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TOWARDS SUSTAINABLE LOGISTICS: THE CASE OF SMALL AND MEDIUM-SIZED ENTERPRISES

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Purpose: The purpose of the article is to identify changes that have occurred in the conditions for the development of sustainable logistics in small and medium-sized enterprises during the post-pandemic period.
Design/methodology/approach: Empirical research was conducted in the fourth quarter of 2020 and the first quarter of 2024 among a group of 50 small and medium-sized enterprises operating in Poland. An electronic survey was used to carry out the research.
Findings: According to the research results, the post-pandemic period is characterized by significant changes in the conditions for the development of sustainable logistics in small and medium-sized enterprises. Increasing pressure from stakeholders and tangible benefits from already implemented solutions have made the implementation of sustainable solutions in the logistics of small and medium-sized enterprises increasingly common.
Research limitations/implications: The research is national in scope; in the future, it would be advisable to conduct research at an international level.
Practical implications: The research facilitated an understanding of the mechanisms behind the development of sustainable logistics in small and medium-sized enterprises and the creation of a catalog of best practices for implementing sustainable practices in business logistics.
Originality/value: The article enabled the identification of current conditions for the development of sustainable logistics in the operations of small and medium-sized enterprises.
Keywords: sustainable logistics; sustainable development; CO_2 reduction; small and medium-sized enterprise.
Category of the paper: Research paper.

1. Introduction

Civilizational development is a universally accepted and desired process. It drives humanity to use increasingly advanced technologies, such as those related to mobility. However, alongside its undeniable benefits, this development results in a growing demand for natural

resources and an escalating negative impact on the environmental and social surroundings. Environmental pollution not only affects the ecosystem but also significantly deteriorates human health. The pressure to reduce the negative impact on the natural environment and to consider social aspects extends to logistics processes as well. As a result, in the realms of economic, ecological, and social objectives, managers and/or business owners of both small and large enterprises must seek new, more sustainable solutions that allow them to adapt to current operating conditions (Carter, Easton, 2011). Nevertheless, it is unimaginable for modern enterprises to operate without substantial support from logistics. In other words, regardless of the size, scale, and scope of a business, logistics processes are an integral part of every operation. Therefore, the goal is not to reduce the scale of logistics processes but rather to transform the methods used in this area.

A review of the literature has shown that the scope of sustainable solutions implemented in enterprises depends on their size (Gonzalez-Benito, Gonzalez-Benito, 2006; Zhu et al., 2008; Chun et al., 2015). For the largest enterprises, the transformation process toward sustainable practices in logistics appears to be easier, primarily due to the resources they possess. In contrast, for smaller enterprises, sustainable transformation may prove significantly more challenging, undoubtedly as a result of the specific characteristics of these businesses (Denisa, Zdenka, 2015).

This article is a continuation of research initiated in 2020 on the development of sustainable logistics in small and medium-sized enterprises. Since 2020 was a particularly difficult year for business operations due to the ongoing COVID-19 pandemic, the research was repeated in 2024. This approach enabled the identification of changes that occurred in the conditions for the development of sustainable logistics in small and medium-sized enterprises during the post-pandemic period, which constitutes the objective of this article.

2. Literature review

2.1. The essence of sustainable development in logistics

The role of business entities is no longer solely focused on maximizing profits but also on assessing how their activities impact the local community, the local labor market, and the natural environment in the long term (Bajdor et al., 2021). These activities are mainly related to the concept of sustainable development, which involves meeting the needs of the present generation while ensuring that future generations have the ability to meet their own needs. This idea was presented in 1987 in the Report of the World Commission on Environment and Development, titled “Our Common Future,” which emphasizes intergenerational solidarity

and aims to actively include all social groups in developmental processes while taking care of the natural environment (Lis et al., 2023).

The concept of sustainable development integrates three main, interconnected, and complementary areas: economic, environmental, and social. The economic area addresses challenges such as: the instability of the national economy, insufficient fulfillment of basic societal needs, inflation, high levels of economic power concentration, external imbalances, such as dependence on raw materials, state debt, inadequate provision of public goods, and unfair income distribution. The ecological dimension primarily involves issues such as: climate change, the destruction of ecosystems, biodiversity and landscape diversity, depletion of non-renewable resources, and threats to human health (e.g., harmful substances, radiation, noise). The social pillar concerns matters such as: democracy and the rule of law, poverty, lack of social security, demographic issues, inequalities in various areas, lack of internal and external security, and burdens on health and quality of life (Rogall, 2010). To achieve sustainable development, policies in these three areas must cooperate and support each other. Enterprises should consider all three aspects to increase economic value while simultaneously reducing their environmental impact and improving people's quality of life (Chiesa et al., 1999). Sustainable development thus entails a long-term approach, focusing on finances, people, communities, and the environment (Peto, 2012).

A review of the literature indicates that the idea of sustainable development is now embedded in the key factors influencing modern logistics (Centobelli et al., 2017; Karaman et al., 2020; Seroka-Stolka et al., 2019; Evangelista et al., 2018; Richnák, Gubová, 2021; Rakhmangulov et al., 2018; Kumar, 2015; Jum'a et al., 2021; Baah et al., 2020). As a result, the concept of sustainable logistics has emerged in the literature, understood as a management concept that integrates sustainable development with the logistics system. A sustainable logistics system focuses on logistics operations (such as supplier selection, procurement, warehousing, and distribution) to reduce company costs, minimize its environmental impact, and address the impact it has on society. In other words, sustainable logistics offers companies economic, environmental, and social benefits, such as improved asset utilization, enhanced customer service, increased energy efficiency, reduced impact on the community, and improved quality of life (Wichaisri, Sopadang 2014).

In Europe, particularly in the European Union, the potential of logistics to reduce the negative impact on the natural environment and society has been recognized for many years, with measures such as the introduction of regulations on emission standards. According to the European Environment Agency, about a quarter of total CO_2 emissions in the EU in 2019 came from the transport sector, of which 71.7% was from road transport (European Parliament, 2019). A significant milestone was reached in 2024. From this point, the first period of mandatory data collection for non-financial reporting on the ESG indicators achieved by companies began. These indicators include environmental protection, social policy, and corporate governance (*Environmental, Social, and Governance*). An important element in

the field of sustainable development and reporting is the CSRD (Corporate Sustainability Reporting Directive), which was adopted by the European Parliament on November 10, 2022. It introduced changes to the European corporate reporting system by establishing mandatory Sustainability Reporting Standards (*European Sustainability Reporting Standards*). Companies will be required to determine both the impact of their activities on the environment and their own exposure to risks related to climate change. In this context, the logistics area will be particularly monitored by managers concerning the impact their companies have on the environment (mainly in terms of transport and warehousing). The new regulations included in the CSRD Directive oblige selected, initially the largest enterprises, to monitor, document, and report structured data from the areas of Environmental, Social, and Governance, including issues related to climate change, pollution, the circular economy, as well as biodiversity and human rights (Ciesielska, 2022; Kamiński, 2024). The first sets of data for the 2024 financial year will be published in the first half of 2025, and in subsequent years, they will apply to increasingly smaller companies, including small and medium-sized enterprises listed on the EU regulated market (Kamiński, 2023). Companies will report their own ESG indicators and require data from their subcontractors.

2.2. Corporate Actions in Sustainable Logistics

The need for companies to take action in the field of sustainable development has been discussed for a long time. However, until now, these actions have primarily focused on environmental protection, including reducing greenhouse gas emissions, decreasing energy consumption, and using recycled materials. Currently, both the UN and the European Commission emphasize the importance of treating sustainable development much more broadly, considering not only environmental issues but also social and labor-related matters (Kasiarz, 2021).

In light of the growing environmental and social awareness within logistics, managers are increasingly focusing on innovative and ecological solutions, placing sustainable development at the heart of their business strategies. Solutions such as fleet electrification, supply chain optimization, and sustainable packaging, although promising, require significant investments and the reorganization of processes.

Large and medium-sized companies are paying more attention to whether their storage spaces meet the standards typical of eco-friendly warehouses. An increasing number of warehouses are equipped with solar panels on their roofs, which helps reduce the consumption of traditional electricity and allows them to achieve energy-efficient building status. LED lighting has become the standard, as it is more efficient and energy-saving compared to conventional light bulbs, contributing to reduced energy consumption. Green warehouses effectively manage all types of waste, which are either fully or largely recycled, generate less waste, and most of it can be reused. They are also increasingly using electric vehicles

(e.g., forklifts) and autonomous warehouse robots to carry out more complex warehouse operations.

An example of a company implementing sustainable logistics practices is FM Logistic. FM Logistic consistently implements one of the main pillars of its long-term strategy, which is the development of sustainable multi-channel supply chains. The company's efforts in this area are known as “Supply Change” and aim to reduce environmental impact, including minimizing the carbon footprint. FM Logistic's new facilities are designed according to the highest industry standards and are certified under the LEED for Sustainable Construction system for Warehouses and Distribution Centers. The company's goal is to develop a fully environmentally neutral warehouse model by 2030. They are implementing modern solutions that allow for space optimization, increased energy efficiency of buildings, and reduced consumption of potable water. Since January 2021, all FM Logistic-owned facilities in Central Europe are fully powered by electricity from renewable sources—specifically, photovoltaic panels. The company has initiated a project in which energy produced by photovoltaic panels is used for the production of green hydrogen. Eventually, the hydrogen produced will power forklifts in warehouses and trucks.

Another significant area of development in sustainable logistics is the electrification of the transport fleet, offering substantial ecological and economic benefits. This process involves replacing internal combustion engine vehicles with their electric counterparts, leading to a significant reduction in harmful emissions such as carbon dioxide, nitrogen oxides, and particulate matter. Electric vehicles, due to fewer moving parts, also offer lower operational and maintenance costs, making them an attractive alternative for logistics and transport companies. Aspects of fleet electrification include: initial investments and operating costs, charging infrastructure, vehicle autonomy and route planning, staff training, and the impact on the company’s image. The development of charging infrastructure is a critical requirement for the effective electrification of transport fleets. For logistics and transport companies, building and accessing the appropriate charging infrastructure is essential to ensure operational continuity, delivery efficiency, and adherence to schedules. Key aspects of expanding charging infrastructure that businesses must consider include: strategic location planning, investments in fast charging, collaboration with energy suppliers, intelligent charging management, and regulations and standards. Examples of companies implementing such actions are presented in Table 1.

Table 1.
Selected practices of companies in the field of sustainable logistics

Enterprise	Measure
LPR - La Palette Rouge sp. z o.o.	Pallet rental: Pallets are reused and exchanged multiple times a year. Returned pallets are checked, sorted, and repaired before reuse. Pallets beyond repair are recycled. Wood used for pallet production and repair comes from responsibly managed forests. Damaged pallets are repurposed into heating pellets or animal bedding.
Solidaris Sp. z o.o.	Purchase of two fully electric Volvo trucks.
DHL Parcel Polska Sp. z o.o.	Purchase of electric MAN eTGE delivery vans for their courier fleet. Implementing the GoGreen policy.
DPD Polska Sp. z o.o.	Purchase of 50 electric buses and plug-in hybrid vehicles. Installation of charging stations. Air quality monitoring with sensors installed on vehicles and in branches. Use of biodegradable packaging materials. Installation of photovoltaic farms. Installation of air quality monitoring sensors in Warsaw.
InPost Sp. z o.o.	Purchase of 500 electric vehicles.
Hipra Polska Sp. z o.o.	Purchase of 9 fully electric vehicles. Installation of 10 electric vehicle charging stations. Installation of 2,798 solar panels on the roofs of five warehouses.
Carrefour Polska Sp. z o.o.	Installation of photovoltaic systems on the roofs of 13 Carrefour stores in Poland.
Knauf Industries Polska Sp. z o.o.	Komebac returnable packaging – plastics processing. Designing products for recycling and reuse.
TARGOR-TRUCK Sp. z o.o.	LNG/BioLNG-powered fleet. Certified by LNG/BioLNG fuel suppliers confirming a 100% CO2 emission reduction in the fleet. Ready for implementation of the e-CMR electronic consignment note.
Rohlig Suus Logistics S.A.	Internship program for students and people over 50. A modern multi-customer warehouse (with an A+ class rating and currently undergoing BREEAM certification at the highest possible level – Outstanding). It also features a photovoltaic system and LED lighting with an intelligent control system (DALI). Electric vehicle chargers have been installed in front of the warehouse, and flower meadows have been planted. The office has been designed with the "Office of the Future" organizational culture in mind to ensure the highest comfort for employees in carrying out their daily tasks. The branch also has a special rest area for drivers, and a picnic and recreational area (with football and basketball fields) is located near the building.
ID Logistics Polska S.A.	Emission-free deliveries for PepsiCo Polska using electric delivery vehicles. Building a low-emission transport fleet in Poland. Specialized training by Renault Trucks on electric vehicle operation and optimal driving.

Source: own study based on: LPR - La Palette Rouge sp. z o.o. Retrieved from: https://www.lpr.eu/pl/ 30.10.2024, Solidaris Spółka z o.o. Retrieved from https://solidaris.pl/?lang=pl 30.10.2024, DHL Parcel Polska Sp. z o.o. Retrieved from: https://www.dhl.com/pl-pl/microsites/supply-chain/fulfillment-network/why-dhl/sustainability.html, DPD Polska Sp. z o.o. Retrieved from: https://www.dpd.com/pl/pl/zrownowazony-rozwoj/ 30.10.2024, InPost Sp. z o.o. Retrieved from: https://inpost.pl/strategia-esg 30.10.2024, Hipra Polska Sp. Z o.o. Retrieved from: https://www.hipra.com/pl/polityka-srodowiskowa 30.10.2024, Carrefour Polska Sp. z o.o. Retrieved from: https://serwiskorporacyjny.carrefour.pl/zrownowazony-rozwoj 30.10.2024, Knauf Industries Polska sp. z o.o. Retrieved from: https://knaufappliances.com/pl/zrownowazony-rozwoj/ 30.10.2024, TARGOR-TRUCK Sp. z o.o. Retrieved from: https://www.logistyka.net.pl/aktualnosci/transport-i-spedycja/item/95522-targor-truck-stawia-na-pojazdy-napedzane-lng?utm_source=newsletter_890&utm_medium=email&utm_campaign=newsletter-portalu-logistyka-net-pl-wydanie-635&auid=22263 30.10.2024, Rohlig Suus Logistics S.A. Retrieved from: https://www.logistyka.net.pl/aktualnosci/item/95018-suus-organizuje-program-stazowy-kierowany-do-studentow-i-do-osob-50?utm_source=newsletter_861&utm_medium=email&utm_campaign=newsletter-portalu-logistyka-

net-pl-wydanie-615&auid=22266 30.10.2024, Rohlig Suus Logistics S.A. Retrieved from: https://www.logistyka.net.pl/aktualnosci/item/94400-nowoczesny-magazyn-logistyczny-suus-w-gliwicach?utm_source=newsletter_824&utm_medium=email&utm_campaign=newsletter-portalu-logistyka-net-pl-wydanie-588&auid=22282 30.10.2024, ID Logistics Polska S.A. Retrieved from: https://www.logistyka.net.pl/aktualnosci/item/94745-id-logistics-zrealizowal-pierwsze-zeroemisyjne-dostawy-dla-pepsico-w-warszawie?utm_source=newsletter_848&utm_medium=email&utm_campaign=newsletter-portalu-logistyka-net-pl-wydanie-604&auid=22272, 30.10.2024.

Implementing economic and environmental actions, as well as supporting the development of natural, social, and human capital in the logistics sector, is beneficial for companies and positively impacts their long-term growth. Emphasizing so-called "longtermism" is expected to have a positive effect on companies' financial performance as well, enabling management to increase investments of financial surpluses in innovations and projects, including in the area of sustainable logistics.

3. Methodology

The empirical research that formed the basis for preparing this article was conducted in the fourth quarter of 2020 and the first quarter of 2024, involving a group of 50 small and medium-sized enterprises operating in Poland. The first study was carried out during the Covid-19 pandemic. This was a very difficult period for business operations and may have influenced the perceptions of certain phenomena among the representatives of small and medium-sized enterprises participating in the study. Taking this into account, the study was repeated in the post-pandemic period. This approach enabled a comparative analysis of the results obtained.

In both studies, the sample selection was quota-based. The predominant type of business activity according to the Polish Classification of Activities (PKD) was considered. The research was conducted using an electronic survey questionnaire, supported by telephone assistance. The same contact database was used in both studies. In both 2020 and 2024, the respondents were primarily business owners and senior and middle management representatives. The structure of the research sample is presented in Table 2.

Table 2.
Quantitative structure of the surveyed sample (2020 and 2024)

PKD sections		2020		2024	
		Small 10-49	**Medium 50-249**	**Small 10-50**	**Medium 50-250**
B C D E	Production	10	5	10	5
F	Construction	5	1	5	1
G	Trade	10	2	10	2
H	Transport and Warehousing Management	3	1	3	1
I J L M N P Q R S	Other services	10	3	10	3
TOTAL		38	12	38	12

Source: author's own study based on Central Statistical Office data.

In recognizing the conditions for the development of sustainable logistics in the studied small and medium-sized enterprises, the influence of various stakeholder groups (both internal and external) was taken into account, driven by the already achieved or yet-to-be-established effects (economic, social, and environmental) of sustainable solutions. On the other hand, as limiting variables for the mentioned development, different types of barriers (internal and external) were identified.

4. Results and discussion

The actions of enterprises carried out within the framework of sustainable logistics can be driven by the influence of various stakeholder groups. In the conducted research, the following were taken into account: the government and other legislative institutions (e.g., the EU), non-governmental organizations and lobbyists, society, suppliers, competitors, the supply chain leader, customers, logistics service providers, owners, managers of the enterprises, and employees of the surveyed companies. The impact of individual stakeholder groups on the development of sustainable logistics in the studied small and medium-sized enterprises was assessed by respondents using a 5-point Likert scale – the results obtained are presented in Table 3.

Table 3.
Stakeholders' influence on the development of sustainable logistics in the surveyed small and medium-sized enterprises (2020 and 2024)

Stakeholder/year of study	2020	2024
Legislative institutions	3.1	4.4
Non-governmental organizations and lobbyists	2.3	3.4
Society	2.9	3.7
Suppliers	3.1	4.3
Competitors	3.2	4.1
Supply chain leader	2.9	4.3
Customers	3.9	4.1
Logistics service providers	3.2	4.2
Owners	3.0	4.3
Managers	3.2	4.1
Employees	3.2	3.7

Source: own research; the table presents the average magnitudes of the responses obtained.

In 2020, according to the respondents' declarations, the highest influence on the implementation of sustainable logistics in the surveyed enterprises came from the customers of these enterprises ($\overline{x}$ = 3.9). The second highest influence was attributed to competitors and logistics service providers, as well as to managers and employees of the surveyed enterprises ($\overline{x}$ = 3.2). In 2024 (compared to 2020), there were significant changes regarding the impact of the stakeholders. Firstly, the influence of all stakeholder groups on the implementation of sustainable solutions in the surveyed small and medium-sized enterprises increased. Secondly, the variation in the influence of all stakeholder groups decreased. In 2024, the highest influence on the implementation of sustainable logistics in the surveyed enterprises came from: legal regulations ($\overline{x}$ = 4.4), supply chain leaders, suppliers, and company owners ($\overline{x}$ = 4.3), and logistics service providers ($\overline{x}$ = 4.2). Considering the differences in the strength of influence from individual stakeholder groups in 2020 and 2024, the greatest increase was observed in the influence of supply chain leader and non-governmental organizations (48%), owners (43%), and legislative institutions (42%) – Figure 1.

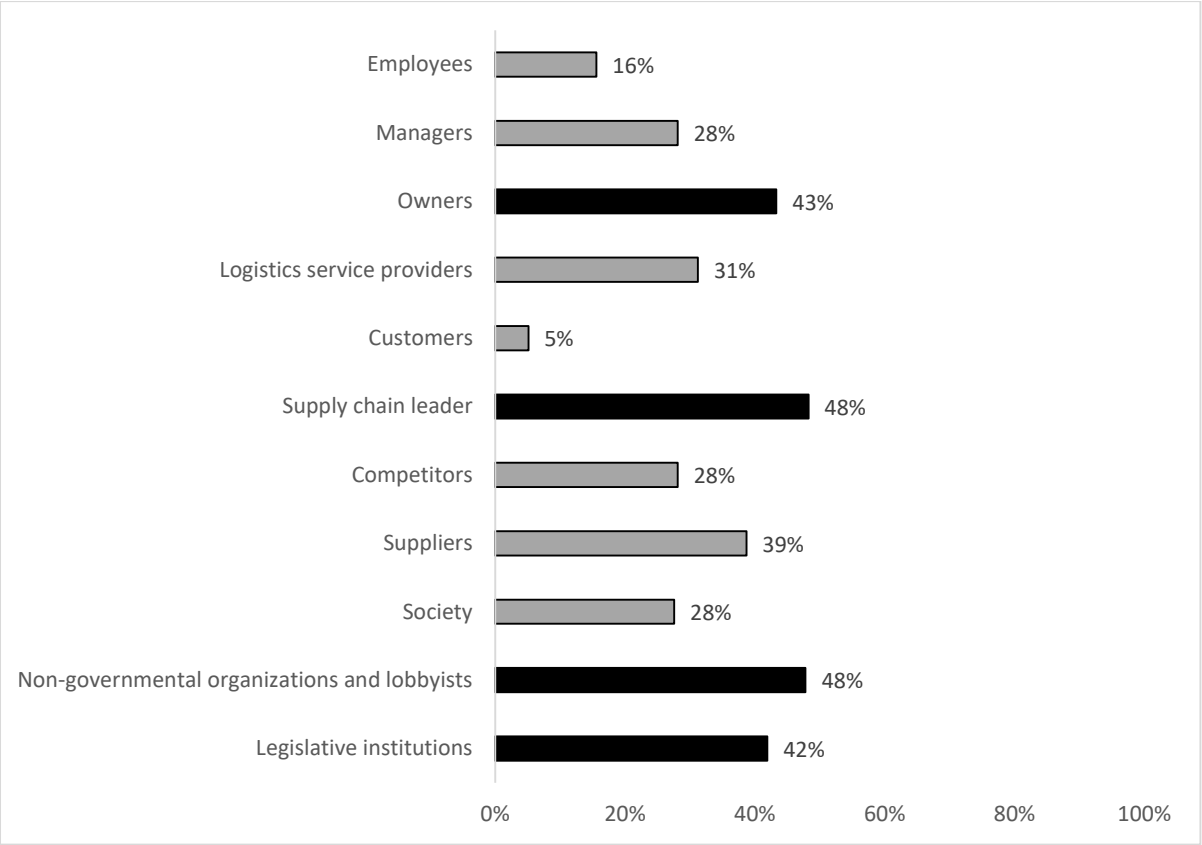

Figure 1. Changes in the Influence of Stakeholders on the Development of Sustainable Logistics in the Surveyed Small and Medium-Sized Enterprises – Relative Increases**.**

Source: Own research; the chart presents the relative differences between the average declared influence of stakeholders in 2024 and 2020.

The variation in the results obtained in 2020 and 2024 reflects the dynamic changes in the operational conditions of the surveyed small and medium-sized enterprises. In 2020, due to the ongoing COVID-19 pandemic, the focus of most stakeholders was on adapting to the new operational conditions and, above all (especially for the smallest enterprises), on the desire to survive this difficult period. Actions undertaken in the area of sustainable logistics at that time were severely limited and, in most cases, served as a response to specific customer requirements or the need to adapt to standards set by competitors. The influence of logistics service providers on the development of sustainable logistics in the surveyed enterprises was (and still is) a result of the extensive cooperation between the SME sector and representatives of the TSL market (Transport, Freight, Logistics). The nature of smaller enterprises prevents them from achieving economies of scale in their logistics operations (Kisperska-Moroń et al., 2010), which arise from the size of the enterprise, its potential, infrastructure, and the scale of operations. In such conditions, smaller enterprises acquire logistics competencies from the market through so-called logistics outsourcing, and thus, the sustainable practices of logistics service providers are adapted within the group of surveyed enterprises. For managers and employees, the implementation of sustainable solutions was most likely driven by the desire to achieve

specific social outcomes, including the need to ensure proper working conditions during the pandemic, especially in the area of logistics processes.

The year 2024 marked a time when enterprises experienced completely different operational conditions compared to 2020. In the post-pandemic period, the need to reduce the negative impact of logistics on the natural environment is becoming increasingly significant. The European Commission's Green Deal policy has outlined the framework for the energy transformation of enterprises operating within the European Union (European Commission, 2021). The plan to achieve climate neutrality in Europe by 2050 also includes changes in logistics operations. Moreover, the accelerated need to reduce dependence on raw materials from the Russian Federation, as a result of the war in Ukraine, is causing a rise in the prices of conventional energy resources and leading to increased costs of material flows. As a result, in the areas of economic, social, and environmental goals, managers and/or business owners must seek new solutions that enable adaptation to these new operational conditions. Secondly, the Directive of the European Parliament and the Council (EU) 2022/2464 of December 14, 2022 (CSRD) – the Corporate Sustainability Reporting Directive – introduced, starting January 1, 2024, the obligation to report on sustainability in accordance with the European Sustainability Reporting Standards. This means that all large companies and small and medium-sized publicly listed companies will be required to include in their annual reports information on environmental, social, and human rights issues, as well as corporate governance. As a result of this new reporting requirement, interested user groups will have broader access to comparable, reliable, and high-quality data on sustainability. This will provide them with an additional tool to exert greater influence on businesses operating within their local communities. For the reporting entities themselves, this is an opportunity to demonstrate – through the ability to present their sustainability actions – that they are socially responsible. This will also make it easier for them to access capital for further development.

The changes introduced based on the aforementioned regulations were reflected in the results of the research conducted in 2024. The most significant increase in the influence of supply chain leader is undoubtedly a result of the implementation of the CSRD Directive provisions. This indicates that the largest companies, often acting as leaders in the supply chain (e.g., major manufacturers or distributors), will exert even greater pressure on their partners to adopt sustainable solutions. From the perspective of the surveyed small and medium-sized enterprises (SMEs), which in most cases belong to the group of partners for larger firms, the increased interest in implementing sustainable solutions among their owners will primarily be driven by the need to comply with the requirements of the supply chain leader or larger suppliers. Consequently, actions undertaken in the area of sustainable logistics will focus primarily on transportation and warehousing operations. Through the organizational and/or technological changes introduced, these actions will enable the achievement of not only economic objectives but also environmental and social goals (Table 4).

Table 4.
Declared effects of the development of sustainable logistics in the surveyed small and medium-sized enterprises (2020 and 2024)

Effects of sustainable logitics/year of study	2020	2024
reducing the costs of logistics processes	2.8	3.2
improving the company's competitive position	3.3	3.9
improving the company's image	3.1	3.6
increase in the efficiency of logistics processes	3.1	3.8
reducing the amount of waste generated (e.g. packaging waste)	2.7	3.4
reduction of CO2 emissions	2.4	3.5
reducing emissions of other harmful substances	2.5	2.6
reduction of noise	2.6	3.4
increase in energy efficiency	2.7	3.1
reducing the degree of use of natural resources	2.8	3.7
reducing the number of accidents at work	3.6	4.3
creating a good working climate	3.3	4.4
providing employees with a wide social package	2.6	4.3
ensuring safe working conditions for employees	3.6	4.1
providing employees with opportunities for development and promotion	3.0	4.4
providing employees with fair wages	3.3	4.3
reducing the degree of use of natural resources	2.8	3.7

Source: own research, the table presents the average magnitudes of the responses obtained.

The analysis of results regarding the declared effects achieved through the implementation of sustainable logistics by the surveyed small and medium-sized enterprises (SMEs) in 2020 and 2024 reveals that the post-pandemic period brought a significant increase in economic, environmental, and social effects. The most notable growth was observed in social effects, particularly in providing employees with extensive social benefits (an increase of 65%) and opportunities for development and promotion (an increase of 47%). For environmental effects, there was a substantial reduction in CO_2 emissions (an increase of 46%), which is closely linked to the strong pressure from stakeholders on decarbonizing logistics (Piecyk, McKinnon, 2010; Tacken et al., 2014; Böttcher, Müller, 2015; Furlan Matos Alves et al., 2017; McKinnon, 2018) (Figure 3).

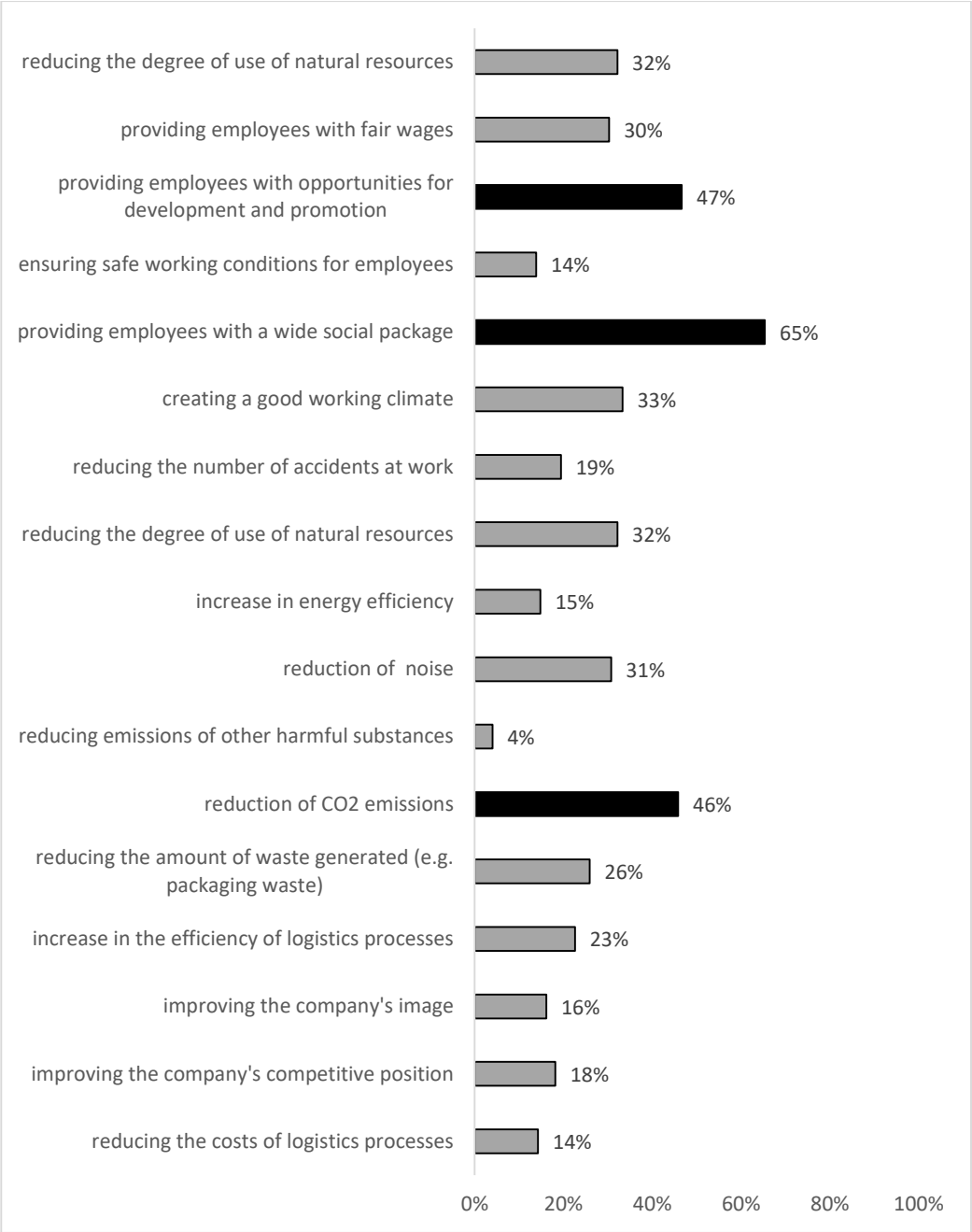

Figure 3. Changes in the declared effects of sustainable logistics development in the surveyed SMEs – relative increases**.**

Source: Own research; the chart presents relative differences between average declared effects achieved in 2024 and 2020.

A more detailed analysis of the study results indicates that while the levels of economic and social effects were similar in 2020, by 2024, social effects had surpassed economic effects. According to the authors, the lower levels of economic effects can be attributed to the discrepancy between the expectations of business owners and managers regarding economic objectives and the actual possibilities of achieving them. Additionally, the high results in the area of social effects achieved in 2024 stem from the necessity to retain valuable human resources with the requisite competencies. In this context, it is also worth mentioning the

challenges in attracting new employees, such as their migration away from the Polish labor market due to the war in Ukraine or the steadily increasing average age of workers in the broadly understood logistics sector. As for the relatively lower level of environmental effects (both in 2020 and 2024) compared to economic and social effects, this is undoubtedly linked to the less tangible nature of environmental goals. Compared to economic and social goals, environmental outcomes are harder for business owners and managers to identify. Moreover, achieving environmental objectives often requires collaboration with other supply chain partners, which, as the research indicates, can be challenging due to the specific characteristics of SMEs (Table 5).

Table 5.
Barriers to the development of sustainable logistics in the surveyed small and medium-sized enterprises (2020 and 2024)

Barriers to the development of sustainable logistics/year of study	**2020**	**2024**
financial barriers	3.7	4.3
lack of resources (non-financial)	3.3	3.9
small scale of operation	3.2	4.2
lack of knowledge and skills (know-how)	3.1	3.9
employee resistance	2.7	3.4
no possibility of influencing cooperators	2.8	3.9
lack of commitment from cooperators	2.8	3.9
industry specificity	3.2	4.0

Source: own research, the table presents the average magnitudes of the responses obtained.

When analyzing the research results, it is essential to note that a small business is not a little big business (Welsh, White, 1981). This distinction highlights the unique characteristics of small businesses, such as limited access to financial and non-financial resources, lack of know-how, and a smaller scale of operations – all of which constrain the development of sustainable logistics. The studies conducted by the authors in both 2020 and 2024 confirm these challenges. However, it is worth noting that in 2020, the surveyed enterprises assessed the significance of individual barriers to sustainable logistics development as lower than in 2024. The observed increase in the perceived significance of these barriers is likely due to the growing interest of the surveyed enterprises in sustainable solutions. As the scale of sustainable implementations expands, businesses are better able to identify and experience real limitations. Secondly, external barriers, such as the lack of commitment from cooperators and no possibility of influencing cooperators, saw a significant increase in importance in 2024 compared to 2020 – a rise of 38% (Figure 4). According to the authors, this situation reflects the evolving nature of sustainable logistics practices. Their implementation increasingly requires collaboration among multiple entities rather than being confined to a single enterprise.

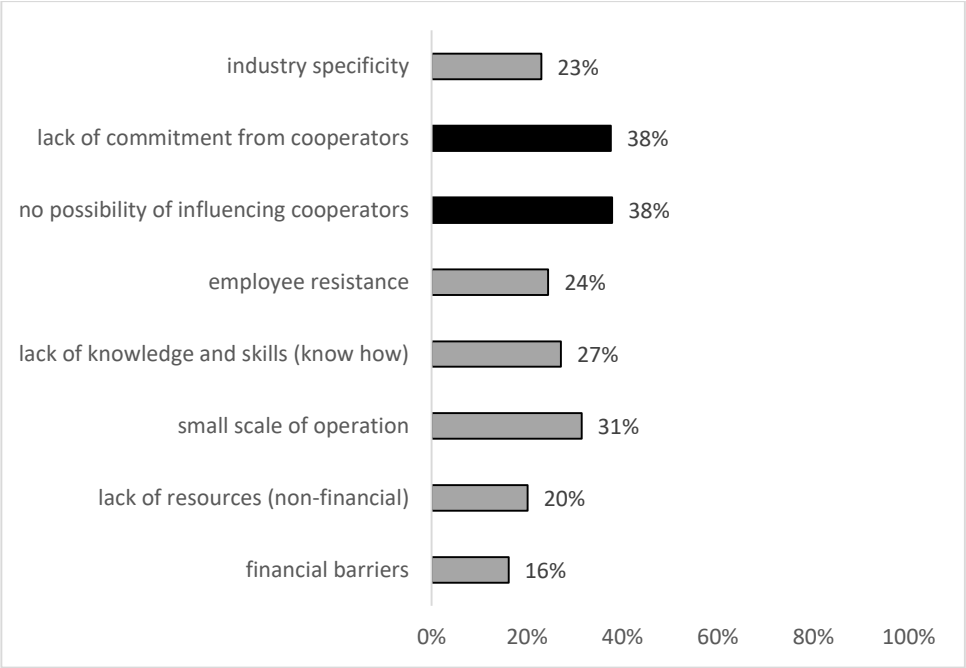

Figure 4. Changes in the barriers to sustainable logistics development in the surveyed SMEs – relative increases.

Source: own research; the chart presents relative differences between the average ratings of individual barriers in 2024 and 2020.

5. Conclusion

The development of sustainable logistics in the surveyed small and medium-sized enterprises is gaining momentum. According to the research findings, the post-pandemic period has been marked by significant changes in the conditions affecting the development of sustainable logistics in smaller businesses. By 2024, compared to 2020, the pressure from stakeholders to adopt sustainable logistics practices has noticeably increased. This trend is undoubtedly linked to the introduction of new legal regulations, which have amplified the influence of stronger supply chain participants relative to the surveyed enterprises. Additionally, in 2024, there was a significant rise in the declared outcomes, particularly social and environmental, achieved through the implementation of sustainable logistics. This includes providing employees with greater opportunities for growth and promotion, as well as achieving a much greater reduction in CO_2 emissions, aligning with the current trend of logistics decarbonization.

The recognized increase in the importance of barriers to sustainable logistics development, particularly external barriers, indicates that in the surveyed SMEs, the implementation of sustainable logistics is occurring not solely at the level of individual enterprises but through collaboration with other supply chain participants. In light of these findings, the authors

recommend continuing research on the mechanisms driving the development of sustainable logistics in SMEs, while also taking into account the dynamic context of their operating environment.

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