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DIGITAL TRANSFORMATION AS NEW CHALLENGE FOR ORGANISATION AND ITS ENVIRONMENT

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Purpose: Technological changes are nowadays some of the key points of reference for enterprises which take innovative steps with an intention of improving the efficiency of their operation on the market. For the reason the authors of the paper focus on the problems of digital transformation in organisations and their implications for the development of inter-organisational collaboration among various entities. The primary purpose of the paper is to define digital technologies that are essential in the process of establishing and reinforcing inter-organisational cooperation.
Design/methodology/approach: The study used an integrated research approach that included both direct interpretations and positivist research procedures. This required qualitative and quantitative research among 350 companies.
Findings: As a conclusion for the results of the study, it should be stated that it was possible to generate three factors referring to the knowledge on digital technologies (1: Monitoring and process automation; 2: Data integration and big data analytics, 3: Protection and cyber-security), as well as two factors which clearly correspond to the 'Establishment of bonds' and 'Bond reinforcement' components, used to measure the force of impact of knowledge about digital technologies on the process of forming long-term relations among enterprises and selected universities at individual stages of such process. The factors above have a stimulating impact on the company's willingness to establish and reinforce inter-organisational cooperation.
Originality/value: The presented factors: 1: Monitoring and process automation; 2: Data integration and big data analytics, 3: Protection and cyber-security, as well as two factors which clearly correspond to the 'Establishment of bonds' and 'Bond reinforcement' components, stimulate the company's willingness to establish and strengthen inter-organizational cooperation, which is the added value of this article.

Keywords: digital transformation, digitisation, inter-organisational relations.

Category of the paper: Research paper.

1. Introduction

One of the modern world's challenges is dynamic development of technology, which is a catalyst of changes and growth of innovation in enterprises, determining the rate of their development (Ginevičius, Nazarko et al., 2021). Technologies offer new opportunities for operation and diverse conditions for competing at the market, and thus they are perceived subjectively: in the categories of opportunities or threats (Rajiani, Bačík et al., 2018). Diversity of technologies that surround an enterprise often intensifies the confusion as to which of them should be implemented and how to make it the most beneficial for the enterprise. Determining the directions of technological development is of primary importance for the formation of a development strategy of an enterprise, but it also requires careful observation of the enterprise's environment and trends changing within it (Wolniak, Saniuk et al., 2020; Michałek, Pachucki, 2020). Nowadays, one of the leading technological trends is digitisation; combined with the growing role of data flow processes in inter-organisational relations, it creates new determinants for the development of economy.

Digital maturity based on properly developed inter-organisational relations offers access to knowledge necessary in the innovation creation process, designated by highly advanced technologies. That is why the knowledge about digital technologies and their application is currently one of the most desired resources and unique competence conditioning survival of an organisation in a world that changes faster and faster (Lis, 2021). Multi-dimensional digital transformation is the most characteristic modern socio-economic process that is an expression of inevitable and permanent technological changes affecting states, societies and enterprises. This process has been additionally accelerated by the COVID-19 pandemic, which started in 2020 and became a catalyst for a digital transformation in enterprises and at universities. Changes in the life cycle of business models based on digitisation trigger a demand for new technologies, which also means the enterprises' greater willingness to search for specialist knowledge about this issue outside their own organisations. Similar processes also refer to universities that introduce digitisation to the sphere for education, science and research and to the organisational and administrative realm. Even though the rate of digital transformation of universities is diverse, without doubt the COVID-19 pandemic became a factor accelerating this process and highlighting multi-dimensional benefits that the academic sector can accomplish thanks to it. Universities develop educational, research, scientific and implementation services related to digital technologies, along with modern systems for administration management and communication with the environment. Given the fact that the competitive pressure related to technological development forces the companies to intensify the digitisation processes in cooperation with the organisations that offer valuable knowledge, a question arises whether and to which degree universities may become partners for the business sector with respect to the formation of inter-organisational ties.

The range of issues discussed in this way leads to the definition of the research problem, which refers to the identification of digital technologies that are significant in the process of establishing and reinforcing inter-organisational cooperation. The primary purpose of the paper is to define these digital technologies that are essential in the process of establishing and reinforcing inter-organisational cooperation. In reference to the central goal, the main research hypothesis was adopted, which is as follows: knowledge about digital technologies has stimulating (positive) impact on the enterprises' readiness to establish and reinforce inter-organisational cooperation, including ties between enterprises and universities.

2. Digital Transformation as Space to Establish and Reinforce Inter-Organisational Relations

Civilisation changes, in particular networking and digitisation, relying on faster than ever technical progress, nowadays apply to almost all areas, aspects and manifestations of the socio-economic life, including organisations operating in such environment and their stakeholders (Szczepańska-Woszczyna, Muras et al., 2021; Szczepańska-Woszczyna, Dacko-Pikiewicz et al., 2015). Apart from the phenomena associated with networking such as, among others, chaos, unpredictability, lack of borders, promotion of intangible resources and cooperation processes among organisations (Skrzypek, 2017), it is also possible to note very rapid absorption of technologies, in particular digital technologies by all entities (Pieriegud, 2016). The key factors driving the development of digital economy include:

- Internet of Things and Internet of Everything,
- hyper-connectivity,
- cloud computing,
- Big Data Analytics (BDA) and Big Data as a Service (BDaaS),
- automation and robotisation
- multi-channel and omni-channel models of product and service distribution (Pieriegud, 2016).

Use of these factors in the socio-economic system leads to, among others, development of the NBIC (nano-, bio-, info- and cogno-) (Stępień, 2015) technologies, which form a collection of components of practical and theoretical knowledge, *know-how* and methods, procedures and physical devices that use knowledge (Dosi, 1982) about digitisation. Such technologies may also be called systematised application of scientific rules and practical knowledge in the area of digitisation (Lowe, 1995) with respect to physical facts and systems. Developing digital technologies are used in organisations as the *know-how*, tools, methods or techniques, but also as a resource determining, among others, operation of machines and devices comprising production systems. For some organisations, the technologies are the product (value) offered to

clients (recipients), while for others they are the process supporting their operation (Bielińska-Dusza, 2020).

The growing dominance of information and the increasing role of data flow processes in inter-organisational relations foster conditions for their most effective processing and, at the same time, offer a basis for the new economy, based on digitisation processes (Zawiła-Niedźwiecki, 2018). One of cognition theories – dataism – stipulates that modern civilisation relies on data which, after uploading to management algorithms, acquire the form of information (Harrari, 2017). The reality creates data generated by machines, devices and artificial intelligence systems. Data processing with the use of algorithms leads to cognition and procurement of information as a result of which, thanks to mental processes, new knowledge is created. This process of cognition is repetitive (Sułkowski, 2005). Data and algorithms which are processed as part of flows guarantee generation of values that are expected by the recipients. This mode of operation characterises a digital organisation, i.e. an organisation efficiently managing data with the use of IT modes, mechanisms and tools defined by it. From the point of view of the recipients of products and services of such organisation, delivery of data generating value for it is of vital importance. In turn, mere sourcing and processing of data does not generate value. Only delivery of knowledge to the client who will be satisfied with it is a value generating action (Cieśliński, 2020).

The term ‘digitisation’ was used for the first time in 1971 in the context of analysis of the process of society digitisation (Brennen, Kreiss, 2016). Generally speaking, digitisation is a process of instrumental use of the ICT tools to efficiently distribute knowledge among decision-makers of the organisational space (Cieśliński, 2020), and thus unite multiple diverse domains of social and economic life around electronic communication and digital media. Use of technical hardware and software allows for rapid sharing of digital content pertaining to text and image; such content can easily be duplicated and teams can work on it in an inter-active mode; it becomes available on devices forming a repository of specific data, information and codified knowledge.

Digitisation, relying on hardware and software, is a sequence of mutually dependent technological solutions, which are manifested by new technical and organisational solutions. When a specific organisational, legal and competence environment has been created, digital technologies can support human creativity and innovation. Actions performed on the digital form of information not only stimulate access to knowledge and allow for generation of new knowledge, but also have a specific cost effect (cost close to zero) and thanks to this, new conditions for innovation are created. Hence, digitisation and digital transformation become a factor of innovation (Kowalczyk, 2017).

Digitisation has a strong value-driving context, as it does not consist in improving what already is at the disposal of an organisation, but in driving new values with efficient use of the ICT technologies. Technology is one of several factors shaping the structural solutions (Klincewicz, 2016), and that is why in the case of implementation of advanced digital

technologies, the organisational structure often needs to transform and become adjusted to the type and terms of using a given technology. Some researchers perceive technology as a component of an organisation, i.e. as the applied mode of production or knowledge about the premises of efficient operation. The representatives of this current tend to treat technology as an element of a technological sub-system of an organisation, which may be deemed strategic in reference to the progressing digitisation (Leonardi, Barley, 2008).

As noted by G. Mazurek, digitisation contributes to improved efficiency within an organisation in the area of quality, consistency, precision and accuracy of implemented processes. Thanks to this – irrespective of the type of organisation – better control is possible over its operational activities and results of its operation, available in real time, thanks to the integration of structured and non-structured data and a better insight into the organisational data, as well as integration of data from various sources. Better access to information had beneficial impact on decision-making and translated to an increase in productivity. Thanks to digitisation, benefits related to interactions between an organisation and its stakeholders, such as, e.g., shorter response time, reduced cost of relationship formation, better availability, etc., are also clearly noticeable (Mazurek, 2019). Digitisation has also changed the perspective of the recipients of products, services and knowledge who – thanks to ICT technologies – nowadays have the possibility of choosing among so many options that they are often unable to consciously analyse them (Feldman, 2002).

The organisations see the inevitability of the breakthrough change which the development of digitisation has brought for their operation. Wishing to meet it half-way or at least intending to adjust to the new conditions of operation, they undergo transformation, i.e. a significant, multidimensional change of organisational and process-related nature, caused by the impact of digital technologies. Digital transformation in an organisation may focus on cost reduction (Collin, Hiekkanen et al., 2015), improvement of performance and efficiency (Westerman, Calméjane, 2011), extension of communication with stakeholders and even procuring a new group, i.e. digital consumers (Berman, 2012), as well as may – in a holistic mode – simultaneously account for all four perspectives: technology, values, structure and finances (Matt, Hess et al., 2014).

In a broader dimension, digital transformation is related to an opportunity for economic development, improved quality of life, realisation of democratic ideals (Śledziewska, Włoch, 2020), but it also exerts a significant impact on the functioning of an organisation. For the majority of organisations, this phenomenon is often a challenge, but at the same time one of the foundations for retaining their position in the environment and further expansion (Adamczewski, 2017). This follows from the concurrent and multidimensional impact of the digital transformation on the society and people that make it up, assuming various roles, among others recipients of diverse products, services and other intangible values (e.g. knowledge) or their producers representing organisations of various types (e.g. public institutions, enterprises or non-governmental organisations).

From the perspective of man as an individual in the socio-economic system, digital transformation heralds significant changes in behaviour, which project on the mode of performance of social and professional roles in various types of organisations (e.g. an employee or a client). This affects, among others, de-materialisation of goods in the form of photos and video recordings, sharing a greater volume of content, creation of image in the social media, as well as the phenomenon of distributed memory, i.e. storage of memories on external memory media (Belk, 2013). Younger people learn technological novelties easier and quicker, while assuming the role of consumers they seem to be better informed, more often communicating with other consumers, notifying higher expectations with respect to digital services (Gray, Sawy, 2015) and demanding the organisations to meet their expectations half-way. Such communities will become an important group of consumers or stakeholders, while their needs pose a growing challenge for the organisations servicing them in various areas. Interest of the so-called digital consumers in the possibility of socialised joint-creation of services, goods and values that are offered to them is very characteristic. They willingly assume the roles hitherto reserved for the employees of organisations, i.e. advisers, testers, reviewers or client service employees (Mazurek, Tkaczyk, 2016).

Communities united by a joint interest and relational communities, relying on similar experiences that often function as virtual communities, exert a growing impact on the functioning of organisations. One may venture saying that skilful formation of relations within such communities, as well as relations with organisations with which they interact, is decisive for their success (Dacko-Pikiewicz, 2022; Dacko-Pikiewicz, 2019). Hence, organisations functioning in digital economy should learn to read and use emotions that emerge in the virtual reality. Fundamental changes in the behaviour of individuals influence the market and social relations and lead to a metamorphosis of both the physical and the virtual reality (Sułkowski, Kaczorowska-Spychalska, 2018). According to G. Mazurek (Castells, 2003; Urry, 2000), quoting M. Castells and J. Urry, significant social transformations with which we are dealing today are caused by the networking of economy, quicker flows and virtualisation of relations, as well as rapid development of many decentralised Internet networks. At the same time, in the managerial approach, this affects the transformation of organisations which develop such features as agility, responsiveness or joint value creation.

The description above attests to the great potential and challenges generated by the development of digital technologies in organisations; however, it should definitely be treated only as a tool, and not as a goal of transformation. It should also be noted that digitisation, leading to multidimensional changes in organisations and in a broader socio-economic context, may generate a number of benefits, but also be a source of multiple threats. In reference books, this observation has been made by, among others, S.K. Reddy and W. Reinartz (2017), who draw attention to such consequences of the process of digitisation as: production of huge amounts of data, irreversible changes in the professional and daily life of people, growing expectations with respect to the generation of new intangible value for various groups of

recipients. Without doubt, the COVID-19 pandemic was a milestone in further accelerated development of digital technologies. The outbreak of the pandemic and the universal lock-down related to it triggered and accelerated progress in the area of digitisation, allowing for the use of broadly-understood technology for a radical improvement of an enterprise's efficiency or its coverage (Westerman, Bonnet, 2014). According to M. Rzeszewski, digital technologies entered the daily world on an unprecedented scale during the pandemic, becoming an inseparable part of the experience of many people – also in an imposed and unwelcome way. At the same time, such technologies became a cure for the current problems and poison replete with new social challenges (Rzeszewski, 2020). Digitisation allows for accomplishing many benefits and embracing many opportunities that are emerging, but it also causes threats and challenges which a modern organisation and its environment has to face. They are presented in Table 1.

Table 1.
Potential benefits and threats resulting from digitisation for organisations and their stakeholders

Reference group	Opportunities and benefits	Threats and challenges
Organisations developing digital technologies, e.g. public institutions, enterprises, non-governmental organisations	Improved efficiency, performance, new methods of value creation, new possibilities of cooperation with various groups of stakeholders, new possibilities of knowledge transfer	Change or loss of existing configurations of value chains, new areas of competition, shortened product life cycles, growing demand for new value created with the use of digital technologies, risk of failure to meet the requirements set by digital technologies
Recipients of values created by the organisations with the use of digital technologies, e.g. clients and stakeholders	Lower prices and better access to new products, services and knowledge, new sensations	Cost of adjustment to the possibility of using new products, services and knowledge related to digital technologies, cost of education, cost of searching for information, loss of privacy
Individuals relying on digital technologies in professional and social life	Higher flexibility of employment, lower costs of work performance, higher degree of commitment to duties, growth of crowd-sourcing and crowd-working, easier sharing of resources, exchange, lease	Automation and other changes in work performance, digital exclusion, technological unemployment, comprehensive performance measurement, efficiency pressure, global competition at the labour market, weakening of interpersonal ties and integration at the work place, improved availability of products, services and knowledge, e.g. on-line education
Society	Better access to efficient and digitised administration, better quality of public sector services, greater availability of public information, higher public participation (on-line communication)	Changes in social communication and changes in social preferences, e.g. the mode of spending leisure time, the mode of handling transactions, digital exclusion causing marginalisation of certain social groups, society's desire to exert greater impact on public issues

Source: own study based on Mazurek, 2019, p. 24.

As follows from Table 1, digitisation produces a number of changes in the functioning of organisations and stakeholders operating in their environment, including changes which may be deemed fundamental and having far-reaching effects. Digitisation blurs the borders of operation of organisations, as more and more processes take place outside of the structures of

organisations, in an organisational space with undefined borders, often within informal networks. These new conditions of operation, caused by a dynamic development of ICT technologies, primarily global Internet, are strongly dependant on new methods and tools supporting the processes of organisation management characteristic for the digital economy. Summing up, it may be concluded that the impact of digital transformation on an organisation, its environment and stakeholders is realised via:

- metamorphosis of an organisation towards adaptation of digital technologies to its operation on all possible fields of exploitation and improved efficiency in managing an organisation, among others by improvement of mechanisms to monitor its efficiency,
- changes in the process of product manufacturing, provision of services and offering other values at the market, e.g. knowledge,
- formation of relations with stakeholders with respect to fuller understanding of their needs, introduction of new channels for communicating with them and joint creation of values on which the stakeholders want to base the bond with the organization,
- strengthening the organisation's position in the environment, sector or socio-economic system based on the use of digital technologies, which have not yet been designed by the competing organisations.

Today, digital transformation refers not only to the technological aspects of an organisation's operation, but should also encompass its entire strategy, shaping the mode of thinking and perceiving the world by the managers of such organisation anew (Gregorczyk, Urbanek, 2020). Literature features the concept of 'digital leadership' (Ahlquist, 2014), which is used to define the leader of a team or an organisation relying on digital technologies, which is also helpful in the implementation of innovations. Digital leadership is one of the key attributes of digital organisations and these organisations which are learning to make efficient use of digital technologies. Several dozen features of digital leadership include innovative visionary, networking intelligence, digital intelligence, digital talent scout, role model, democratic delegative leading style, employee-orientation and social intelligence (Kreutzer, Neugebauer et al., 2017). Other important features are: openness, ability to adapt, agility, creativity, learning from mistakes and knowledge orientation (Klein, 2020). Digital leadership not only supports internal transformation of an organisation, including implementation of process or product innovations based on digital technologies, but may also play a vital role in shaping relations of an organisation with its stakeholders in the digital world. Wherever leaders of digital technologies are perceived as attractive partners in cooperation and in exchange of resources or values (e.g. such as knowledge), digital transformation and solidification of digital leadership may elevate an organisation to a much higher level of competitiveness within its environment. Thus, building the digital leaders' competence is nowadays one of the key educational challenges for universities cooperating with enterprises, which necessitate such leaders (Szczepańska-Woszczyna, 2020).

An impulse for establishing inter-organisational cooperation between science and economy in the area of joint studies on new digital technologies is the possibility of financing or co-financing them by the EU institutions (among others, the Horizon 2020 programme, COSME, Erasmus Plus, the International Visegrad Fund, etc.), as well as domestic ones (among others, programmes of the National Centre for Research and Development such as Infostrateg or the so-called 'fast track' of financing under the Smart Growth Operational Programme 2014-2020). An example of scientific cooperation between a university and an enterprise in the area of digitisation are projects pertaining to the Digital Innovation Hubs, which were selected in 2019 (https://przemyslprzyszlosci.gov.pl/...). This area of cooperation in development of digital technologies is one of the most promising, as studies show that probably approx. 60% companies implemented new digital solutions by 2020, while company expenses on systems supporting digital transformation in 2019 approximated USD 431 billion (https://itelligencegroup.com...).

Among European research initiatives related to digitisation, special attention should be paid to the European Institute of Innovation and Technology (EIT) (https://europa.eu...), which supports innovation by tightening cooperation between companies, research and educational institutions as part of the so-called communities of knowledge and innovation. One of the areas of the EIT activities is EIT Digital, focusing on digital products and services. Universities and enterprises may also commence joint research projects in the area of digitisation via the Joint Research Centre. It promotes independent research studies pertaining to the subjects of vital importance for the European integration (Mazur, 2020). In turn, as part of the European Research Area (https://ec.europa.eu...), the following initiatives are available: CORDIS (website with information about research projects financed by the European Union and their results), OpenAIRE (website that forms a network of generally accessible repositories, magazines and archives) and the EU Open Data Portal (databases shared by the EU institutions to be used for research and commercial purposes) (Mazur, 2020).

3. Directions and Determinants of Development of Digital Technologies in Enterprises

Technological changes are nowadays some of the key points of reference for enterprises which take innovative steps with an intention of improving the efficiency of their operation on the market, boosting competitiveness or satisfying the needs of their clients better. Digital transformation is one of the causes of increasing variability and unpredictability of market determinants in which the enterprises are operating. G. Mazurek (2016) defines the following key features of this phenomenon:

- the degree of complexity of digital transformation exceeds the level characterising implementation of new IT solutions,
- the effects of digital transformation and its potential benefits are related to going beyond the classic organisational borders and contribute to the networking of an enterprise,
- the basis of the process of transformation is the digitised client and the client's experience and, to a lesser degree, infrastructure,
- links among various innovative solutions in the physical and digital space emerge as a result of coupled effects of various technologies.

Digital transformation shapes the specific environment for modern companies, which determines, to a significant degree, not only their actions, but also their competitiveness. It is known as Industry 4.0, the 4th Revolution, Internet of Things or SMART, Industry Revolution 4.0 (IR 4.0). Two realities permeate in this environment: the physical reality (PR) and the Virtual Reality (VR) (Adamik, Nowicki, 2017), but it is also conducive to intense development of network cooperation or virtual network. The most dynamic development refers to cyber-physical systems (CPS), big data analytics (BDA), Internet of Things (IoT), Internet of Services (IoS), Cooperation, Partnering and Team Working (Adamik, 2016), Strategic Partnering (SP), Knowledge Partnering (KP), Cooperation, but also Machine-to-Machine (M2M) Communication, Artificial Intelligence and Neural Networks (Adamik, 2018).

The majority of enterprises treat digital transformation as the inevitable necessity, while the need of facing it is dictated by the instinctive desire to retain the position in the sector, and in particular at the market serviced by the enterprise, among clients and other stakeholders to which the enterprise is related. Hence, digital transformation is used to accomplish visibly better results of operation (McKeown, Philips et al., 2003), which may be understood as reduction in costs or accelerated performance of tasks (Kane, Palmer et al., 2015) or streamlining of operational activities (Fitzgerald, Kruschwitz et al., 2014).

According to P. Adamczewski (2017), digital technologies determine organisational changes in the area of formation of relations with clients and contracting partners (better understanding of their needs, extension of communication channels) and modelling of an organisation's actions within the scope of generation of products and services delivered to the market. According to G. Mazurek (2019), technology should offer an added value primarily to the clients, yet it also requires focus on two supplementing activities: formation of a value proposal for the client anew and re-designing activities with the use of digital solutions, allowing for furnishing the clients with the highest level of interaction and cooperation (Berman, 2012).

Development of digital economy and all the consequences thereof are thus changing the modes of operation of enterprises, as well as affecting the life-cycle of various business models (among others, they accelerate the ageing processes of products). In other words, digitisation and evolution of ICT technologies are constantly contributing to the increased application of business process IT enhancement, yet enterprises should carefully think the mode of their

operation through in the context of digital challenges of the future (Tapscott, 2008; Poznańska, Szczepańska-Woszczyna, et al., 2022). From the point of view of an enterprise, technology cannot set the directions of development, but it has to become adjusted to the enterprise's strategy, its potential and these areas that require support on the organisational level. Such support most often refers to (Adamczewski, 2016):

- technical infrastructure (hardware),
- system and communication infrastructure,
- application software,
- integration of business processes with external contractors.

Digital transformation is not only a layer of tooling, but a thorough change within the organisation pertaining to management, mode of operation, values cherished or communication with stakeholders, including clients (Kotelska, Lis, 2022; Lis, Kotelska, 2022). As stated by G. Mazurek, the scale and extensiveness of digital transformation in an enterprise is often so great that implementation of new business models gives rise to a number of challenges and problems with ensuring their complementarity with the ones on which the enterprise relied earlier (Mazurek, 2019).

Digitisation is a process ushered by the response to the questions: 'What is the level of competitiveness of an organisation operating in a traditional business model?' and 'Whether and to which scope is it necessary to launch actions conducive to the development of organisations, the effect of which is going to be an organisational hybrid (combination of a process model with elements of digitisation) and eventually a digital model of business?' (Cieśliński, 2020). Setting and anchoring an organisation in a digital environment requires its transformation and is a process that has multiple interim stages. On the level of every sector or market, it is possible to designate leaders, i.e. enterprises most active and efficient with respect to innovation, where technological changes are implemented faster than in other companies. Transformation directions of these companies blaze the trail for others, which are following the leaders at a various pace. However, it must be assumed that some enterprises, due to various reasons, will never implement the process of full transformation, but will stop at some of its interim stages. This may be follow from numerous factors, e.g. inner barriers for development of innovations, lack of capital or change in the business model. However, it may be assumed that systematically performed digitisation processes allow a company to accomplish digital maturity which is conducive to the reliance of organisations on business and organisational models designated by highly advanced technologies, e.g. Industry 4.0. The development of Industry 4.0 also leads to a change in business models from product orientation to service orientation, e.g. offering the best on-line service for performance of a given fragment of production process as part of a company's expertise (Gajdzik, Grabowska, 2018). The source of value is the combination of network links based on cooperation (Porter, 2006) and thus integration is of vital importance in business activities in line with the concept of Industry 4.0, i.e. a broad range of flexible cooperation among various entities, as only cooperation among participants allows for meeting all the expectations of a recipient at a given time.

Industry 4.0 comprises digital management and production tools and tools allowing for the use of Internet and social media for the purpose of integration of smart machines, systems and introduction of changes to production processes, aimed at increasing efficiency of production and introduction of possibilities of flexible changes in product assortment. Industry 4.0 refers not only to technologies, but also to new modes of work and people's role in an organisation. Cognitive challenges pertaining to the implementation of a business model based on the Industry 4.0 concept in enterprises are presented in Fig. 1.

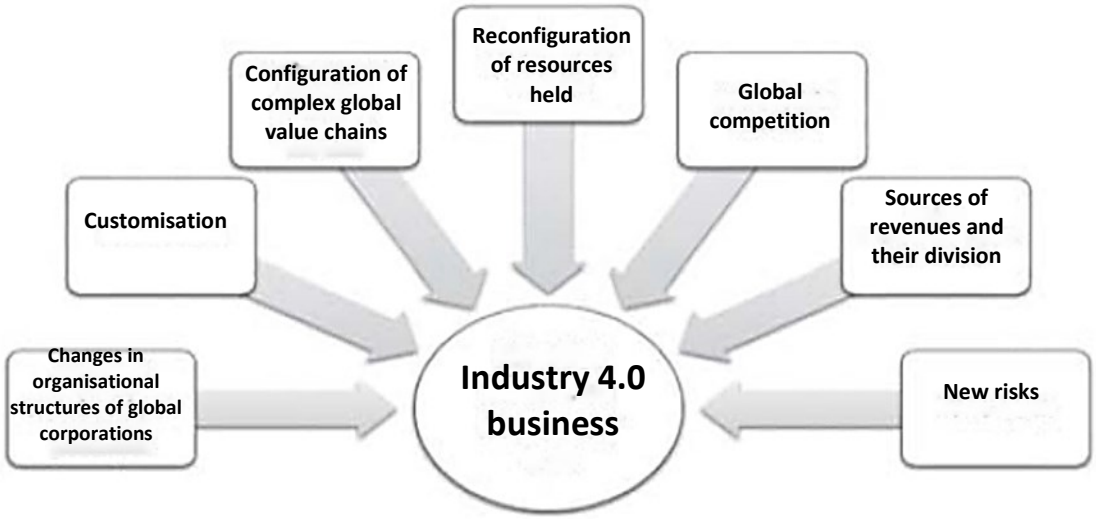

Figure 1. Structure of a business model based on the Industry 4.0 concept.

Source: Frankowska, Malinowska, Rzeczycki, 2017, pp. 97-109.

The analysis of the extent and the nature of issues comprising the business model presented above shows that the main factors allowing for development of Industry 4.0 are: access to proper data and holding tools for their analysis. Implementation of technological solutions in the area of Industry 4.0 may become an impulse for multiple beneficial changes in an enterprise, as presented in Fig. 2.

Development opportunities	Description
Growth of productivity	Industry 4.0 allows to optimise the production process, reduce the downtime, allocate the resources better and create new products
Development of new sectors	Development of new sectors thanks to suppliers of Industry 4.0 solutions and companies implementing such solutions
Innovative economy	Economy becoming increasingly innovative, allowing for expansion of technology abroad
Attractiveness for investors	High employee competence and vigorously developing innovative economy attracts investors when the mechanisms are adequate
New work places with high added value	New work places are being created, focused around automation and IT and new sectors related to, among others, cooperation of robots and people
Drop in production costs	Improved quality of products and drop in stock reduce costs of production
Efficient use of materials and energy	Rational use of materials and improved energy efficiency go hand in hand with sustainable development
Consumers' needs met in a more adequate way	Custom-made products produced in small batches (mass customization)

Figure 2. Enterprise development possibilities based on Industry 4.0.

Source: Buła, Schroeder, 2020.

Organisational modelling of the processes of embedding and anchoring of organisations in the new 4.0 business models is a process that starts with procurement of data (PD) and subsequently their transformation (cognitive and/ or machine) to the form of information (I). The outcome of the process of organisational modelling is knowledge and its diffusion (DK) among the organisation's stakeholders (Cieśliński, 2020). Figure 3 presents a management model of organisational modelling from the digital perspective, using the terms outlined above.

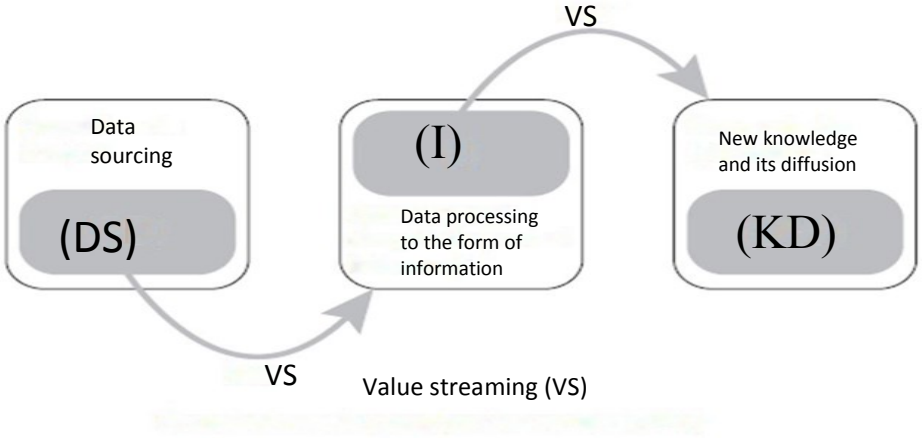

Figure 3. Organisational modelling management outline from the digital transformation perspective. Source: Cieśliński, 2020.

According to W. Ciesielski, a new business model requires linear progress: from birth, through growth, to improvement; nevertheless, an organisation's reliance on new digital technologies disrupts this ordered process. Organisations which are at a stage of growth and which increase the significance of IT systems in business processes are thus shaping their core of organisational development towards digitisation. A model approach to digital transformation of an enterprise comprises stages presented in Table 2.

Table 2.
Stages of transition of an enterprise into a business model based on digital transformation

Name of stage	1. Digital reality	2. Digital ambitions	3. Digital potential	4. Digital readiness	5. Digital implementation
Description	Procuring knowledge about digitisation and analysis of clients' requirements for the purpose of creating a value chain with the participation of various stakeholders, e.g. clients, universities, etc.	Determination of digital ambitions of an enterprise and specification of a new business model based on digital transformation.	Use of best available practices pertaining to digital transformation, determination of digital potential of a new business model of an enterprise and appointment of digital transformation ambassadors.	Evaluation of adequacy of alignment of a digital business model with respect to the fulfilment of clients' and other stakeholders' expectations, along with possibilities of meeting the designated targets.	Implementation of the new business model at all areas of operation of an enterprise, development of a digital network for value creation and incorporation of business partners and other stakeholders into this process.

Source: own study based on Mazurek, 2019, p. 74.

Three critical factors of embedding organisations in digital business models are distinguished (Cieśliński, 2020). The first is the streaming of data, information and knowledge as an element allowing for extension of value chains. Streaming consists in the use of modern technologies and Internet to manage the value flows in an organisation. The second element is gamification, which improves the efficiency of teamwork and allows for better monitoring of task performance efficiency. The last element, i.e. machine processing, influences the process of automatic, as well as cognitive data processing, with respect to the inventive creation of new knowledge and its subsequent diffusion to entities making business decisions and cooperating with an organisation (Cieśliński, 2020).

Figure 4. Critical factors for embedding and anchoring organisations in digital business models.
Source: Cieśliński, 2020, p. 320.

A common element for all three factors used for embedding the organisations in digital business models is their relationship with knowledge, used in the process of digital transformation in many diverse dimensions and applications:

- as a resource in a process (next to data and information),
- as a basis for evaluation of process efficiency (as part of control activities),
- as a process outcome (a value which a company jointly creates together with stakeholders during the application of digital technologies).

Knowledge is the basis for implementing modern technologies in an enterprise, both based on own invention, but also on good practice deriving from the environment. Hence, knowledge has key application in the digital transformation as the resource which an enterprise contributes to the process or procures from the stakeholders cooperating with it, but also develops jointly with them, among others by joint learning. Integration of knowledge pertaining to the business environment, familiarity with new technologies that may support the manufacturing of products and services, and the possibility of admitting them to the new markets, is the main opportunity for an enterprise to accomplish a competitive advantage, among others on account of innovations. A great dispersion of innovations in the business eco-systems and a variety of organisations cooperating within them changes the nature of the technological evolution (Iansiti, Levien, 2004). In the future, not so much the leading enterprises engaged in the

technological race, but inter-organisational and diverse networks of cooperation embedded in business eco-systems, will be its driving force.

Digital technologies implemented by enterprises are based on digital solutions generally defined as SMAC, i.e. social media, mobility, big data analytics and cloud computing (Adamczewski, 2017). These four pillars on which the new business models rely may be characterised as follows (Adamczewski, 2017):

1. Social: social networks breaking the barriers of information flow among people and acting as platforms that enable quick and efficient exchange of knowledge, improving interactions with clients and offer greater capacity for exchange of experiences and problem solving.
2. Mobile: mobile devices (smart phones and tablets) that increase the efficiency of the companies' outreach to clients, used for on-line marketing, processing of transactions and any forms of communication, among others via websites and applications.
3. Analytics: analytical tools, using advanced algorithms that allow for understanding behaviour and preferences of clients that shore up client loyalty, improve processes of product development and service provision, facilitate business decisions.
4. Cloud: cloud computing technology, offering tools that enable efficient capturing of information and efficient management of organisations. Use of tools available in the cloud allows the organisations to reduce costs, overcome geographical barriers and access data at any time and place.

Next to technologies generally known as the SMAC, companies most often implement solutions in the area of automation and robotisation aligned to the profile of their operation (Adamczewski, 2016), yet apart from it, at least several dozen digital technological solutions which enjoy growing popularity among enterprises may also be listed. They are presented below, together with a brief characteristic of the possibility of being used in business, with an assumption that practically each of these technologies requires adaptation to the conditions of operation of sectors and industries, as a result of which product, process, organisational and marketing innovations are created in companies.

At the present moment, the most popular are solutions based on automation and robotisation of production. Automation consists in activities carried out independently by a machine, which previously were or could have been carried out by a man, but also these that are too difficult to perform by a man (Lis, Bhatt, 2021). As a result of work automation, man only performs supervisory and control functions in reference to machines and their work. Automation may refer to the entire process of manufacturing or some of its stages that may be supplemented with people's work (Lemański, 2020). Robotisation is a form of production automation which is related to the substitution of man by a robot (Grzeszak, Sarnowski et al., 2019). Apart from industrial robots that more and more often substitute people in work performed in difficult conditions, mobile robotics is dynamically developing. Modern robots are characterised by diverse structures, dependant on their intended use. The level of their autonomy is going to be

increased, in particular the mode of thinking, moving and behaving (Kowalczuk, Czubenko, 2015). The commonness of automation and robotisation in industrial activities and in daily life results in development of these solutions both in simple and more complex professional activities (e.g. a humanoid robot substituting a reception desk worker at a hotel or a seller in a store, holograms offering information or advice to clients) and home activities (e.g. humanoid robots caring for the elderly or disabled persons or, for example, smart vacuum cleaners and lawnmowers). Solutions aimed at automation of managerial processes (e.g. servicing of electronic mail, processing of parts of financial transactions) are also implemented.

Irrespective of the industry, more and more companies are reaching for solutions in the area of cyber-security which encompass, in a broad range, technologies intending to offer better protection of the ICT networks, devices, programmes and data from hackers' attacks, damages or unauthorised access. They encompass all tools and systems that prevent damages, are used for protection and allow for restoration of capacity for correct functioning of computers, systems of electronic connectivity or communication services in the cyber-space. They aim to protect the electronic communication to ensure confidentiality with simultaneous authentication of authorised persons (Górka, 2017; Michałek, Pachucki, 2021).

Other digital solutions gaining popularity in business are based on machine learning, i.e. focused on teaching computers how to learn from data and improve, along with acquisition of experience. These technologies encompass solutions allowing the computers to perform tasks for which they have not been programmed earlier. Machine learning leads to the creation of algorithms, which are subsequently trained with respect to finding models and correlations in big data sets and making the best decisions and formulating forecasts based on the results of such analysis. Systems that use machine learning become more and more efficient, while better access to data leads to an increase in their accuracy (Alafif, Tehame et al., 2021).

In turn, big data systems allow for the use of computing potential and technologically advanced software to capture, process and analyse data which are characterised by significant volume, quick generation and value (McAfee, Brynjolfsson, 2012). They are used for sets of data which are so bulky, complex and deriving from diverse sources that their processing requires new technologies, such as artificial intelligence. The *big data* system enables very rapid data capturing (in a time approximate to real time) and their analysis and assessment for drawing new conclusions.[1] Such systems also allow for broadly understood data aggregation and are used more and more often as an efficient tool supporting decision-making processes.

[1] *Big Data: Bringing Competition Policy to the Digital Era*, Directorate for Financial and Enterprise Affairs, Competition Committee, 26 April 2017, https://one.oecd.org/document/DAF/COMP/M(2016)2/ANN4/FINAL/en/pdf, 15.07.2021, https://www.europarl.europa.eu/news/pl/headlines/society/20210211STO97614/big-data-definicja-korzysci-wyzwania-infografika, 15.07.2021.

The technological solution of *edge computing* focuses on efficient modes of data processing, delivered in huge amounts by smart items connected to the Internet as part of the so-called Internet of Things. It allows for the initial processing of data on the so-called edges of the network, which are any computing and network resources located at the interface between sources of data and centres of data, e.g. in cloud computing (Shi, Cao et al., 2016). *Edge computing* allows for an increase in speed and safety of data processing, consisting – among others – in transfer of the computing capacity closer to the place of data generation (Satyanarayanan, 2017).

Blockchain is a distributed ledger, containing a continually accruing amount of information (records) grouped into blocks and combined in a way that every next block contains a timestamp of its creation and a link to the previous block which is a coded 'summary' (hash) of its content (Piech, 2016). Thanks to the application of such solution, it is much easier to document transactions, track resources and build trust (Jacobovitz, 2016), as well as securely store information based on creation and recording of the full path (chain) of data flow in an organisation.

Cloud computing consists in delivery, via computing services of, e.g., databases, networks, software, etc., to offer quicker innovations, flexible resources and economies of scale (Xun, 2012). The technology assumes storage of data, files, applications, software and IT systems in the cloud, i.e. on servers located outside of the local network held by an external supplier. This is an increasingly common and available solution, offering a number of benefits to organisations, from lower costs to data security guarantees (Voorsluys, Broberg et al., 2011).

A *chatbot* is an application communicating with the recipients in the form of dialogue, whose task is to simulate an interactive conversation with any interlocutor and to reduce the load on the administrator of the on-line customer service centre, as well as to assist communication in the social media (Szymański, Józwiak, 2018). Tools of this type are used for conversations with the use of a computer (e.g. virtual consultants offering advice or answers to questions frequently asked by clients) and they greatly facilitate work in industries where the same operations are carried out with many clients, in relation to which it is possible to foresee typical procedures which are entrusted to such applications.

Virtual Reality (VR) is a 3D environment created by computers, allowing the users to move and to interact, which stimulates one of five human senses (Berbeka, 2016). VR solutions rely on computer simulations which create images of physical or virtual reality, e.g. computer simulations of objects, spaces or events. They are applied, e.g., in design, modelling of decision making or behaviour studies. In turn, augmented reality (AR) is a system used to supplement the reality with virtual, interactive elements located in it, which are an intermediate stage between the real world and the virtual reality. In this technology, impact on the senses of sight, hearing and touch is applied, yet there are also concepts of impacting other senses (Skórska, 2017). The AR-type solutions allow for creation of computer simulations that combine the real world with computer-generated images (e.g. imposing 3D graphics in real time on a camera image).

The Internet of Things (IoT) is an eco-system where objects may communicate among themselves via man or without man's participation (Grodner, Kokot et al., 2015). These solutions furnish the devices with smart features, e.g. by connecting them to the Internet (e.g. smart fridges where the content can be checked with the use of a smartphone app). The scope of application of the Internet of Things is extensive both in the sphere of economy and daily life. The Internet of Everything, i.e. a network connecting people, processes, data and objects, also has a great potential. The next stages of technological development, including cloud computing and big data, will allow for using this potential to a greater degree. At the present moment, only 1% of objects in the physical world are connected, but the potential is far greater. The Internet of Everything generates benefits not only for enterprises and their clients, but also for countries, cities and their residents, among others due to the fact that it increases productivity and revenues of the public sector and improves the quality of public services (Kolek, 2019).

Artificial Intelligence (AI) comprises systems or machines simulating human intelligence for the purpose of task performance and successively improving their operation based on the compiled information (Acemoglu, Restrepo, 2019). These are tools materially supporting the making of managerial decisions in various spheres of operation of organisations, including marketing, production and logistics.

Experience design is an interdisciplinary action comprising elements of psychology, ergonomics, art, utility, industrial design and technology. It allows for forming an enterprise's relations with various stakeholders (including clients) around a product or a service (Benyon, 2019), via information systems for ordering, analysing and evaluating the hitherto reciprocal experiences. The process aims to design a product or a service that allows the user for intuitive use thereof. Thanks to it, the user's attention is fully devoted to the performed activity and not to thinking how to use a product to accomplish a specific goal.

The 5G technology is the most sophisticated technology in wireless communication. It is most probably going to revolutionise the entire area of wireless networks, offering a possibility of efficient and safe communication wherever wireless communication cannot be replaced (Korzeniewska, Krawczyk, 2019). It forms a realm of solutions based on mobile communication with multiplied (above-standard) transfer of data and may be used in numerous spheres of life, e.g. remote treatment of people by monitoring vital signs, remote control of facilities, e.g. cars, etc.

Summing up, diverse directions and possibilities of making use of technical progress have opened up before enterprises of the digital era. Implementation of the technologies described above requires a number of requirements related to the process of digital transformation to be met, the result of which should be accomplishment of the highest possible level of digital maturity by an enterprise and development of inter-organisational relations which offer full access to knowledge indispensable in the process of innovation creation.

4. Impact of Digital Transformation on the Process of Establishing and Reinforcing Inter-Organisational Cooperation from the Perspective of Own Studies

To carry out a research procedure pertaining to the determination of impact which knowledge about digital technologies exerts on the companies' willingness to establish and to reinforce ties, it was necessary to define the components of these technologies. These components were prepared on the basis of properly selected statements. The respondents had the task of assessing a set of 18 solutions from the area of digital technologies. These were solutions that the representatives of entities covered by the study would like to get to know better or apply in their enterprise in the next five years. 350 persons, representatives of enterprises, with whom interviews were carried out, offered responses with the use of a seven-grade scale. The majority of the respondents (depending on the statement: 57-79%) expressed interest in the use of presented solutions; a different opinion was expressed by 7-21% of the respondents. Average grades divided into micro, small, medium-sized and large enterprises are presented in Figure 5.

It follows from the performed CATI interviews that the representatives of companies covered by the study would be most willing to get to know solutions aimed at better protection of IT networks, devices, programmes and data from hackers' attacks, damages or unauthorised access, hence solutions related to cyber-security (in total 79% of positive indications, average grade at 5.63). An equally high share of positive responses (i.e. 79%) was given to the solution pertaining to the IT systems allowing capturing and analysing data deriving from multiple diverse and distributed sources and their management, e.g. big data (average grade of 5.46). In turn, 77% of the respondents would like to learn or implement solutions aimed at automation of managerial processes, e.g. e-mail handling, processing a part of financial transactions, i.e. process automation, robotisation (average grade 5.35) – most often, these are large organisations (89%) and entities cooperating with at least six universities (100%). Almost 75% of the respondents are interested in solutions allowing for reinforcement of relations linking organisations with clients via IT ordering systems, analysis and assessment of hitherto experiences, i.e. new experience design (average grade 5.40). It also follows from the performed studies that 74% of company representatives would like to learn or apply solutions that allow for safe storage of information based on creating and saving a full path (chain) of data flow, i.e. blockchain (average grade of 5.39) – most often, these are entities cooperating with six or more universities (100% in this group of entities). The same share of positive responses also pertained to a solution related to IT systems that support decision-making in an organisation, e.g. marketing, based on artificial intelligence – the highest result was recorded among small companies that have from 10 to 49 employees (79%).

No.	Statement (variable) Would you like to get to know or apply these solutions in your enterprise in the next five years?	Average grades on the scale from 1 to 7 (where 1 means definitely no and 7 means definitely yes)
1	IT systems supporting decision-making in an organisation, e.g. marketing (artificial intelligence)	
2	IT systems allowing for capturing, analysis and management of information deriving from multiple diverse and distributed sources (*Big Data*)	
3	Solutions focused on automation of managerial processes (e.g. e-mail handling, processing of financial transactions) (process automation, robotisation)	
4	Solutions allowing for reinforcement of relations between organisations and clients via IT systems to order, analyse and evaluate mutual experiences	
5	Solutions enabling an increase in speed and safety of data processing consisting – among others – in transfer of the computing capacity closer to the place of data generation (*edge computing*)	
6	Solutions allowing for safe storage of information, relying on creation and saving a full path (chain) of data flow (*blockchain*)	
7	Solutions enabling storage of data, files, applications, software or IT systems on external supplier's servers	
8	Solutions aimed at better protection of IT networks, devices, programmes and data from hackers' attacks, damages or unauthorised access	
9	IT systems enabling computer assisted conversations (e.g. virtual consultants offering advice or answering questions of clients, *chatbot)*	
10	Solutions that substitute people in simple professional activities (e.g. holograms offering information or advice to clients)	
11	Solutions that substitute people in complex professional activities (e.g. a humanoid robot replacing a reception desk assistant in a hotel or a shop assistant)	
12	Solutions that substitute people in simple household tasks (e.g. smart vacuum cleaners, smart lawnmowers)	
13	Solutions that substitute people in complex household activities (e.g. humanoid robots taking care of elderly or disabled people)	
14	Solutions based on mobile communication with multiplied (above-standard) data transfer (e.g. remote treatment of people by monitoring their vitals)	
15	Solutions providing devices with smart features, e.g. by connecting them to the Internet (e.g. smart fridges where the content can be checked the use of a smartphone app)	
16	Solutions focusing on the so-called machine learning (e.g. allowing a computer to perform tasks for which it has not been programmed before, machine learning)	
17	Solutions enabling computer simulation which create images of physical or virtual reality, e.g. computer simulations of objects, spaces or events	
18	Solutions enabling computer simulation that combine the real world with computer-generated images (e.g. superimposing real-time 3D graphics on a camera image).	

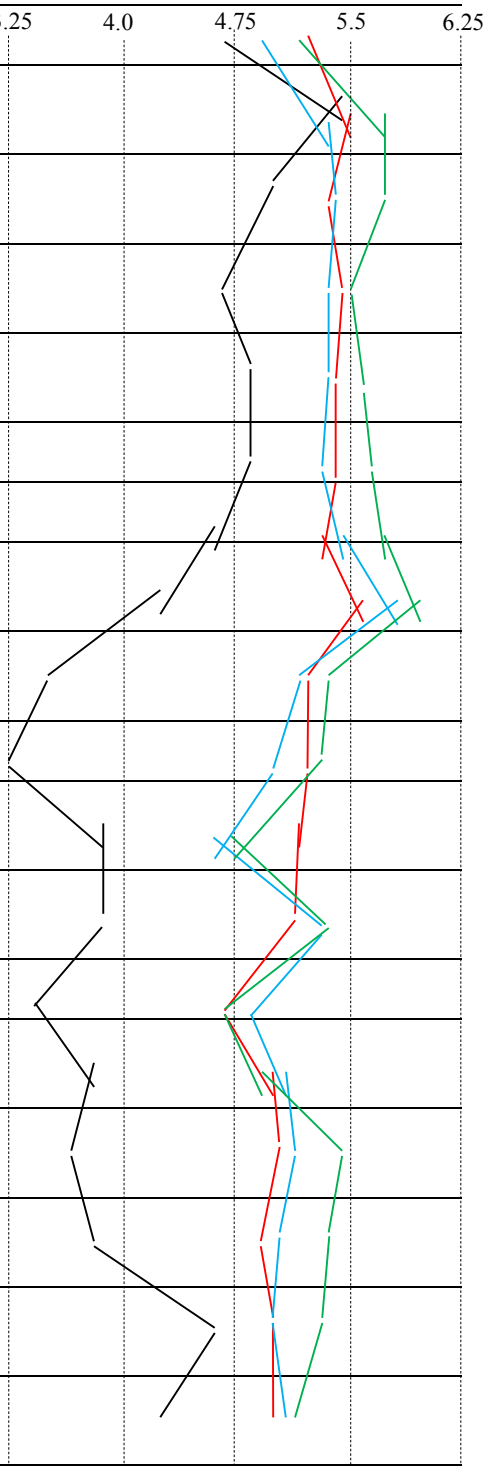

Figure 5. Interest of companies covered by the study in solutions from the realm of digital technologies (black line denotes micro, red line – small, blue line – medium-sized and green line – large companies).

Source: author's own study.

It follows from information presented in Fig. No. 5 that interest in solutions in the area of digital technologies is correlated with the size of a company measured with the number of employees. In general, one may conclude that the lowest interest in digital technologies was recorded in the group of micro-companies. This observation does not come as a surprise, because smallest entities have specific needs and limited potential with respect to implementing the presented technological solutions.

Next, eighteen statements (Table 3) were used to measure the power of impact of knowledge about individual digital technologies in the process of forming long-term inter-organisational relations. The statements were aligned to the seven-degree Likert scale, ranging from the 'strongly disagree' (1) to 'strongly agree' (7) answers. The basic descriptive statistics for all eighteen statements are presented in Table 3.

Table 3.
Basic descriptive statistics for statements pertaining to digital technologies

No.	Statement (variable) Would you like to learn or apply these solutions in your enterprise in the next five years?	Statistics	Value	Standard error
1	IT systems supporting decision-making in an organisation (e.g. artificial intelligence) [P11a]	Average	5.1343	0.06678
		Median	5.0000	-
		Variance	1.561	-
		Standard deviation	1.24928	-
		Skewness	-0.513	0.130
		Kurtosis	0.242	0.260
2	IT systems allowing for capturing, analysing and management of data deriving from multiple diverse and distributed sources (*Big Data*) [P11b]	Average	5.4343	0.06985
		Median	6.0000	-
		Variance	1.708	-
		Standard deviation	1.30679	-
		Skewness	-0.960	0.130
		Kurtosis	0.818	0.260
3	Solutions focused on automation of managerial processes, e.g. e-mail handling, processing of financial transactions (process automation, robotisation) [P11c]	Average	5.3600	0.07487
		Median	6.0000	-
		Variance	1.962	-
		Standard deviation	1.40061	-
		Skewness	-1.013	0.130
		Kurtosis	0.845	0.260
4	Solutions allowing for reinforcement of relations connecting organisations with clients via IT systems of ordering, analysis and evaluation of mutual experiences (new experience design) [P11d]	Average	5.3600	0.07595
		Median	6.0000	-
		Variance	2.019	-
		Standard deviation	1.42092	-
		Skewness	-0.715	0.130
		Kurtosis	-0.077	0.260
5	Solutions enabling an increase in speed and safety of data processing consisting – among others – in transfer of the computing capacity closer to the place of data generation (*edge computing*) [P11e]	Average	5.3057	0.07764
		Median	6.0000	-
		Variance	2.110	-
		Standard deviation	1.45248	-
		Skewness	-0.899	0.130
		Kurtosis	0.431	0.260

Cont. table 3.

6	Solutions allowing for safe storage of information, relying on creation and saving a full path (chain) of data flow (*blockchain*) [P11f]	Average	5.3000	0.07896
		Median	6.0000	-
		Variance	2.182	-
		Standard deviation	1.47714	-
		Skewness	-0.855	0.130
		Kurtosis	0.326	0.260
7	Solutions allowing for storage of data, files, applications, software or IT systems on external supplier's servers (*cloud computing*) [P11g]	Average	5.2743	0.07907
		Median	6.0000	-
		Variance	2.188	-
		Standard deviation	1.47924	-
		Skewness	-0.769	0.130
		Kurtosis	0.086	0.260
8	Solutions aimed at better protection of IT networks, devices, programmes and data from hackers' attacks, damages or unauthorised access (cyber-security) [P11h]	Average	5.5543	0.08105
		Median	6.0000	-
		Variance	2.299	-
		Standard deviation	1.51636	-
		Skewness	-1.096	0.130
		Kurtosis	0.665	0.260
9	IT systems enabling computer-assisted conversations, e.g. virtual consultants offering advice or answering questions of clients, *chatbot* [P11i]	Average	5.0086	0.08569
		Median	5.0000	-
		Variance	2.570	-
		Standard deviation	1.60316	-
		Skewness	-0.698	0.130
		Kurtosis	-0.121	0.260
10	Solutions that substitute people in simple professional activities, e.g. holograms offering information or advice to clients [P11j]	Average	4.8914	0.08874
		Median	5.0000	-
		Variance	2.756	-
		Standard deviation	1.66015	-
		Skewness	-0.658	0.130
		Kurtosis	-0.304	0.260
11	Solutions that substitute people in more complex professional activities, e.g. a humanoid robot substituting a reception desk assistant in a hotel or a shop assistant [P11k]	Average	4.7057	0.09114
		Median	5.0000	-
		Variance	2.907	-
		Standard deviation	1.70511	-
		Skewness	-0.500	0.130
		Kurtosis	-0.586	0.260
12	Solutions that substitute people in simple household tasks, e.g. smart vacuum cleaners, smart lawnmowers [P11l]	Average	5.0257	0.08906
		Median	5.0000	-
		Variance	2.776	-
		Standard deviation	1.66609	-
		Skewness	-0.733	0.130
		Kurtosis	-0.195	0.260
13	Solutions that substitute people in complex household chores, e.g. humanoid robots taking care of elderly or disabled persons [P11m]	Average	4.6543	0.09356
		Median	5.0000	-
		Variance	3.064	-
		Standard deviation	1.75029	-
		Skewness	-0.548	0.130
		Kurtosis	-0.559	0.260
14	Solutions relying on mobile communication with multiple (above-standard) data transfer, e.g. remote treatment of people by monitoring their vitals, remote control of facilities, 5G [P11n]	Average	4.9314	0.08755
		Median	5.0000	-
		Variance	2.683	-
		Standard deviation	1.63798	-
		Skewness	-0.708	0.130
		Kurtosis	-0.114	0.260

Cont. table 3.

15	Solutions providing the devices with smart features, e.g. by connecting them to the Internet, e.g. smart fridges where the content can be checked the use of a smartphone app (Internet of Things, IoT) [P11o]	Average	4.9914	0.08934
		Median	5.0000	-
		Variance	2.794	-
		Standard deviation	1.67141	-
		Skewness	-0.701	0.130
		Kurtosis	-0.243	0.260
16	Solutions focused on the so-called machine learning, e.g. allowing a computer to perform tasks for which it has not been programmed before, machine learning [P11p]	Average	4.9029	0.08462
		Median	5.0000	-
		Variance	2.506	-
		Standard deviation	1.58313	-
		Skewness	-0.763	0.130
		Kurtosis	-0.002	0.260
17	Solutions that enable computer simulations which create images of physical or virtual reality, e.g. computer simulations of objects, spaces or events (virtual reality) [P11r]	Average	4.9457	0.08725
		Median	5.0000	-
		Variance	2.665	-
		Standard deviation	1.63238	-
		Skewness	-0.807	0.130
		Kurtosis	-0.035	0.260
18	Solutions that enable computer simulations that combine the real world with computer-generated images, e.g. superimposing real-time 3D graphics on a camera image, augmented reality [P11s]	Average	4.9600	0.08417
		Median	5.0000	-
		Variance	2.480	-
		Standard deviation	1.57473	-
		Skewness	-0.819	0.130
		Kurtosis	0.061	0.260

Source: author's own study.

Eighteen variables (see Table 3) were taken into account in the factor analysis. As a result of the performed analysis, three factors were identified, which significantly clarify the variability observed in the input data set. Three distinguished factors account for almost 74.1% of the variability of the input data set. This means that reduction of the 18-dimension set to the 3-dimension set described with the distinguished factors results in a loss of only approx. 25.9% of full information from the input set. Some variables (5) were rejected due to no possibility of assigning a given variable to a specific factor (similar load values in the case of both components). Using the Varimax orthogonal rotation, the final distribution of factor loads is presented in Table 4.

Table 4.
Distribution of factor loads for variables in the area of digital technology

Factor distinguishing method – principal factors Rotation method – Varimax with Kaiser normalisation
a. the rotation was convergent in 3 iterations.

Statement (variable)	Factor		
	1 Process automation and monitoring	**2 Data integration and big data analytics**	**3 Protection and cyber-security**
Solutions substituting people in complex professional activities, e.g. a humanoid robot substituting a reception desk assistant in a hotel or a shop assistant	**0.834**		
Solutions substituting people in complex household chores, e.g. humanoid robots taking care of the elderly or persons with disabilities	**0.832**		
Solutions that enable computer simulations which create images of physical or virtual reality, e.g. computer simulations of objects, spaces or events (virtual reality)	**0.784**	0.405	
Solutions substituting people in simple household tasks, e.g. smart vacuum cleaners, smart lawnmowers	**0.751**	0.301	
Solutions that enable computer simulations that combine the real world with computer-generated images, e.g. superimposing real-time 3D graphics on a camera image in real time, augmented reality	**0.738**	0.458	
Solutions based on mobile communication with multiplied data transfer, e.g. remote treatment via vital sign monitoring, remote control of facilities, 5G technology	**0.730**	0.389	
Solutions focused on the so-called learning of machines, e.g. allowing a computer to perform tasks for which it has not been programmed before, machine learning	**0.722**	0.398	
Solutions furnishing the devices with smart features, e.g. by connecting them to the Internet, e.g. smart fridges where the content can be checked the use of a smartphone app, Internet of Things	**0.713**	0.327	0.360
Solutions substituting people in simple professional activities, e.g. holograms offering information or advice to clients	**0.679**		0.533
IT systems supporting decision-making in an organisation (e.g. marketing, artificial intelligence)		**0.817**	
IT systems allowing for capturing analysing and managing information deriving from multiple diverse and distributed sources (Big Data)		**0.798**	
Solutions allowing for reinforcement of relations between organisations and clients via IT systems of ordering, analysis and evaluation of mutual experiences (new experience design)	0.330	**0.696**	0.356
Solutions aimed at better protection of IT networks, devices, programmes and data from hackers' attacks, damages or unauthorised access (cyber-security)		0.444	**0.743**

Source: author's own study.

It follows from the results contained in Table 4 that thirteen out of eighteen input variables were assigned to three factors. The variables are moderately strong and strongly bound to each factor. The following factors have been distinguished:

- factor 1: interest in solutions in the area of process monitoring and automation – the factor comprises knowledge related to monitoring and automation and substituting people in household and professional activities,

- factor 2: interest in data integration and big data analytics – solutions comprising knowledge related to capturing, integration and processing of large sets of data as support in the decision-making proces,
- factor 3: interest in cyber-security and protection of data – issues related to knowledge about network protection, e.g. from a hacker's attack or another type of unauthorised access.

Similarly to variables in the area of digital technologies in reference to variables describing the enterprises' willingness to establish and to reinforce inter-organisational bonds, an exploratory factor analysis was carried out with the use of the principal component method and orthogonal Varimax rotation with the use of SPSS. All the assumptions remained unchanged. In effect, the KMO sampling adequacy ratio reached 0.933. The Bartlett Test of Sphericity for the studied set is on the B = 3818.933 level (df = 91, p-value = 0.000) – Table 5.

Table 5.
The results of the KMO test and the Bartlett Test of Sphericity for variables pertaining to enterprises' inclination to establish and reinforce inter-organisational bonds

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.933
Bartlett' s Test of Sphericity	Approx. Chi-Square	3818.933
	df	91
	Sig.	0.000

Source: author's own study.

Hence, it may be stated with absolute certainty that the use of factor analysis has been justified. The received results indicated their alignment to data – none of the scale items used were eliminated from the analysis. Taking into account the degree of clarification of the variability of the initial data set, two factors were detected explaining 67.4% of information for the full set of 14 observable variables. The variables are moderately bound to every factor. Some variables (7) were rejected on account of:

- no possibility of assigning a given variable to a specific factor (similar load values in the case of both components),
- statements that are insignificant or difficult to interpret in the context of establishment or reinforcement of bonds.

Thanks to the performed statistical procedure, it is possible to determine the degree to which the aforementioned variables (factors) are responsible for the willingness to establish or reinforce inter-organisational bonds, also with selected universities. Using the Varimax orthogonal rotation, the final distribution of factor loads is presented in Table 6.

Table 6.
Distribution of factor loads for variables pertaining to the enterprises' inclination to establish and reinforce inter-organisational bonds and with selected universities

Factor distinguishing method – principal factors. Rotation method – Varimax with Kaiser normalisation
a. the rotation was convergent in 3 iterations.

Statement (variable)	Factor	
	1 Bond reinforcement	2 Bond establishment
I would like to pursue joint international projects also with selected universities	**0.810**	
I would like to create research and development projects also with selected universities	**0.781**	0.398
I would like to influence the educational offer, directions of teaching and curricula at selected universities	**0.764**	0.305
I would like to create joint international projects also with selected universities	**0.744**	0.392
I would like to use expert knowledge and counselling also from selected universities		**0.775**
I would like to use results of studies carried out by selected universities for the sake of enterprise's development	0.368	**0.754**
I would like to use modern technologies popularised by selected universities	0.409	**0.728**

Source: author's own study.

It follows from the data presented in Table No. 6 that seven out of fourteen input variables were assigned to two factors which may be described in the following manner:

- factor 1: willingness to reinforce inter-organisational bonds also with selected universities, focused on close cooperation and implementation of joint projects, requiring engagement of both parties, good recognition of the mode of organisation and processes, relations based on trust and reciprocal impact of both entities,
- factor 2: willingness to establish inter-organisational bonds, also with selected universities, encompassing simple forms of cooperation and use of expert university knowledge, not requiring significant engagement on the part of the enterprise and advanced cooperation.

The results of the performed factor analysis show that it was possible to generate three factors referring to the knowledge on digital technologies (1: Monitoring and process automation; 2: Data integration and big data analytics, 3: Protection and cyber-security), as well as two factors which clearly correspond to the 'Establishment of bonds' and 'Bond reinforcement' components, used to measure the force of impact of knowledge about digital technologies on the process of forming long-term relations among enterprises and selected universities at individual stages of such process. The factor loads adopt values testifying to moderately strong correlation between the observable input variables and the reduced factors.

5. Conclusion

Universities as organisations that have the indisputable potential for knowledge development are particularly predisposed to satisfying cognitive needs of other organisations within the scope of digital technologies (including enterprises), offering value that constitutes the core of services adopting diverse forms. At the same time, interest in the use of technologies of this type is growing at the universities and in enterprises that operate in various fields, which additionally intensifies the necessity of exploring this subject. Digital transformation leads to a situation where knowledge about digital technologies becomes a key element in the process of forming long-term inter-organisational relations.

The performed direct studies offered a basis for defining eighteen statements identifying knowledge about individual digital technologies, which in the opinion of the interviewed managers may be of significance in the process of forming long-term inter-organisational relations. Next, a factor analysis was carried out that allowed for reducing the prepared set of solutions from the area of digital technologies to three factors focusing knowledge on process automation and monitoring, integration of data and big data analytics and protection of data and cyber-security, which allows for concluding that the primary purpose of the paper has been accomplished.

According to the authors, the factors above have a stimulating impact on the company's willingness to establish and reinforce inter-organisational cooperation. These assumptions were confirmed by the estimation of parameters in two subsequent factors corresponding to them: 'Establishment of relations' and 'Reinforcement of relations', from which it follows that all three distinguished factors that focus knowledge about digital technologies (1: Process automation and monitoring, 2: Data integration and big data analytics, 3: Protection and cyber-security) have a uni-directional, positive impact on the enterprises' willingness to establish and reinforce inter-organisational cooperation, which in turn confirms the main hypothesis adopted in the paper. The extensive range of the issues analysed in the paper thus induces the authors to conclude that the main research problem has been settled.

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