sustainability as a core component in the original research reflects a gap that must be addressed to align with contemporary expectations and environmental imperatives.

Collaboration among stakeholders is a shared priority but is treated differently in the literature and original research. The original findings highlight the need for coordination among logistics teams, emergency services, and technical personnel, emphasizing real-time cooperation to address challenges. However, the literature provides a more structured approach to stakeholder collaboration, advocating for integrated planning committees, stakeholder mapping, and transparent communication frameworks (Getz, Page, 2007). This broader perspective ensures that diverse priorities are harmonized, contributing to the resilience and efficiency of logistical systems. The original research, while practical, lacks this strategic emphasis on stakeholder alignment.

In conclusion, the management of logistics infrastructure for mass art and entertainment events is a complex and evolving field. The literature and original research share a foundation of core practices, such as thorough planning, space design, transportation management, and safety measures. However, significant differences emerge in their emphasis on sustainability, technology, long-term infrastructure planning, and experiential dimensions. The literature offers a forward-looking perspective, integrating advanced tools, environmental considerations, and strategic stakeholder collaboration, while the original research provides grounded, event-specific strategies. Bridging these approaches can lead to a more comprehensive and effective framework for logistics infrastructure management, ensuring both operational success and alignment with global trends and expectations.

6. Conclusion

Mass events have become an essential element of contemporary social life, exerting a profound influence on various domains, including culture, tourism, and urban promotion. These gatherings not only foster cultural exchange and collective identity but also serve as catalysts for attracting visitors, boosting local economies, and enhancing the global visibility of cities. By showcasing unique cultural offerings and infrastructure, such events contribute to the development of a city's brand and reputation on the international stage. Noticeable economic and educational impact, as well as support of social integration processes are just some of the features that make these events known as incubators of artistic, technological and social transformations. The changes are also visible in the area of logistical infrastructure, which is subject to processes of transformation, shaped by the preferences of artists and the need to meet the growing demands of participants of such events.

The analysis presented is a source of valuable guidance for mass event organisers. A summary of key findings relevant from the perspective of logistics infrastructure management is presented in table 2.

Table 2.

Suggestions for organisers of mass events - logistics infrastructure management

“Good practice”	Description
Modern technology integration	Leverage advanced technologies such as AI, IoT, and big data analytics to optimize logistical operations. Use mobile apps to provide real-time updates on schedules and navigation while monitoring crowd density and adjusting resource allocation dynamically (Gong et al., 2020; Silvers, 2012).
Efficient space planning	Strategically zone key areas such as entrances, exits, food service zones, and medical facilities to ensure smooth participant flow and minimize congestion. Integrate aesthetically pleasing green zones to enhance participant satisfaction and environmental integration (NAS Nik Him et al., 2018; Getz, Page, 2007).
Transportation logistics	Plan transportation systems to align with event schedules, ensuring accessibility and reduced congestion. Collaborate with local authorities on public transit options, encourage carpooling through incentives, and provide electric vehicle charging stations (Cerezo-Esteve et al., 2022; Ballarano et al. 2022).
Flexibility and adaptability	Prepare for dynamic challenges by implementing modular infrastructure designs and backup systems. Create alternative transportation routes and contingency plans to address potential disruptions such as weather changes or technical failures (Feliciani et al., 2022).
Stakeholder Collaboration	Establish integrated planning committees to facilitate communication and coordination among event organizers, local authorities, transport agencies, and emergency services. Pre-event workshops and stakeholder mapping align priorities and resolve potential conflicts (Getz, Page, 2007).
Participant communication	Enhance participant experience by using mobile applications and on-site staff to provide real-time information on schedules, navigation routes, and emergency protocols. This improves clarity and ensures participants feel informed and supported (Woźniak, 2017).
Continuous monitoring and evaluation	Conduct thorough post-event analyses of logistical efficiency, participant behavior, and resource usage to refine future event planning. Collect feedback from attendees to better understand their expectations and improve subsequent events (Patel et al., 2016).
Sustainable planning	Adopt environmentally conscious practices to minimize the ecological footprint of events. Promote public transportation, carpooling, and bike parking to reduce CO2 emissions. Integrate renewable energy solutions and implement robust waste management systems, including recycling and composting (Cerezo-Esteve et al., 2022).

Source: own elaboration.

In conclusion, the adoption of best practices such as sustainable planning, the integration of advanced technologies, efficient spatial design, adaptable logistical strategies, effective stakeholder collaboration, proactive participant communication, and ongoing evaluation is essential for the successful execution of mass events. These practices not only enhance logistical efficiency and operational effectiveness but also address the growing environmental and societal expectations placed on event organizers. By embracing these approaches, organizers can establish new benchmarks for excellence in managing large-scale art, cultural, and entertainment events, fostering innovation while promoting sustainability and inclusivity.

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CITY RESILIENCE IN THE LIGHT OF THE MUNICIPAL SELF-GOVERNMENT SYSTEM IN POLAND

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Purpose: Analysis of the resilience of local government units.

Design/methodology/approach: Formal-dogmatic method. Literature studies.

Findings: Due to the binding nature of the administration's activities by law, local self-governments have little freedom to choose measures leading to resilience. In addition, the inadequate funding of local self-governments makes it difficult to build up resources for times of crisis. The regulation of resilient instruments is relatively extensive and coherent, but it is not flawless and mainly focuses on procedures.

Social implications: The article points out the shortcomings of the adopted solutions. The local communities resilience would increase if they were eliminated by the legislator.

Originality/value: Analysis of the legal regulations in the light of the achievements of management sciences in the field of the local self-government organisations resilience.

Keywords: resilience, crisis, municipality.

Category of the paper: Research paper.

1. Introduction

1.1. The idea of resilience

Nowadays, it is characteristic of organisations to operate in a turbulent environment, due to fluctuations in demand and supply, frequent and profound changes in customer preferences, health, economic, migration and weather crises, natural disasters, etc. This has recently led to an increased interest in the issue of the resilience of organisations (Clements, Kinman, 2023). This resilience is variously defined in management science. Ingram defines it as the ability of an organisation to withstand crises and difficulties (Ingram, 2023). Another definition, on the other hand, defines it as the ability of a system to regenerate and recover from disruptions and to survive in a turbulent environment (Gaudenzi, Pellegrino, Confente, 2023). According to Annarelli and Nonino, it is the ability to resist and respond to a shock (internal and/or external) and to recover from it (Annarelli, Nonino, 2016).

If an organisation is resilient to disruption, its operations are characterised by (Sundarakani, Onyia, 2021):

- (a) efficient service delivery - the ability to provide full and uninterrupted customer service despite the disruptive impact of the crisis,
- (b) customer satisfaction - the rate and level of satisfaction achieved among new and existing customers through continued service performance despite the crisis,
- (c) customer retention - the number of existing or lost customers and the number of new customers gained or not gained thanks to the level of customer satisfaction achieved during the crisis.

The above considerations of resilience lead to the conclusion that it is the ability of an organisation to maintain its functioning and fulfill its tasks, despite of various disturbances and obstacles disorganising its normal functioning. Resilience understood in this way must be characterised by the following attributes (Giustiniano, Cantoni, 2018):

- (a) reliability, meaning the ability to absorb and withstand disruptions,
- (b) redundancy, meaning the excess capacity of system components or the existence of a backup system to maintain the basic functionality of the organisation in the event of disruption,
- (c) resourcefulness, behind which is the ability to adapt to crisis situations, the flexibility to respond, the ability to turn threats into opportunities.

1.2. The idea of self-government

Local self-government is a specific structure of a part of public administration, which is local administration (i.e. administration in charge of units of territorial division of the state), consisting in the fact that public tasks are delegated directly to the local communities to be performed by them independently. These tasks include meeting the collective needs of these communities, such as maintenance of green spaces, roads, cemeteries, issuing administrative decisions, local transport, education, etc. (Dolnicki, 2016).

Already this very general definition of self-government illustrates how important the issue of resilience is for local government, because administration, is not an entity that can be closed down for a certain period without much harm to the users (like a clothes shop, for example), but on the contrary, it is the responsibility of the administration to safeguard the community and meet its needs. It is even emphasized in the literature that a feature of administration is to function all the time (Zimmermann, 2016). The needs of the inhabitants therefore arise not only in times of calm, but also in times of tension and crisis, and local authorities must be prepared for these crisis. Furthermore, ensuring public order and the safety of citizens as well as fire and flood protection, including the equipping and maintenance of a municipal flood warehouse, are explicitly mentioned as tasks of the local government. A related task is the provision of video surveillance of public spaces. This feature therefore forces the administration to provide appropriate organisational solutions.

The structure of local government comprises municipal, poviát and provincial governments, according to the territorial division of the state in which the community performs its tasks. On top of this, municipalities are divided into urban and rural, and towns can be ‘ordinary’ towns or cities with poviát status. The latter is a municipality that simultaneously (additionally) performs district tasks. This is of such significance that there is a difference in the system of authorities between districts and cities with poviát rights. There is also a difference between the authorities of a rural municipality and a city municipality (which is not a city with poviát rights). These differences will be discussed in the following section.

1.3. The scope of the research

The resilience attributes showed above must be achieved by managing the organisation and adjusting the solutions adopted to the specificity of each organisation. One of the organisations are also public organisations, and in particular cities that are local self-government units. Hence, it may be interesting to analyze what solutions to improve resilience are used in local government, including their type and effectiveness. Such analysis is the subject of this article.

This topic has not been addressed in the legal literature. Resilience is a subject of research in management sciences and the law doctrine does not address it from the management sciences point of view.

2. Methods

In order to analyse the resilient solutions applied in local government, there is no need to study each local government unit, with the selection of an appropriate research sample and to generalise the results to the entire population. This is due to the fact that the activities of local authorities, as administrative entities, are strictly regulated by law (Zimmermann, 2016). Hence, to assess the resilience of a public organisation such as a local self-government, it is necessary to analyse the legal acts that set the framework for its activities, as only within their boundaries local self-governments units can build the components of resilience, i.e. reliability, redundancy and resourcefulness. Legal acts are usually analysed through legal literature and judicial decisions. Such a research method is used in the legal sciences and is called the formal-dogmatic method and this method will be used in this study.

The legal acts regulating the principles of local government are:

- (a) the Act on Municipal Self-Government (1990),
- (a) the Act on Poviát self-government (1998),
- (b) the Act on Provincial Self-Government (1998).

These are the so-called constitutional self-government acts as they set foundations to its structure and operation. In addition to the above, the activities of self-governments are regulated by other acts, which will be referred to further in the relevant parts of the discussion.

3. Results

3.1. Decision-making process in the local self-government

One of the fundamental problems in setting up a new organisation is the question of its organs, their tasks and decision-making mechanisms. After all, an organisation is not human being and needs organs to function effectively (Dmowski, Rudnicki, Trzaskowski, 2014; Stahl, 2011). The importance of this issue is evidenced by the history of the formation of state systems, which led to the formation of the principle of the division of power with three systems of organs. In Polish local self-government, this issue was resolved by establishing the ruling and executive authorities, partly transferring the principle of separation of powers and the consequent mechanism of mutual control and braking of authorities to the level of local administration (Dolnicki, 2106; Bandarzewski, Chmielnicki et al., 2022; Augustyniak, Cybulska et al., 2021).

The decision-making body is the council - municipal, district or voivodship - consisting of a dozen to several dozen councillors elected by universal suffrage for a five-year term, while in the voivodships this council is called the voivodship assembly.

More complicated is the case of executive bodies. It is the mayor, but if the headquarters of the authority is in a city located within the municipality then it is the city mayor (e.g. the city mayor of Mikołów in the municipality of Mikołów), and in - generally speaking - larger cities and towns with powiat rights it is the city president. These are therefore single-member authorities and are also elected by universal suffrage for a five-year term. In poviats and voivodeships, on the other hand, it is a multi-member powiat board or a voivodeship board elected for the same term of office, but by the powiat council or the voivodeship assembly.

As this article refers to cities that may be municipalities or cities with powiat rights, it will refer to the city council and the single-member executive body, and if it mentions the mayor, it should also be understood to mean the city mayor and the city president.

The relationship between the above-mentioned decision-making and executive bodies is shaped in such a way that decision-making and executive powers are divided between them and decisions on the most important issues are left to the decision-making body (Szewc, Jyż, Pławewski, 2012). These are so-called strategic decisions (Kowalewski, 1971). Such issues include, for example, disposing of major assets, spatial planning, adopting the budget, deciding on cooperation with other local government units. This is related to the functioning of this body, which is a collegial body, i.e. consisting of more than one person. The feature of a collegial

body is the possibility of balancing different points of view and choosing the optimal solution (Łętowski, 1995; Starościak, 1969). The decision-making body not only protects the community from imprudent decisions made by the executive one-person body, but the council also has the possibility of anticipating threats and arranging the community management in such a way that it is resilient to crisis situations, e.g. by designating areas at risk of mass earth movements, floods, or plants with a high risk of a major industrial accident.

The executive body, in turn, manages the day-to-day functioning of the community, represents it externally and carries out the tasks assigned to the local community and the resolutions of the decision-making body. It thus takes tactical decisions (Kowalewski, 1971). As already mentioned, it is a single-member body and can therefore act more quickly, does not need to convene sessions, but at the same time is limited in its decision-making powers by a subjective point of view, greater susceptibility to influence and even the threat of direct responsibility. This responsibility is difficult to attribute to a specific person in a collegiate body expressing its will through voting (Kisielewicz, 2008).

Apart from the above-discussed ways of ensuring resiliency, which can be described as internal, there are also instruments used by external actors situated outside the local self-government unit. The fact that the construction of self-government presupposes a high degree of independence of local communities executing public tasks, however, does not imply full arbitrariness and freedom (Niewiadomski, 2011). The activity of the self-government is supervised by the government administration in terms of the legality. This supervision is divided between the Prime Minister, the voivode and the regional chambers of audit, but the jurisdiction of the latter is limited to financial matters.

Supervision is a specific construction of administrative law, comprising two competences of the supervisory authority: control and interference in the activity of the supervised entity. Control is the verification of the activity in terms of a specific criterion (and, as mentioned, this criterion is a legality), while interference is the application of means affecting the functioning of the local self-government units. These means are, of course, various, and only those relevant to the resilience of the local self-government unit will be here considered. We are talking about the suspension and the dissolution or revocation of the local self-government unit's bodies and the appointment of a government commissioner in their place to carry out their tasks. The difference between revocation and dissolution depends on whether it is a single-member or collegiate body.

In the first case (suspension), the rationale is that there is no hope of rapid improvement and prolonged inefficiency in the performance of public tasks by the organs of the entity. The Prime Minister then suspends both bodies (i.e. the decision-making and the executive) for up to two years, but no longer than until the next election. This measure is rightly alleged in the literature to:

- (a) uses imprecisely defined grounds (Dolnicki, 1993),
- (a) does not in fact assess the legality but the purposefulness of the action of the self-government, which goes beyond the constitutionally established limits of supervision of the self-government (Bandarzewski, Chmielnicki et al., 2022; Augustyniak, Cybulska et al., 2021),
- (b) does not lead to the intended objective, i.e. the improvement of the management of the local self-government community, because after the expiry of the suspension, the same bodies that have been declared ineffective take over the power in the municipality (Agopszowicz, Gilowska, 1999).

In the second case (dissolution or revocation), the premise is a repeated violation of the Constitution or laws. For the decision-making body, the Sejm is competent to take the decision, and for the executive body, the Prime Minister.

The possibility of replacing the municipal executive is of a similar nature. The regulations provide for a situation where the executive body holder, that is the specific natural person assigned to the post (Ochendowski, 2005), is unable to perform his or her functions due to a transient impediment (and thus, after the cessation of the impediment, he or she resumes his or her activities), as well as situations where the mandate of the holder has expired and a new one has not yet been elected. A transient impediment may be preventive detention, serving a custodial or prison sentence, incapacity for more than 30 days, and suspension from office. Regardless of whether the executive is permanently or temporarily prevented from exercising his or her functions, he or she is replaced by a substitute (or first substitute) or, if there is no substitute, by a government commissioner. This regulation is quite detailed, as it even provides for a procedure to be followed - that is, the chairman of the municipal/city council notifies the voivode within 48 hours of being informed that the tasks and competences of the mayor have been taken over by the deputy or first deputy or that a government commissioner has to be appointed. If, on the other hand, the term of office has expired, the information to the voivode must be sent within 7 days of the expiry of the term of office.

Local self-government is not only about meeting the needs of local residents, but also about being able to introduce locally applicable regulations. This is justified primarily by the speed of action and excellent knowledge of local circumstances (Dąbek, 2004). It is not surprising, therefore be able to enact so-called local laws, of which statutory provisions and rules of order will be important for the resilience of the organisation.

In clarifying these concepts, it should be pointed out that acts of local law are regulations which are universally binding (i.e. binding on all addressees), but whose binding force is territorially limited to the area of activity of the authority which issued them (Dąbek, 2004). Statutory provisions define, among other things, the system and organisation of the local government unit and the rules for the use of municipal public utilities (e.g. in the form of rules for the use of the municipal park). By this means, solutions can be introduced to prevent crises. On the other hand, rules of order are aimed at protecting the life or health of citizens and

ensuring public order, peace and security. Their issuance is of a subsidiary nature, i.e. they may be enacted only if a specific issue is not regulated by other provisions.

An example of such regulations may be the resolution of the Radzionków Town Council (2023). It results, for example, from the ban on bringing pyrotechnic materials by participants of the event to the sports facility and their possession on the sports facility by participants of the event organised at the facility during its duration.

Such regulations may be issued by both the legislative and executive bodies, however, regulations can be issued by the executive body only in urgent situations and must be approved at the next session of the council of the municipality. Importantly, the enforcement regulations may provide for liability for their non-compliance under the rules of misdemeanour, which means that a fine of up to PLN 5,000 or arrest of up to 30 days may be imposed.

3.2. Resources

When considering the resilience of a local authority to crisis situations, the issue of resources cannot be overlooked. Resources can be understood in terms of financial human resources and uniformed services. Each of these aspects can be analysed in terms of legal regulations.

3.2.1. Financial resources

When it comes to local self-government finances, this is the area where achieving resilience is by far the most difficult. This is due to the fact that a significant part of the local self-government's income is made up of transfers from the state budget, and a smaller part (45% in 2023) is its own income (Informacja..., 2024).

At the same time, these revenues are not proportional to the costs of implementing the tasks imposed on the local self-government, what is a fact that has been widely known for years and in this respect little has changed (Grześkiewicz, 2002; Poniatowicz, Jastrzębska, 2021). In 2023, municipalities had a deficit around PLN 23 billion (Zestawienie..., 2024). As a result, this makes it difficult to generate financial surpluses and to achieve resilience. Hence, in the event of a crisis situation, it is possible to quickly obtain additional funds either by borrowing (Filipiak, 2017), or through help from others local self-government units. This assistance can be both material (e.g. supply of goods, provision of services) and financial. Such external support can be assessed as an element that increases the redundancy of local government. However, it is difficult to grant it quickly, because it requires a resolution of the decision-making body and must fit into the municipal budget (Bandarzewski, Chmielnicki et al., 2022; Augustyniak, Cybulska et al., 2021).

Also, the decision to take out a loan depends on the decision-making body, which may specify its maximum amount in a resolution, within the limits of which the mayor may decide on the loan on his own; a loan of a higher amount requires the consent of the council, which prolongs the procedure.

Some preventive solutions supporting financial resilience can be also mentioned. The first are prudential procedures related to the indebtedness of a local government unit. This indebtedness cannot exceed the amount of the Individual Debt Index determined for each municipality separately, based on many criteria, in accordance with the formula provided in art. 243 of the Public Finance Act (2009). Additionally, this formula takes into account a wide range of financial instruments classified as debt, which significantly limits the borrowing capacity of the local self-government (Dylewski, 2024). Neglecting this requirement led to the well-known case of the liquidation of the Ostrowice municipality (Gmina..., 2024). In an extreme situation, a municipality using financial instruments beforehand may not be able to increase its resources in order to overcome the crisis situation. The second is a countersignature of actions that may give rise to monetary liabilities. It is then granted by the treasurer of the local self-government unit. This is a confirmation that the action is carried out within the financial resources (budget) of the municipality.

3.2.2. Human resources

The principle of completing community tasks by an executive body acting alone, or even collectively as a board of several people, is of course impossible to effectuate in practice. Therefore, the executive body implements community tasks with the help of the municipal or city office, as well as with the help of various types of organizational units. The people employed there support the executive body in implementing its duties. Their employment is regulated by a separate Act on Local Self-government Employees (2008). This act specifies the types of positions in local self-government structures, requirements for candidates for employees and the rights and obligations of employees.

From the point of view of the resilience of the unit and the use of additional resources in a crisis situation, three solutions are worth considering. The first is the possibility of hiring employees in lower positions, so-called auxiliary and service positions without conducting a competition (in the case of other categories of positions, especially of the offices, this competition is required), which allows for the ad hoc employment of people for simple works, i.e. cleaning or building flood embankments. The second is the possibility of giving an employee an order to work overtime, including - in exceptional cases - also at night, on Sundays and holidays. The third option is to assign an employee to a different job than he or she has done so far for up to 3 months in a calendar year.

3.2.3. Uniformed services

Uniformed services are meaningful resources of local communities in crisis situations. These are municipal guards (in cities called city guards) and Volunteer Fire Departments.

The tasks of municipal guards include:

- (a) cooperation with relevant entities in the scope of saving the life and health of citizens, assistance in eliminating technical failures and the effects of natural disasters and other local threats,

- (b) securing the place of a crime, disaster or other similar event or places threatened by such an event from access by unauthorized persons,
- (c) protection of municipal facilities and public utility devices,
- (d) cooperation - during public gatherings or events - with their organizers and other services in order to protect public order (Tyczkowska-Kowerczyk, 2020).

The municipal guards may also perform tasks together with the Police in the event of a general threat to public safety, a catastrophe, a natural disaster, a state of epidemic threat, an epidemic state or another crisis situation. The voivode decides about this and informs the relevant mayor. In such a case, the guard is subordinate to the command of the territorially competent Police commander. Joint performance of tasks differs significantly from cooperation, mentioned earlier, because there is no equality in the relationship between the guard and another entity, but subordination to the Police.

Volunteer Fire Departments (VFD) are not officially self-government entities, as they are associations of amateur firefighters, however, due to the obligation of the municipality to conclude an agreement with the VFD in order to specify the activities undertaken by the VFD and the municipality's obligations towards the VFD, mainly in terms of financial and material support, and the VFD's obligations towards the municipality and its residents, they can be considered a municipal entity in practice. In terms of strengthening the resilience of the municipality in the event of an emergency, VFDs are obliged in order to protect life, health, property or the environment to:

- (a) conducting rescue operations,
- (b) participating in rescue actions, including activities conducted by other services, inspections and guards,
- (c) participating in alarming and warning the population about threats,
- (d) participating in protecting the population.

The obligation to support the VFD includes (within the scope of the municipality possibilities):

- (a) providing facilities, areas and technical equipment,
- (b) financing training other than that paid for by the State Fire Service,
- (c) bearing the operating costs.

3.3. Crisis situations – specific regulations

As shown above, some mechanisms of the system and management of a local self-government entity, designed for standard situations, may be useful to some extent in crisis situations. Nevertheless, it is obvious that in the event of a serious crisis, they will be insufficient. Hence, the legislator answers to the needs of practice and provides regulations for the functioning of the administration in exceptional situations. Two solutions can be indicated here. The Act on the State of Natural Disaster (2008), introducing unitary management in times of crisis, goes the furthest.

A natural disaster is a natural catastrophe or technical failure, the consequences of which pose a threat to the life or health of a large number of people, to property on a large scale or to the environment over large areas, and assistance and protection can only be effectively provided through the use of extraordinary measures, in cooperation with various bodies and institutions and specialist services and formations operating under unified management.

The Council of Ministers decides to introduce a state of natural disaster by means of a regulation, which means that local community bodies cannot decide on the occurrence of a state of natural disaster on their own and apply extraordinary measures as a result. Only from the moment of publication of this regulation in the Journal of Laws separate rules for the functioning of the administration can be applied. An example of such a regulation can be the Regulation on the Introduction of a State of Natural Disaster in the Area of Pparts of the Lower Silesian, Opole and Silesian Voivodeships (2024).

Unified management during a state of natural disaster means that the mayor manages the actions carried out in the municipality area in order to prevent or eliminate the effects of the natural disaster. In this purpose, he may issue orders to the bodies of auxiliary units, managers of entities established by the municipality, managers of fire protection units operating in the municipality area and managers of organizational entities temporarily put at his disposal by the competent authorities and addressed to perform tasks in the municipality area. He may also claims managers of other entities operating in the municipality area to perform activities necessary to prevent or eliminate the effects of the natural disaster. In the event of refusal to perform these activities or their improper performance, the mayor shall immediately notify the body to which the manager is subordinate or which supervises him. At the same time, the mayor executes such orders received from the starost or voivode, if the state of natural disaster has been announced in the powiat or voivodeship, respectively.

If the mayor is unable to manage or improperly manages the activities carried out to prevent or remove the effects of a natural disaster, the starost may suspend his or her powers in this regard and appoint a proxy to take over these tasks. This regulation leaves a large margin of interpretation and in reality does not contain any criteria, because the wording ‘inappropriate’ is far from being precise.

In the reality of functioning of the administration, it turned out that there is also a lack of an intermediate solution, in situations of growing threat, but not yet meeting the conditions of states of emergency (i.e. also a state of natural disaster). This lack is filled by the Act on Crisis Management, 2007 (Bandarzewski, Chmielnicki et al., 2022). This act ‘creates a crisis management system in the event of threats requiring special actions [when] it is required to implement special mechanisms aimed at ensuring effective monitoring of threats and taking actions to eliminate them or at least significantly reduce them’ (Projekt..., 2007). Such regulation lets to increasie the efficiency of the administration and provides a legal basis for creating the necessary structures and documents defining the procedures, which will allow for preventive action by removing the sources of crisis situations and quickly eliminating their

effects. This is a very important aspect in the light of the principle of competence governing administrative law. This also applies to financing - municipalities are entitled, but also obliged to allocate in the budget a special reserve of 0.5% of the budget to finance tasks in the field of crisis management. Additionally, they can receive subsidies from the state budget for this purpose.

Crisis management is based on the competences of the mayor supported by the crisis management team. They primarily include:

- (a) managing the monitoring, planning, response and removal of the effects of threats,
- (b) developing a crisis management plan,
- (c) carrying out projects resulting from the operational plan for the functioning of municipalities,
- (d) managing, organizing and conducting training, exercises and exercises in the field of crisis management,
- (e) preventing, counteracting and removing the effects of terrorist incidents,
- (f) organizing and implementing tasks in the field of critical infrastructure protection,
- (g) defining specific forms of providing assistance to the local community in a crisis situation or the possibility of a crisis situation.

Crisis management also requires the functioning of crisis management centres at every level of administration. Their role is to be on duty 24 hours a day, warn the population and transfer information between services and entities conducting rescue operations. However, in lesser cities and rural municipalities, its creation is optional and the mayor is a kind of equivalent of the centre. Its task is to alert members of the communal crisis management team 24 hours a day, and in crisis situations, to ensure 24-hour duty in order to provide for information and document the activities carried out. The obligation to operate such a centre applies to cities with poviats rights.

Given the large number of crisis management bodies (mayor, starost, voivode), a dispute may arise as to which body is to take action. Hence, the Act on Crisis Management introduces the principle that the obligation to take action of crisis management rests with the body that first received information about the occurrence of a threat. This body immediately informs the other bodies of the appropriate higher and lower level about the event, presenting at the same time its assessment of the situation and information about the intended actions (Pawelczyk, Sokal, 2014). This regulation should be assessed positively as preventing disputes over competences and accelerating the taking of actions to overcome the crisis.

It is also worth adding that the mayor is obliged to carry out the orders of the voivode issued in order to prevent threats to life, health or property and threats to the environment, state security and to maintain public order, protect civil rights, as well as to prevent natural disasters and other extraordinary threats and to combat and to eliminate their effects (Article 25 of the Act on the Governor and Government Administration in the Voivodeship, 2009). The voivode's authority

mentioned here therefore covers not only the state of natural disaster and crisis management (as already mentioned), but also other situations, as long as they are aimed at preventing threats.

Concluding the issue of regulating specific procedures aimed at increasing the resilience of the municipality in crisis situations, we can also mention some independent competences of the mayor, including:

- (a) suspension of any business activity. The mayor may order any entrepreneur, in the form of a decision with immediate enforceability, to suspend business activity if it is conducted contrary to the law, and also in the event of determining: a threat to life or health, a risk of significant property damage or environmental damage as a result of conducting such activity and at the same time it is not possible to notify the competent authority that could intervene in the matter of such activity (Article 60 of the Act - Entrepreneurs' Law, 2018). This provision prevents the occurrence or increase of damage as a result of conducting activity that is unlawful or dangerous (Bielecki, Gola et al., 2019);
- (b) preparation of an operational plan for flood protection. The regulations do not specify the content of this plan, so it will have to be determined in practice. Documents defining the flood risk developed by Polish Waters (Wody Polskie) may be of assistance (Augustyniak, Cybulska et al., 2021);
- (c) announcing and cancelling a flood alarm. The regulations do not indicate the consequences of a flood alarm, therefore the mayor will have to specify the procedures for action in each case, e.g. order the readiness of services, verification of equipment, observation of water levels, etc. (Augustyniak, Cybulska et al., 2021);
- (d) ordering evacuation from areas directly threatened if the direct danger to human life or property cannot be removed in any other way.

4. Discussion

The resilience instruments examined above can be analyzed in two directions:

- a) in terms of their impact on resilience (effectiveness),
- b) classification in the light of various attributes of resilience.

When assessing the entirety of legal solutions increasing the resilience of municipalities, it can be said that, in principle, they create a relatively coherent system of complementary instruments allowing for the prevention of crisis situations or for responding to them if they do occur. This system is of a cascading nature, containing instruments of varying intensity of impact, depending on the threat. Here, we can distinguish 'ordinary' instruments, such as preparing plans for the event of a threat, the ban on conducting business activity, the possibility of replacing ineffective bodies or those unable to perform their functions. Next, we can indicate

procedures resulting from crisis management, provided for the event of threats requiring special actions. Finally, the farthest solutions are related to the state of natural disaster, which introduces the principle of one-person management of rescue operations, along with a severe sanction as the possibility of depriving it.

However, not all instruments seem to be properly formed. The analysis has revealed flaws in the adopted solutions, such as:

- a) loopholes in the law (concerning the absence of the mayor due to illness lasting less than 30 days),
- b) granting far-reaching discretionary power in assessing the grounds for applying supervisory measures (concerning the suspension of local self-government bodies or depriving the right to direct rescue operations during a state of natural disaster),
- c) ineffectiveness of the applied measures (concerning the suspension of municipal bodies for two years resulting in the reinstatement of the same bodies or the inability to use financial instruments due to debt limit),
- d) inconsistency of the adopted solutions with the systemic assumptions of local government enacted in the Constitution, and above all the principle of local government independence through centralization of management (concerning a state of natural disaster and issuing orders to local government bodies).

Of course, regardless of the above-mentioned disadvantages, the existence of any pro-resilience mechanisms should be assessed positively, especially in the area of crisis management and natural disasters. It is also worth noting that many activities increasing resilience can only be implemented in a supra-local level, because they exceed the capabilities of municipalities, such as efficient and versatile services, building flood embankments, retention reservoirs, regulating rivers, etc.

Moving on to the classification, it is possible to consider the attributes of resilience to which individual resilience instruments belong.

Analyzing the self-government system, it can be considered that it primarily provides for resourcefulness as a component of resilience. This is due to the possibility of making the most important decisions in a well-considered manner and of correcting the action of a single-member body. At the same time, a monocratic body making decisions quickly can therefore be considered robustness as a component of resilience.

The use of supervising measures primarily promotes the reliability of the local self-government unit. The appointment of a government commissioner in place of the suspended or revoked or dissolved organs makes it possible to ensure their continuity of operation and may even be regarded as a redundancy of the organs of the local self-government community. On the other hand, the suspension of municipal bodies can only have an effect for a certain period of time, i.e. two years, after which the previous bodies will take over again in the municipality (unless new ones have been elected in the meantime as a result of the expiry of their term of office). It is thus clear that the legislator places a strong emphasis on maintaining

continuity in the operation of the local government unit (WSA Judgement, 2010). However, it does not do so consistently, as it allows a 30-day absence of the executive body caused by illness without any mechanism to ensure continuity of operation during this period, which can lead to significant perturbations in the functioning of the municipality. Admittedly, the government website www.gov.pl explains that ‘During the illness of the mayor of a municipality, mayor, mayor of a city, which lasts up to 30 days - these functions are temporarily performed by the deputy. In municipalities where more than one deputy has been appointed - these functions are performed by the first deputy. [...] This is a so-called transient obstacle’ (Zastępstwo..., 2024), this explanation, however, is at odds with the wording of the provisions of the Municipal Self-Government Act requiring an absence of more than 30 days for a deputy to take over the tasks and competences of the mayor. Moreover, the provision that allows such a possibility contains a closed catalogue of reasons for the deputy mayor to take over the competences of the mayor, which means that it cannot be extended by interpretation (Augustyniak, Cybulska et al., 2021).

This is not the only loophole that can be blamed on this regulation. It is possible to identify a number of situations in which the mayor is absent for some time and cannot be replaced. These include, in particular, the failure to submit the aforementioned medical certificate - it is then impossible to determine the day on which he or she will take over mayor's tasks as it cannot be established that the mayor's absence is due to illness (Szewc, Jyż, Pławewski, 2012), a holiday lasting longer than 30 days, or disappearance in a catastrophe where there is no body and the death has to be judicially established (Augustyniak, Cybulska et al., 2021), which is only possible after six months. In addition, when a mayor's mandate expires, the authority to replace him also expires, so until a new mayor is elected, there is no one to manage the municipality (Szewc, Jyż, Pławewski, 2012).

The legislative competences promote the resourcefulness and reliability of the self-government organisation. And there is no doubt that making local law increases the resilience to a very high degree, preventing undesirable behaviour.

The legal provisions regarding local resources can be perceived as ensuring all the components of resilience. Most of all it is a feature of versatile regulations of the Act on Local Self-government Employees. People who are needed to help in a crisis situation can be quickly employed. Financial instruments ensure solidity because they prevent disruptions in the functioning of local government organizations, except regular revenues that are insufficient. The municipal guards can be considered as conducive to reliability and resourcefulness, because they can be used to respond to a crisis situation. However, they do not meet the redundancy criterion, because the quantity of staff is conditioned by the local self-government entity's income, and these are sufficient to finance the guard only in the scope of performing its tasks in ‘normal’ circumstances, and even then not always at a sufficient level. On the other hand, the VFD certainly meet all three resilience attributes, because their functioning only supplements the tasks of the State Fire Service.

When assessing the solutions adopted in the Act on the State of Natural Disaster, it should be recognized that they increase the resourcefulness of local government units, as they enable flexible adaptation to the situation.

The solutions concerning crisis situations cover virtually all aspects of resilience: resourcefulness (crisis management centre), reliability (competence of the mayor in terms of preparing for and responding to crisis situations) and redundancy (separate budget for crisis management, crisis management centre).

To sum up the above categorizations, the classification of resilience instruments can be presented in the form of a table (Table 1).

Table 1.
Classification of legal instruments of local self-government resilience

Item		Reliability	Redundancy	Resourcefulness
1	Division of competences between legislative and executive bodies			x
2	Suspension/dissolution of local government bodies	x	x	
3	Local law acts	x		x
4	Local government income	-	-	-
5	Loan		x	
6	Mutual help		x	
7	Countersignature	x		
8	Indebtedness to an individual limit	x		
9	Employment of local government employees	x	x	x
10	Municipal guards	x		x
11	Voluntary Fire Departments	x	x	x
12	Unified management during a state of natural disaster			x
13	Competences of the mayor in the scope of preparing for and responding to crisis situations	x		
14	Crisis management budgeting		x	
15	Crisis management centre		x	x
16	Video monitoring	x		
17	Execution of the voivode's orders by the mayor in the event of a threat			x
18	Suspension of business activity by the mayor			x
19	Development of an operational plan for flood protection	x		
20	Announcement and cancellation of flood alarm			x
21	Ordering an evacuation from areas directly threatened			x
	Total	10	7	11

Source: own work.

5. Conclusions

It is possible to draw certain conclusions from the conducted research. Firstly, it is clear that the legislator puts stress mainly on procedures for action in crisis situations, because resourcefulness is an attribute that is most often obtained as a result of introducing various statutory instruments (as seen in the Table 1). On the other hand, it supports local self-governments to a lesser extent in terms of solidity, and the least in terms of redundancy, which is in line with the policy of insufficient financing of local self-government that has been pursued for years. The local government revenues in turn do not make for resiliency at all. This makes it difficult, if not impossible, to implement the principle of a rational remainder assuming that certain spare is left for the implementation of unforeseen tasks when designing the structure of the office (Łukasiewicz, 2002).

Secondly, the legal regulation of the resilience of cities as local government units is not perfect. Some flaws were revealed, of formal (related to the lack of legislative technique) as well as substantive nature consisting in depriving cities of resources, especially financial resources.

Thirdly, the research results can be used for further scientific research and during legislative work aimed at correcting the shortcomings of the existing legal regulations. The basic thing should be to increase the financing of municipalities, which will enable them - even within the framework of existing procedures and institutions - to increase their resilience by preparing for crises, taking into account the individual situation of each city. It is also necessary to eliminate the defects of regulations in the area of using the wrong legislative technique.

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DIGITALIZATION IN BUILDING THE RESILIENCE OF PUBLIC ORGANIZATIONS

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Purpose: The environment of contemporary public organizations is characterized by high dynamics of change, including those implied by crises. One important trend in the environment is the widespread digitization of organizations and the strong trend toward digitizing the management of public organizations and the use modern technologies in the delivery of public services. The COVID epidemic has significantly increased these activities. At the same time, demonstrating the need to build the resilience of public organizations. This article aims to look at how digitization can be used to build the resilience of public organizations.

Design/methodology/approach: a literature review was used as the research method.

Findings: the literature search conducted indicates that digitalization, and strictly digital maturity of organizations, can foster organizational resilience.

Originality/value: (Mandatory) The value of the article is the initial analysis of the literature on the digitalization of public organizations in relation to building organizational resilience in the public sector, which implies possibilities for future research and development of this research thread

Keywords: public organization, resilience, digitization.

Category of the paper: General review.

1. Introduction

Social, political, economic, and demographic changes are making public organizations look for better ways to provide public services. At the same time, cultural changes are taking place in the last decade of the twentieth century, resulting from the transition from an industrial civilization to a knowledge civilization. The change from a traditional society to a digital one has been so fast that people have decided to call it the fourth industrial revolution, which is also called Industry 4.0. We've seen a lot of digitization lately, which has been made even faster by the global Covid-19 pandemic. The digitization trend is supported by a number of European Union activities, such as an increase in funds allocated for ICT development and a change in the EU strategies in force for the Member States. The most recent strategy, Digital Compass

2030: The European Way in the Digital Decade, presented in 2021, focuses activities around creating conditions for achieving four main goals: (1) a digitally skilled society and highly skilled digital professionals; (2) secure, efficient and sustainable digital infrastructure; (3) digital transformation of businesses; and (4) digital transformation of public services. At the same time, the Covid-19 pandemic has clearly highlighted the need to build the resilience of public organizations, which can be supported precisely by the digitalization of organizations. This article presents considerations regarding the possibility of supporting the building of organizational resilience through the digitization of organizations. The article presents general considerations derived from the literature search.

2. Digitization of public organizations

The pressure to raise the quality and standard of life and the search for efficient ways of providing services has influenced the expansion of the areas of emanation of the Industry 4.0 concept, and the observed practice reveals many applications outside the context of the manufacturing industry in, for example, urban management, public and social services, and social and healthcare systems (Giulio, Vecchi, 2021; Chute, French, 2019). Regarding the public sector, the drive to improve operational efficiency through the use of modern technologies applies both to the actions of individual organizations that choose to do so, but also to entire areas of public service delivery through the implementation of relevant central or regional level programmes, thereby realizing the drive to transform the public sector towards Government 4.0 (Naqvi Al, Munoz, 2020). The transition towards Government 4.0 is not a single and short-term implementation of a specific technology, but rather a long-term evolutionary process of transforming the government/public sector to focus on citizen services (Walencik, 2018). The evolution towards Government 4.0, following Janowski (2015), can be divided into four stages:

- Digitalization - implementing ICT to improve its internal processes and structures, e.g. launching websites.
- Transformation - implementation of ICT with applied organizational and process transformation within the administration itself, without changes in stakeholder relations, e.g. e-government.
- Engagement - the use of ICT to both support internal processes and to support the communication and relations of the public administration with stakeholders, e.g. e-processes, e-public services, e-governance.
- Contextualization - the impact of ICT use in public administration on the whole public sector and its stakeholders.

The use of modern technology in the public sector can help improve the delivery of public services and contribute to the best use of available resources. The benefits of using modern technology in the public sector (Väyrynen, Helander, Jalonen, 2023; Ziemba, Papaj, 2023; Naqvi Al, Munoz, 2020; Stern, Daub et al., 2018; Walencik, 2018) include. Identification of problems in real time and faster response to them; faster and more efficient decision-making and more accurate decisions; access to huge amounts of data, which allows improving the analysis carried out, provides new *evidence* for the design and adaptation of public policies to the new reality (*evidence-based public policies*); reduction of time in dealing with official matters, bureaucracy, more personalized service for citizens and business; cost reductions; increased efficiency of the administration; improved innovation in public service delivery; ICT enables the introduction of reforms relating to the way in which public organizations operate; increased transparency of public sector activities; increased quality of services; new channels of communication and, as a result, improved information flow and support for active citizen participation.

At the same time, reaping the full benefits of applying the technologies known as Industry 4.0 to the public sector requires overcoming emerging obstacles. Among them, we can point out (Kitsios et al., 2023; Kuhlmann, Heuberger, 2021; Naqvi Al, Munoz, 2020): (1) the often outdated information technology (IT) infrastructure in public organizations; (2) the lack of statistical awareness and the lack of tool experience of staff (especially relevant for Big Data analyses); (3) the problem of data access while protecting sensitive data; (4) the low quality of available data (e.g. incompleteness); (5) problem of bureaucratic internal procedures in the organization; (6) lack of financial resources; (7) lack of trust of users (citizens) in new technological solutions; (8) resistance of employees of public organizations; (9) lack of specialists; (10) outdated regulations and working procedures; (11) administrative law.

The implementation of modern technology into the functioning of the public sector is a significant change in its operating principles and requires proper management of the change process. Müller and Abildgaard Skau (2015), based on a literature review, identified six areas that need to be examined in the change process to increase the likelihood of success, viz:

- External environment (legislation, political and administrative reforms, socio-economic factors).
- Organization (financial resources, organizational infrastructure, cooperation, stakeholders, organizational culture).
- Governance (commitment, strategy, project management).
- Employees (human resources, resistance to change, education and training).
- Citizens (digital exclusion, education and training, citizens' needs and trust).
- Technology (infrastructure, security, design, and access).

The areas of digitization related to public management concern various spheres of socio-economic life. Digitization, together with the dynamic development of increasingly sophisticated ICT, are becoming alternatives to or replacing existing solutions. The main domain of digitization expansion in public institutions is the creation of public e-services as *front office* (supporting interaction between the customer and the public institution) and the implementation of IT systems as *back office* (supporting *back office* and internal processes in public institutions).

3. Resilience of public organizations

Key findings and developments in research on the resilience of public organizations highlight the dynamic and context-dependent nature of resilience. Organizational resilience is defined as the ability to absorb shocks, develop responses and engage in transformational action to take advantage of disruptive events (Bracci, Tallaki et al., 2021). This resilience is not just about returning to a previous state, but involves transformation and adaptation to new circumstances (Bracci, Tallaki et al., 2021). Resilience can be both planned and adaptive, encompassing predetermined planning opportunities and emergent responses to crises, respectively (Bracci, Tallaki et al., 2021). Resilience is increasingly recognized as crucial for organizations facing complex technologies and external dependencies that expose them to multiple risks and require them to maintain or improve their performance in times of adversity. Several characteristics and processes that underpin organizational resilience have been identified in the literature, including risk awareness, collaboration, agility and improvisation, supported by corporate philosophy, decentralization, information systems and human resource management processes (Leite, Hodgkinson et al., 2021). However, these characteristics and processes are not universally applicable but vary according to context, highlighting the need for a contextual approach to resilience in public organizations (Leite, Hodgkinson et al., 2021). Resilience is influenced by an organization's strategy, resources, culture and structures, and can be significantly affected by political leadership during crises (Bracci, Tallaki et al., 2021). For example, local government organizations demonstrate resilience by reinventing institutional forms and strategically managing change through decision support systems that facilitate information flows (Bracci, Tallaki et al., 2021). Resilient organizations are characterized by situational awareness, tolerance for ambiguity, agility, creativity and the ability to manage vulnerabilities and learn from experience (Parker, 2023). Employee resilience is also crucial, emphasizing the need for continuous learning, collaboration and adaptability in the face of high demands and an uncertain environment (Pineiro et al.). Public organizations need to balance the need for flexibility and adaptability with stability, predictability and efficiency, as they are primarily responsible for providing daily services to the community

(Duit, 2016). Interorganisational coordination and citizen co-production are identified as mechanisms to increase the resilience of public service delivery systems. These mechanisms improve governance effectiveness and transform service delivery systems into resilient structures capable of coping with shocks (Shen, Cheng et al., 2022). Overall, the research suggests that resilience in public organizations is a complex, multi-faceted phenomenon that requires a nuanced understanding of the specific characteristics, processes and contextual factors that contribute to resilience. This understanding is essential for developing effective strategies to enhance the resilience of public organizations in the face of crises and disruptive change. Key challenges in public organization resilience include balancing the need for flexibility and adaptability with stability and predictability, addressing bureaucratic constraints that hinder resilience, and the complexity of interorganisational collaboration and multi-level governance (Duit, 2016; Bracci, Tallaki et al., 2021; Leite, Hodgkinson et al., 2021). Open questions include how to effectively integrate resilience thinking into daily public service delivery and how to develop resilience as a dynamic capability among employees (Pinheiro et al.; Shen, Cheng et al., 2022).

4. Digitization and resilience of public organizations

Digitalization significantly increases the resilience of public organizations, enabling them to adapt quickly, improve efficiency and make data-driven decisions (Rădoiu, Bătușaru, Porancea-Răulea, 2024). It also fosters collaboration and ensures business continuity by putting stakeholders at the centre and promoting an integrated, innovation-driven mindset (Rădoiu, Bătușaru, Porancea-Răulea, 2024). In the context of public service delivery, digital platforms have decentralized the process, enabling citizens and communities to co-produce and ensuring government responsiveness after a crisis, which contributes to transformative resilience (Shen, Cheng et al., 2022). This transformative resilience is further supported by digital platforms reducing the cost of citizen participation, thereby potentially addressing the scale of co-production and shared governance (Shen, Cheng et al., 2022). Overall, digitization not only supports recovery resilience, but also fosters transformational resilience, enabling public organizations to effectively manage change and increase resilience (Shen, Cheng et al., 2022; Bracci, Tallaki et al., 2021). Digitalization plays a key role in enhancing the resilience of public organizations, enabling them to adapt quickly, improve operational efficiency and ensure continuity of service delivery. However, the integration of digital tools also comes with challenges, such as concerns about data privacy, the need for interoperability between different systems and the potential monopolization of digital platforms (Rădoiu, Bătușaru, Porancea-Răulea, 2024; Shen, Cheng et al., 2022). Opportunities provided by the digitization of public organizations in relation to building organizational resilience:

- Improved decision-making: Digital tools facilitate data-driven decision-making, which can significantly improve the responsiveness and adaptability of public organizations in crisis.
- Citizen participation: Digital platforms reduce the cost of citizen engagement, thereby increasing the shared governance and co-production of public services that are essential for transformational resilience (Shen, Cheng et al., 2022; Yang, Cheng et al., 2020).
- Sustainability and efficiency: Digitization in building design and construction promotes sustainability by enabling analysis of long-term impacts and supporting complex decision-making processes for retrofitting and greener buildings (Muench et al.)
- Talent management: Digitalization supports the continuous development of human capital through training and talent management, which is key to maintaining an innovative and resilient workforce.
- Ethical and secure digitization: Consideration of ethical issues such as data privacy and cybersecurity can lead to best practices to ensure safe and responsible use of digital tools in public organizations.
- Improved crisis management: Digitalization can improve the resilience of public organizations, enabling more effective crisis management through real-time data and better communication tools (Gaie, Lacerda et al., 2022).
- Knowledge management: implementing continuous improvement plans based on critical knowledge can significantly increase organizational resilience, preparing them better for future challenges (Lima, Sell et al., 2023).
- Educational integration: developing educational programmes that integrate digitalization with public sector-oriented courses can better prepare future employees, ensuring a smoother transition and adaptation to digital technologies in public organizations (Müller-Török, Prosser et al., 2022).

As Elston, Bel et al. (2022) the use of advanced technologies to enhance situational awareness and operational efficiency can help organizations maintain or improve performance during unexpected adversity.

Digital maturity has also been linked to higher levels of organizational resilience, as digitally mature organizations showed better situational awareness and adaptive capacity during the COVID-19 pandemic (Robertson, Botha et al., 2022). Digital maturity was identified as a key driver of organizational resilience, with digitally mature organizations demonstrating greater adaptability and situational awareness during disruptions such as the COVID-19 pandemic (Robertson, Botha et al., 2022). This suggests that digital leadership, not just capabilities, play a key role in enhancing resilience (Robertson, Botha et al., 2022).

Furthermore, the resilience of community and care organizations during pandemics highlighted the role of absorptive, adaptive and transformational capacities in responding to crises, with organizations that created networks of trust and intra-organisational collaboration

adapting more effectively (Dayson, Bimpson et al., 2021; Orru, Nero et al., 2021). Finally, the development of resilience frameworks and models has facilitated a more profound understanding of the factors contributing to organizational resilience and provided a basis for further research into effective strategies for enhancing resilience in different organizational contexts (Tashiro, Kitago et al., 2024; Nair, Manohar et al., 2024).

Key findings and developments in the research topic of public organization digitization and organizational resilience include several aspects. Firstly, the digitization of public sector ICT is driven by factors such as increased self-service via the Internet, IoT, real-time business intelligence and integrated information systems, which are fundamentally changing the public sector ICT landscape (Müller-Török, Prosser et al., 2022). This transformation is particularly evident in the context of smart cities, which rely heavily on smart infrastructure (Müller-Török, Prosser et al., 2022).

Secondly, a focal point of the research was the resilience of public organizations, especially during crises such as the COVID-19 pandemic. The research showed that public organizations can maintain resilience by managing critical knowledge and developing continuous improvement plans based on this knowledge (Lima, Sell et al., 2023). Furthermore, the resilience of IT projects in public services has been enhanced by strengthening the organizational, operational, functional and design dimensions, which proved crucial during the pandemic (Gaie, Lacerda et al., 2022).

In addition, research highlights the importance of flexible organizational structures, a cohesive organizational culture and multi-stakeholder participation in promoting project success and resilience (Yang, Cheng et al., 2020). Public participation and the use of big data are also highlighted as important factors for improving organizational resilience (Yang, Cheng et al., 2020).

Finally, the transition to teleworking during the COVID-19 pandemic tested the resilience of public services and the results suggest that public services were resilient to the crisis and that the transition to teleworking was manageable for employees (Fischer, Siegel et al., 2022). This indicates that public organizations have the potential to adapt to significant changes in the working environment while maintaining operational resilience.

Recent developments in the digitization of public organizations and organizational resilience include various innovative approaches and tools to enhance resilience and adapt to changing environments. For example, the Resilience Analysis Grid (RAG) has been successfully used to assess and improve the organizational resilience of the Santa Catarina Civil Defence, demonstrating the importance of critical knowledge management in public organizations (Lima, Sell et al., 2023). In addition, information systems integration, particularly in the context of smart cities, has been identified as a key driver of public sector ICT digitization, fundamentally changing the landscape of public sector operations (Müller-Török, Prosser et al., 2023).

Digitising public organizations and enhancing organizational resilience are crucial in today's rapidly changing global landscape. Key challenges include integrating new technologies, managing the digital divide and ensuring continuous improvements in resilience through critical knowledge management (Lima, Sell et al., 2023; Müller-Török, Prosser et al., 2022; Skøtt, 2021).

5. Conclusion

The field of organizational resilience is evolving from a mechanistic view of bouncing back from the bottom after a crisis to a more adaptive and transformational approach that emphasizes learning and network relationships. Key challenges include the need for comprehensive assessment methods and a more profound understanding of the interaction between resilience and other organizational attributes such as digital maturity and social capital. In conclusion, the digital transformation of public sector organizations, driven by the rapid advancement of Industry 4.0 technologies and accelerated by the COVID-19 pandemic, presents both significant opportunities and challenges. As public organizations embrace digitization, they are increasingly equipped to enhance operational efficiency, support data-driven decision-making, and foster greater citizen engagement, all of which contribute to their resilience. Digitization allows these organizations to respond more effectively to crises, adapt to changing environments, and maintain continuity in public service delivery.

However, realizing the full potential of digital technologies in building organizational resilience requires addressing critical barriers such as outdated IT infrastructure, data privacy concerns, and resistance to change among staff. Successful digital transformation also demands strong leadership, a commitment to continuous learning, and the development of flexible structures that promote collaboration and innovation. Ultimately, digitization not only supports the immediate recovery and adaptive resilience of public organizations but also enables their long-term transformative resilience, positioning them to thrive in an increasingly complex and dynamic world. The integration of digital tools and strategies, when effectively managed, will be crucial for the continued evolution and resilience of the public sector in the face of future disruptions.

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DOES A PERSONAL BRAND REALLY CREATE TRUST? LEADER'S PERSONAL BRAND AND TEAM TRUST

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Purpose: This article presents pilot study findings on team leaders' use of the personal brand concept to support team trust-building.

Design/methodology/approach: A literature review identified personal branding activities potentially aligned with trust-building attitudes and behaviors. Preliminary empirical research, conducted via a diagnostic survey in May 2024, involved members and leaders of five teams from a major Polish retail chain.

Findings: The highest rated characteristic of strong personal brands surveyed team supervisors noted was communication ability. This is one of the factors necessary to build a personal brand. According to the survey results, personal branding activities can be effectively used in supporting the process of building team trust.

Research limitations/implications: The conclusions obtained from the presented research are worth verifying by conducting further research in other organizations. Furthermore, it is worth correcting and completing the list of activities that contribute to building a personal brand in the organization.

Practical implications: The results can help leaders effectively use the knowledge and skills needed to build a personal brand in supporting building trust within the teams they lead.

Social implications: Ensuring equal treatment of team members is a socially significant aspect of leadership, essential for building team trust. Such practices within work teams can influence broader social awareness and behaviors.

Originality/value: The analysis results and theoretical considerations discussed in this article complement existing research concerning the use of personal brand concept in building team trust.

Keywords: leader's personal brand, team trust, team management

Category of the paper: Research paper.

1. Introduction

Functioning in a world fraught with constant change is demanding for all organizations and individuals involved in social or economic life. The nature and size of the entity are not important here, although they undoubtedly influence the type of challenges it confronts. Collective, economic, institutional units and individuals are functioning nowadays in the B.A.N.I. world. (Cascio, 2020; Grabmeier, 2020; Le Roux, Lucinda, 2022). Reality is perceived therein as *brittle* (the world and all entities are exposed to catastrophes, nothing is certain), *anxious* (no decision is without risk, organizations and individuals therefore move constantly between fear and passivity), *nonlinear* (strategic planning in the classical approach no longer provides an advantage, every decision in a non-obvious and nonlinear way can lead to unimaginable consequences, often distant in time), *incomprehensible* (the possibility of action is the need to accept the impossibility of knowing all the answers). People naturally search for meaning and cause-and-effect connections. In modern reality, this is extremely difficult and often impossible.

The reality, which is proving to be so complex and unfavorable, enforces the search for even the smallest havens of respite allowing the fulfillment of the tasks assigned or the goals set. Precisely under such conditions trust gains importance. Trust is becoming the currency of the future (Szafranski, 2018). However, in the intermingling virtual and real worlds, it is difficult to trust even the simplest message, for it could appear to be a well-crafted fake news or deepfake. This can have an even stronger impact on the need for trust in teams, with people performing their assigned tasks daily. Research on team trust is developing rapidly in many directions, with many indications suggesting that it is one of the significant factors influencing teamwork's effectiveness (Dirks, de Jong, 2022). Distrust in the team can be seen as a fundamental dysfunction of teamwork (Lencioni, 2016a). Analyzing the factors that affect the ability to build trust in a team and developing recommendations for techniques that support trust are some of the significant challenges of today's organizations as well as team leaders.

Business practitioners as well as management and especially marketing researchers recognize that branding today is one of the important tools for building trust in an organization, product or service (Kall, 2001; Kim et al., 2019; Maurya, Mishra, 2012). While brand trust is not the same concept as people trust (Mathews, Gotsi, 2018), by looking at teams through the perspective of their members' personal brands, some potential synergies can be seen precisely in the use of a personal brand to build trust within a team. However, this possibility has not been sufficiently explored so far.

2. Leader's personal brand and team trust

The personal brand (PB) concept has been of interest to business researchers and practitioners since at least the late 20th century (Peters, 1997). However, many of its components were analyzed and practiced much earlier. The range of activities included in the broad catalogue supporting building a personal brand (BPB) has today become the preserve of people with very diverse professions: aristocrats (Otnes, Maclaran, 2018), politicians (Armannsdottir et al., 2020), entrepreneurs (Gandini, 2016), managers (Górska, Mazurek, 2021; Muszyńska, 2021; Nanton, Dicks, 2015), white-collar workers (González-Solar, 2018; Kucharska, 2022; Shyle, 2022), artists (Cocker et al., 2015; Kucharska, Mikołajczak, 2018). Personal branding is a concept used not only by the self-employed, although the intensity and variety of personal branding activities undertaken varies among different professional groups (Walczak-Skałecka, 2023; Walczak-Skałecka, Mieszajkina, 2021). Increasingly, personal branding is a tool used in corporate marketing, and employee personal brands are considered one of the value forms an organization can offer to various stakeholder groups (Kucharska, 2022; Muszyńska, 2022; Wojtaszczyk, Maszewski, 2014). It is also becoming increasingly challenging for team leaders to manage a team with employees committed to building their own personal brands (Sidor-Rządowska, 2016).

2.1. Personal brand in the organization

Building a personal brand can be done in many ways. Models discussed in the literature include: expert, celebrity, artist, creator, hustler, nomad, activist, politician or inspirer (Walczak-Skałecka, 2022a). Due to the business nature of their activities and diverse target groups, people building a personal brand decide on diverse actions, activities, communication channels, as well as diverse message categories. A scientist will build, enhance and communicate his brand differently from a personal finance specialist, an athlete or a performative artist.

One of the most frequently used models and the most appropriate in the case of an employee brand is the expert brand. Organizations, due to the nature of their activities, need employees with diverse intellectual capital, different fields of expertise and specific but undoubtedly very differing skills and qualifications. Assuming that every employee engages or should engage in personal branding activities hardly seems right, although the activity of every employee in one way or another affects the organization's ability to achieve its goals, as well as build its competitive advantage. Considering this, employees' intellectual capital seems to be an important factor (Szara, Pierścieniak, 2007; Stähle et al., 2011; Beyer, 2012; Rosińska-Bukowska, 2017; Panasiewicz, 2021). Personal brand – the expert focuses on using and communicating own knowledge and skills. This may be done through direct meetings, organizing or participating in internal and external events, sharing knowledge through internal

communication platforms within the organization or by blogging and speaking at conferences and meetings on topics related to one's area of expertise. A person focused on building a personal brand within an organization does not have to but can share knowledge with a wider audience (a presentation at an important industry event will influence the perception of such a person within the organization as well). These are activities related only to the brand presentation. However, the brand building process is not confined to communication alone (Wojtaszczyk, Maszewski, 2014; Scheidt et al., 2020; Walczak-Skałeczka, 2023), although this indeed is often the most accessible indicator of BPB activities undertaken.

In the case of a manager's personal brand, a leader's brand can equally prove effective, a model combining elements of activities and communications characteristic of either the expert model or the inspirer or hustler model.

2.2. Leader's personal brand as a tool to support building team trust

Trust is undoubtedly a complex concept, as it comprises a set of beliefs and predictions about certain social structures or individuals' intentions and behavior (Miłaszewicz, 2016). Trust and distrust are two opposite ends of a continuum within which we navigate in everyday social situations, they „are peculiar bets on the future, uncertain actions of other people” (Sztompka, 2006, p. 310). People don't only trust other people. The term is also used to refer to specific professions or functions, not individuals performing these responsibilities. Nowadays we trust companies, brands, products, political and economic systems (Sztompka, 2007). Trust is the bond that builds cultures, societies and teams. Trust in organizations is also the conviction that the people with whom we interact have the right knowledge, skills, qualifications (Penc, 2011, p. 326) and attitudes that will support the realization of the common goals that organization sets for individuals. Organizational trust is one of the factors supporting today's crucial enterprise innovation. Manager-employee trust and trust in other team members are important components of organizational trust and influence team members' commitment, openness and innovation (Krot, Lewicka, 2012; Lewicka, Krot, 2014). The literature on team trust is quite extensive (Feitosa et al., 2020; Dirks, de Jong, 2022), and the rapid changes we are experiencing necessitate further exploration of this topic (np. Breuer et al., 2016; De Jong et al., 2016; Costa et al., 2018; Grossman, Feitosa, 2018). The situation is similar in the brand trust area (np. Dryl, 2012; Kim et al., 2019; Marmat, 2023), although to analyze so far here have been institutional or product brands. Area of building team trust appear to be still insufficiently explored, at least when we consider a team not only as a work team, but also as a team of people building their own personal brands.

3. Methods

Building a personal brand involves specific knowledge, skills and competencies, with specific cultural and social capital. Undoubtedly, it is a concept and elaborate set of tactics and tools nowadays, designed to influence the building of a positive image, increase credibility and recognition in specific audiences, in particular contexts, based on a specific set of desired associations and activity fields. The research problem can be formulated as follows: whether people who engage in building a personal brand use competencies from this area in their leadership roles, among other things, to build the team trust they lead. The research conducted aimed to identify key abilities used in leaders' personal branding, which they also use to build trust within teams.

'For today's business leaders, personal branding is seen as a necessity' (Macalik, 2023, p. 42). The efforts of managers at various levels in this area of activity are often focused on social media presence, building contacts and creating a consistent image (Cottan-Nir, 2019; Gandini, 2016; Harris, Rae, 2011; Muszyńska, 2021). On this basis, a hypothesis H1 was formulated.

H1. Leaders undertake various activities such as social media activity, networking and creating a consistent image to build their personal brand.

The impact of a leader's personal brand on different stakeholder groups is related to their perception of that brand (Cottan-Nir, 2019; Górska, Mazurek, 2021), which leads to the H2 and H3 hypotheses.

H2. Employees are aware of actions taken by leaders in building a personal brand.

H3. Employees positively evaluate the effects of leaders' personal branding efforts regarding team trust.

Among many characteristics that are associated with personal brand builders (Walczak-Skałeczka, 2022b), authenticity, empathy, honesty and the ability to communicate effectively stand out as those that contribute to building better relationships outside the context of personal branding (Costa et al., 2018; Dirks, de Jong, 2022; Krot, Lewicka, 2012; Mathews, Gotsi, 2018). On this basis, hypothesis H4 was formulated.

H4. Leader's personal brand characteristics perceived as key to team trust are authenticity, empathy, honesty and the ability to communicate effectively.

The research presented in this paper is a pilot study. A diagnostic survey method using a computer-assisted web interviewing (CAWI) technique was used to verify the hypotheses. The research tool was proprietary survey questionnaires – one for the team leader, one for the other team members. The questionnaire for team leaders focused on the personal branding activities undertaken by the leader. The questionnaire for team members, in addition to questions on evaluating the diversity of leaders' personal branding efforts, included questions

on assessing the trust level within the team, including in the team leader. Both questionnaires used a five-point Likert scale.

The survey was conducted among employees from one of the largest retail chains operating in Poland. The company offers a wide range of food products, household chemicals, hygiene products and various everyday products. The organization has been present in the Polish market for almost thirty years. Participation in the survey was voluntary. Five teams participated in the survey. The only inclusive condition was the response from both the team leader (manager or deputy manager) and team members (in two of the five teams surveyed, all employees participated). The total number of participants in the survey was thirty-nine, 74% were women.

4. Results

Trust in the supervisor in the surveyed teams was highly evaluated (Table 1). One indicator was rated lower than the others (averaging 3.90) - the supervisor's efforts to treat all team members equally.

Table 1.
Trust evaluation for supervisor in individual teams

Item	Team 1	Team 2	Team 3	Team 4	Team 5	Average evaluation
I have trust in my supervisor	5	5	4.75	5	5	4.95
In case of difficulties at work, I can turn to my supervisor for help	5	5	4.88	5	5	4.98
In conversations with me, my supervisor is honest	4.67	4.67	4.88	4.86	4.67	4.75
My supervisor tries to treat everyone equally	3.33	3.33	4.63	4.71	3.5	3.90
My supervisor keeps his promises	4.67	4.67	4.5	5	4.83	4.73
My supervisor is not withholding important information from me	4.5	4.5	4.5	4.71	4.17	4.48
I have trust in the decisions that my supervisor makes	4.5	4.5	4.63	5	5	4.73
My supervisor shows empathy and understanding towards my needs	4.67	4.67	4.63	4.86	4.83	4.73

Source: own elaboration.

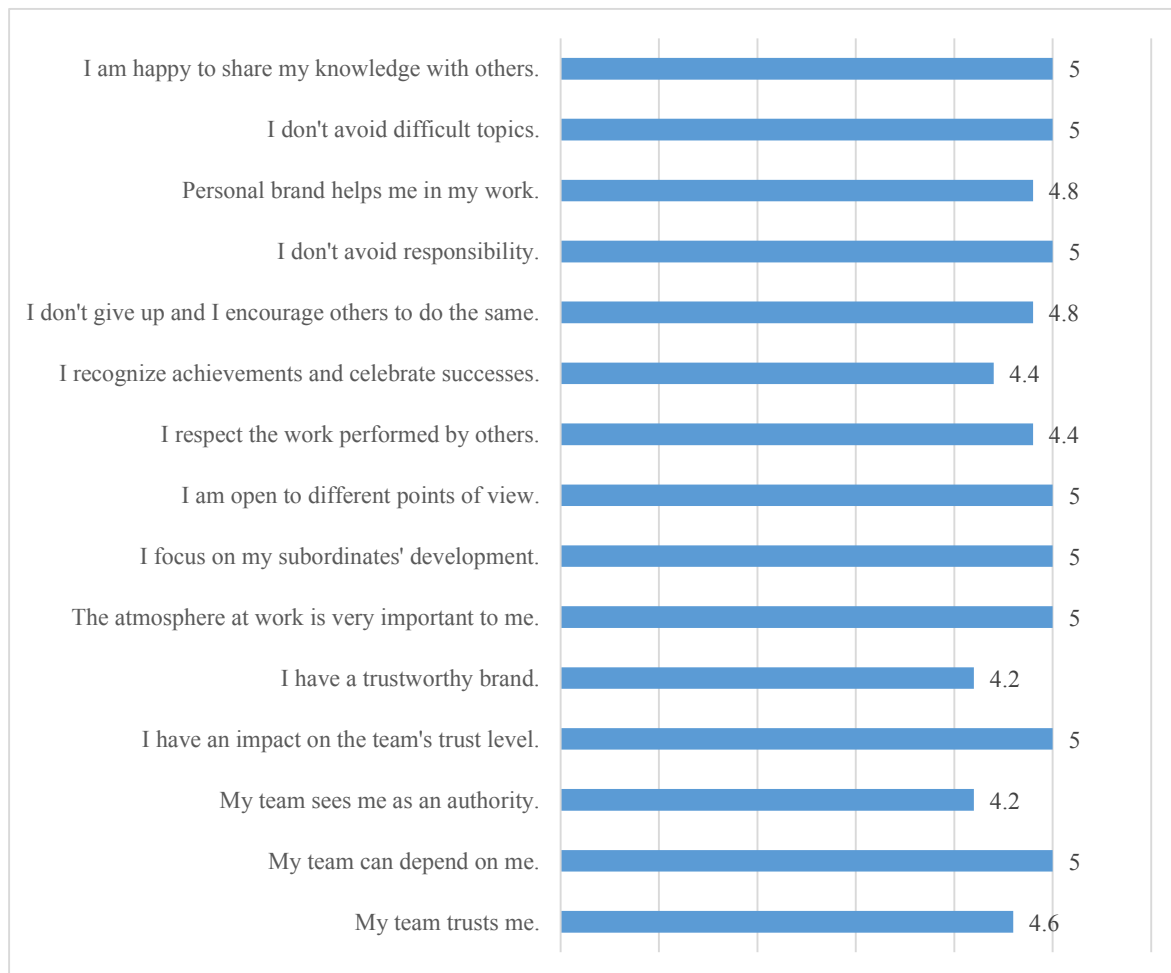
Team members also evaluated which supervisor behaviors they believe affect building team trust (Table 2). In all teams, the evaluation of the behaviors presented by supervisors performed very well. The average evaluations ranged from 4.54 to 4.9. These behaviors are large components of certain corporate standards that should be but are not always, respected in specific organizations or teams.

Table 2.*Evaluation of behaviors affecting trust building in the team (evaluation of team members)*

Item	Team 1	Team 2	Team 3	Team 4	Team 5	Average evaluation
Ability to admit mistakes made	4.57	5	5	4.86	4.17	4.72
Providing feedback	5	4.83	4.83	4.86	4.67	4.84
Listening and asking the team for their opinions and suggestions	5	4.83	4.83	4.71	3.83	4.64
Acting fairly	4.57	5	5	4.86	4.67	4.82
Showing respect	4.86	4.83	4.83	5	5	4.90
Taking responsibility	4.86	4.5	4.5	5	5	4.77
Showing results	5	4.5	4.5	5	5	4.80
Defining expectations	5	4.5	4.5	5	4.5	4.70
Righting the wrongs	4.71	4.83	4.83	5	4	4.67
Giving trust to others	4.71	4.83	4.83	4.86	5	4.85

Source: own elaboration.

Team leaders were asked to self-assess the proposed indicators of the team's trust in the supervisor (Figure 1).

**Figure 1.** Evaluation of the leader's behaviors that build trust among team members (self-assessment).

Source: own elaboration.

Three of them averaged less than 4.5 in the self-assessment: I have a trustworthy brand, my team sees me as an authority, and I recognize achievements and celebrate successes.

Surveyed team leaders were asked to self-assess their degree of involvement in various personal branding activities (Figure 2).

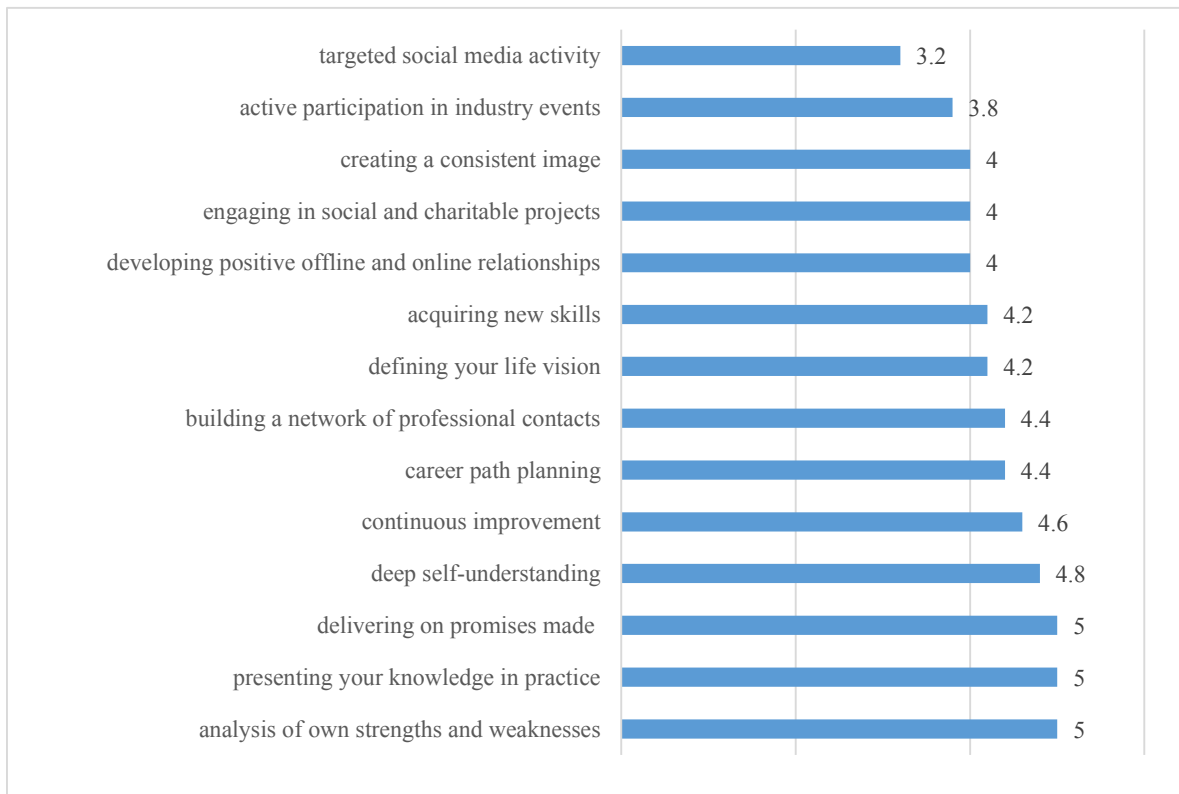


Figure 2. Activities undertaken by leaders in building a personal brand (self-assessment).

Source: own elaboration.

They are least likely to engage in targeted social media activities. Of the fourteen indicators, as many as nine received an average evaluation of less than 4.5. Therefore, the surveyed team leaders undertake a variety of personal branding activities, but they are not very intensive. Hypothesis one cannot be confirmed, no group of activities included in it received an average score of 4.5.

Team members also evaluated their supervisors' engagement levels in personal branding activities (Table 3). The only indicator evaluated below 4.5 was *the skillful use of social media*. It received an average score of 4.35. This evaluation can result from several reasons, ranging from a lack of interest in keeping in touch with a supervisor on social media, to a supervisor's lack of interest in using this means of communication to build a personal brand, to a lack of ability to use social media or to evaluate that use. Also interesting is the low rating in the two indicator teams *has clear values and mission*. Lack of understanding of a supervisor's personal values and missions can indicate an inability to communicate them adequately, as well as other reasons. However, regardless of the reasons, misunderstanding in this area can long term affect team trust.

Table 3.*Team members' level of awareness of supervisors' efforts to build their personal brands*

Item	Team 1	Team 2	Team 3	Team 4	Team 5	Average evaluation
Is consistent in his actions	5	4.83	4.75	5	4.67	4.85
Is consistent in his words	5	4	4.63	5	4.83	4.69
Has clear values and mission	4.86	4.17	4.88	5	3.83	4.55
Has the ability to communicate effectively	5	4.5	4.75	5	4.5	4.75
Has the ability to build relationships with other people	5	4.5	4.75	4.86	4.67	4.76
Takes care of his personal development	5	4.67	4.75	4.86	4.83	4.82
Takes care of his professional development	5	4.83	4.88	4.86	4.83	4.88
Skillfully uses social media	4.29	4.33	5	4.14	4	4.35
Works according to the declared values	5	4.83	4.5	5	4.67	4.80

Source: own elaboration.

Hypothesis two should be considered confirmed. Employees are aware of the personal branding activities undertaken by their superiors.

The impact of supervisors' actions on the team was evaluated (Table 4). The average scores for all indicators were high: 4.51-4.89. Interestingly, the greatest fluctuations are seen between the teams regarding *stimulating creativity and encouraging innovation*.

Table 4.*Evaluation of the supervisor's actions on the team*

Item	Team 1	Team 2	Team 3	Team 4	Team 5	Average evaluation
Inspire	4.71	5	4.5	4.57	4.17	4.59
Motivate	4.86	5	4.63	5	4.67	4.83
Stimulate innovation	4.57	4	4.63	4.86	4.5	4.51
Stimulate creativity	4.71	4	4.63	4.86	3.83	4.41
Encourage personal development	4.86	4.5	4.63	4.86	5	4.77
Encourage professional development	4.86	4.33	4.63	4.86	5	4.74
Improve communication	4.57	5	4.75	5	4.83	4.83
Facilitate conflict management	4.43	4.83	4.63	5	4.83	4.74
Improve the atmosphere	4.86	5	4.75	4.86	5	4.89
Improve cooperation	4.86	4.67	4.75	5	5	4.86

Source: own elaboration.

Hypothesis three should be considered confirmed.

Team members evaluated the extent to which their superiors demonstrate qualities identified as important for personal branding (Table 5). The highest average ratings were given to *communication skills and responsibility*. The lowest, on the other hand, was *humility and a person who is known*.

Table 5.

Important characteristics in building a personal brand presented by the surveyed teams' supervisors

Item	Team 1	Team 2	Team 3	Team 4	Team 5	Average evaluation
High qualifications	4.86	4.63	4.88	4.86	4.83	4.81
Extensive experience	5	4.33	4.75	5	4.67	4.75
Professional in his field	4.86	4	4.75	4.86	4.33	4.56
Effectiveness in achieving goals	5	4.5	4.88	4.86	4.67	4.78
Role model	4.86	4.33	4.88	4.71	4.5	4.66
Successful person	5	4.33	4.63	4.71	4.17	4.57
Has an extensive network of contacts and business relationships	5	4.5	4.88	4.57	4	4.59
Person who is known	4.86	4.67	4.38	4.71	3.17	4.36
Persistence	4.86	4.17	5	4.86	4.5	4.68
Confidence	5	4.17	5	4.71	4.5	4.68
Authenticity	5	4.5	4.63	4.71	4.83	4.73
Empathy	4.57	4.33	4.67	4.71	4.83	4.62
Honesty	4.86	4.5	4.88	4.86	4.67	4.75
Ability to cooperate	5	4.5	4.88	4.71	4.83	4.78
Determination	5	4.5	4.63	5	4.5	4.73
Respect for others	4.71	4	4.75	5	5	4.69
Has communication skills	5	4.67	4.88	5	4.83	4.88
Appreciates achievements	5	4.37	4.75	4.71	4.33	4.63
Decisiveness	4.86	4.17	4.5	5	4.33	4.57
Humility	4	4.17	4.38	4.57	3.67	4.16
Engagement	4.86	4.33	4.88	5	4.83	4.78
Openness to change	4.57	4.17	4.88	5	4.33	4.59
Responsibility	5	4.5	4.88	5	5	4.88

Source: own elaboration.

The fourth hypothesis can be considered partially confirmed. Surveyed team members ranked communication skills as among the most important characteristics presented by their superiors for building a personal brand, which positively impacts team trust. Authenticity, empathy and honesty were evaluated highly, but not the highest.

5. Discussion

Team members who participated in the preliminary survey trust their superiors, as indicated by their acceptance of the attitudes and behaviors presented by their superiors. This is the basis of all relationships in the organization (Ghosh, 2014; De Jong et al., 2016; Dirks, de Jong, 2022). However, trust has its own internal dynamics, so trust can not only be given, but also lost. This means that once gained, the trust of team members must be nurtured. Therefore, team trust should be continuously worked on (Lencioni, 2016b). Among the surveyed teams, *equal treatment of team members by the supervisor* proved to be an issue worth examining. It is an extremely important topic in research, business practice and public debate (Blustein

et al., 2016; Allan et al., 2020; Nourafkan, Tanova, 2023), and the sensitivity of employees as well as managers on this issue is undoubtedly growing.

Surveyed team leaders rated quite highly their behaviors and attitudes toward building team trust. One of the lowest rated items was *having a trustworthy brand*. This may indicate that these individuals do not see themselves in the personal brand context. Another reason may be humility, although this one in the average team evaluations was indicated as rarely present among the surveyed team leaders. Leaders participating in the survey were reluctant to admit that they were seen as authorities by their teams. Perhaps because of the personal definition of authority, which would be worth clarifying in the next survey. Their team members evaluated them highly regarding their responsibility, authenticity, knowledge and experience, while their actions were described as motivating and inspiring. Aren't these the qualities and terms we tend to ascribe to our personal authorities? These are also qualities that are often associated with personal brands (Malinowska-Parzydło, 2015, p. 302; Walczak-Skałeczka, 2022b).

Subordinates notice their superiors' activities in building their personal brand. Their observations are also largely consistent with their superiors' self-assessments in this regard. This confirms the widespread use of the personal brand concept. (Osorio et al., 2020; Gorbatov et al., 2023). The low level of engagement in the purposeful use of social media for team leaders' personal branding is in keeping with the need to tailor the tools to both the nature of the brand and the recipient group of the personal brand. In the context of strengthening team trust, such activity appears unnecessary in light of these results. Interpersonal communication skills are more important, as they are not only a basic tool for a leader working with a team, but also a basic tool for building a personal brand in an organization. Therefore, at this point, the use of the personal brand concept can support the building of trust in the team.

Organizations create behavioral standards and develop competency profiles for individual positions. Not every organization can afford to do such actions, and not every organization has people with the right knowledge and skills. However, where such documents are introduced, it is essential to periodically verify to what extent they are completed. The scales used in the research were based on literature research and some minimum standards of social coexistence. It would be interesting to see to what extent they are consistent with the standards prepared and implemented by the organization under survey.

It also seems interesting that humility and recognition received such low indications. A personal brand is a concept that considers recognition in specific circles to be one of the primary outcomes of actions taken (Żyrek-Horodyska, 2020; Muszyńska, 2024). However, perhaps the terminology in this area needs to be refined. It is also possible that building a personal brand within an organization, as well as the leadership role itself, differs significantly in this regard from the practices and effects of building a personal brand in the free market among independent professionals or influencers. This is one of the interesting directions for further research.

6. Summary

Personal brand is an interesting field of theoretical inquiry, as well as a developing set of practices in various areas of market activities. Although the concept is directly derived from marketing, it is used in the personal field of individual human activity, and this means that it is primarily a concept for building relationships in different contexts, with different groups, for different purposes, using different tools. Therefore, it seems important to examine how building a personal brand affects these relationships also regarding teamwork, where trust is a basic condition for building any relationship. The pilot study's results seem interesting given that team leaders more or less consciously engage in personal branding activities, and their team members not only notice this but are also able to consider the extent to which personal branding competencies are useful in their collective teamwork.

Due to the preliminary nature of the research, the possibilities for broader conclusions are limited. In the future, it is worth inviting organizations from other industries and of varying sizes to the survey. Indeed, there is a possibility that the involvement in team leaders' personal branding activities will be significantly different in large, corporate-type organizations and medium-sized or small enterprises.

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RANKING OF STAKEHOLDERS INFLUENCING THE FLOW OF GOODS IN THE CITY

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Purpose: The main purpose of this paper is to identify the main stakeholders of freight flows in a city using an expert method. The research conducted will attempt to answer the following research question: Which stakeholders have the greatest influence on freight flows in the city?

Design/methodology/approach: The research on the city's stakeholders important for the city's freight flows started with the identification of typical city stakeholders based on a literature analysis. A survey questionnaire was then created to determine the strength and direction of influence of each stakeholder and distributed to 12 experts. The final stage of the research was to determine the average score for each stakeholder.

Findings: Based on the literature research, various stakeholders of the city that can influence the flows of goods in the city were identified. Following the research, four stakeholders were identified that, according to experts, are of key importance in the city's goods flows.

Research limitations/implications: The research was limited to a narrow group of experts. In the future, the research should be broadened to include the opinion of a wider group of respondents.

Originality/value: The paper shows the stakeholders that are important, not only in urban goods flows, but also in urban logistics in general. The paper can become a valuable source of information when modelling urban goods flows, but also provides a foundation for building urban goods flow management.

Keywords: city logistics, urban goods flows, city stakeholders.

Category of the paper: Research paper.

1. Introduction

Transport is one of the most important elements of a city's logistics. Freight transport reflects all aspects of a city's economic activity and for this reason its proper planning is of paramount importance. Freight transport permeates many spaces of city life and influences the development and marketing significance of a city. It is also very important from the perspective of the individual resident. In order to meet the challenge posed by the city's freight transport

system, a reliable planning framework is needed to analyse and implement any measures aimed at increasing the efficiency of the city's freight transport system, while minimising external costs and environmental damage. For this reason, it is important to know the stakeholders of freight flows in the city's logistics system with a primary and secondary role. The research conducted will attempt to answer the following research question: Which stakeholders have the greatest influence on the flow of goods in the city?

The topic of this paper therefore focuses on identifying the main stakeholders in urban freight flows using the expert method. The research hypothesis was also formulated: "Identifying key stakeholders will enable their active involvement in the urban logistics planning process and the optimization of freight flows by improving collaboration, increasing social acceptance of implemented solutions, and making more efficient use of urban infrastructure".

Undoubtedly, one factor in the continued growth in popularity of road transport is the development of cities and their infrastructure. The possibility of accessing places that were previously inaccessible is increasing (Krysiuk et al., 2015). The problems and determinants affecting urban freight flows are the subject of much debate. A study in the UK found that around 40% of traffic in London belongs to cars delivering products to businesses and courier deliveries. A study in Germany found that as much as 80% of all transport carried out in urban areas is done using road transport (Kijewska, Iwan, 2011). T. Crainic notes that 'city logistics was created to emphasise the need for the consolidation of the loads of different forwarding and transport companies using the same means of transport and the coordination of activities resulting from freight transport in a city' (Kiba-Janiak, 2018). Thus, the management of urban freight flows is one of the basic logistics activities in urban areas and directly affects its functioning.

2. Literature review

2.1. Freight transport system in the city logistics system

Freight transport plays an important role in cities, supporting industrial and commercial activities and contributing to the competitiveness of industry in a region. It influences economic strength, product availability and the quality of life and attractiveness of urban areas (Macharis, Melo, 2011). Freight flows in urban areas account for 20-30% of total vehicle kilometres (Dablanc, 2007). Cities need freight transport, but often underestimate its importance ((Macharis, Melo, 2011; Macharis, 2011). In the literature, many approaches can be found to define the structure of the freight logistics system. On the one hand, it can be defined from the point of view of the elements consisting of needs, structure and organisation (Jachimowski

et al., 2011) and the links between these elements (Rodrigue, 2020). On the other hand, some studies (Rodrigue, 2020) include a network approach to determine the structure of the freight transport system.

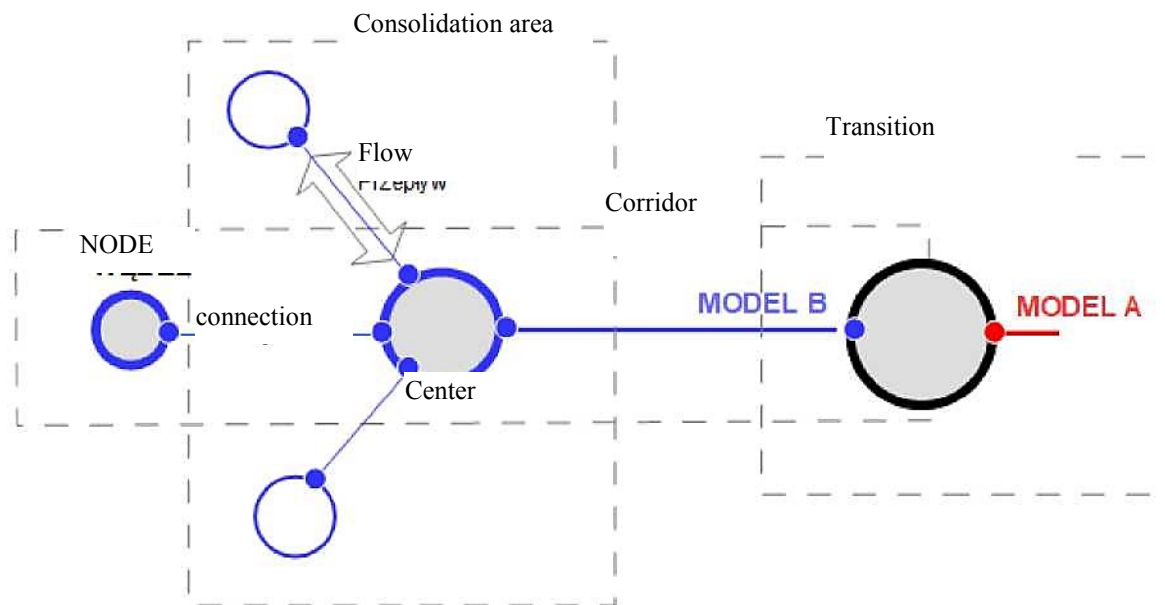


Figure 1. Structural elements of transport networks.

Source: Rodrigue, 2020, p. 643.

Transport networks, like many other networks, are generally shaped as a set of locations and a set of links representing connections between these locations (Figure 1). The layout and connectivity of a network is known as its topology, with each transport network having a specific topology. The most basic elements of such a structure are the geometry of the network and the level of connectivity. A freight transport system can also be defined as a technical¹, organisational² and economic/legal³ system that operates under conditions shaped by its environment, its performance largely depends on the degree of integration of the system and the environment in which it operates. There is no single precise model of a logistic transport system, but certain elements and fixed tasks can be distinguished, which are present in most of them. These include: supply centre operations, inventory management, delivery performance and the infrastructure to perform these tasks. The transport system also includes the coordinated activities of those responsible for loading, storage, transport, unloading, labelling, packaging, picking, etc.

¹ This should include: rolling stock, roads, transport points and hubs, transshipment and transport facilities and technical facilities.

² It is constituted by the links and rules of intra-company transport cooperation, as well as the links and rules of cooperation between the transport contractor and the environment.

³ It defines tariffs, legal and financial aspects.

In turn, D. Boyce (Boyce, 2016) states that a freight transport system is a three-element set, which may include:

- load handling facilities and their equipment,
- objects that enable the movement process,
- sets of procedures, enabling the movement of cargo and people in a safe and organised manner.

In line with the presented approaches to defining the freight transport system, most authors emphasise that an adequate infrastructure is an essential element of the system (Gołemska, 2010).

The listed set of elements of the freight logistics system significantly influences the functioning of freight flows in the city logistics system. The modernity of the elements and their good coordination allow for the smooth movement of freight in cities. However, in order to coordinate and strengthen the internal links between the system elements, it is necessary to use electronic information flow systems in parallel. The systems currently available and in use are developed independently of each other and work on the basis of many independent databases. There is therefore a need to create solutions that would contribute to greater coordination of activities in the freight logistics system, thereby reducing delays, avoiding excess inventory, or lowering the costs of operating such a system (Sungwon, 2001).

Urban freight transport, in order to perform its specific tasks, requires an appropriate technical environment, but also proper management. It has three important functions:

- consumption based on meeting transport needs,
- production to create an appropriate business environment,
- integration in the management of tangible and intangible resources (Kozłak, 2010).

Additional functions, considered as complementary, can be divided into two groups: economic and social. Goods flows in the city's logistics system and their impact on the ecology. In recent years, there has been an increase in the use of road transport. One of the reasons for this is the increasing use of the just-in-time strategy, according to which delivery should be fast and reliable.

However, the main disadvantage of the transport system as a whole is that it generates high external/social costs, which include:

- air pollution through exhaust emissions,
- accidents and catastrophes in land, water or air traffic,
- high infrastructure maintenance costs,
- noise emissions,
- occupation of greenfield sites for the construction of transport infrastructure (Kempa, 2014).

However, considering the needs of society in terms of demand for transport services, it should be emphasised that the importance of urban freight transport is increasing, and stopping freight traffic in the city could result in large consequences, as also highlighted by McKinnon in his research (McKinnon, 2006). A similar study was carried out by S. Åkeriföretag (Åkeriföretag, 2020), who only confirmed McKinnon's thesis that stopping basic transport functions in the city, i.e. food supply, rubbish collection, would cause chaos on all social levels. Increasing consumer expectations mean that the transport system of the 21st century should be characterised by a high degree of flexibility and frequency of delivery, while maintaining a high quality of service and safety of the goods transported. Short delivery times and low transport costs are also important. All these features imply the need for continuous change in the transport system. The development of e-commerce is also not without significance, which contributes to the high volume of groupage shipments delivered to city centres. This transport is carried out to the greatest extent using road transport due to the dispersion of consignees and senders within the city (Mężyk, Zamkowska, 2016).

A negative factor affecting the city's logistics system is congestion, i.e. congestion on transport routes. This is a concept most often used in relation to road transport, but it can be applied to any other transport mode. A. Altshuler defines congestion as a situation in which the demand for use of an infrastructure facility prevents free flow at the maximum permitted traffic speed (Mucha, 2010). One of the most troublesome effects of congestion is the loss of time, which directly affects most of the participants in the transport process and prevents the delivery of a good within a certain timeframe. Another negative factor affecting the functioning of the city's logistics system is traffic noise emitted from transport means and road, rail, air and water infrastructure. The noise problem is increasing year on year, especially in densely populated cities. In the literature, noise is defined as "any unwanted, unpleasant, annoying or harmful mechanical vibration of an elastic medium acting through the air on the organ of hearing and other senses and elements of the human body" (Szołtysek et al., 2012).

The negative impact of road transport on the functioning of the city's logistics system can also include damage to the infrastructure by heavy goods vehicles. Although Poland's road infrastructure covers about 3% of the country's area, about 50% of Poland's area is within the direct influence of traffic pollution. Soils and vegetation even 50m away from the road are exposed to heavy pollution, which reduces its ability to graze animals (Badyda, 2010).

Compared to any other mode of transport, road transport has a major impact on the environment and on the lives of residents. It is one of the biggest generators of air pollution in the city.

2.2. Stakeholders in freight flows in the city's logistics system

There are many shipment and receipt operations within the city, and it happens that entities located outside the city are responsible for freight flows within the city. Most of the transport is carried out in a chaotic and uncoordinated way, as it is the responsibility of different actors,

who are mainly driven by their own interests. It is therefore worth analysing which links in supply chains determine how and when a transport service order is fulfilled. One of the actors influencing the freight flow process in a city is the logistics centre, which is a stop for many transported goods. It is one of the most popular ways to reduce costs associated with the procurement, storage, distribution and forwarding of goods. Logistics centres are an important part of the supply chain, providing its members with logistics services (Ying, Dayong, 2005) and fostering relationships between them that depend on mutual commitment to end-customer satisfaction, common goals, trust, interdependence, good communication to look after the interests of the other partners (McQuiston, 2001). Further actors influencing the movement of goods in the city are freight forwarding and transport companies. Forwarding is an integral part of the transport process in the TSL industry. A key characteristic of many forwarding companies is good organisation and planning. Freight forwarders are usually responsible for all formal and legal issues. They are also obliged to react quickly in the event of problems along the route or breakdowns.

Urban freight transport typically accounts for around a quarter of the value of road space use. It is estimated that freight tonne-kilometres will increase by 63% by 2030 and, that freight transport will reach an energy consumption of 45% in 2030 in the context of total transport (Civitas, Cities, 2019).

3. Results

3.1. Assumptions and description of the method

A group expert appraisal method was used to detail the stakeholders with the greatest influence on the flows of goods in the city. Group expert assessment uses the idea that the collective opinion of many experts is more accurate than that of a single individual. The diversity of experience and knowledge of the group allows for more objective and comprehensive assessments.

The method was applied in terms of determining the relative importance of the individual experts' assessments of the sites. The appropriate selection of the expert team influences the outcome of the study; it should be competent and consist of high-level experts with moderately concordant opinions. The expert competence index can be defined as the arithmetic mean of the coefficient of the expert's degree of familiarity with the given problem and the argumentation coefficient obtained on the basis of the self-assessment included in the questionnaire (formula 1) (Żebrucki, 2012).

$$K_k = \frac{k_z + k_a}{2} \quad (1)$$

where:

K_k - expert competence coefficient,

K_z - coefficient of the expert's degree of familiarity with the problem, taking a value in the range $<0.1>$, based on the self-assessment carried out,

K_a - argumentation coefficient, taking a value in the range $<0.1>$ based on the self-assessment carried out.

In this research, the potential stakeholders of the city who influence the flows of goods in the city were taken as the object of the assessment. A team of 12 experts was appointed for the assessment. The questionnaire sent out to the experts consisted of two parts. The first, necessary to determine the expert's competence coefficient, and the second, in which the importance of individual city stakeholders was assessed. The coefficient for the expert's degree of familiarity with the problem was determined on the basis of the expert's self-assessment on a six-point scale (Table 1). The respondent was asked to objectively indicate his or her own familiarity with the problem.

Table 1.

Expert self-assessment scale

Item	Expert self-assessment table	pt.
1.	Expert does not know the problem	0
2.	Expert knows little about the problem	1
3.	Expert has a satisfactory knowledge of the problem, but it falls within his sphere of interest	2
4.	Expert is sufficiently familiar with the problem, but not involved in practical problem solving	3
5.	Expert knows the problem well, participates in practical problem solving	4
6.	Expert knows the problem very well and it belongs to the expert's narrow specialisation	5

Source: Own work based on: Sorychta-Wojaszczyk, 2010, p. 95.

The expert's familiarity factor K_z is calculated as the product of the points indicated by the respondent and a value of 0.1. The argumentation factor K_a is determined taking into account the structure and sources of arguments used by the expert. During the survey, respondents should indicate the way in which they argue for individual objects or the whole group of surveys. The argumentation coefficient is determined as the sum of the values indicated by the expert in Table 2.

Table 2.

Degree of influence of the argumentation on the expert's opinion

Source of argumentation	Argumentation		
	high	average	low
Expert's theoretical analysis	0,5	0,3	0,2
Practical experience of Expert	0,5	0,35	0,15
Generalisation of the work of indigenous authors	0,05	0,05	0,05
Expert intuition	0,1	0,1	0,1

Source: Own work based on: Żebrucki, 2012, p. 147.

The following assumptions were taken into account in constructing the argumentation degree table (Męczyńska, 1999):

- argumentation factor $K_a < 1$,
- argumentation factor increases when moving from theoretical analysis to practical experience,
- certain threshold value for the competence factor ε is set (e.g. $\varepsilon = 0.5$). If $K_k \geq \varepsilon$, the expert concerned is appointed to the team.

1.1. Research results

The team of 12 experts was presented with an initial list of city stakeholders who might influence the flows of goods in the city, selected on the basis of literature research. The experts were then asked to identify their competences, according to an expert self-assessment table, to state the influence of the argumentation source on the expert's description and to evaluate the stakeholders on the list. A summary of the argumentation coefficients (k_a), the expert's degree of familiarity with the problem (k_z) and competence (K_k) is provided in tab 3.

Table 3.

Summary of coefficients of the expert's degree of familiarity with the problem, argumentation, competence.

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
kz	0.5	0.3	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.6	0.2	0.3
ka	0.5	1.15	1.15	1.15	1	0.8	1.15	0.7	0.7	0.8	0.8	0.8
Kk	0.5	0.725	0.825	0.825	0.65	0.55	0.725	0.5	0.5	0.7	0.5	0.55

Source: own work.

In line with previous assumptions, 12 experts were appointed to the team with a competence coefficient value of $K_k \geq 0.5$. The research on the city's stakeholders important for freight flows in the city started by identifying typical city stakeholders based on a literature analysis.

A list of typical stakeholders (primary - i.e. those with a direct impact on freight flows in the city's logistics system and secondary - their importance in the decision-making process is not crucial, they are not directly affected by freight flows in the city's logistics system) divided into four categories: government, business, community and others is presented in Table 5.

Table 4.

List of typical stakeholder groups involved in freight flows in the city's logistics system

Government/Authorities	Companies/operators	Local communities	Other
Local governments	National business associations	Associations	Business environment institutions
Neighbouring cities	International/national companies	Trade unions	Experts
Organisations responsible for transport development	Regional/local companies	Local community organisations	Media
Other local transport authorities	Local business associations	Local interest groups	
Other local authorities	SME	Society	
Politicians	Logistics operators		
Other decision-makers	Transport service providers		
	Transport companies		
	Carriers		

Source: own work based on: Dohn, Knop, Kramarz, Przybylska, 2019, p. 90.

Next, using the expert method, the strength of influence of the identified stakeholders on freight flows in the city's logistics system was determined. The prepared strength of influence assessment sheet for the identified stakeholders was critiqued by expert judges. The group of experts included a total of 12 persons. Three representatives of the local government, seven people associated with the city logistics research community and two people involved in the city's transport systems. The questionnaire was sent out electronically to the experts invited to the study. In addition to questions regarding their direct knowledge of the influence of stakeholders on freight flows in the city, they were also asked about the role of the stakeholders concerned in the city and their impact and influence on the city's functioning. The questionnaire ended with questions taking into account the expert's self-assessment of their knowledge of the issues under study. The following rating scale was adopted:

- Role of the stakeholder:
 - Foreground 2 pt.
 - Secondary 1 pt.
- Impact and influence (direction and strength of influence):
 - Positive strong 2 pt.
 - Positive weak 1 pt.
 - Neutral 0 pt.
 - Negative weak 1 pt.
 - Negative strong 2 pt.
- Stakeholder interest (impact of commodity flows on stakeholder interests):
 - Very strong impact 2 pt.
 - Strong impact 1 pt.
 - Neutral 0 pt.
 - Weak impact 1 pt.
 - Very weak impact 2 pt.

Each expert assessed all stakeholders in terms of their role, impact and influence on the flows of goods in the city and, the impact of the flows on the stakeholder's interest. The results obtained were analysed and summarised in a table (Appendix 1). For each stakeholder, the average of the scores obtained was calculated taking into account all three aspects examined. The results are presented in Table 4.

Table 4.
Average ratings from expert reviews

Stakeholder	Average stakeholder rating
Local governments	1
Neighbouring cities	0.527778
Regional/local companies	0.972222
Other local transport authorities	0.583333
Other local authorities	0.75
Other decision-makers	0.444444
National business associations	0.583333

Cont. table 4.

International/national companies	0.694444
Organisations responsible for transport development	0.916667
Local business associations	0.777778
SME	0.777778
Logistics operators	0.916667
Transport service providers	0.833333
Transport companies	0.75
Carriers	0.833333
Associations	0.583333
Trade unions	0.527778
Local community organisations	0.666667
Local interest groups	0.694444
Society	0.972222
Business environment institutions	0.583333
Experts	0.555556
Media	0.416667

Source: own work based on surveys conducted.

According to the experts, the most important stakeholder influencing freight flows in the city is the local government, as shown in Table 4. In second place were the public and local businesses (mean approx. 0.97). This was followed by logistics operators and organisations responsible for transport development. The least influence on freight flows in the city, according to experts, is the media.

4. Discussion

Despite numerous scientific articles highlighting the significant role of stakeholders in urban logistics, most focus on using their opinions to study specific phenomena (Szmelter-Jarosz, Rześny-Cieplińska, 2020). In research on stakeholder analysis related to urban freight transport, stakeholders are typically treated as individuals, organizations, or companies acting as respondents and opinion providers (Matusiewicz, Rolbiecki, 2021). However, few studies analyze stakeholders in the context of urban freight flows. The author of this article emphasizes the importance of classifying stakeholders and determining their influence on urban freight flows.

The purpose of such research is to identify the most critical stakeholders regarding freight flows, enabling their participation in balancing these flows in the future. According to M. Matusiewicz and R. Rolbiecki, an integrated approach involving stakeholder consultations and consideration of their perspectives is essential before implementing specific urban logistics solutions (Matusiewicz, Rolbiecki, 2021). Taniguchi observed that urban logistics could create more efficient and eco-friendly urban freight transport systems when modern information and communication technologies (ICT) and intelligent transport systems (ITS) are utilized (Taniguchi, 2014). One significant challenge for smart transport is last-mile deliveries, which

typically involve transporting goods from a warehouse or distribution center to the end customer (Boichuk, 2022). The research conducted identified stakeholders who, according to the author, should be involved in building sustainable urban freight flows, especially for last-mile logistics. Each stakeholder group has different expectations of urban logistics systems. Entrepreneurs and operators aim to expand offerings and increase profits through cost reduction and higher sales. Local communities prioritize ensuring a good living environment by reducing congestion and emissions (NO_x and CO₂). Local authorities focus on creating transportation systems that minimize environmental impact and maximize economic efficiency. Meanwhile, logistics operators aim to provide high levels of customer service, characterized by timeliness, frequency, flexibility, reliability, and order completeness. Although shippers, freight carriers, and logistics operators focus on financial goals, authorities and local communities prioritize non-financial, social, and environmental objectives. Preventing congestion, ensuring safety, and reducing noise and pollution are shared concerns among all stakeholders involved in urban freight logistics systems (Dohn et al., 2019). As Russo and Comi (2010) and Lindholm (2014) point out, compromises among key city stakeholders are vital for success. It is also worth noting that while businesses are among the city's most important stakeholders (Dohn, Knop et al., 2019), they are often excluded from developing intelligent transport systems (Kmiciek, Wierzbicka, 2024). In 2017, it was observed that "one of the major challenges in selecting urban freight transport solutions is choosing those aligned with the key requirements and goals of stakeholders, who are often overlooked". Therefore, identifying stakeholders with the greatest impact on urban freight flows is a critical step.

5. Summary

Urban freight flows are a key element in the functioning of the urban economic ecosystem and their effective management requires the involvement of a variety of stakeholders. In this context, according to the study, the main actors influencing goods flows are city authorities, entrepreneurs, logistics operators and residents. Municipal authorities play a central role in regulation and spatial planning, which directly influence the efficiency of freight flows. Through transport policies, authorities can shape transport networks, set delivery rules in city centres and designate restricted zones for trucks. Such decisions aim to balance the need for efficient freight transport with the requirements of environmental protection and quality of life for residents. Traders and logistics operators are key stakeholders responsible for the organisation and execution of freight flows. Decisions on the location of warehouses, the choice of delivery routes and strategies on when and how to deliver have a direct impact on the urban transport infrastructure and the environment. Businesses seek to minimise transport costs and maximise efficiency, which often leads to conflicts with the objectives of municipal authorities,

especially in the context of emission and noise restrictions. In this case, public-private partnerships can be an effective solution to work together to optimise freight flows while respecting environmental requirements. Residents have an important influence on decisions concerning goods flows, although this influence is often indirect. Through their daily consumption choices, residents influence the demand for goods and thus the intensity and frequency of supply. In addition, increasing expectations of the quality of urban life, such as the reduction of noise or pollution, put pressure on city authorities and logistics companies to seek more sustainable transport solutions.

Key stakeholders, including logistics operators, entrepreneurs, residents, and municipal authorities, have diverse, often conflicting needs and expectations regarding urban logistics. Including them in the decision-making process and collaboratively developing solutions can reduce resistance to change, align actions with local needs, and contribute to better urban space management. This approach can also support the creation of innovative solutions, such as night delivery zones or the use of Intelligent Transport Systems (ITS), which are more effective when accepted by all stakeholders.

In summary, urban freight flows are the result of complex interactions between different stakeholders, each bringing unique perspectives and objectives. Achieving harmony between logistical efficiency, environmental protection and quality of life for residents remains a key challenge, which requires an integrated approach to managing the urban transport system.

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THE ROLE OF INCLUSIVITY IN BUILDING ORGANISATIONAL RESILIENCE

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Purpose: Increasing knowledge about the inclusivity of companies towards their stakeholders and the significance of inclusion in building organizational resilience.

Design/methodology/approach: A qualitative study based on the scenario of interviews with managers, developed as part of an interdisciplinary research project titled "The Role of an Inclusive Approach in Building Organizational Resilience: A Case Study of the TSL Sector (2023-2025)".

Findings: Corporate inclusivity is usually demonstrated towards employees. Its benefits include resource diversity acceptance, increased engagement, stronger identification with the company, higher levels of trust and loyalty, better cooperation, positive image, improved market responsiveness, talent acquisition and retention, which contributes to shaping and development of organizational resilience. Inclusivity is manifested in the inclusion policy and diversity management. Specific procedures and regulations help define the boundaries of inclusivity. Global operations and multiculturalism often necessitate an inclusive approach towards stakeholders. Most respondents believe that greater inclusion of company stakeholders in planning and conducting other activities builds company resilience. This allows for the utilization of diverse experiences, broader perspectives, better cooperation, and flexible actions. Better relationships with various groups increase company's resilience. Inclusivity is a key factor on which the resilience of businesses to unforeseen events depends.

Research limitations: The data derives from specialists and managers of large companies, which exhibit a higher level of inclusivity compared to small and medium-sized enterprises. Their senior staff is better prepared for inclusive management.

Practical implications: The findings are useful to managers interested in building organizational resilience through the inclusion of various stakeholders.

Social implications: Raising awareness of inclusive practices towards stakeholders and highlighting inclusion as a key factor in building corporate resilience during crises.

Originality/value: The article contributes to the development of management and quality sciences.

Keywords: inclusion, resilience, organization, diversity management, stakeholders.

Category of the paper: Research paper.

1. Introduction

Previous studies on inclusion have primarily focused on its positive impact on organizational employees, such as their attitudes, behaviors, and intentions. However, there is a lack of research on the impact of social inclusion on other stakeholders (Dudek, 2023).

A previous systematic literature review on the inclusive approach of organizations in relation to their main stakeholders—employees and customers—revealed a wealth of diverse key concepts and types of inclusion. In the case of employees, these include: workplace inclusion, social inclusion, inclusive growth (development), financial inclusion, inclusive labor market, inclusive leadership, inclusive work environment, and inclusive human resource management. For customers, relevant concepts include stakeholder inclusion, financial inclusion, inclusive customer experience, inclusive marketing practices, and social inclusion (Winnicka-Wejs, Burgiel-Szewc, Mercik, 2024).

A research gap has been identified, noting the lack of studies linking inclusion with organizational resilience. The topic of including employees, customers, and suppliers in corporate activities has been explored further in the context of building organizational resilience. The aim is to determine how and to what extent an inclusive (participatory) approach enables organizations to overcome barriers in their environment and strengthens their resilience. It is assumed that inclusivity can be a method for building organizational resilience, based on engaging all stakeholders in this process. Inclusivity is understood as a model of participation involving both internal and external stakeholders in achieving organizational resilience (Winnicka-Wejs, Burgiel-Szewc, Kos-Łabędowicz, Mercik, Trzęsiok, Zwolińska, Kamińska, 2023). Resilience refers to the ability to withstand internal and/or external shocks, respond to them, and recover after their occurrence (Annarelli, Nonino, 2016).

The concepts of inclusivity, resilience, preparation and reaction to crises are becoming critical and prospective research topics, which are worth focusing on (see Cooke et al., 2020).

From the perspective of sustainable development and social changes, inclusivity turns into a megatrend in the global scale (Sidor-Rządkowska, Sienkiewicz, 2023, p. 31). For example, inclusive engagement is crucial for building a resilience model in response to natural disasters (see Rauhaus, Guajardo, 2021). Even though the significance of inclusive business models has been previously discussed in the literature (Teneta-Skwiercz, 2016; Komańda, 2016), it seems that currently it requires further exploration and updating, especially in terms of stakeholder inclusion which balances in time the needs, interests and expectations of important stakeholders in the best interest of the organization (Phaswana, Pelsler, 2021).

This article seeks to address the following research questions regarding inclusion and resilience: What does corporate inclusivity towards stakeholders entail, and which stakeholder group is the most important (employees, customers, suppliers)? Should companies involve employees and customers in their activities, and is such an approach beneficial for them?

Do companies have an inclusive approach towards employees and customers, and how is it manifested? How important is it for companies to include various stakeholder groups in the planning and execution of activities to build resilience? Can inclusion be a key factor determining corporate resilience in the face of crises and unforeseen events?

The answers to these questions were provided by practitioners, which allowed for discovering new aspects of reality and integrating data with theory (Bansal, Corley, 2012).

2. Description of Methodology and Characteristics of Respondents

For the purposes of this study, and based on the literature on the subject, a scenario for interviews with managers was prepared in the second quarter of 2024. This was part of the interdisciplinary research project "The Role of Inclusive Approaches in Building Organizational Resilience: A Case Study of the TSL Sector", which won the "Beyond Barriers" competition (Winners of the 2nd Edition of the Competition, 2023; Winnicka-Wejs, Burgiel-Szewc, Kos-Łabędowicz, Mercik, Trzęsiok, Zwolińska, Kamińska, 2024).

Participants included attendees of the postgraduate studies program "Manager's Academy" at the University of Economics in Katowice (6th edition, academic year 2023/2024). On June 29-30, 2024, 41 individuals provided complete responses to 22 substantive questions on inclusivity and resilience, as well as 6 demographic questions.

The structure of respondents is presented in Table 1.

Table 1.

Structure of respondents by gender, year of birth, management level, work experience, company size, industry

Diagnostic category		Response Distribution
Gender	Female	26
	Male	15
Position	Managerial	23
	Executive	7
	Specialist	10
	Other: Business owner	1
Work experience in managerial positions	No experience	10
	Less than 1 year	3
	1-4 years	17
	5-8 years	4
	9-12 years	5
Company size	Over 12 years	2
	Micro (up to 9 employees)	1
	Small (10-50 employees)	5
	Medium (51-250 employees)	6
	Large (over 250 employees)	29

Cont. table 1.

Industry	Administration	1
	Banking	2
	Construction	2
	E-commerce	1
	Energy	1
	Financial and insurance	5
	Gaming	1
	Retail	3
	HR & Payroll / Accounting, Payroll outsourcing	2
	IT	4
	Logistics	3
	Marketing	1
	Medical	2
	Automotive	5
	Real estate	1
	Waste management	1
	Packaging	1
	Legal	1
	Production	4
Years the company has been operating in the market	Up to 10 years	7
	11-20 years	7
	21-30 years	11
	31-40 years	5
	41-50 years	1
	Over 50 years	9
	No data	1

Source: Own elaboration based on the empirical research.

The analysis of the data in Table 1 shows that 63.4% of women and 36.6% of men took part in the survey. More than a half of them (56.0%) work in managerial positions, followed by specialist positions (24.3%) and executive positions (17.0%). Only one person is a business owner. These individuals are characterised by varying managerial experience, with most of them (41.4%) indicating a time span of 1-4 years.

Majority are people from large companies (70.7%), from the following industries: finance and insurance, automotive, IT, trade and logistics. These companies have been operating on the market for several to several dozen years. In the 'over 50 years' category, there were five organisations with market experience of 100 years or more.

For the purpose of this article, the content of the responses to only six questions selected from the interview scenario was analysed (see Table 2). A research procedure typical of qualitative research was followed, coding the data, interpreting them and formulating research conclusions in terms of theory and practice (see Czernek, 2020), remembering to include quotations (Czernek, 2014).

Table 2.*Selected questions from the interview scenario with managers.*

Question Number	Question Content
1.	Have you encountered the concept of inclusivity in corporate activities?
2.	If yes » What, in your opinion, is the nature of corporate inclusivity towards its stakeholders: employees, customers, suppliers? Which of these groups is the most important? If no » Inclusivity is understood as a model of engaging both internal and external stakeholders of a company in achieving its resilience.
3.	Is inclusivity a good idea, or is it just a new fad and trend? Should the company involve employees and customers in its activities? Is such an inclusive approach beneficial for the company? If yes » Why? How can the company do this? If no » Why not?
4.	Does your company have an inclusive approach towards its employees? What about towards its customers? If yes » How is it manifested? If no » Why not?
5.	In your opinion, what factors does the resilience of a company to crises/unforeseen events depend on? Which of these factors are crucial? (Resilience refers to the ability to anticipate and respond to crises and difficulties, as well as to adapt and recover after their occurrence. The goal is not only survival but also growth and innovation, based on learning from experiences). Hint: What role do internal and external relationships, development strategy, resource management, organizational culture, competition strategy, organizational structure, leadership, prior experiences, established procedures, and business models play in building resilience?
6.	How important is greater inclusion of different stakeholder groups in planning and conducting activities for building the company's resilience? Hint: For example, collaboration with the fire department to secure infrastructure, collaboration with customers to streamline returns processing.

Source: Own elaboration based on (Winnicka-Wejs et al., 2024).

3. Results of the Empirical Study and Conclusions

3.1. Concept of Inclusivity and Its Perception

Out of the 41 respondents, 29 had encountered the concept of inclusivity in corporate activities before, while 12 responded negatively. Table 3 shows how company inclusivity was understood, along with its manifestations towards stakeholders, i.e., employees, customers and suppliers, according to the respondents who answered question 1 affirmatively, leaving their comments in question 2.

Table 3.*Company inclusivity towards stakeholders according to respondents*

No.	Respondents' answers to question no. 2*
1	Acceptance of diversity, lack of exclusion based on various characteristics/factors.
2	Equal treatment, equal opportunities, transparent communication, dialogue with stakeholders, ethics policy.
3	Employing individuals with disabilities, openness to diverse customers.
4	I don't deal with customers or suppliers, but for employees, this is visible during recruitment, annual reviews, and promoting diversity.

Cont. table 3.

5	Openness, business expansion, freedom, focus on development.
6	In the service sector, in company-client relationships.
7	How it is manifested: employees – building mutual understanding among diverse groups, fostering a positive organizational culture. Customers, suppliers – no discrimination, shared values on inclusivity.
8	Internal regulations state that no one should be excluded. They focus on employees.
9	Inclusivity in my company is manifested by accepting people as they are, but also by giving everyone the opportunity to present ideas or comments about the company's operations, both in HR matters and in those related to projects.
10	Organizing workshops, talks with experts (panels), support groups for diversity & inclusion, support marches, community meetings.
11	It is manifested through awareness-raising activities, training, and even dismissing individuals for discrimination or racism. Inclusivity involves engaging and respecting people's culture, religion, and personality.
12	It is manifested towards employees.
13	Accessibility adjustments, providing access for people with physical difficulties or disabilities, hiring competent people regardless of their abilities (or lack thereof), race, nationality, etc. Offering employees the opportunity to purchase shares.
14	Openness to different groups, nationalities, values, opinions.
15	Building organizational culture, feedback culture, managing through relationships.
16	Inclusivity is most important for employees.
17	Mainly in the area of disability. Including them regardless of gender, age, religion, disability, private life, children, etc.
18	Openness to diversity, tolerance, variety.
19	Respect for different cultures, differing opinions, drawing inspiration from diversity.
20	Everyone is accepted and appreciated regardless of age, gender, background, or beliefs.
21	Engaging people with disabilities, e.g., employing them. As for customers, adapting to their needs. Suppliers, on the other hand, are not excluded based on the disability of the owner or employees.
22	All groups are important, and the inclusivity policy should be skillfully designed to encompass all stakeholders.
23	The most important group is employees. This then resonates with other entities and company activities.
24	Tolerance of beliefs, background.
25	Supporting LGBTQ+ and minorities.
26	The workplace is accessible to everyone regardless of age. High positions are held by both women and men.
27	For example: educating employees on diversity, campaigns saying "we are all equal," adjusting the work environment.
28	Everyone is important. Work and cooperation as a whole.
29	In my company, employees – we want them to know that what matters is not their age, background, children, or tattoos, but their competence and engagement.

* see content of the question in Table 2.

Source: own elaboration based on empirical survey.

As per the respondents' comments, inclusivity was seen as an organizational approach that allows employees to participate and contribute fully to various areas of the company's operations (cf. Miller, 1998). It was also viewed as a practice that recognizes diversity and the new meanings that participants bring to creating a work environment that encourages the effective use of diverse potentials and skills (cf. Burnett, 2003), and as a means to promote fairness, integrity, and complete involvement at both personal and collective levels, ensuring that individuals from diverse backgrounds are not only granted the same opportunities, the right to make their own choices, and the chance to take on leadership roles, but are also explicitly recognized and valued for their distinct perspectives. (cf. Holvino et al., 2004).

Respondents also highlighted the practical implementation of DEI (diversity, equity, and inclusion) concept more in the area of "people" rather than "technology" or "space" (cf. Marciniak-Madejska, 2024). They emphasized the context of workplace inclusion and inclusive climate (cf. Li, Perera, Kulik, Metz, 2019), as well as inclusive HRM (cf. Jonsen, Point, Kelan, Griebel, 2021).

When asked about which stakeholder group is the most important, not everybody responded and made a direct indication. 14 respondents identified employees as the most significant stakeholder group, while 3 persons chose customers ("The most important of all is the customer, the company strives to always make them feel eagerly awaited, appreciated and fulfilled"), 2 persons selected suppliers, and the remaining 2 persons indicated no specific group priority.

Interestingly, all respondents, regardless of whether they had encountered the concept of inclusivity in corporate activities before or not, agreed that inclusivity is a good idea and beneficial for companies. Only four respondents expressed some reservations in their generally positive replies: "It's beneficial, however, it may also bring about threats"; "It depends, it's worth including and supporting the minority, but it should be done with care so that it doesn't end up discriminating against the majority"; "Good idea, but it shouldn't be the guiding principle of the company"; "Yes, but it should be done in a very careful way".

The benefits of involving employees and customers in corporate activities, as listed by respondents, included acceptance of resource diversity, increased engagement, stronger identification with the company, higher levels of trust and loyalty, better cooperation, positive company image, improved responsiveness to market changes as well as talent acquisition and retention. In general, respondents described inclusivity as a good idea that could enable further development of the company (cf. Table 4).

Table 4.

Benefits of corporate inclusivity – respondents' answers to question no. 3, categorized*

Categories	Respondents' answers to question no. 3*
Acceptance of resource diversity/ Reduced perception of discrimination and inequality	<ul style="list-style-type: none"> – Inclusivity enriches the company by employing everyone regardless of limitations. Such actions help build fundamental values that unite the company's community. – Accept diversity, support, and create supportive policies. – Somewhat a trend, but also a real need for a certain group of people. It's beneficial, as everyone feels accepted. – Yes, because every person is accepted regardless of cultural differences. – By promoting equality, regardless of age, gender, etc. – Yes, it's about diversity and openness in actions. – Yes, this allows disabled people to participate in social and professional life. – Yes, I think it positively impacts the sense of acceptance and safety among employees, customers, and suppliers.

Cont. table 4.

Increased engagement and job performance	<ul style="list-style-type: none"> – Yes, this can lead to greater engagement of all employees in their work. – It teaches employees and stakeholders engagement in the organization. Collecting ideas from employees. – Yes, it's a good idea because it includes everyone's ideas, increasing engagement and the number of (good) ideas. – It's beneficial because it builds trust and a sense of security in the work environment for diverse groups, thus increasing engagement. How can it be done? Organizing events targeted at each group, inclusive communication, preparing managers to apply inclusivity in practice. – It's beneficial because it involves employees in the company's activities, strengthening their position and identity. – The company should include its stakeholders in inclusivity because this will increase employee engagement, as they will feel part of the company.
Stronger identification with the company and its success	<ul style="list-style-type: none"> – Greater attachment and identification with the company. It allows employees and customers to influence actions according to their own beliefs. – Yes, it's a good idea. Including all employees is beneficial; it builds responsibility and a sense of belonging to the company. – Yes, by including employees and customers, the employer activates a mechanism of attachment and belonging to the entire organization.
Increased loyalty and trust	<ul style="list-style-type: none"> – Yes, it builds trust, satisfaction, and certainty. – A good idea, because it builds trust and relationships, impacting the atmosphere. The company can involve employees and customers in its activities. – Yes, when employees, customers, and suppliers are included in the company's activities, they feel that their presence and opinions matter, and they become more loyal as a result.
Improved cooperation	<ul style="list-style-type: none"> – Yes, it positively influences cooperation, atmosphere, and organizational culture. – Better mutual understanding leads to better cooperation in crisis situations. – It's rather a good idea, especially for employees, to work together.
Positive image	<ul style="list-style-type: none"> – It's beneficial from the perspective of building a positive image. – It may be beneficial, creating space for developing areas that were not previously sufficiently addressed, expanding the offer, and supporting good Employer Branding.
Better market responsiveness	<ul style="list-style-type: none"> – Inclusivity is not only a good idea but a necessity in today's world. It leads to better decisions, better reputation, increased motivation and engagement, and better market understanding. – Yes, I cannot imagine managing a company without including employees in at least some processes. For customers, this can be done to a limited extent. This allows for real-time market trend monitoring and adjusting the company's operations accordingly.
Talent acquisition and retention	<ul style="list-style-type: none"> – Yes, because this helps companies attract and retain the best employees.
Good/developmental idea	<ul style="list-style-type: none"> – Yes, the company should include employees. – Yes, because they view the company's operations from a different perspective. They also have a different approach to the company, which can be valuable. – A good idea, it leads to development. – Yes, it's a good idea. Employees have knowledge that can help. – Yes, it's important to raise awareness and train employees. Inclusivity should be part of the company's culture. – It's necessary if the company wants to grow. – Inclusivity offers great potential for organizations; it allows for knowledge and inspiration, provided full acceptance is present. – Yes. It seems that this trend is not only a contemporary fashion but the future. The generation which enters the labor market will force these changes. – Yes.

* see content of question in Table 2.

Source: Own elaboration based on empirical research.

The information listed in Table 4 confirms previous empirical findings on the benefits that diversity management and inclusion can bring to organizations (Gross-Gołacka, 2022).

3.2. Inclusive Approach Towards Employees and Customers

When answering question 4 (see Table 2), only one fifth of respondents stated that their company did not have an inclusive approach towards its employees and customers. Among the answers to the question "If not » why not?" were: "No", "No. I suspect an overly ossified management model", "No, decisions are up to the management and employees have to accept them", "No, there isn't. I don't know why not", "No, outdated stereotypes", "No. The company has a high turnover of employees. It happens that 20/30 people will leave", "No, it's company policy".

The remaining 80% of respondents observed an inclusive approach to employees and clients in their company practices, particularly in the general inclusion policy and diversity management. Specific procedures and rules that regulate the limits of inclusivity are also important. In some cases the global scale of operations and cultural diversity enforces an inclusive approach towards various stakeholders. Respondents noted also inclusive leadership, support for employing people with disabilities, and identification and personalization of customer needs (see Table 5).

Table 5.

Inclusive approach towards employees and customers – positive responses to question no. 4, categorized*

Categories	Affirmative responses to question no. 4*
Inclusion policy/ Diversity management	<ul style="list-style-type: none"> - Yes, it is open to employees, their individuality, and welcomes their ideas. - Yes, based on no exclusion and understanding needs. - Yes, the company where I work has an inclusive approach to employees and customers, manifested mainly through dialogue. - Yes, because diversity and difference are appreciated. - The company does not exclude individuals who may socially deviate from the standard (living standard, lifestyle, clothing). In fact, they are very open to unique individuals. - Yes, employees – during recruitment, training on DEI, listening in one-on-one meetings and setting goals. Yes, customers – we sell to everyone, study the market and expectations. - Employees – everyone can express their views and feedback. Regarding diversity support, in our company, we organize small integration events (twice a month) where we engage in activities proposed by employees to get to know each other better and learn who likes what. - Engaging in EB activities, celebrating various occasions regardless of religion and culture, e.g., instead of Christmas, we celebrate Star Wars Day to maintain neutrality and ensure everyone enjoys themselves at the company. - Yes, through the acceptance of diversity. Demonstrating that everyone can have a different threshold of acceptance. - It is expressed through tolerance for differences. The main customer also demands such an approach and conducts social audits emphasizing tolerance. - Yes: flexible working hours, organizational culture, marketing communication, more engaged team. - Considering needs based on different cultures and beliefs. - Yes, training. - Yes, a lot of additional events are organized. The company's offer changes frequently, depending on market needs. - For employees, yes, for customers – I don't know. There are webinars and meetings on inclusivity.

Cont. table 5.

Inclusion regulations	<ul style="list-style-type: none"> – We have procedures, regulations, and rules for everything. Some are open to inclusivity, others are very restrictive. – Yes, internal regulations. Even without them, people treat each other with respect. There is significant awareness in this area within my company. – I believe the company probably applies this, but only in theory.
Multiculturalism and interculturality	<ul style="list-style-type: none"> – It is also expressed towards customers. We are open to foreign markets, diverse nationalities, and often invite customers to the company. We try to get to know the customer, their values, and beliefs. We don't judge. – Yes, the same rules apply to customers and employees. We have customers from all over the world, so multiculturalism is one of our pillars, and thus inclusivity. Manifestations: respecting differences, training on intercultural differences, business ethics in such an environment, and applying human-oriented values. – Yes, we are a global, multicultural company. This enforces an inclusive approach.
Inclusive leadership	<ul style="list-style-type: none"> – Yes, towards employees. Through managers' approach to employees. – I encourage employees to take actions and make independent decisions, assuring them that if problems arise, I will stand up for them.
Inclusion of people with disabilities	<ul style="list-style-type: none"> – Yes, I know a person who has a degree of disability but realizes themselves in my company, working 7 hours a day. – We are working on inclusivity for people with disabilities.
Personalization of customer needs	<ul style="list-style-type: none"> – Yes, towards customers by identifying and personalizing their needs.
"Yes" responses without detailed comments	<ul style="list-style-type: none"> – Yes (5 responses) – Yes, but it's hard to specify. – If yes, it is unconscious.

* See the content of the question in Table 2.

Source: Own elaboration based on empirical research.

3.3. Inclusivity as an Important Factor in Building Organizational Resilience

A vast majority of respondents believe that greater inclusion of various stakeholder groups in planning and conducting activities is important for building organizational resilience. Only 7 out of 41 respondents left question no. 6 (see Table 2) unanswered/ without a comment, while one respondent said "I don't know".

The respondents indicated that inclusivity may be a key factor in enhancing resilience of an organization. Their contributions have been grouped according to specific thematic categories (see Table 6).

Table 6 shows that the majority of people rated the importance of including different stakeholder groups to build company resilience by noting that it will result in broader action prospects, faster response, better cooperation and obtaining a specific market position. It should be emphasized that their rating was very high (e.g. "Very!", "Very important"). Some of them directly stressed the importance of inclusiveness from the perspective of building resilience, also in crisis situations. There were also examples of the inclusion of particular individuals and institutions in company activity.

Table 6.

"How important is the greater inclusion of various stakeholder groups in planning and conducting activities for building the company's resilience?" – positive responses from the respondents, categorized

Categories	Positive responses to question no. 6
Assessment of importance	<ul style="list-style-type: none"> – Very! The more groups involved, the more diverse the perspectives and better-tailored the solutions and risk assessments. – Very important, stakeholders and their opinions, feedback help build a stronger position and organization. – Very important, they are additional resources that help build our value and development. – Involving various groups in planning and conducting activities is very important, it influences integration and clear goal setting. – Very important, as it streamlines work in the company, allowing for securing appropriate areas. – Openness and transparency allow for a flexible work schedule. – People can have different experiences and ideas, which is always valuable. – Very important, broader perspective of needs, support, introducing new solutions, faster reactions, better cooperation. – The company should function as a whole. From my perspective, involving different groups is important. – What's very important is cooperation with the customer, their openness to new products and solutions. – I think it's important, but not necessarily crucial. – It is a key aspect because each person in the organization has different experiences and knowledge. – Very important. It develops the company and adjusts it to the current situation. – No individual (nor any company) is an island. There are always dependencies, without which goal achievement is impossible. Therefore, a network of cooperation should be built wherever it positively influences company operations. – Better adjustment, alignment, shared goal. – Very important. Thanks to this, we can consider factors we would not have considered otherwise. – It is important because we can draw from and base decisions on the knowledge and experience of other groups and stakeholders. – On a scale of 1-5, it's a 4, as a variety of perspectives is beneficial, assuming an appropriate number of different groups. – Very important, it allows for work optimization. – Openness to changes allows for development. – Very important (4 responses without elaboration).
Better resilience building (including in crisis situations)	<ul style="list-style-type: none"> – A company functions in a specific environment. The better and faster the relationships with diverse groups, the stronger the resilience. – I believe it is very important because in crisis situations customers can be more understanding. However, it also has advantages in everyday work, improving processes. – The more stakeholders, the more support in building resilience. – Very important. It helps build resilience. – It is important to maintain good relations with companies that can help when a crisis or a problem arises.
Examples of inclusion	<ul style="list-style-type: none"> – Collaboration with schools and universities to conduct internships – selecting good employees. – Cooperation with suppliers, law firms, recruitment agencies, IT support, network maintenance, and cybersecurity. – The County Employment Office – training systems, availability of employees. Environmental Protection Office – legal regulations – knowing and following them. – Building collaboration between company departments and external bodies for smooth crisis response.

* See the content of the question in Table 2.

Source: Own elaboration based on empirical research.

It appears that a company's resilience to a crisis or unforeseen events may depend on an inclusive approach. This may be evidenced by some of the statements to question 5 (see Table 2), pointing to inclusiveness as a key factor: "Inclusiveness creates loyalty and in a crisis it is important to be able to count on each other. Relationships that are too intimate can cause difficulties. However, the basis must be the same values and strategic goals"; "It is not possible to foresee all the crises that may occur, so procedures can only help to a certain extent. In my opinion, organizational culture, relationships within the organization and diversity make it possible to overcome a crisis more easily and learn lessons for the future"; "From the flexibility of managers. Building teams of people with a diverse cross-section of ages", "Key factors are external relationships (customers with orders), internal relationships (employees), development strategy, resource management".

4. Conclusion

The article, based on qualitative empirical research, provides a new perspective on the surveyed reality and can therefore be considered socially relevant. The findings expand existing knowledge on the subject of inclusivity and resilience, encouraging further scientific exploration.

Firstly, we know that over 70% of respondents have encountered the concept of inclusivity in corporate activities before. In their view, inclusivity is primarily manifested in the aspect of the human factor, through the implementation of the DEI concept. They mention employees more frequently than clients which may indirectly state that they are the most important stakeholder group. Direct indications also put employees first.

Secondly, all respondents—whether or not they had encountered the concept of inclusivity in company activity before — agreed that it is a good idea and that an inclusive approach is beneficial for companies. Benefits such as increased engagement, higher trust and loyalty, and better cooperation could be useful in improving companies' responses to market changes and building organizational resilience.

Thirdly, an inclusive approach towards employees and customers is most often manifested in the general policy of inclusivity and diversity management. It may be driven by internal regulations or multiculturalism present within global organizations. Inclusive leadership also plays an important role in this process.

Lastly, a vast majority (80%) of respondents believe that greater inclusion of various stakeholder groups in corporate planning and other activities is important for building resilience, allowing for the utilization of diverse experiences, broader perspectives, better cooperation, and more flexible operations. The better and faster the relationships with diverse groups, the better the resilience of companies. Some respondents identified inclusivity as a key

factor in determining corporate resilience to unforeseen events, alongside a well-prepared crisis strategy and effective management.

Although the findings confirm the inclusive approach of companies towards their stakeholders and highlight the role of inclusivity in building resilience, it is important to note that the empirical data mainly comes from large companies. This could be a limitation of the study, as managers in large organizations are keen on and better prepared for inclusive management (see Szydło et al., 2023) and one of their desirable competences is inclusivity (see Juchnowicz, Kinowska, Krzyżanowska-Celmer, 2024).

Given the above, in the further stage of the research, which will adopt a quantitative approach, a more diverse company structure will be considered, including a broader range of employment sizes. The perspectives of operational employees and institutional customers will also be included. Further research will focus on a specific industry (the Transport-Forwarding-Logistics (TFL) sector) and will aim to identify dimensions or features of resilience that require particular involvement of employees and customers in the resilience-building process.

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DIGITAL INNOVATION OF PUBLIC SECTOR INSTITUTIONS. CASE STUDY OF THE REGIONAL EDUCATION AUTHORITY IN KRAKOW

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Purpose: The research aims to substantiate the assumption that public sector institutions, such as the Regional Education Authority in Krakow, are digitally innovative units that, due to progressive digitization, adapt their offer to the needs of stakeholders. Implementing this goal required identifying innovative digital solutions implemented by the Regional Education Authority in Krakow in the fields of tasks performed, process improvement, information and communication and work organization.

Design/methodology/approach: The theoretical part of the article describes the results of the literature review within the problem framework and the practical part presents and discusses the results of empirical research. The study was conducted using the survey technique (CAWI), and the study results were developed using descriptive statistics.

Findings: Research conducted at the Regional Education Authority in Krakow showed the average level of digital innovation of this institution. The study identified and analyzed digital solutions used in the areas of task execution, process improvement, information and communication, and work organization.

Research limitations/implications: The limitations of the conducted research mainly relate to their scope, the surveys were conducted only among employees of the Regional Education Authority in Krakow willing to participate in the study. The research should be expanded in the context of expanding the sample, preferably by employees of all Regional Education Authorities in Poland.

Practical implications: Research conducted at the Regional Education Authority in Krakow allows us to conclude that the level of digital innovation of this institution requires support, especially in terms of financial resources and the establishment of teams dedicated to the introduction of innovative digital solutions.

Social implications: The level of digital innovation, both in Polish and foreign public organizations, is an important issue and a long-term process, requiring changes and flexible adaptation to technological challenges and stakeholder expectations.

Originality/value: The presented research results on the implementation of digital innovation solutions in the Regional Education Authority in Krakow are in line with the current trend of research, which emphasizes the need to adapt the offer of services provided by public sector institutions to the expectations of diverse stakeholder groups. An important advantage of the

research is its unique character both in terms of the research area, which is the Regional Education Authority in Krakow, and the subject of research. This institution is often the subject of research in the context of the educational process and pedagogical supervision. However, there is little research using this institution to analyze management processes and the context of digitalization remains poorly recognized.

Keywords: digital innovation, public sector institutions, education, Regional Education Authority in Krakow, digitalization.

Category of the paper: Research paper.

1. Introduction

Recently, public administrations, like private companies, have faced the challenge of digitizing both their service offerings and internal processes. In addition to the clear benefit of increased efficiency and efficiency, digitalization also offers hope for increased citizen participation in public processes. Governments often need to adapt to changes in the social, political and technological environment and innovation is crucial to governments' ability to adapt to changing conditions (Janssen, Van Der Voort, 2016). This is especially true for management in increasingly turbulent times when different organizational agencies interact in highly volatile, inconsistent, unexpected and unpredictable ways (e.g., Ansell, Trondal, Øgård, 2017). The issue of innovation in the public sector is currently of increased interest to both managers of public organizations and policymakers, although it is still not seen as a disruptive phenomenon that radically changes the way public organizations operate. Researchers and practitioners assume that innovations implemented in public sector organizations contribute to the improvement of the quality of public services, the effectiveness and efficiency of operations, as well as solving stakeholder problems and coping with new social challenges (Bloch, 2011, p. 8).

The article aims to justify the assumption that public sector institutions, such as the Regional Education Authority in Krakow, are digitally innovative units that, as a result of progressive digitization, adapt their offer to the needs of stakeholders. Implementing this goal required identifying innovative digital solutions implemented by the Regional Education Authority in Krakow in the fields of tasks performed, process improvement, information and communication, and work organization.

The article in the theoretical part contains a description of the results of the literature review within the framework of the problem undertaken and in the practical part the presentation and discussion of the results of empirical research. The study was conducted using the survey technique (CAWI) and the results of the study results were developed using descriptive statistics.

2. The importance and development of digitalization in the public sector

The digitization of the public sector is one of the key challenges of modern economies and its development has a direct impact on the efficiency and innovation of public institutions. This process, understood as the introduction of modern information and communications technologies (ICT) into administrative activities and public services, includes both the transformation of internal organizational structures and relations with citizens and enterprises. The growing importance of digitization is primarily due to growing social expectations regarding the improvement of the quality of public services, shortening the time of their implementation, and increasing online accessibility. At the same time, progressing globalization and technological development force public institutions to adapt modern digital solutions to meet international competitiveness and build a stable administration based on digital data.

The development of digitization in the public sector is taking place at various levels, from the introduction of electronic document management systems, through the development of e-government portals, to advanced platforms enabling remote handling of official matters. A key element of this process is the integration of databases, which enables a more efficient exchange of information between individual public institutions, as well as improves the monitoring and management of public policies. The introduction of digital technologies in the public sector not only contributes to increasing the efficiency of administration but also strengthens the transparency and openness of government activities, which is an important aspect of building public trust.

It is worth noting that in the European context, the digitization of the public sector is strongly supported by the European Union's policy, which aims to build a digital single market. This strategy includes, among others, the development of e-services (e.g. e-health and digital identities) to enable citizens and businesses to freely access public services throughout the Community (European Commission, 2020).

The development of digitization in the public sector is a dynamic process, requiring not only the modernization of technological infrastructure but also a change in the approach to management and shaping public policies. A significant challenge remains the adaptation of new technologies by public sector employees and their effective implementation, which is associated with the need to systematically improve digital competencies and introduce innovative methods of managing digital projects.

Digital Government Transformation (DGT) plays a key role in the modernization of structures, processes and organizational culture of public institutions. It affects not only the need to introduce new technologies but also the overall reorganization of the activities and tasks of officials. This process includes the reconstruction of existing procedures and the introduction of technological innovations that change the way institutions operate at many levels (Tangi

et al., 2021). Thanks to the implementation of modern digital solutions, the administration can better respond to the needs of citizens and decision-making processes become more transparent, which is important given the growing importance of civil society. Ch. Ofoma and U. Suleiman pay particular attention to the challenges in the digitization of public administration (Ofoma, Suleiman, 2023) pointing out that one of the most important challenges related to the digitization of the public sector is the need to integrate various information systems, which requires not only significant financial outlays, but also appropriate competences on the part of administration employees. Solving the challenges is not possible without extensive training activities among officials, which are aimed at improving the efficiency of the use of modern technologies supporting the digitization process.

The digital transformation of the public sector is not limited to the implementation of technology but also includes building a new organizational culture that promotes innovation and collaboration. Thanks to the use of digital tools, it is possible to improve decision-making and executive processes, which translates into faster and more effective delivery of services to citizens. In addition, digital technologies support the transparency of the administration, which increases public trust in the processes carried out by offices. These examples show that digitalization has a broad impact on the development of values at various levels, including both economic and social (Cui, Aulton, 2023). However, the changes caused by the digital revolution not only affect the organizations themselves but also have a significant impact on all stakeholders involved in creating the organization's value. This is because no technology alone is sufficient to create public value. It is essential to put in place appropriate governance mechanisms and cooperation processes to involve citizens and other stakeholders in the value co-creation process. Digitalization, combined with an appropriate collaborative strategy, should lead to more sustainable and inclusive solutions in the public sector. Similar theses can be found in V. Cluley, S. Parker and Z. Radnor (2023), who note that the co-creation of public value is becoming an increasingly important aspect in the design and delivery of public services, especially in the context of cooperation between public entities and private stakeholders, as well as representatives of the third sector and citizens themselves. The development of digitization must therefore be a key element in building solutions that allow for the integration of modern technologies with public management processes, which not only leads to the improvement of services provided but also enables advanced coordination of cross-sectoral activities (Cluley et al., 2023). The authors also draw attention to the risks of "value destruction" (dis/value) resulting from the fact that in some cases decisions on the implementation of digital services may lead to the marginalization of certain social groups or their exclusion from co-creation processes, which harms the perception of public value. Certainly, digitalization in the public sector requires careful consideration of the needs of all stakeholders to minimize the risk of undesirable effects resulting from the digital exclusion of public organizations' stakeholders. Concerns about excessive and uncontrolled digitization are also expressed by Ch. Ofoma (2024), pointing to the risks resulting from the potential for cyberattacks on public administration organizations.

In conclusion, the development of digitalization in the public sector is an important element of the transformation of public services, enabling more effective, transparent and inclusive management. Digitalization not only streamlines administrative processes but also enables the co-creation of public value by involving citizens and stakeholders in the design and delivery of services. Thanks to the use of modern technologies, public institutions can better respond to the needs of society, while increasing the efficiency of their activities and sustainable development. However, as emphasized in the literature on the subject, digitization also brings challenges, such as the risk of marginalization of social groups that may be excluded from the processes of co-creation of public value and the risk of cyberattacks on public sector institutions. To prevent this, it is necessary to put in place appropriate governance strategies and cooperation mechanisms that enable the full involvement of all stakeholders. As a result, digital transformation in the public sector not only improves service delivery but also becomes a key tool in building a more inclusive and equitable society.

3. The essence of digital innovation in the public sector

According to P.F. Drucker (1992) innovation is a change in the value and satisfaction of consumer needs through the use of specific resources. The basis for the contemporary interpretation of innovation is the OECD methodology, in which innovations are perceived through the prism of product, process, marketing method and organizational solutions. The general definition of innovation in the latest edition Oslo Handbook, which applies to all sectors of the economy, including the public sector, provides that an innovation is a new or improved product or process (or a combination thereof) that differs significantly from a previous product or process that has been made available to potential users (product) or put into use by an entity (process) (OECD, 2020). Product innovation in the public sector refers to the introduction of new or significantly improved goods or services. These services may include, for example, administrative tasks or law enforcement functions; Process innovation, on the other hand, is concerned with the improvement of processes that contribute to the basic functions of public sector organizations. A particular role is given to the implementation of new technologies and frameworks for self-organization to improve the quality of services provided and efficiency (Singler, 2023).

In the public sector, innovation is defined equally broadly (De Vries, Bekkersi Tummers, 2016). It is understood as an idea, practice, or object perceived as new by an individual or organization (Rogers, 2003); as an adaptation of an existing idea for the first time by an organization (Borins, 2000); as new or significant changes in services, operational processes, methods of organization or ways of organizing and communicating with the user (Bloch, 2011). They are also seen as the introduction of a new service a significantly improved service,

or an improvement in service delivery, which is often the result of communication, organizational and process innovation. Innovation in the public sector rarely involves the implementation of a completely new service or delivery method. More often, it is an adaptation to the local context of a service or a method of its provision that has already been used elsewhere (Innovation in the Public Sector..., 2013).

Innovation is seen as a key factor in improving the efficiency and effectiveness of public service delivery and increasing the capacity to solve problems in the face of various societal challenges, such as demographic pressures and climate change (OECD, 2020; Torfing, Ansell, 2017; De Vries et al., 2016; Damanpour, Schneider, 2009). Thus, managers of public sector institutions perceive innovation as an important element of the state and see the need to act to strengthen the innovation potential of public administration (Singler, 2023). A review of the literature on the subject allows us to identify different types of innovations in the public sector (e.g. Windrum, 2008; Halvorsen, 2005; De Vries, Bekkers, Tummers, 2016; OECD, 2020, Singler, 2023).

In recent years, digital innovation has become an important phenomenon in the context of organizational transformation (Mergel et al., 2019; Baptista et al., 2020; Kemal, Shah, 2023).

Digital innovation, although there is no clear conceptualization of this concept and digital technology is a key component of digital innovation research, includes IT tools that are embedded in a socio-technical vision (Nambisan et al., 2017). Nambisan et al. (2017, p. 223) believe that digital innovation is the use of digital technology during the innovation process, which causes the resulting digital innovation to radically change the way services and products are created and structured, enabling new ways of creating and absorbing value. The authors define digital innovation as a sociotechnical phenomenon and conceptualize it "as the creation (and consequent change) of market offerings, business processes, or models that are the result of the use of digital technology. Thus, in digital innovation, digital technologies and related digitization processes are an integral part of a new idea and/or its development, diffusion, or assimilation.

Digital innovation is concerned with the continuous creation and organization of social and technical/physical artifacts for new and improved products, services, and business models, while it is limited to technological artifacts only and affects organizational change only (Kemal, Shah, 2023). Digital innovation extends beyond organizations and industries to include users and consumers, as the use of digital innovation involves actively selecting the resources of an offer and configuring them with other resources, and even thinking about their use and purpose (Henfridsson et al., 2018, p. 91). On the other hand, Hund et al. (2021), understand digital innovation as the creation or adoption and use of novelty that is inherently unlimited and adds value (e.g. product, service, process, or business model) through the inclusion of digital technology. They highlight the socio-technical contribution of digital technology as an essential part of digital innovation; internal or external innovation and novelty that adds value in terms of various possible outcomes in the form of a product, service, process, or business model.

Digital innovation in the public sector is also defined as the use of digital technologies and applications to improve processes and procedures in the delivery of public services (Mergel, Edelmann, Haug, 2019).

To effectively and efficiently pursue digital innovation, organizations need to find ways to engage both external and internal partners. Researchers report that digital innovation is radically changing the nature and structure of new products and services, enabling innovation collectives that engage diverse groups of actors with different goals and more generally, transforming entire industries. The dynamic, collective and limitless nature of digital innovation highlights the creation of innovative inter-organizational networks and open innovation networks, so I emphasize that innovation should be understood as a process of co-creation (Holmström, 2021).

Innovation at the organizational level is determined primarily by professionalism and the availability of free resources. The larger the organization, the more resources are available that can be involved in the adaptation of innovative solutions. In addition, the ability to innovate is also determined by the organizational culture and the presence of talented employees. The issues of empowering employees and transferring decision-making functions to them are important and at the same time, high skills and qualifications as well as entrepreneurial competencies, which are often characteristic of innovative employees, are desirable (Wodecka-Hyjek, 2023).

4. The Regional Education Authority and its role in the education system

The Regional Education Authority is the body that controls public and private educational centers and institutions. As a government unit operating locally in specific provinces, it takes care of maintaining education standards throughout the country. The tasks of the Board of Education and the functions it performs are strictly defined by the Ministry of National Education and relevant legal acts (Dziewulak, 2020; Act of 7 September 1991 on the education system, as amended). The superintendent's office is responsible for implementing the regulations of the Ministry of National Education, while the guidelines of the superintendent's office must be adhered to by the headmasters of both public and non-public educational institutions. On the websites and in the offices of the Regional Education Authority, you can find all the information on the functioning of schools and guidelines on the work of headmasters and teachers. The Regional Education Authority is therefore an intermediary body in cooperation between schools and the Ministry of National Education. The Regional Education Authority is located in each province and supervises educational institutions in their subordinate area, e.g. the Regional Education Authority in Kraków supervises schools and other educational institutions in the Małopolska Region. The main tasks of the Regional Education Authorities

include the implementation of the state education policy, including the implementation of the core curriculum, the distribution of funds for co-financing education, as well as the development of programs to improve the level of education and competencies of teachers in the province. In addition, the Regional Education Authorities organize scientific olympics competitions and reviews in their provinces, supervise the development needs of teachers, and initiate activities to improve teachers' competencies. They are also responsible for the organization of school exams, for the coordination of ways of spending free time with children and young people, and for the organization of additional activities during summer and winter holidays.

In addition to typical organizational tasks, the Regional Education Authorities also perform control functions. An inspection by the Regional Education Authority may be related to the work of the Regional Examination Board or the implementation of the core curriculum in schools in a given province. As the body supervising regional examination boards, the regional education authorities are also responsible for supervising school examinations. The tasks of the Regional Education Authorities also include the control of conditions at school, care for pupils, and counteracting social pathology. The Regional Education Authorities check whether schools comply with the rules for assessment, classification, and promotion of pupils, and whether the regulations related to full-time and part-time compulsory education are properly implemented. The Regional Education Authority may also audit the rights of the child and pupils/students in a given school, as well as the verification of the conditions of learning, education, and care for pupils in terms of safety and hygiene. The education authorities are responsible for selecting the techniques used to carry out all inspections and cooperating with other institutions that may affect school performance. The information collected during the visit is necessary to improve the Polish education system and search for the most effective methods of student development. Reports of the Heads of the REAs are delivered to voivodes and the Ministry of National Education. Conclusions drawn during inspections in given institutions and further plans for school inspections are officially communicated electronically to the general public access. The achievements of proven schools, teachers and students are also made public.

5. Research Methodology

The research aimed to assess the level of digital innovation as well as to identify and analyze innovative digital solutions implemented in the Regional Education Authority in Krakow. The methodological basis for distinguishing the types of innovation was the classification proposed by De Vries et al. (2016) and the Central Statistical Office (2018).

The study distinguished:

- Digital innovations in the scope of tasks carried out for stakeholders are identified with innovations in the field of digital products and services used to perform the tasks of the Regional Education Authority.
- Digital innovation for process improvement.
- Digital innovations in the organization of work aimed at increasing the level of quality of services and service.
- Digital innovation in the field of information and communication methods with both stakeholders and employees.

The survey was conducted using the survey technique (CAWI) from September 18 to September 25, 2024. The survey involved 101 employees out of 165 people employed at the Regional Education Authority in Krakow, which is 61% of the employees¹. The questions to which answers were sought were:

1. What types of digital innovations are implemented and used in the Regional Education Authority in Krakow?
2. Which categories of digital innovations are particularly popular/developed in the Regional Education Authority in Krakow.
3. What type of digital innovation solutions are missing at the Regional Education Authority in Krakow?

The above questions became the basis for the adoption of the following research hypotheses:

H1: The Regional Education Authority in Krakow is a public sector institution implementing innovative digital solutions.

H2: At the Regional Education Authority in Krakow, digital innovations are implemented in the following areas: process improvement, task improvement, improvement of information and communication methods, and improvement of work organization.

H3. Some modern digital solutions in the field of process improvement, task improvement, improvement of information and communication methods, and improvement of work organization are rarely or not at all used in the work of the Regional Education Authority in Krakow.

To verify the H1 hypotheses, seven questions were used:

1. Has the Regional Education Authority in Krakow implemented digital innovations in the field of process improvement?
2. Has the Regional Education Authority in Krakow implemented digital innovations in the scope of the tasks performed?

¹ It is worth mentioning that the total number of employees of the Regional Education Authority also includes people who, due to their positions (e.g. drivers or porters), did not receive a questionnaire to fill in.

3. Has digital innovation in information and communication methods been implemented in the Regional Education Authority in Krakow?
4. Has the Regional Education Authority in Krakow implemented digital innovations in the organization of work?
5. Does the Regional Education Authority in Krakow use solutions to encourage employees to submit digital innovations?
6. Does the Regional Education Authority in Krakow have financial resources dedicated to the development and implementation of digital innovations?
7. Are project teams dedicated to the implementation of digital innovations established in the Education Authority in Krakow?

Respondents had the option of answering using a five-point Likert scale, where a score of 1 meant "definitely not" and a score of 5 meant "definitely yes". The answers provided allowed us to examine the opinions of employees on the main areas and conditions for the implementation of digital innovations in the Regional Education Authority in Krakow.

The verification of the H2 hypothesis was possible thanks to the analysis of answers to the seven general questions described above and the following five specific questions:

1. Which of the following digital solutions does the Regional Education Authority in Krakow use in the field of process improvement?
2. Which of the following digital solutions does the Regional Education Authority in Krakow use to improve tasks?
3. Which of the following digital solutions does the Regional Education Authority in Krakow use to communicate with external stakeholders?
4. Which of the following digital solutions does the Regional Education Authority in Krakow use to communicate with employees?
5. Which of the following digital solutions does the Regional Education Authority in Krakow use to improve the organization of work?

The answers to the indicated questions also allowed us to identify solutions in the field of digital innovations, which are missing in the Education Authority in Krakow, which verifies the third hypothesis (H3).

The above five questions were semi-closed, respondents could choose from the versions of the answers below them or add their suggestions. Respondents could select more than one answer.

6. Analysis and discussion of the survey results

Characterizing the implementation of digital innovation solutions in the Regional Education Authority in Krakow is in line with the trend of research in which the need to adapt the offer of services provided by public sector institutions to the expectations of diverse groups of stakeholders is highlighted. The efficiency and quality of public service delivery depend to a large extent on the ability of local authorities to transform administrative structures and processes that respond to rapidly changing conditions and growing needs of citizens, determined by advancing digitalization.

From the answers to the first four questions concerning the areas of implementation of digital innovations (Table 1), it can be concluded that in the opinion of the employees of the Regional Education Authority in Krakow, it is difficult to indicate one area that stands out. The average results of responses to these questions obtained from 101 surveys indicate that in the case of each of the areas, respondents rate the implementation between "moderate" and "rather yes". The highest score was given to digital solutions implemented in the field of process improvement (3.61) and the lowest to improving task performance (3.20). The next three general questions identified how the Regional Education Authority in Krakow supports the development and implementation of digital innovations. The assessment of the degree of support by the Regional Education Authority in Krakow for activities aimed at creating digital innovations indicated certain needs in this area. Support for individual employee initiatives was rated relatively best (3.14). The average rating of the other two ways of support fell below the average rating of 3 on the adopted scale and amounted to 2.98 for the establishment of teams dedicated to the implementation of digital innovations, and 2.86 for the provision of financial resources dedicated to digital innovations. The results indicate that the situation in terms of support for digital innovation in the Regional Education Authority in Krakow is not bad, but requires the attention of managers and further financial support. The answers given to the questions about the areas of implementation of digital innovations and the creation of conditions for their implementation allow us to conclude that the H1 hypothesis is true.

Table 1.

Assessment of digital innovations and conditions for their support

Question	Mean	Median	Minimum	Maximum	Standard deviation
Has the Regional Education Authority implemented digital innovations in the field of process improvement?	3,61	4,00	1,00	5,00	0,91
Has digital innovation been implemented in the Regional Education Authority in the field of task improvement?	3,20	3,00	1,00	5,00	1,05
Has the Regional Education Authority implemented digital innovations in the field of information and communication methods?	3,41	3,00	1,00	5,00	1,03

Cont. table 1.

Has the Regional Education Authority implemented digital innovations in the organization of work?	3,59	4,00	2,00	5,00	0,91
Does the Regional Education Authority use solutions to encourage employees to submit digital innovations?	3,13	3,00	1,00	5,00	1,27
Does the Regional Education Authority have financial resources dedicated to the development and implementation of digital innovations?	2,86	3,00	1,00	5,00	1,01
Are project teams dedicated to the implementation of digital innovations established in the Education Authority?	2,98	3,00	1,00	5,00	1,14

Source: own study.

The first of the detailed questions included in the survey concerned the digital solutions used by the Regional Education Authority to support process improvement. The respondents indicated three main solutions in this area (Table 2). More than half of the respondents indicated the fact that integrated information resources are used to improve digital processes, and slightly less paid attention to the procedures and instructions used for this purpose to manage electronic process data resources. Only one in three respondents used electronic systems such as ERP for this purpose.

Table 2.

Digital innovation for process improvement

Type of solution	Number of responses	Number of positive responses	Positive response rate
Digital, integrated information resources necessary for the execution of processes	101	54	53,46
Procedures and instructions for managing electronic data assets supporting the implementation of processes	101	50	49,5
IT system supporting the implementation of processes (e.g. ERP)	101	30	29,7

Source: own study.

In the next in-depth question, respondents were asked about digital solutions for improving stakeholder tasks. The results of the answer to this question are presented in Table 3. The largest number of respondents indicated the use of the Regional Education Authority's in Krakow website (87.13%) and ex-quo electronic system for submitting forms or submitting applications (73,27%) and various types of online platforms (73.27%). It is worth noting that there are only a few indications of solutions such as online appointment systems (3.96%), electronic voting systems (1.98%), or artificial intelligence (0%). The latter solution did not receive a single indication in the study.

Table 3.*Digital innovation for tasks delivery improvements*

Type of solution	Number of responses	Number of positive responses	Positive response rate
Websites	101	88	87,13
Online platforms	101	74	73,27
Electronic system for submitting forms or submitting applications	101	74	73,27
Electronic systems for issuing consents and certificates	101	24	23,76
Big data	101	22	21,78
Electronic application systems	101	22	21,78
Online appointment systems	101	4	3,96
Electronic voting systems	101	2	1,98
Artificial Intelligence (AI)	101	0	0

Source: own study.

The next question concerned the digital innovations used by the Regional Education Authority in Krakow in the process of informing and communicating with external stakeholders. The answers to this question (Table 4) indicate that the website (88.12%) and the BIP website (86.14%) were used for this purpose. Another frequently indicated form of digital contact with external stakeholders is mailing (64,36%). On the other hand, solutions such as chat with an employee or a mobile application are indicated extremely rarely (0.99% and 2.97%, respectively), and a chatbot (AI) was not indicated at all.

Table 4.*Digital solutions for stakeholder information and communication*

Type of solution	Number of responses	Number of positive responses	Positive response rate
Websites	101	89	88,12
BIP website	101	87	86,14
Mailing	101	65	64,36
Social media	101	30	29,7
Electronic Stakeholder Request Systems	101	28	27,72
Information campaigns on the Internet	101	19	18,81
Electronic contact form	101	18	17,82
Online tutorials and training for stakeholders	101	18	17,82
The Mobile Application	101	3	2,97
Chat with an employee	101	1	0,99
Chatbot (AI)	101	0	0

Source: own study.

The next question also referred to the use of digital innovations in processes related to information and communication, but this time between the employees of the Regional Education Authority in Krakow. As the answer to this question (Table 5) shows, the most frequently used digital solutions in this area include electronic documentation management system (98.02% of responses) and mailing (84.16%). The next places were taken by online instructions and training for employees (66,34%) as well as contact using the website (59,41%). On the other hand, social media (4.95%) and electronic systems for submitting employee requests (7.92%) are used the least frequently.

Table 5.*Digital solutions for employee information and communication*

Type of solution	Number of responses	Number of positive responses	Positive response rate
Electronic Documentations Management System (EDMS)	101	99	98,02
Mailing	101	85	84,16
Online instructions and training for employees	101	67	66,34
Websites	101	60	59,41
Intranet	101	23	22,77
Electronic systems for submitting employee requests	101	8	7,92
Social media	101	5	4,95

Source: own study.

The last of the analysed questions concerns the use of digital innovations in improving the organization of work (Table 6). The most frequently indicated solutions in this area include electronic documentation management systems (98.02%), electronic time and attendance (34,64%), and the use of online platforms for online work (35.64%) and remote work (30.69%). On the other hand, the hybrid work (10.89%) and integrated data archiving systems (13.86%) are used the least often.

Table 6.*Digital solutions for organization of work*

Type of solution	Number of responses	Number of positive responses	Positive response rate
Electronic Documentation Management System (EDMS)	101	99	98,02
Electronic time and attendance	101	36	35,64
The use of online platforms for online work (MS Teams, Zoom)	101	36	35,64
Remote work	101	31	30,69
Integrated data archiving systems	101	14	13,86
Hybrid work	101	11	10,89

Source: own study.

The answers to general questions concerning the areas of implementation of digital innovations, along with answers to specific questions about specific forms of solutions implemented in this area, allow us to confirm the H2 hypothesis.

To verify the H3 hypothesis, modern digital solutions were identified in process improvement, task implementation, information and communication methods, and work organization, which the Regional Education Authority in Krakow used sporadically or not at all. In terms of process improvement, the respondents least often indicated the use of ERP systems, which were mentioned by less than 30% of the respondents. In the area of improving task performance, a particularly low number of indications was noted for solutions such as online appointment scheduling systems (3.96%), electronic voting systems (1.98%) or artificial intelligence, which was not indicated even once. Concerning information and communication methods, the study distinguished two levels: solutions related to informing and communicating with stakeholders and internal communication addressed to employees. In the first case,

solutions such as chat with an employee (0,99%) and mobile applications (2,97%) were indicated the least, while chatbots were not indicated at all. In the second area, the least popular solutions turned out to be electronic systems for submitting employee requests (7.92%) and social media (4.95%). The last area analyzed concerned the use of digital tools in work organization. In this respect, the respondents indicated the hybrid work model (10.89%) and integrated data archiving systems (13.86%) the least often. The results of the research presented above allow us to confirm the H3 hypothesis.

An analysis of the literature on the subject allows us to notice that the context of digital innovations and their implementation at the level of public administration institutions has been taken up by various researchers. Hong et al. (2022) in their research focused on the analysis of the use of digital technologies such as big data, artificial intelligence, the Internet of Things, and augmented reality by Korean local governments in the transformation of their services. They noted that the implication of digital innovations in the public sector is mainly determined by the expectations of users and it can be directly said that there is demand-pull innovation, which is a response to citizens' demands for innovation. These researchers suggest the existence of isomorphic pressure as a driver of innovation in the public sector, state that public organizations imitate other organizations or companies in adopting innovative practices and found justification for the statement that the motivation of local governments to innovate digitally depends on local politicians and their election promises, and suggested that younger decision-makers are more active innovators. A specific adaptation of public sector organizations to the expectations of the social environment can be seen in the processes of their transformation. The processes of making public organizations similar to the organization of the business sector are an expression of a rational strategy resulting from the assumptions of modern concepts of public management. A kind of imitation and its key determinants are visible in the implementation of management methods in public organizations, often taken directly from the practice of enterprises. It also seems that institutional isomorphism, undoubtedly dominant among public organizations in recent decades, is the result of a kind of pressure to increase the rationality, effectiveness and efficiency of the functioning of the public sector (Wodecka-Hyjek, 2023). In turn, Kafel et al. (2021) characterize the use of digital technologies in public organizations in Poland. The authors indicate that the most frequently implemented tools in public administration in Poland are electronic record boxes, electronic document workflow, electronic handling of HR matters, online meetings, online courses, internal virtual network drives, electronic time recorders, and social media in contact with stakeholders. Kuhlmann and Heuberger (2023), on the other hand, characterize the state of digitization in German public offices on the example of the functioning of local citizen service points. The authors, based on the conducted research, stated that although local citizen service points are crucial for the digitization of local administration, the digital transformation in the surveyed service points is currently mainly limited to the information function of e-government, online communication between local authorities and citizens is much less developed,

and the transactional function is practically non-existent. Employees of the surveyed authorities do not see significant benefits of digitalization, on the contrary, they often reported increased stress, higher workload, additional time needed to process each case, more demanding procedures, and increased workload due to constant availability to superiors via email as a result of digitalization approaches. On the other hand, citizens, users of the digital office, mostly expected an increase in the package of e-services and the same level of digital interaction with public authorities as takes place in contacts with commercial suppliers. Equally interesting research is described by Kwon et al. (2024), who investigated the use of various digital technologies such as artificial intelligence (AI), blockchain, big data, 3D printing, augmented reality (AR), QR codes, drones, and the Internet of things (IoT) to improve public services and meet the needs of citizens. They noted that many local governments have embraced digital innovation and advanced technologies, including artificial intelligence, the Internet of Things, and big data, to solve often complex, often unprecedented problems, improve processes and procedures, and increase citizen engagement, despite the existence of significant differences in the adoption of digital innovations among local communities. At the same time, these authors provided evidence that community wealth/education levels and independent IT departments significantly affect the level of involvement of California governments in innovation and digital technologies.

The cited cases allow us to conclude that the level of digital innovation, both in Polish and foreign public organizations, is an important issue and a long-term process, requiring changes and flexible adaptation to technological challenges and stakeholder expectations. Research conducted at the Regional Education Authority in Krakow allows us to conclude that the level of digital innovation of this institution requires support, especially in terms of financial resources and the establishment of teams dedicated to the introduction of innovative digital solutions. The highest score was given to digital solutions implemented in the field of process improvement, while the lowest score was given to those related to the improvement of task performance. The most used innovative digital solutions in the area of process improvement are integrated information resources, procedures and instructions for managing electronic process data resources, and electronic systems such as ERP. In another area, improving tasks for stakeholders, the most frequently indicated were the websites of the Regional Education Authority and ex-quo the electronic system for sending forms or submitting applications, and various types of online platforms. The most used digital solutions in the field of employee information and communication are the electronic documentation management system and mailing, while the digital solutions used in informing and communicating with external stakeholders are primarily websites and BIP websites, as well as an electronic contact form. On the other hand, the most common digital innovations in improving work organization include electronic documentation management systems, electronic time and attendance the use of online work platforms, and remote work.

7. Conclusions

E-administration has become a response to the challenges commonly faced by public administration, i.e. debureaucratization, transparency, efficiency, friendliness, and compatibility. Modern technologies make it easier to meet these challenges. Universal access to online services contributes to reducing the specificity of resources necessary to carry out a given activity, which was analyzed in the context of the theory of transaction costs. Operations carried out electronically leave a trace, making their verification easier. This improves the transparency of operations, which is key to effectively reducing corruption. In addition, services that are not dependent on the official's decision, but are allocated 'automatically', are characterized by greater objectivity (Cichocki, Nagańska, 2021). Alvarenga et al. (2020) believe that digital local government is more likely to boost citizen engagement in local affairs and stimulate them by including innovative digital solutions. The innovativeness of institutions in the public sector is determined by many factors, among which the following deserve special attention: limited budget, responsibility of managers of public organizations for the decisions made and the risk of disposing of public funds, the possibility of significant political influence on the decisions made, the inability to overcome rigid rules and procedures, the inability to see long-term benefits, low level of adaptation of new technologies, changing social needs and expectations, organizational culture that is not conducive to innovation, ineffective cooperation with the private sector and society, poor leadership, employee resistance, and excessive demands of citizens (Wodecka-Hyjek, 2023). While research conducted a decade ago drew attention to barriers to innovation, contemporary research is focused on highlighting the premises and factors conducive to the implementation of innovation in public sector organizations (e.g. De Vries, Bekkers, Tummers, 2016, Moussa, McMurray, Muenjohn, 2018).

Summing up the research conducted by the authors, it can be stated that all three hypotheses have been positively verified, which means that the Regional Education Authority in Krakow is a public sector institution implementing innovative digital solutions. In the analyzed institution, digital innovations are implemented in four areas related to improvement: processes, tasks performed, methods of information and communication, and organization of work. At the same time, it should be emphasized that some modern digital solutions are rarely used or are not used at all in the work of the Regional Education Authority in Krakow. In conclusion, it should be noted that innovative digital solutions are used in the surveyed office, but there is a need for further development of their practical application.

Undoubtedly, the conducted research has certain limitations, resulting primarily from its limited scope (the surveys were conducted only among employees of the Regional Education Authority in Krakow willing to participate in the survey). Therefore, these results cannot be generalized and their analysis should be critical. Next, it would be necessary to expand the

research in the context of expanding the sample, preferably by employees of all Regional Education Authorities in Poland. It would be interesting to diversify the survey depending on the faculties or delegations and to confront the results obtained by extending the survey to other public sector institutions.

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SOCIAL ENTERPRISES AND SHORT FOOD SUPPLY CHAINS: INSIGHTS FROM EXPLORATORY CASE STUDIES

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Purpose: This paper investigates the role of social economy organizations and social enterprises in promoting sustainable local food systems through short food supply chains (SFSCs).

Design/methodology/approach: Using an exploratory case study methodology, the paper analyzes seven European cases, relying on qualitative data from documents and interviews within the JustGreen project. This approach examines how social economy organizations and social enterprises integrate SFSCs into their operations, aligning social missions with economic activities.

Findings: Participation in SFSCs can bring numerous benefits for actors involved into supply chain. The research finds that social economy organizations and social enterprises in SFSCs can reduce environmental impacts, support local economies, and enhance social inclusion by providing employment to marginalized groups.

Research limitations/implications: The study is limited by its reliance on existing case studies rather than extensive primary data collection. Future research could broaden the scope with quantitative methods and additional SFSC models to validate the findings.

Practical implications: The study offers insights for policymakers and practitioners on how SFSCs can support local food systems, improve access to markets for small producers, and foster collaboration between producers and consumers.

Social implications: SFSCs strengthen community resilience, promote social inclusion, and support sustainable local economies. By shortening supply chains, social economy organizations and social enterprises can address food insecurity, empower vulnerable populations, and contribute to the green transition.

Originality/value: The paper highlights the innovative role of SFSCs in uniting social, economic, and environmental objectives, offering a model for sustainable community development.

Keywords: social economy organization, social enterprise, social entrepreneurship, supply chain, short food supply chain, resilience.

1. Introduction

The importance of developing sustainable and resilient food systems has garnered significant global attention, particularly in light of pressing challenges such as climate change, food insecurity, and economic inequality. The intersection between social enterprises and sustainable food systems represents a dynamic area of inquiry within social and economic policy, particularly given the increasing global emphasis on sustainable development and the transition to a greener economy. Social enterprises, as hybrid organizations that blend social missions with market-driven activities, are well-positioned to address complex challenges such as food insecurity, environmental degradation, and community resilience. Short food supply chains (SFSCs), which aim to reduce the distance between producers and consumers, offer a promising avenue for social enterprises to foster sustainability and local economic development. By prioritizing local production and direct consumer relationships, SFSCs can not only reduce the environmental impact of food production but also enhance the social inclusion of marginalized groups and strengthen local communities.

Despite the growing body of literature on social entrepreneurship (Borzaga, Bodini, 2012; Doherty et al., 2019) and SFSCs (Kneafsey et al., 2013; Galli, Brunori, 2013), limited research explores the intersection of these two fields. Existing studies highlight the environmental and social benefits of SFSCs, including reduced carbon footprints, strengthened local economies, and enhanced social inclusion (Marsden et al., 2000; Renting et al., 2012; Twaróg, Wronka-Pośpiech, 2023). Meanwhile, the potential of social enterprises to drive community development and sustainability has been well-documented (Defourny, Nyssens, 2021; Saebi et al., 2019). However, the specific mechanisms through which social enterprises engage with SFSCs to achieve these outcomes remain underexplored. This gap in knowledge underscores the need for a deeper investigation into how social enterprises operationalize SFSCs to fulfill their social missions.

This paper explores the role of social enterprises in promoting SFSCs, focusing on innovative practices implemented by social economy organizations across Europe. Drawing on case studies from the international "Social Economy for a Just Green Transition" (JustGreen) project, the research highlights how social enterprises contribute to the development of resilient and sustainable food systems through their engagement in SFSCs. By examining the initiatives of these organizations, the study aims to provide new insights into the synergies between social entrepreneurship, local food systems, and sustainable development, while offering practical lessons for policymakers, practitioners, and researchers working in these fields.

2. Theoretical assumptions

2.1. Social entrepreneurship and social enterprises

Social entrepreneurship (SE) is increasingly recognized as vital instruments in social and economic policy, particularly for tackling issues such as unemployment, social exclusion, and sustainable regional and local economic development (Borzaga, Bodini, 2012). The manifestation of social entrepreneurship is evident in the activities of organizations, projects, or ventures known as social enterprises (Mair, Martí, 2006). The term "social enterprise" encompasses a variety of organizations, including social economy organizations, that engage in trading activities with the primary objective of achieving a social mission (Haugh, 2007). According to Ebrahim et al. (2014), social enterprises combine elements of both charitable organizations and for-profit businesses, aiming to generate profits that are reinvested to meet multiple bottom lines, including social and environmental impacts alongside financial sustainability (Cieslik, 2016). Their primary objective is to achieve long-term social change and generate social impact, prioritizing these goals above profits for their owners or shareholders (Pacut, 2022). Thus, social enterprises strive to balance fulfilling a social and/or environmental mission with market-driven activities (Defourny, Nyssens, 2021; Bacq et al., 2016). This dual focus has led to their characterization as hybrid organizations—neither fully commercial entities nor traditional non-profits.

Social enterprises predominantly rely on commercial activities for revenue, scaling their operations through market mechanisms rather than depending solely on donations or grants (Ebrahim et al., 2014). Situated within the third sector of the economy, social enterprises emerge in response to gaps in social welfare provision by the market or government. They have gradually become significant contributors to social progress. The self-sustaining economic model employed by these organizations presents a promising alternative to state dependency for social welfare, demonstrating its efficacy in driving social change (Hillman et al., 2018). Social enterprises have the potential to revitalize communities by addressing local needs, promoting community independence, and building social capital among individuals and communities (Haugh, 2007). Consequently, community-level approaches and social enterprises enhance engagement with local stakeholders, enabling the tailoring of sustainability initiatives to meet the specific needs of each community (Laurisz, 2019).

Over the years, there has been a notable rise in the number of social enterprises, with their presence now spanning numerous economic sectors (Defourny, Nyssens, 2021; Defourny et al., 2021; Saebi et al., 2019; Doherty et al., 2019). Consequently, the range of their activities has progressively broadened to address emerging societal challenges such as climate change, pollution, financial and gender inclusion, and digitization. The realm of social entrepreneurship and the social economy has been rapidly advancing, propelled by new innovations and trends across key global sectors. Social enterprises are increasingly implementing creative solutions

in diverse fields such as professional activation, social and health services, and local development, as well as in renewable energy, socially engaged agriculture, environmental initiatives (including recycling), and cultural endeavors (EC, 2020). This growth is fueled by the adoption of broader social objectives that resonate with the United Nations' Sustainable Development Goals (SDGs). As a result, numerous social economy organizations and social enterprises are now focusing on "green policy", poverty alleviation, gender equality, and environmental sustainability (EC, 2020). Reflecting these goals, there has been an increasing interest in the circular economy (Costanza, 2023; Ćwiklicki, O'Riordan, 2022), decarbonization (Wronka-Pośpiech, 2023; Manjon et al., 2022), energy cooperatives (Sengupta et al., 2020; Alevizou et al., 2017), and various other initiatives that promise substantial social and environmental benefits. Among these areas, short food supply chains stand out for their potential impact.

2.2. Short food supply chain as a new avenue for social enterprises

A short food supply chain (SFSC) is one type or strategy within the broader concept of supply chains. SFSCs are among the recently reinvented food supply systems recognized as a notable sustainable approach (Kumar et al., 2019; Wang et al., 2022; Twaróg, Wronka-Pośpiech, 2023). However, there is no common or unique definition of SFSCs within the scientific community (Kneafsey et al., 2013). SFSCs function similarly to local food systems but shorten traditional long food supply chains. It is important to emphasize that "short" refers not only to geographical proximity but also to direct social connections between producers and consumers (Aubry, Kebir, 2013). In this context, the distance between producers and consumers is not strictly defined, as it depends on the morphological and demographic characteristics of the territory, as well as the actors involved and their goals (Paciarotti, Torregiani, 2021). Therefore, two basic criteria that define SFSCs are physical/geographical and social proximity (Galli, Brunori, 2013). Nevertheless, geographical proximity remains significant, as "short" is primarily perceived as something comparatively close physically or produced within a specific region or locality (Galli, Brunori, 2013). The essence of SFSCs lies in building a special relationship between producers and consumers. Marsden et al. (2000) emphasize the importance of the relationship between producer and consumer in constructing value and meaning, rather than focusing solely on the product itself. Direct contact with the producer is a primary driver for consumers purchasing products from SFSCs (González-Azcárate, 2021). SFSCs encompass a wide range of initiatives, such as community-supported agriculture, farmers' markets, and farmer shops, often characterized by geographical and relational proximity, local food, and a commitment to cooperation (Michel-Villarreal et al., 2021). Typology of SFSC initiatives include various activities such as: direct selling (on farm sales, farmers' market, pick-your-own, producers' shop, etc.), box schemes, community supported agriculture, collective points of sale, consumer cooperatives, direct internet sales, supermarkets provisioning and e-commerce (Kebir, Torre, 2013). Participation in SFSCs can bring numerous benefits for producers, consumers, and society as a whole (Table 1).

Table 1.*Main expected benefits*

Expected benefits		
Producer	Consumer	Society
<ul style="list-style-type: none"> - Prices increase at farm gate - Value added increase - Easier market access, especially for small producers - Better communication and information to consumers - Differentiation of marketing channels and higher resilience - More stable commercial relations - Opportunity to develop cooperation with other farmers - Opportunity to develop cooperation with consumers - Allow for a strategic re-orientation of the whole farm 	<ul style="list-style-type: none"> - More affordable prices for food - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Reconnect food to the farming and processing process - Easier access to healthier food options - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Reduction of transport - Reduction of pollution (fuel, plastic ...) - Reduction of plastic packaging - Less food waste - Improved diets: easier access to fresh food, more variety in diet, less preservatives - Preserving peri-urban agriculture - Preserving small farming/artisanal food processing - Preservation of traditional products - Preservation of products based on local agro-biodiversity - Strengthening social ties - Increasing awareness about food system problems - Working opportunities for women - Explore niches of innovation

Source: United Nations Industrial Development Organization. Short Food Supply Chains for Promoting Local Food on Local Markets; Department of Trade, Investment and Innovation (TII): Washington, DC, USA, 2020; Available online:

<https://tii.unido.org/sites/default/files/publications/SHORT%20FOOD%20SUPPLY%20CHAINS.pdf>

SFSCs have emerged as a promising avenue for social enterprises, offering a pathway to promote sustainability, local economic development, and social inclusion. SFSCs prioritize reducing the distance between producers and consumers, fostering transparency, and ensuring that more value is retained by local producers. This model is particularly attractive for social enterprises, as it aligns with their dual objectives of economic viability and positive social impact. Renting, Schermer, and Rossi (2012) highlight that SFSCs contribute to rural development by empowering small-scale farmers, creating local jobs, and enhancing community resilience. Social enterprises engaging in SFSCs can capitalize on these benefits while addressing food insecurity and providing vocational training to vulnerable populations. Marsden, Banks, and Bristow (2000) argue that by shortening the food supply chain, social enterprises can also contribute to environmental sustainability by reducing food miles and carbon footprints, which is increasingly important in the context of climate change. Moreover, SFSCs offer a platform for innovative business models that integrate fair trade practices and ethical consumption, resonating with consumers' growing interest in sustainable and socially responsible products (Galli, Brunori, 2013). Thus, SFSCs represent a synergistic opportunity for social enterprises to drive both economic and social outcomes.

Nowadays, supply chains require resilience to prepare for, respond to, and recover from unexpected disruptions while continuing their operations (Ivanov, 2022). During the pandemic, the severity of product shortages increased alongside the growing distances between processing units and retail stores (Mahajan, Tomar, 2020). Interruptions in international transportation and closed borders limited the availability of imported perishables (Siche, 2020), leaving consumers

facing supply shortages. Consequently, the supply side also experienced significant challenges. The European Commission acknowledged the increasing importance of SFSCs and local food systems, noting that demand for shorter food supply chains rose, particularly during the pandemic, as a means of strengthening the resilience of regional and local food systems. Additionally, the COVID-19 pandemic underscored the significance of SFSCs, as these chains acted as critical safeguards for food security and nutrition during periods of economic uncertainty (FAO, 2020).

3. Research methodology

Given the limited knowledge about short food supply chains as a new avenue for social enterprises, this paper aims to address these issues by exploring two research questions:

RQ1: What are the different approaches to SFSCs as reported by social enterprises?

RQ2: What are the key benefits of the participation of social enterprises in the structure of short food supply chains (SFSCs)?

In the research conducted, the ontology is relativistic. This means that knowledge is viewed as an intersubjective construct, rather than an objective one. In this article, a qualitative methodology was used to collect and analyze data, as it is the most appropriate approach to achieve the purpose of the study. The paper employs an exploratory case study methodology, which is recognized as a powerful sensitizing tool due to its inherent flexibility and capacity to adapt to complex research settings. Its strength lies in its ability to explore underdeveloped or emerging theoretical frameworks, enabling researchers to refine or build new constructs when existing theories fall short (Yin, 2018). This adaptability is crucial for studying intricate social and organizational systems, where rigid variables may obscure critical insights. By fostering deep, context-specific understandings, exploratory case studies provide a rich qualitative lens through which researchers engage with participants' lived experiences (Stake, 1995), addressing how and why questions to uncover underlying mechanisms that might be missed through other methods (Yin, 2018). The iterative nature of this methodology allows for ongoing adjustments to the research focus as new themes and patterns emerge (Eisenhardt, 1989), making it indispensable for theory-building in complex environments (Eisenhardt, Graebner, 2007). The capacity to integrate various data sources, including interviews, documents, and observations, enhances the reliability of findings through triangulation, adding depth and multi-dimensionality to the analysis (Denzin, 2017), which further solidifies its value as a robust sensitizing device.

The research material and data for the analysis were collected as part of the international project "Social Economy for a Just Green Transition (JustGreen)" funded by the European Union under the COSME program (grant agreement number 101015873). A destination

comprising four municipalities, namely the Municipality of Vila Nova de Famalicão from Portugal, Comune di Mozzo from Italy, Gmina Świetochłowice from Poland, Budapest-Terézváros from Hungary and one European network – European Network of Social Integration Enterprises (ENSIE) was selected. The Just Green project aimed to promote the transition of social economy organizations and social enterprises to a greener and fairer economy and society, in line with the motto of the UN Sustainable Development Goals “leaving no one behind”. It explored three key topics, including supporting short food supply chains and agroecology. The cross-cutting goal was to support social entrepreneurship by targeting the vocational integration of vulnerable and unmet social needs groups, often the most vulnerable (i.e., the elderly, the disabled) (Project Proposal, 2020). Ensuring the effectiveness of the objectives, the project consortium brought together five highly diverse partners with demonstrated good practices, along with a broad spectrum of social economy stakeholders, which allowed, among other things, to strengthen the dynamics of social economy organizations in local and interregional ecosystems, stimulating learning, collaboration and building to a transnational Social Economy community.

Throughout the one-year period from February 2020 to January 2021, the project facilitated the engagement of a diverse group of participants, including 24 social economy organizations and social enterprises with varying levels of experience in European projects and green transition topics. This initiative fostered an enriching process of knowledge sharing, mutual learning, and the development of connections and networks. Additionally, the project sought to promote collaboration among various stakeholders from different countries and regions, while empowering participants to contribute to a fair and sustainable green transition. As part of the project, study visits were conducted, allowing the use of observation and interview methods.

4. Research results and remarks

This section outlines the seven good practices gathered during the project period. These practices, submitted by the partner organizations, were analyzed and assessed based on the project's established criteria (refer to the radar charts for each good practice below), which include – see table 2.

Table 2.
Project's established criteria

Criteria	Description of criterion
Collaboration 1	<ol style="list-style-type: none"> 1) The practice involves no collaboration between social economy organizations and municipalities 2) There is occasional collaboration between social economy organizations and municipalities 3) There is regular collaboration between social economy organizations and municipalities
Collaboration 2	<ol style="list-style-type: none"> 1) The practice does not network with other social economy organizations 2) The practice is part of an informal network of social economy actors and collaborates occasionally with them 3) The practice is part of a formal network of social economy actors and cooperates constantly with them
Environmental value	<ol style="list-style-type: none"> 1) The practice involves no or little concern for short food supply chains 2) The practice aims to promote short food supply chains 3) Promotion of short food supply chains confirmed by quantitative or qualitative evidence
Social value	<ol style="list-style-type: none"> 1) The practice involves no or little concern for inclusion or employment (job creation, access to goods and services, participation or learning opportunities - for vulnerable groups) 2) The practice aims to promote inclusion or employment (job creation, access to goods and services, participation or learning opportunities - for vulnerable groups) 3) Positive effect on inclusion or employment confirmed by quantitative or qualitative evidence
Maturity	<ol style="list-style-type: none"> 1) The practice is less than 4 years old 2) The practice is between 4 and 9 years old 3) The practice is 10 years old or more
Transparency	<ol style="list-style-type: none"> 1) The responsible organizations communicate poorly about the practice; few information is available 2) Some information about the practice (activities, beneficiaries, outcomes, funding, finances, and governance) is made publicly available and information requests are answered 3) Information on activities, beneficiaries, outcomes, funding, finances, and governance is made publicly available on a regular basis

Source: Project materials.

4.1. Good practice 1: Banyaerdő social enterprise, Hungary

The social enterprise Banyaerdő is located in Baranya County. Its mission is to build a sustainable model that produces and sells marketable products while providing fair wages and forming partnerships based on local resources. Banyaerdő processes and sells mushrooms and other forest plants, collecting raw materials from the nearby forests and fields and applying zero-waste solutions during packaging and sales. By focusing on short food supply chains, Banyaerdő ensures that their products reach local markets quickly and efficiently, reducing the carbon footprint and supporting local economies. This product category was chosen due to its scarcity in farmers' markets, the ease of collection and processing, and the existing cooperation with the local forest management company, the municipality, and other authorities.

The workers, mostly socially disadvantaged Roma women, are central to the enterprise. The basic idea was to develop a model that leverages the strengths of the target group, the local natural and social environment, and existing skills. This model ensures decent wages, builds partnerships, and harnesses local knowledge, combined with urban trends. As a family-friendly workplace, Banyaerdő offers flexible policies regarding absences due to childcare, and employees can work alongside their children (3rd project newsletter).

Banyaerdő aims to create long-term jobs and integrate inactive individuals, primarily women, into the workforce, fostering their independence and self-sufficiency. This is accomplished by supporting the community and offering alternative solutions, such as flexible work hours, incorporating the target group's ideas, involving them in product development, and organizing community programs. In addition to production, the social enterprise is gradually expanding its services, including joint mushroom foraging tours with training and community cooking sessions.

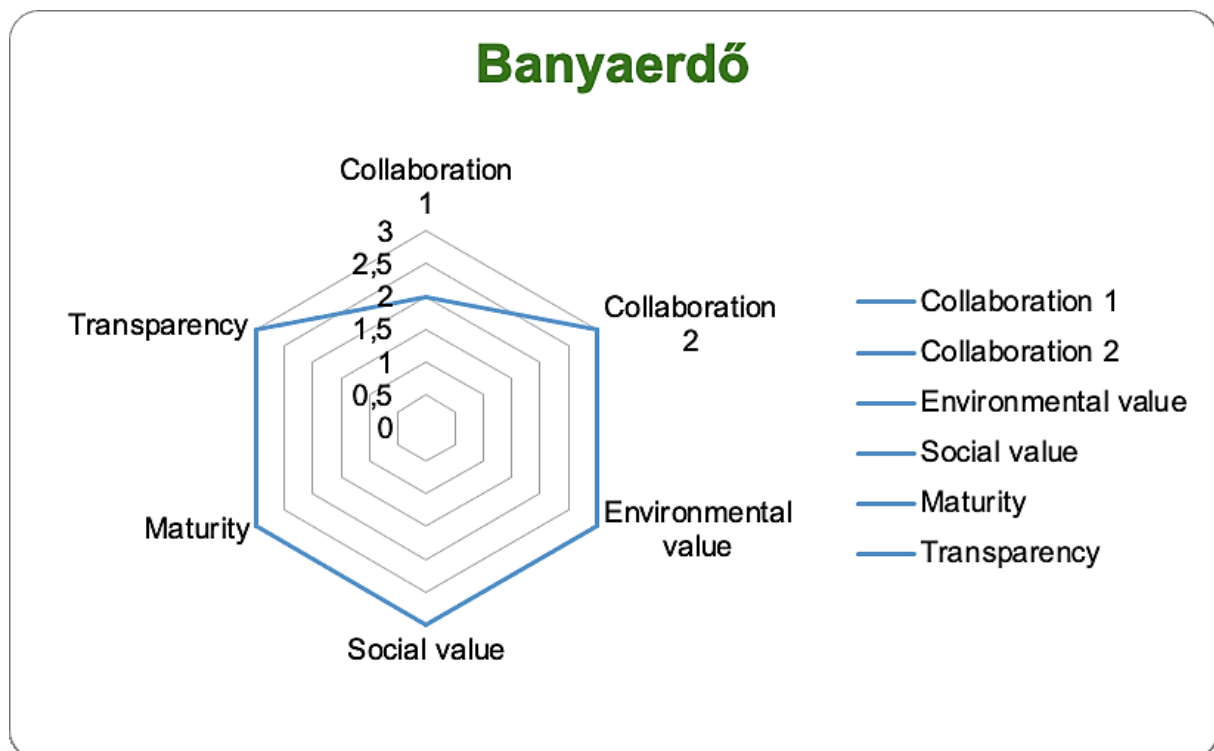


Figure 1. Radar chart for good practice 1.

Source: own elaboration based on project materials.

4.2. Good practice 2: Kockacsoki social enterprise, Hungary

Kockacsoki is a social enterprise and chocolate manufactory that produces gourmet products while guaranteeing work opportunities for vulnerable individuals. Their mission is to improve the living conditions of youths with autism. The primary aim of Kockacsoki is to assist people with autism spectrum disorders, one of the most disadvantaged groups in the labor market. Among all people with disabilities, those with autism face the greatest challenges due to their lack of social and communication skills and inflexible routines. However, with the right

support, they can perform valuable work, even in mainstream workplaces. Kockacsoki's intention is to enhance the quality of life and employment opportunities for people with autism through a comprehensive employment program. This program includes coaching courses to help individuals become more self-sufficient in their daily lives, opportunities to gain work experience through trainee programs, and provision of permanent employment (3rd project newsletter).

Kockacsoki also emphasizes the importance of short food supply chains by sourcing ingredients locally and ensuring their products reach customers quickly and efficiently. This approach supports local farmers and reduces the environmental impact of transportation. Their café, KockaPont, offers guests premium coffees in an autism-friendly and accessible space, where they can also purchase Kockacsoki's premium chocolate products. Additionally, the café hosts community programs, events, and concerts, fostering a sense of community and inclusivity.

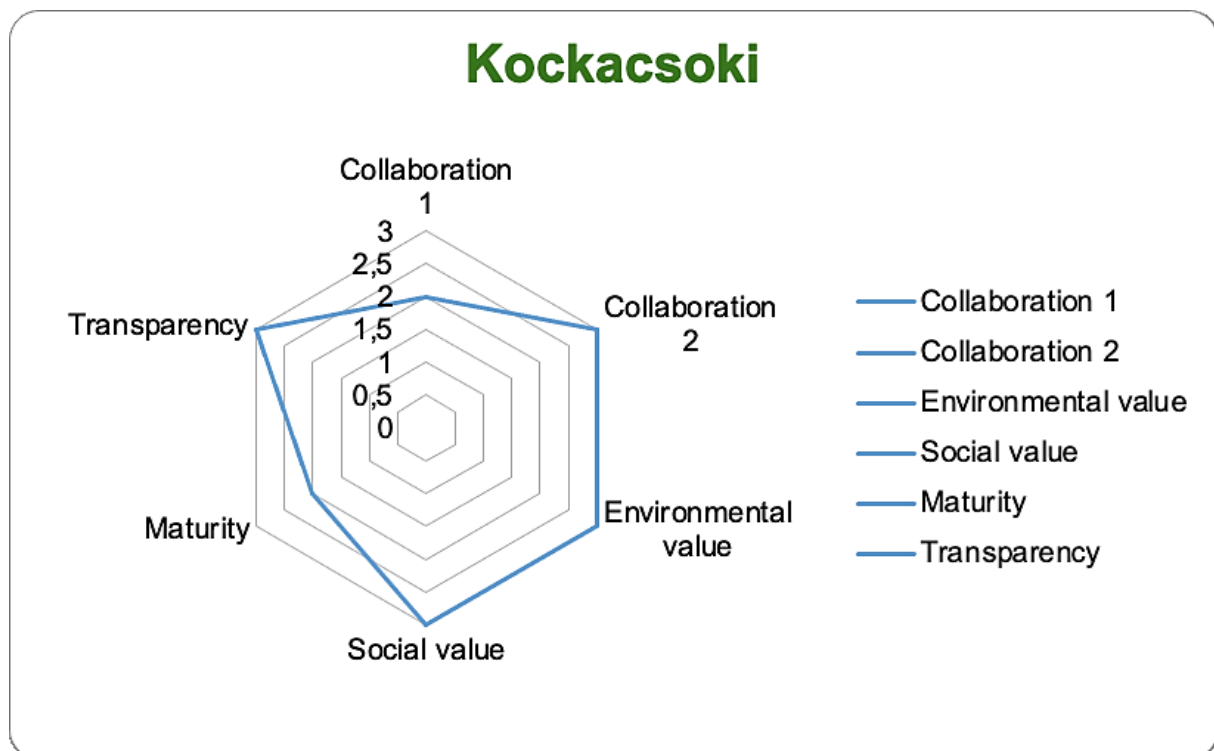


Figure 2. Radar chart for good practice 2.

Source: own elaboration based on project materials.

4.3. Good practice 3: Centro Social e Cultural de São Pedro de Bairro (CSCSPB), Portugal

Centro Social e Cultural de São Pedro de Bairro is a private institution of social solidarity, recognized as a public utility and non-profit organization. Founded as an association in 1983, it has gradually expanded its services to meet the needs of the community. Its regional scope focuses on the Municipality of Vila Nova de Famalicão. The organization's goal is to foster

development, social and cultural promotion, and create solutions to address the deficiencies of the local and municipal community.

Centro Social de Bairro is actively involved in several projects with a primary focus on social care, personal development, and sustainability, such as "To sow values, to harvest smiles!" The aim is to transform lives through value-driven activities, including:

- Sustainable agricultural production: Feeding children and the elderly with produce from greenhouses equipped with modern irrigation systems. The waste produced is utilized to feed farm animals, ensuring a closed-loop system.
- Reuse of wood residues: Producing pellets and briquettes from wood residues, employing young disabled people in the process.
- Growing medicinal and aromatic plants: Drying these plants using a solar heater and selling them within the community, emphasizing local production and consumption.
- Education and training programs to enhance community skills and knowledge (3rd project newsletter).

By incorporating short food supply chains, Centro Social de Bairro ensures that locally produced food and products are quickly and efficiently distributed within the community. This approach supports local agriculture, reduces environmental impact, and strengthens community ties. Through these initiatives, the organization not only promotes sustainability but also fosters a sense of community and self-sufficiency, turning life into value for all involved.

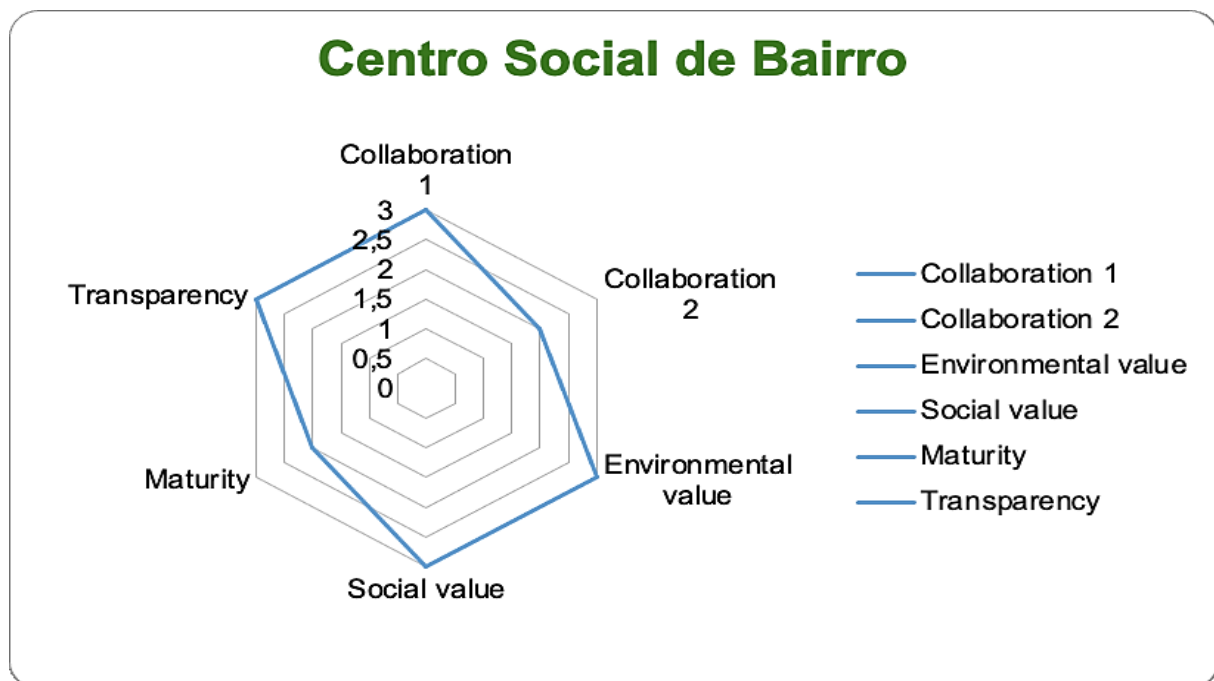


Figure 3. Radar chart for good practice 3.

Source: own elaboration based on project materials.

4.4. Good practice 4: Il Sole e la Terra, Italy

Il Sole e la Terra is a non-profit consumer cooperative founded in 1979, dedicated to food, agriculture, sustainability, and conscious consumption. The cooperative offers members quality products at fair prices, promoting healthy food access, sustainable production methods, environmental care, social relationships, and community engagement. Currently, the cooperative has about 13,000 members, with more than half actively making purchases. Il Sole e la Terra is a crucial reference point for local organic producers, serving as the main market outlet for many. The cooperative supports a robust food supply chain characterized by minimal steps from producer to consumer, emphasizing local production. This approach helps maintain viable companies in the area and encourages the growth of new productive enterprises. Many suppliers operate in the social economy field. These organizations employ people with disabilities, produce organic vegetables, and offer educational and work opportunities (3rd project newsletter).

Il Sole e la Terra supports individuals in difficulty through targeted projects, work grants, and internships in collaboration with various partners. The cooperative emphasizes environmental sustainability by reducing packaging, using recycled and compostable bags, and collecting plastic and stoppers for reuse.

By prioritizing short food supply chains, Il Sole e la Terra ensures local organic products are efficiently delivered to consumers, supporting local farmers and reducing the environmental impact of long-distance transportation. This approach bolsters the local economy and fosters a sense of community and sustainable consumption practices.

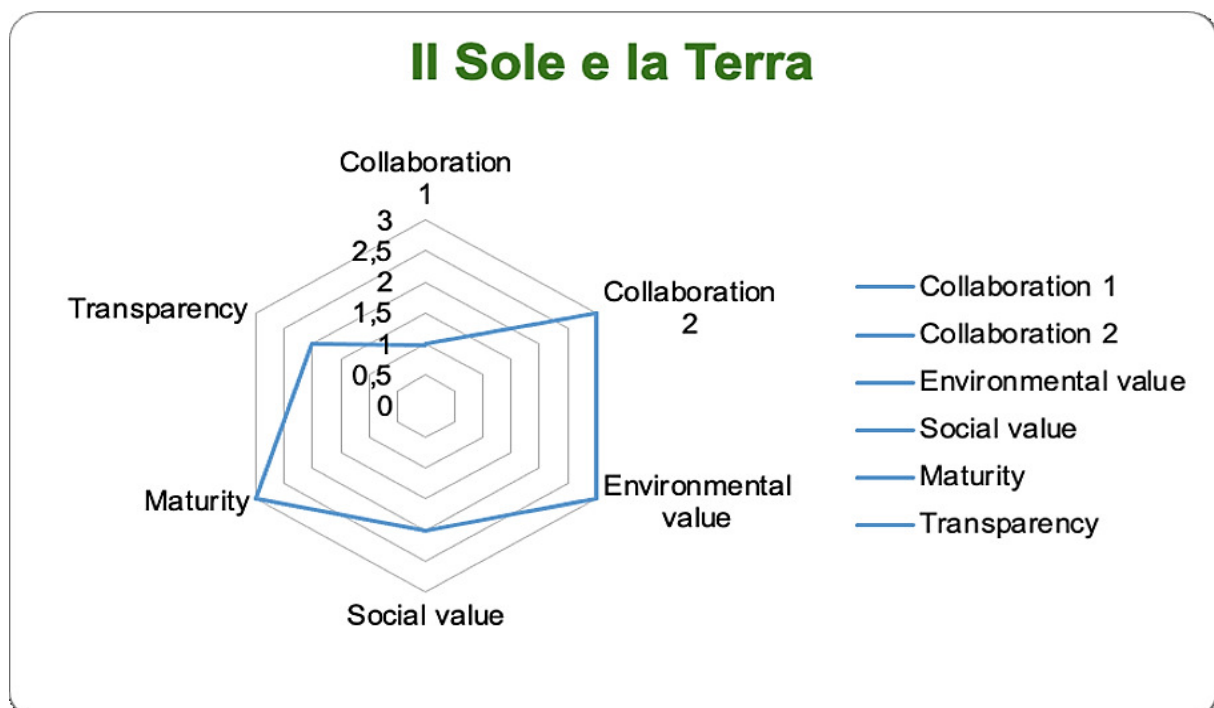


Figure 4. Radar chart for good practice 4.

Source: own elaboration based on project materials.

4.5. Good practice: La Porta del Parco, Italy

La Porta del Parco is a community project aimed at enhancing the value of an agricultural area and promoting sustainable practices that engage citizens. It is the result of a collaboration between the Oikos and Alchimia social cooperatives, which received the land through a public tender. The project comprises the following elements:

- A vineyard: Gradually converted to organic cultivation and managed by the Oikos cooperative, which includes vulnerable individuals in its operations.
- Social and collective vegetable gardens: Managed by families to encourage local food production and community engagement.
- A didactic orchard: Provides educational opportunities about sustainable agriculture.
- A restaurant: Utilizes produce from the project, showcasing the benefits of short food supply chains.
- A children's play area: Enhances the community's recreational and family-friendly environment.

La Porta del Parco is a meeting place where numerous cultural events take place and where every Saturday there is a farmers' market featuring small local producers. This farmers' market is a key element, promoting short food supply chains by connecting consumers directly with local farmers (3rd project newsletter).

The project highlights the importance of sustainable, local food systems. The vineyard's organic cultivation and the vegetable gardens managed by families emphasize low-impact farming techniques and self-sufficiency. The didactic orchard educates visitors about sustainable agriculture, further strengthening community engagement with local food production. By incorporating these elements, La Porta del Parco demonstrates a commitment to creating a resilient and sustainable local food system. The restaurant utilizes produce from the project, showcasing the benefits of short food supply chains by offering fresh, locally sourced meals. By integrating these elements, La Porta del Parco demonstrates its commitment to building a resilient and sustainable local food system.

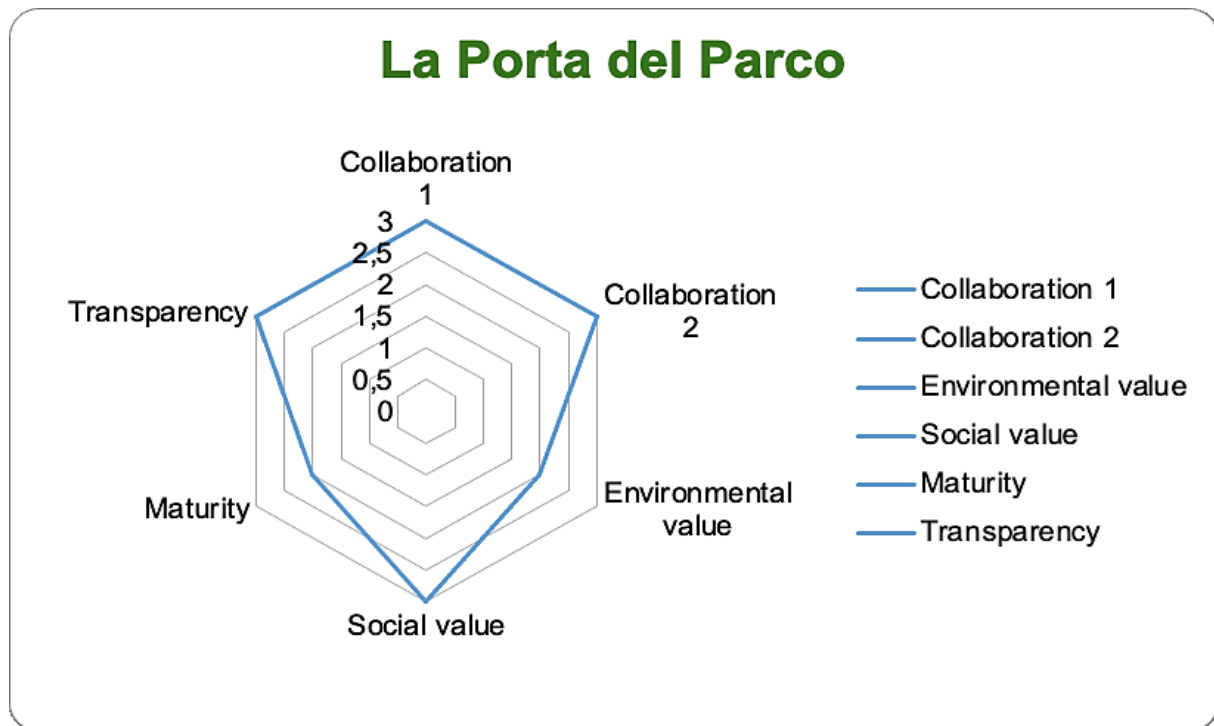


Figure 5. Radar chart for good practice 5.

Source: own elaboration based on project materials.

4.6. Good practice 6: I Raïs Community Cooperative, Italy

I Raïs Community Cooperative was established by a group of young people with the goal of revitalizing and fostering development in a challenging mountainous region. Their primary objectives are to provide additional services to residents, making mountain living more convenient, and to attract non-residents to appreciate the region by visiting, thereby creating a tourist economy beneficial to the entire community. These objectives are achieved through the production of goods and services that significantly enhance the quality of social and economic life (3rd project newsletter).

In addition to supporting residents and promoting sustainable tourism, I Raïs operates ‘Trattoria Alpina,’ which offers traditional dishes made with local products. The cooperative also produces the flagship cheese, ‘Ol Minadùr,’ made by five local farms since 2016 and aged for three months in restored local mines. The constant temperature and humidity of the mines impart a special intense and nuanced taste to the cheese (Twaróg, Wronka-Pośpiech, 2023).

By focusing on short food supply chains, I Raïs ensures that the products used in Trattoria Alpina and the production of ‘Ol Minadùr’ are locally sourced. This approach reduces the environmental impact associated with long-distance transportation, supports local farmers, and ensures the freshness and quality of the food. It also strengthens the local economy by keeping the production and consumption of goods within the community, fostering a sustainable and self-sufficient food system.

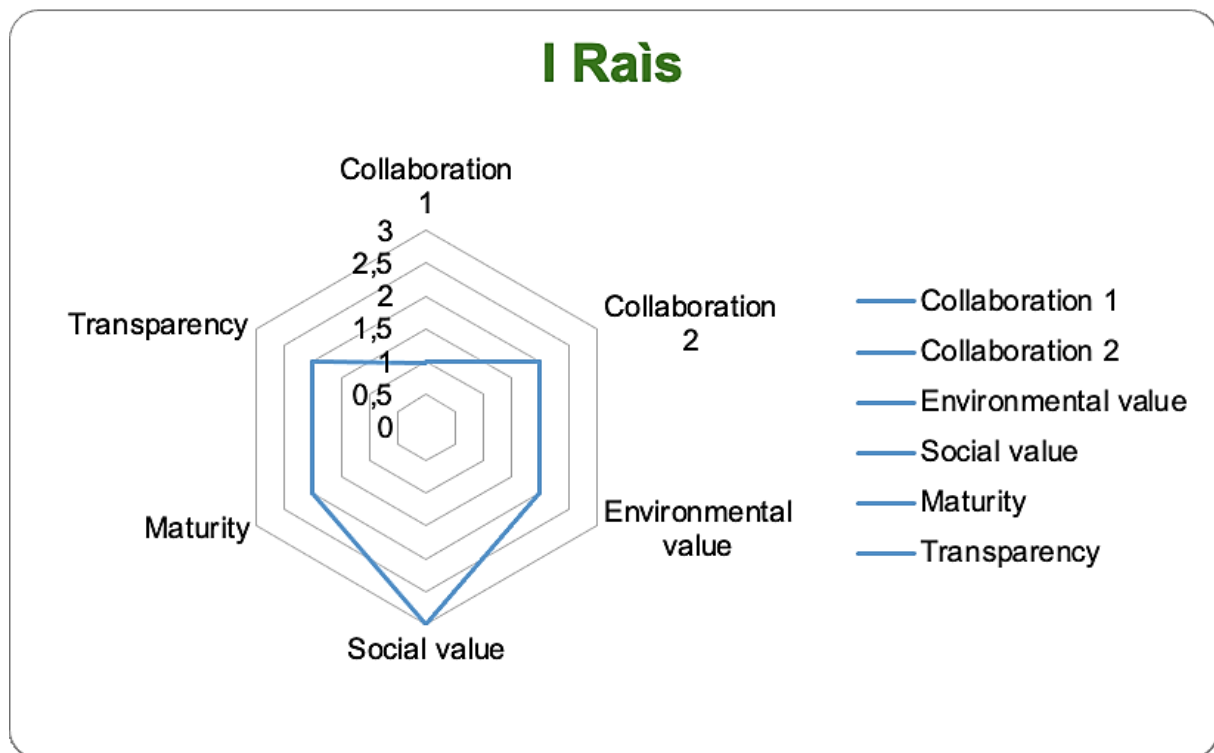


Figure 6. Radar chart for good practice 6.

Source: own elaboration based on project materials.

4.7. Good practice 7: Delivery of meals in Świętochłowice Municipality, Poland

The main goal of the meal delivery program in Świętochłowice Municipality is to provide support to seniors (people over 60 years of age who are professionally inactive) by offering access to social integration activities. These activities include health integration, physical activity, kinesiotherapy, as well as educational, cultural, and leisure integration.

The program, commissioned under the Multiannual Program for 2021-2025 "Senior+", includes several components:

- The Social Integration Centre (CIS) provides one meal a day to its 80 participants, who take part in workshops for marginalized groups. It also provides Christmas packages for the participants and children from poor families in Świętochłowice.
- Occupational therapy workshops and the Support Centre for Victims of Family Violence also provide one meal a day.
- The Social Welfare Centre in Świętochłowice donates food to 57 seniors, with 40 seniors enjoying meals on-site and 17 meals provided by caregivers.
- The Old People's Home "Senior" serves 50 individuals over 60 years of age, offering free dietary meals (breakfast and lunch) prepared by the Nursing Home "Gold Autumn" from Monday to Friday.

By focusing on short food supply chains, this program ensures that meals are balanced and adapted to the needs of the elderly. Seniors can articulate their nutritional preferences and needs, and meals are prepared using locally sourced ingredients. This not only supports local producers

and reduces the environmental impact associated with long-distance food transportation but also enhances the freshness and nutritional value of the meals provided. Overall, the program strengthens community ties by integrating social care with sustainable food practices, promoting a healthier and more connected community.

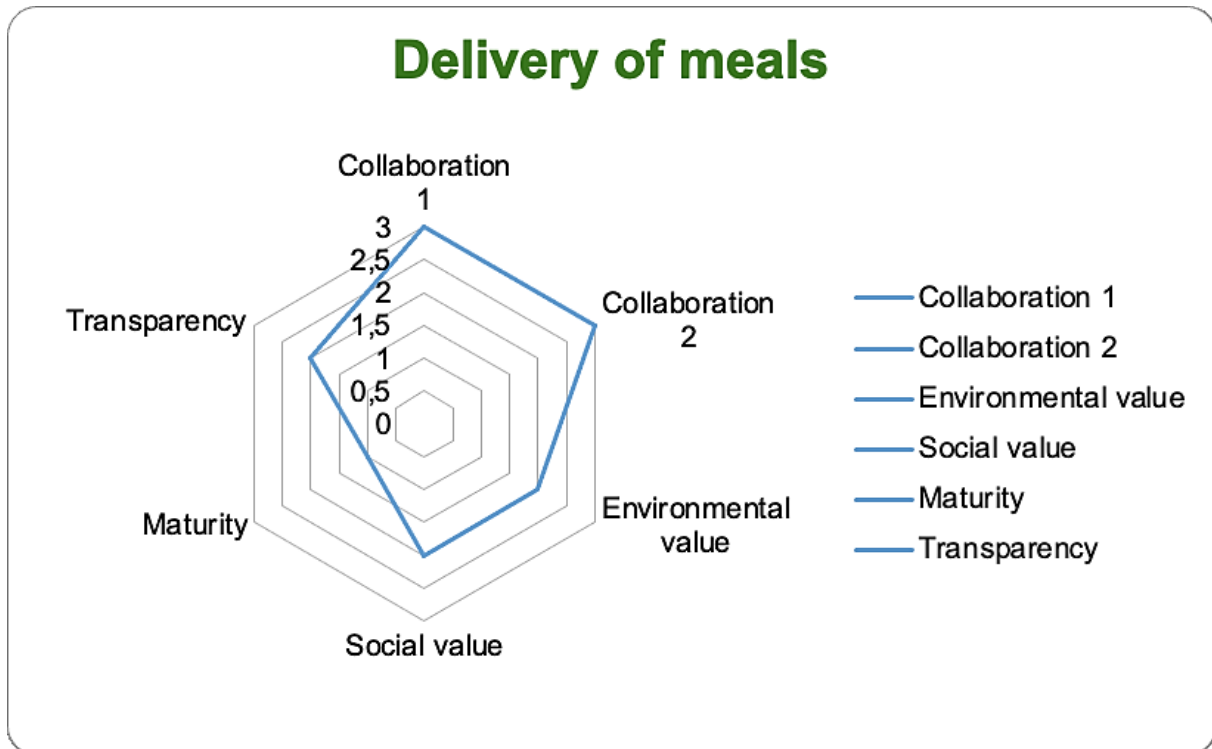


Figure 7. Radar chart for good practice 7.

Source: own elaboration based on project materials.

5. Summary

It is increasingly important to acknowledge the vital educational contribution that the social economy and social enterprises can make in motivating and empowering individuals in short food supply chains. By highlighting new areas of involvement for these entities, this study expands the understanding of strategies they employ to amplify their positive impact in the transition towards a more sustainable economy and society. A key benefit of this research is offering insights into other countries with varying levels of social entrepreneurship development. Furthermore, the examples of case studies illustrate how new social economy initiatives can emerge or be strengthened, such as by addressing social needs.

The following table presents a summary of case studies and remarks subsequently summarized in a table to provide a comprehensive synthesis – see table 3.

The table illustrates the participation of social enterprises in short food supply chains across several European countries. In Hungary, Banyardó and Kockacsoki have engaged in direct selling and community-supported agriculture, promoting increased value for producers and improved consumer access to local, traceable food. Similarly, the Centro Social e Cultural de São Pedro de Bairro in Portugal integrates social enterprises in SFSCs, emphasizing benefits such as more affordable food, reduced pollution, and heightened consumer awareness of food system issues. Italy's Il Sole e la Terra and I Rais contribute to peri-urban agriculture preservation, offering healthier food options, preserving biodiversity, and supporting local economies. In Poland, the Municipality of Świętochłowice's initiative further reduces food waste and improves diet variety. These initiatives reflect a consistent focus on building resilient, localized food systems that foster collaboration between producers and consumers while promoting sustainable agricultural practices and societal well-being.

Regarding the key benefits of social enterprises participating in SFSCs, the involvement of these organizations enhances value for both producers and consumers, providing easier market access for small-scale producers and fostering cooperation among stakeholders. Social enterprises also facilitate better communication and information sharing, allowing consumers to make informed choices about food traceability and origin. This participation supports local economies and strengthens social ties by offering healthier, locally-sourced, and more affordable food options. Additionally, these initiatives contribute to environmental sustainability by reducing food waste, minimizing pollution, and preserving biodiversity. The social economy's engagement in SFSCs promotes ethical objectives, such as supporting artisanal food production and offering employment opportunities, particularly for women.

The primary limitations of this study arise from its qualitative methodology, which focused on interviews and document analysis rather than incorporating quantitative metrics such as cost savings or emissions reductions. While this approach provides valuable context-specific insights into the mechanisms and impacts of SFSCs, it lacks the quantitative validation that could substantiate claims related to environmental and economic benefits. Consequently, the findings should be interpreted with caution. Nonetheless, this study lays important groundwork for future research that combines qualitative and quantitative methods and offers practical insights for local governments, logistics managers, and coordinators working to enhance sustainable food systems.

The study offers insights for policymakers and practitioners on how SFSCs can support local food systems, improve access to markets for small producers, and foster collaboration between producers and consumers. SFSCs also help social economy organizations and social enterprises achieve greater environmental and social impact. Furthermore, the study discusses practical implications but can go further by detailing more actionable recommendations. Policymakers could incentivize social enterprises to engage in SFSCs through targeted policies such as tax breaks, grants, or training programs aimed at building capacity and fostering innovation. Additionally, the study could highlight potential barriers that need addressing,

including logistical challenges, regulatory constraints, or limited awareness among consumers and producers about the benefits of SFSCs. By tackling these issues, SFSCs can more effectively strengthen community resilience, promote social inclusion, and support sustainable local economies. Shortening supply chains enables social economy organizations and social enterprises to address food insecurity, empower vulnerable populations, and contribute to the green transition.

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Appendix

Table 3.

Participation of social enterprises in short food supply chains

Country	Year	Type of organisation	Type of a good practice is it?	Types of SFSC initiatives	Benefits for ...		
					...Consumer	...Producers	...Society
Banyaerdő							
Hungary	2011	Social Enterprise	Initiative of SEO	direct selling, community supported agriculture, collective points of sale, supermarkets provisioning	<ul style="list-style-type: none"> - Value added increase - Easier market access, especially for small producers - Opportunity to develop cooperation with consumers 	<ul style="list-style-type: none"> - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Reconnect food to the farming and processing process - Easier access to healthier food options - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Reduction of plastic packaging - Less food waste - Improved diets: easier access to fresh food, more variety in diet, less preservatives, ... - Preserving small farming/ artisanal food processing - Preservation of products based on local agro-biodiversity - Working opportunities for women
Kockacsoki							
Hungary	2015	Social Enterprise	Initiative of SEO	direct selling, supermarkets provisioning	<ul style="list-style-type: none"> - Value added increase - Better communication and information to consumers - Opportunity to develop cooperation with consumers 	<ul style="list-style-type: none"> - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Preserving small farming/ artisanal food processing - Strengthening social ties - Working opportunities for women

Cont. table 2.

Centro Social e Cultural de São Pedro de Bairro							
Portugal	2016	Social Centre	Initiative of local/regional authorities involving SEO	direct selling, community supported agriculture, collective points of sale, supermarkets provisioning	<ul style="list-style-type: none"> - Value added increase - Better communication and information to consumers - Opportunity to develop cooperation with consumers 	<ul style="list-style-type: none"> - More affordable prices for food - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Reconnect food to the farming and processing process - Easier access to healthier food options - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Reduction of pollution (fuel, plastic ...) - Less food waste - Improved diets: easier access to fresh food, more variety in diet, less preservatives, ... - Preserving peri-urban agriculture - Preservation of products based on local agro-biodiversity - Increasing awareness about food system problems
Il Sole e la Terra							
Italy	1979	Non-profit consumer cooperative	Initiative of SEO	community supported agriculture, collective points of sale, consumer cooperatives	<ul style="list-style-type: none"> - Value added increase - Easier market access, especially for small producers - Better communication and information to consumers - Differentiation of marketing channels and higher resilience - Opportunity to develop cooperation with other farmers - Opportunity to develop cooperation with consumers 	<ul style="list-style-type: none"> - More affordable prices for food - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Reconnect food to the farming and processing process - Easier access to healthier food options - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Reduction of transport - Reduction of pollution (fuel, plastic ...) - Reduction of plastic packaging - Less food waste - Improved diets: easier access to fresh food, more variety in diet, less preservatives, ... - Preserving peri-urban agriculture - Preserving small farming/artisanal food processing - Preservation of traditional products - Preservation of products based on local agro-biodiversity - Increasing awareness about food system problems - Working opportunities for women

Cont. table 2.

Municipality of Mozzo / Alchimia social cooperative / Oikos social cooperative							
Italy	2013	Municipality and two social cooperatives	Initiative of local/regional authorities involving SEO	community supported agriculture, collective points of sale, supermarkets provisioning	<ul style="list-style-type: none"> - Value added increase - Easier market access, especially for small producers - Better communication and information to consumers - Differentiation of marketing channels and higher resilience - Opportunity to develop cooperation with other farmers - Opportunity to develop cooperation with consumers 	<ul style="list-style-type: none"> - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Reconnect food to the farming and processing process - Easier access to healthier food options - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Preserving peri-urban agriculture - Preserving small farming / artisanal food processing - Preservation of traditional products - Preservation of products based on local agro-biodiversity - Strengthening social ties - Increasing awareness about food system problems
I Raïs							
Italy	2016	Community cooperative	Initiative of SEO	direct selling, community supported agriculture, collective points of sale, supermarkets provisioning	<ul style="list-style-type: none"> - Value added increase - Better communication and information to consumers - Differentiation of marketing channels and higher resilience - More stable commercial relations - Opportunity to develop cooperation with other farmers 	<ul style="list-style-type: none"> - Easier access to quality products: fresh, local, “authentic”, origin food - Buy products traceable from a known producer - Reconnect food to the farming and processing process - Easier access to healthier food options - Pursue of social and ethical objectives - Support local economy 	<ul style="list-style-type: none"> - Less food waste - Improved diets: easier access to fresh food, more variety in diet, less preservatives, ... - Preserving peri-urban agriculture - Preserving small farming / artisanal food processing - Preservation of traditional products - Preservation of products based on local agro-biodiversity - Strengthening social ties - Explore niches of innovation

Cont. table 2.

Municipality of Świętochłowice							
Poland	2021	Municipality	Initiative of local/ regional authorities involving SEO	collective points of sale	<ul style="list-style-type: none"> - Value added increase - Better communication and information to consumers 	<ul style="list-style-type: none"> - More affordable prices for food - Easier access to healthier food options - Pursue of social and ethical objectives 	<ul style="list-style-type: none"> - Reduction of transport - Reduction of pollution (fuel, plastic ...) - Less food waste - Improved diets: easier access to fresh food, more variety in diet, less preservatives, ...

AREAS OF BLOCKCHAIN TECHNOLOGY APPLICATION IN SMART CITY – PART II

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Purpose: The objective of this paper is to highlight the potential of blockchain technology in the context of smart cities. The author examines the current state of blockchain-based solutions and connects them to various aspects of urban operations. Additionally, the paper aims to emphasize the significance of blockchain applications in improving the quality of life for city residents and enhancing the efficiency of industries operating within urban environments, with a particular focus on sectors such as telecommunications, energy, and transportation.

Design/methodology/approach: The purpose of the paper were achieved by analyzing literature, industry reports as well as selected blockchain projects' websites. The theoretical scope of the article is the description of blockchain technology application areas within selected industries.

Findings: The author identified three key areas of blockchain application and discussed several existing blockchain-based solutions related to them, highlighting their potential impact on urban development. In the conclusion, the author outlined areas for further research, focusing on different aspects of city growth and enhancing the quality of life for its residents.

Practical implications: The successful implementation of blockchain solutions requires significant conceptual and technological efforts within organizations. The article outlines potential areas for blockchain application in cities and presents examples of existing solutions that can serve as a reference and inspiration for future innovations.

Social implications: Blockchain technology holds the potential to enhance the quality of life for city residents by creating solutions that eliminate the need to rely on service providers, whose trustworthiness is often compromised by unethical behavior and negligence in ensuring secure and transparent information flow. Consequently, the widespread adoption of blockchain in urban environments is undoubtedly in the best interest of society.

Originality/value: The originality of the paper lies in its comprehensive examination of the use of blockchain in the functioning of modern cities, highlighting both the potential for future implementation and existing solutions in the field. Additionally, the author emphasizes the social benefits, such as enhanced trust and improved quality of life for city residents.

Keywords: blockchain, smart city, telecom industry, energy industry, smart transportation.

Category of the paper: Literature review, viewpoint.

1. Introduction

Blockchain technology is playing an increasingly important role in the development of modern cities, which must face the challenges resulting from increasing urbanization, sustainable development and efficient resource management (Gade, Aithal, 2020). Thanks to its unique features, such as secure and irreversible data storage, blockchain is becoming a tool with great potential to revolutionize the functioning of cities (Alam, 2022). It opens up new possibilities in the areas of urban infrastructure management, provision of services to citizens, as well as in sectors such as transport, environmental protection, public health and digital identification (Ullah et al., 2023). The first part of the author's study, published in one of the previous issues of these Scientific Papers entitled "Areas of blockchain technology application in modern city - parti I", discusses three key areas of blockchain technology application in cities: food supply chain management, the functioning of the tourism industry and smart healthcare for residents (Zaczyk, 2024). Each of these areas has significant transformational potential, which is analyzed in detail, taking into account both the benefits and challenges related to the implementation of this innovative technology. This second part of the study extends this analysis, focusing on other key sectors: telecommunication industry, energy management and intelligent transport systems.

2. Materials and methods

A literature review - in particular bibliometrics - was carried out for research without the publishing time limitation on the topic of blockchain technology for smart city area of research. The first step was to analyze publications included in the Scopus database. However, for a comprehensive study, the analysis was deepened to include the Web of Science database. The following queries were run on September 30th 2024:

- Scopus: TITLE-ABS-KEY ("blockchain AND smart AND city"),
- Web of Science: TOPIC: ("blockchain smart city"); Indexes: SCIEXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCREXPANDED, IC.

The search results showed given numbers of publications in subject area:

- Scopus – 2256,
- Web of Science – 1257.

Figure 1 shows the number of publications on analyzed topics (years 2016-23) in both analyzed databases.

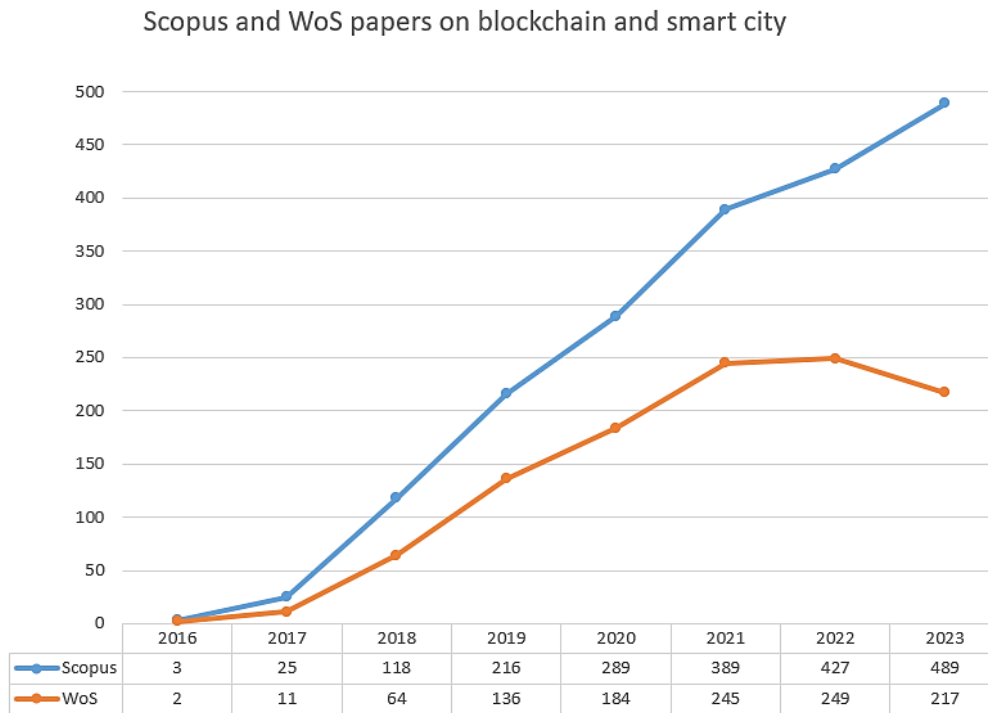


Figure 1. Scopus and WoS papers on Blockchain in Smart City.

Source: own elaboration.

The search results indicate a relatively big number of publications (Scopus – 2256, WoS – 1257) embedding the topic of blockchain technology in the field of smart city, which confirms the author's assumptions about the popularity of chosen topic and legitimacy of in-depth analyzes in this area. The graph of the number of papers in the analyzed area clearly shows an upward trend, signaling the constantly growing interest of researchers in the applications of blockchain technology in the area of city management. During the preparation of this article, the literature review resulting from the above bibliometric analyzes was supplemented with a review of reports from analytical and consulting companies as well as a review of selected blockchain projects websites.

3. Blockchain technology applications in the context of smart city

In the context of rapid advancements in urban development and technology, the concept of Industry 4.0 serves as a cornerstone of the digital revolution, reshaping industrial production processes while simultaneously driving significant innovations within smart city frameworks (Safiullin, Krasnyuk, Kaplyuk, 2019; Lepore, Testi, Pasher, 2023). Blockchain technology, a fundamental pillar of Industry 4.0, emerges as a critical enabler for efficient, secure, and transparent data management within urban ecosystems (Javaid et al., 2021). This study examines contemporary blockchain-based solutions, situating them within the paradigms of

smart cities and Industry 4.0. The analysis emphasizes how blockchain can enhance the development of smart cities by optimizing operational processes, improving infrastructure, delivering resident-focused services, and fostering innovative solutions essential for sustainable urban growth in the digital age (Zaczyk, 2022). While the foundational principles of blockchain technology and smart contracts have been extensively addressed in prior works by the author (Zaczyk, 2021) and other researchers (Warburg, Wagner, Serres, 2019), they are excluded from the scope of this paper.

Modern cities are increasingly being designed to address challenges such as urbanization, the necessity of reducing CO₂ emissions, and enhancing residents' quality of life through the integration of advanced ICT technologies (Yusoff, 2020). ICT advancements are pivotal to the dynamic development of various urban management subsystems, including healthcare, energy management, water resources, urban transportation, tourism, food supply chains, and education (Tcholtchev, Schieferdecker, 2021). The primary components of the smart city concept are illustrated in Figure 2.

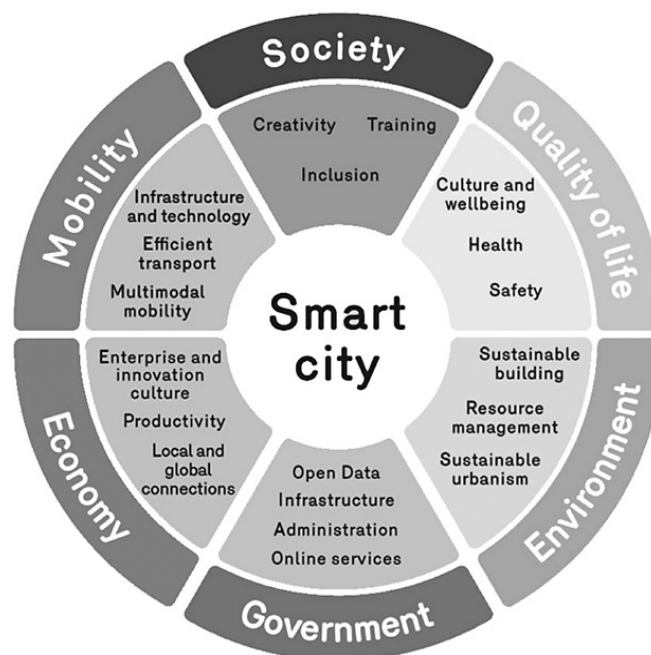


Figure 2. Main components of Smart cities.

Source: Qureshi, Hadi, Haroon, Bashir, Islam, 2020, pp. 75-92.

In this context, blockchain technology, which is one of the pillars of Industry 4.0, plays a key role in managing data in an efficient, secure and transparent manner (Shen et al., 2022). This is discussed in more detail in the first part of this study, where it is indicated how blockchain can support the development of smart cities by optimizing processes, improving infrastructure and providing services to residents (Zaczyk, 2024). Modern cities are designed with increasing urbanization in mind, reducing CO₂ emissions and improving the quality of life of residents, thanks to advanced ICT technologies (Rani et al., 2021). These technologies support the development of various urban systems, such as healthcare, energy management,

transport, tourism, food supply chains and education. Blockchain applications are increasingly mentioned as a key element of the transformation of cities (Treiblmaier, Rejeb, Strebinger, 2020). The combination of IoT technology, 5G (or even 6G) networks and blockchain offers huge potential for increasing security and automating processes thanks to smart contracts. Blockchain is used, among others, in: in supply chain management, tourism, smart healthcare, telecommunications, energy management and transport (Ullah et al., 2023).

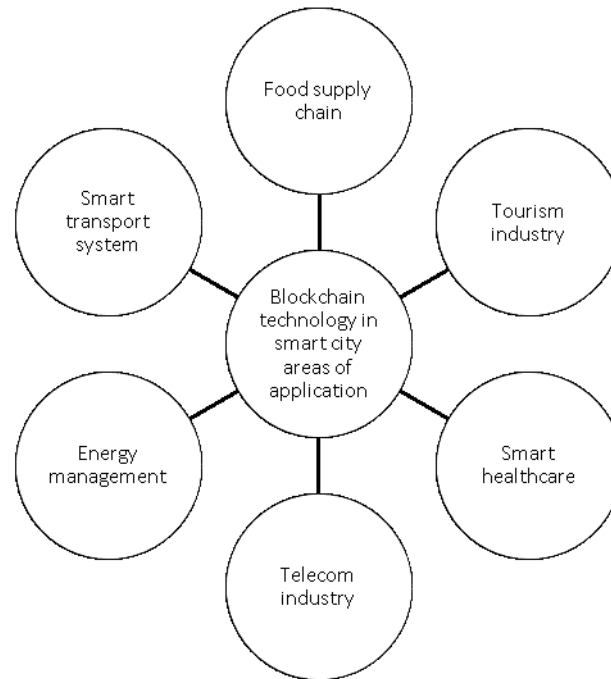


Figure 2. Areas of application of blockchain technology in smart city.

Source: own elaboration based on Ullah, Naeem, Coronato, Ribino, De Pietro, 2023.

The first three areas mentioned above and visible in Figure 2 were characterized in part I of this study, while this part focuses on the remaining three: telecommunication industry, energy management and smart transportation.

3.1. Blockchain solutions for telecom industry

The role of the telecommunications sector cannot be overestimated in the context of managing the flow of information between people performing different roles in society (Leonelli, Beaulieu, 2021). Moreover, this sector is characterized by a high level of complexity of business processes and a huge amount of data flowing in its area (Al-Alwan et al., 2022). These features result in a growing interest in the use of blockchain technology in the telecommunications industry. Selected areas of application of blockchain-based solutions in the telecom industry are indicated in Table 1.

Table 1.*Selected blockchain-based solutions' in the telecom industry*

Area of application	Description	Source
Identity management	Blockchain's cryptographic techniques ensure user authentication and data privacy, allowing customers to have better control over their identities and streamline authentication processes across various services.	- Liu et al., 2020 - Veramo.io - Hyperledger.org
Mobile number portability	Blockchain can improve MNP by establishing a secure and transparent record of mobile numbers. This more efficient system will enable quicker number transfers, minimizing downtime for customers during the switch.	- Shah et al., 2021 - Wipro.com - Zeebu.com
Smart contracts for roaming agreements	Blockchain-based smart contracts can securely automate and enforce roaming agreements between operators. This automation enhances efficiency, minimizes the potential for disputes, and accelerates the settlement process, benefiting both operators and customers.	- Sandholm, Mukherjee, 2021 - Tmforum.org
Billing and settlement	Blockchain's distributed ledger can provide real-time updates of usage and facilitate transparent and automatic settlement between telecom operators. This feature improves the accuracy of billing and ensures prompt payments, leading to better financial management.	- Afraz et al., 2023 - Ledgerinsights.com
IoT connectivity	Blockchain's decentralized architecture offers robust security and authentication mechanisms for IoT Connectivity devices. It enables IoT devices to communicate securely with each other, reducing the risk of unauthorized access and potential vulnerabilities in the network.	- Hewa et al., 2020 - Helium.com - Simbachain.com

Source: own elaboration.

In each of the areas indicated in Table 1, there are already some blockchain-based solutions. Some of them are already in use, others are in the development phase. In the author's opinion, supported by the current analysis of business trends, a further increase in the number of functioning and developing solutions using blockchain is expected in the context of the challenges of the telecommunications sector.

3.2. Blockchain solutions for energy management

Electricity supply is one of the key problems for modern cities, having a broad impact on the quality of life of residents and development conditions for enterprises operating within them (Strielkowski et al., 2020). Blockchain technology appears as a promising tool used to record and streamline transactions between entities generating energy and its consumers (Lv, 2023).

Numerous blockchain-based applications, from peer-to-peer energy trading solutions to energy source verification systems are developed nowadays (Thukral, 2021). Experts predict that blockchain can revolutionize the energy sector by improving value chain operations and managing the diversity of decentralized energy systems (Wang, Su, 2020). Blockchain can impact the energy sector by providing solutions that ensure legitimacy, security and automation of flows between market participants. According to Emergen Research, the value of the blockchain solutions market in the energy sector will reach USD 8.76 billion by 2027 (Emergen Research, 2024).

Blockchain solutions present major opportunities in the energy sector such as (Bao et al., 2020):

- supporting achievements of major European energy objectives, e.g. in the Clean Energy for All Europeans Package,
 - promoting energy efficiency, renewables and their integration into energy systems, by mitigating the risk of investments and ensuring transparency, integrity and traceability of technical and commercial transactions and reporting,
 - linking consumers and prosumers and enabling exchanges decoupling of any man-in-the-middle control,
 - allowing to manage the complexity of future energy markets, i.e. this achieve quasi-real-time coordination of electricity supply and demand data, proper management of energy storage capacities on the energy grids, e-mobility support, etc.
 - enabling to report compliance with sustainable finance, ESG criteria, NFRD and CSRD.
- Selected blockchain-based solutions for the energy industry are indicated in Table 2.

Table 2.

Selected blockchain-based solutions for the energy industry

Company involved	Description	Source
Siemens Energy	Siemens Energy's Automated Pay-Per-Use is a new service allowing utilities to pay for upgrades only when they are utilized. Part of the cost is covered when revenue is earned from successful electricity sales. Blockchain technology enables this model by ensuring accurate calculation and fair distribution of the power plant's profits on a pro-rata basis.	Siemens-energy.com
Shell	The company is considering blockchain as a way to validate carbon credit programmes. By tracking the effectiveness of nature-based solutions for carbon capture and avoided emissions, blockchain can prevent the double-counting of carbon credits, maintain the quality of reforestation or conservation projects, and ensure the transparency of the carbon market.	Shell.com
Engie	The company manages energy transactions across supply, distribution, and consumption. It also leverages blockchain technology for trading renewable energy certificates (RECs), peer-to-peer energy trading, and electric vehicle (EV) charging.	Engie.com
WePower	An Australian blockchain company enables direct connections between green energy providers and buyers, such as investors and end-users, allowing them to purchase energy in advance at discounted rates. The company has developed Ethereum Smart Energy contract tokens, sold via its e-commerce platform. These tokens aim to simplify and standardize renewable energy transactions, allowing businesses to buy the precise amount they need and sell any excess capacity.	Ledgerinsights.com
Power Ledger	The company partnered with ekWateur, a renewable energy provider in France, to create a blockchain energy trading platform that lets users choose their preferred energy source within the country. In 2021, Powerledger further enhanced its energy blockchain technology by migrating its platform from Ethereum to the more energy-efficient Solana, enabling faster transaction speeds and higher throughput.	Powerledger.io

Cont. table 2.

SunContract	A peer-to-peer energy trading platform utilizing blockchain technology to facilitate the buying and selling of renewable energy. With over 5,000 registered users in Slovenia, the platform caters to environmentally conscious consumers. SunContract aims to establish a Global Energy Marketplace (GEM), removing intermediaries and enabling customers to trade directly with one another. This approach promotes greater energy self-sufficiency and supports the development of a more sustainable energy economy.	Suncontract.org
Iberdrola group	A blockchain-based pilot project that enables real-time verification of the renewable origin of supplied and consumed energy. By leveraging this technology, the company has successfully linked electricity generation plants to specific consumption points, providing full traceability of the energy source. This approach enhances transparency and encourages the adoption of renewable energy.	Iberdrola.com
GreenH2 chain	This platform is designed to ensure that all green hydrogen is produced from renewable sources by enabling users to track and visualize the entire green hydrogen value chain in real time, from anywhere in the world. Additionally, the platform will be used in the Power to Green Hydrogen project, which aims to build a green ecosystem on the island of Mallorca, Spain.	Acciona.com

Source: own elaboration.

The multitude of blockchain-based solutions developed within the broadly understood energy management and the energy industry itself is evidence of the growing interest of industry practitioners in blockchain technology. It has the potential to permanently change the landscape of the energy market, contributing to increased transparency of flows within it and contributing to the implementation of sustainable development goals set for the energy industry.

3.3. Blockchain solutions for smart transport systems

Among the areas of city management, according to many researchers, transport systems occupy a central place (Savin, 2021). They seem to be crucial both at the individual level and at the level of the city's logistics systems. Blockchain technology shows the potential to impact both public and private transportation (Enescu et al., 2022). It can support transport companies in terms of fleet management, route management and overall operational efficiency. It can also help monitor road incidents and other negative situations affecting the smooth movement of people in the city, provides transparency and security for transport companies while minimizing the occurrence of various threats and frauds (Sundaresan et al., 2021). The areas of application of blockchain technology in the transport industry are indicated in Table 3.

Table 3.*Areas of application of blockchain technology for smart transport systems*

Area	Description	Source
Data Security	Blockchain makes it difficult for hackers or fraudsters to change or steal data from companies. Because of the nature of a decentralized data management system, there is no central point of failure for malicious parties to exploit.	Zhou et al., 2021
Tracking Systems	Companies can easily track the movement of a parcel for delivery. This also applies to a passenger's journey to a scheduled pick-up or destination. Blockchain makes it easy to trace where delays occurred to improve operations.	Balfaqih et al., 2023
Order Delivery Tracking	Intelligent order delivery tracking systems use blockchain. Many companies now offer same-day or express delivery within one or two hours. Doing this requires a digital solution that can immediately authenticate orders, complete them, and initiate delivery and tracking. A blockchain platform can easily coordinate these processes and provide the information required through a shared database.	El Midaoui et al., 2021
In-Vehicle Payments	Another real-life example of blockchain technology improving transportation is the in-vehicle payments used by IBM in coordination with UBS and ZF Friedrichshafen AG. The Frankfurt-based company worked with IBM to use a blockchain-based transaction platform for their mobility services. It includes in-vehicle payments for motorists to pay tolls, car-sharing app payments, parking fees, and even electric vehicle battery charging fees.	ibm.com
Transportation payment and dispute resolution	Blockchain technology can streamline payment processes in the transportation industry by providing transparent and secure transactions. It can automate payment terms through smart contracts, ensuring quicker and more efficient settlements while reducing payment disputes significantly. With an auditable record on the immutable ledger, disputes can be resolved more efficiently and accurately, leading to smoother financial operations.	Narayanam et al., 2020
Administrative costs reduction	Blockchain can reduce administrative costs in the transport industry by replacing paper-based processes with digital, decentralized systems. By digitizing documentation, approvals, and communication, blockchain enables seamless information sharing among stakeholders, reducing paperwork, human errors, and administrative expenses. This streamlined approach enhances operational efficiency while cutting down on unnecessary overheads.	Koh, Dolgui, Sarkis, 2020
Transportation of temperature-controlled goods	Blockchain can help solve the challenges of transporting temperature-sensitive goods, such as pharmaceuticals, by offering an unalterable record of temperature data at each stage of the supply chain. By integrating Internet of Things (IoT) sensors with blockchain, temperature conditions can be continuously monitored and recorded, ensuring compliance and minimizing the risk of product loss. This enhances the quality of temperature-controlled shipments and reduces waste.	Vergine et al., 2023
Decentralized freight tracking and load board reliability	By utilizing blockchain's distributed ledger, the transportation industry can improve freight tracking and tracing capabilities. This technology offers secure and authenticated data, leading to more reliable and efficient tracking information. Moreover, blockchain can enhance the reliability of load boards by providing unalterable, time-stamped loads verified by the blockchain network, thereby reducing the risk of incorrect load requests and boosting overall efficiency.	Henesey et al., 2020

Source: own elaboration.

Similarly to the telecommunications and energy industries, as well as the sectors described in the first part of this study, blockchain technology is being heavily explored by entities involved in the development of transport systems. This indicates that blockchain technology is being recognized by specialists in this industry, which can provide a number of solutions to problems affecting transport systems.

From author's perspective, blockchain holds transformative potential for transport systems, offering not only operational improvements but also fostering trust and collaboration among stakeholders. It is strongly believed by the author that blockchain's ability to provide decentralized, tamper-proof data can revolutionize urban mobility, enabling seamless integration of diverse transport modes while addressing inefficiencies and security challenges.

4. Summary

In this, second part of the study, the focus was put on the telecommunications, energy, and intelligent transportation systems sectors. The analysis of these key areas provided deeper insights into the role of blockchain technology in the development of smart cities. This part is the supplement of the first part of the study entitled "Areas of blockchain technology application in smart city". The first part was focused on the usage of the blockchain technology in sectors such as food supply chain, tourism industry and smart healthcare.

The entire study reveals that blockchain technology has already become a crucial element in the operation of many smart city sectors. Its solutions play a significant role in enhancing both the quality of life for residents and the efficiency of industries that are essential for smart city development. By fostering transparency in data exchange between residents, businesses, and city authorities, blockchain enables seamless communication among these groups. The technology's ability to provide secure and transparent access to public services is one of its key strengths. Across the various essential areas that make up a smart city, blockchain introduces numerous innovative solutions, with its rapid evolution suggesting even broader applications in the future.

Looking ahead, blockchain's potential to drive advancements in civic engagement, the job market, cultural identity, urban development, and security systems stands out. Whether it's through resident loyalty platforms, job certification on the blockchain, or the secure management of land and video surveillance, blockchain technology is seen as a foundation for further progress in smart cities and industry 4.0, with promising benefits for both urban life and business environment. This is an interesting direction for further research and certainly directs the author's scientific interests in this direction.

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