

## SHARING ECONOMY AS A TOOL OF LOW-CARBON LOGISTICS

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**Purpose:** It is becoming increasingly difficult for individual companies to achieve a reduction in CO<sub>2</sub> emissions in logistics. One of the tools that can bring measurable results in terms of the effects of low-carbon logistics in the B2B area is the sharing economy. The aim of the article is to identify the relationship between the use of the sharing economy concept and the economic and ecological effects achieved in low-carbon logistics.

**Design/methodology/approach:** Empirical research was conducted in a group of 250 enterprises in the first quarter of 2023. An electronic questionnaire was used to conduct the research.

**Findings:** The use of the sharing economy concept for logistics resources allocation is a tool for achieving the goals of low-carbon logistics. The conducted empirical research confirmed the relationship between the use of the sharing economy and selected economic and ecological effects of enterprises in the area of low-carbon logistics.

**Research limitations/implications:** The period in which the research was conducted was very difficult for the functioning of enterprises due to the post-pandemic times. In the future studies should be repeated for comparative analysis.

**Practical implications:** The surveyed companies, indicated that logistics is an area which offers significant potential for sharing resources. Achieving the goals of low-carbon logistics is possible without significant capital involvement, a fact that has been indicated so far as a basic barrier to the development of pro-ecological practices in the field of logistics.

**Originality/value:** The article identifies the relationship between the use of the sharing economy concept and economic and ecological results in low-carbon logistics achieved by enterprises.

**Keywords:** sharing economy; low-carbon logistics; CO<sub>2</sub> reduction; Carbon emission reduction; crowd logistics.

**Category of the paper:** Research paper.

## 1. Introduction

In order to keep up with the requirements of the environment, companies must strive for sustainable development. Government organisations put pressure on businesses by regulating the level of sustainability with laws and directives.

In this context, one of the most important directives is the European Green Deal presented by the European Parliament in December 2019. Legislation was tightened and the CSRD (Corporate Sustainability Reporting Directive) was introduced, requiring entrepreneurs to report ESG relating to environmental, social and corporate governance standards from 2023 (European Commission, 2020).

Modern society increasingly demands that products and services are produced sustainably. In particular, they point to the environmental impact and the inclusiveness of access to products and services. The vogue for buying sustainable products has become so important that the customer is willing to pay more for them.

One of the three elements of sustainable development is the reduction of CO<sub>2</sub> emissions. The main cause of global warming is carbon dioxide (CO<sub>2</sub>) emissions. The transport sector accounts for almost 30% of the EU's total CO<sub>2</sub> emissions, 72% of which come from road transport, according to European Parliament data from 2019. According to Doherty and Hoyle (2009), it is estimated that 5 to 15% of the total CO<sub>2</sub> emissions associated with the product lifecycle come from logistics. Modern enterprises consider low CO<sub>2</sub> emissions to be one of the most important features of their business (Ramanathan et al., 2014).

Companies are increasingly demanding sustainable action in terms of supplier selection and development, carrier selection, warehouse location, distribution, freight, as well as routing and vehicle efficiency (Carter, Easton, 2011). On the other hand, customers increasingly expect secure and socially and ecologically responsible supply chains, according to research by Sundarakani et al. (2010). At the same time, the knowledge-based economy with the growing role of innovation and the dynamic development of highly advanced technologies, initiates considerations regarding the preferences of consumers and producers in terms of fundamental economic categories, such as ownership, benefit or profit (Rutkowska, 2018).

However, the challenges of low-carbon logistics that the world faces today are too great for any company to tackle alone. By contrast, combining resources, intelligence, leadership and common sustainability goals with other companies can translate into improved economic, ecological and social results. One of the tools that can demonstrate measurable effects in the field of low-carbon logistics is the sharing economy.

“The sharing economy trend refers to an ecosystem in which users (companies and consumers) temporarily make available, rent or lend assets or services instead of buying and owning them. This system is usually supported by digital platforms that help to combine supply and demand (for example, a platform connects owners of unused assets with people who want

to use them)" (Sharing Economy, n.d.). The sharing economy trend is listed on DHL's global "The Logistics Trend Radar" list, as having a mild impact with implementation within 5-10 years (Sharing Economy, n.d.).

The phenomenon of the sharing economy has already been widely described in the literature over the past decade. The definitions of the sharing economy, as well as similar, broader or narrower concepts (collaborative economy, access economy, peer-to-peer economy, collaborative consumption) are already highly developed. This point is also considered in a specialised form – e.g. crowd logistics. However, many of the questions associated with the sharing economy have not yet been investigated. In particular, the relationships between low-carbon logistic and the sharing economy are under-represented in the literature.

The aim of the article is to identify the relationship between the use of the sharing economy concept and the economic and ecological effects achieved in low-carbon logistics. The article is based on the results of literature analysis and empirical research.

The article begins with an analysis of the literature on low-carbon logistics, its characteristics and effects. Next, the phenomenon of the sharing economy is described, in particular from a B2B logistics point of view, followed by a presentation of its results. Subsequently, the authors compare the effects of low-carbon logistics with the results yielded by the sharing economy. The next part of the article presents the methodology of the undertaken research. The authors then present the findings and related discussion. In the last part of the article, the authors summarise the considerations and indicate further research directions.

## **2. Literature review and hypothesis development**

### **2.1. The essence and effects of the low-carbon logistics concept**

Logistics processes in enterprises can cause significant pollution of the environment. However, due to the important role of logistics in the functioning of today's supply chains, reducing the scale of logistics processes is difficult. Therefore, it is not a question of decreasing the number of logistics processes, but about transforming them in a way that will reduce the negative impact on the environment.

In the literature, the terms "low-carbon logistics" (Böttcher, Müller, 2015) or "low-emission logistics" are used (Osieczko et al., 2021), which define activities aimed at minimising greenhouse gas emissions, mainly CO<sub>2</sub>, during logistics processes. Low-carbon logistics are optimisation processes in logistics that apply new technologies and innovative management methods to reduce resource consumption and CO<sub>2</sub> emissions (Li et al., 2020). Low-carbon logistics aims to reduce energy consumption, pollution and emissions through the use of renewable energy and energy efficiency technologies (Xu, 2011). The authors define low-

carbon logistics as a strategy for managing material flows and related information flows, starting from their design, so as to achieve economic as well as environmental goals by reducing greenhouse gas emissions and improving energy efficiency in logistics processes.

Stakeholders are taking action to develop low-carbon logistics in view of expected economic and environmental benefits. For individual companies, the economic benefits associated with low-carbon logistics usually include reduced costs, enhanced competitiveness and positive PR as a company responsible for the environment (Alves et al., 2017; Lai, Wong, 2012; Pazirandeh, Jafari, 2013; Rao, Holt, 2005). In the context of ecological effects, it is important not only to use resources more economically and boost energy efficiency but, above all, to reduce greenhouse gas emissions, especially carbon dioxide (CO<sub>2</sub>).

## **2.2. The essence of the sharing economy concept**

In 2011, "Time" magazine ranked the sharing economy as one of the top ten ideas that will change the world. The sharing economy trend includes cultural, social, economic and technological aspects. According to the central tenet of sharing economy, the market exchange process is oriented towards sharing resources. Therefore, we are dealing with a peculiar reorientation and transition from ownership to the availability of goods and services (Rutkowska, 2018). R. Botsman (2011) defines collaborative consumption as a system that activates dormant assets by launching models and markets within them. It provides access to these resources and increases their efficiency. The sharing economy is an economic model in which internet users join forces to share goods and services. The intermediary platform connects the provider (who has an excess of a particular commodity) with the recipient. The sharing economy model is based on the mutual advantage principle, and its attractiveness stems from the idea of consuming without owning property. The sharing economy promotes "positive" materialism, i.e., more conscious consumption based on care for the quality of purchased goods, their origin, manner of use, more efficient use of resources, as well as extending the life cycle of the product (Jaros, 2016). Customers decide to participate in the sharing economy due to its added value, in particular: saving time and money and convenience of use, personalisation and socialisation of experience, as well as the service flexibility and individualism (Cicharska et al., 2019). A key aspect of the sharing economy is improved efficiency, sustainability and social ties. The popularity of this model stems from globalisation and the development of online platforms (Bukietyńska, 2018). The essence of the sharing economy can be considered to lie in a new way of doing business, based on digital techniques that enable the organisation of commercial exchanges (Pietrewicz, Sobiecki, 2016).

The sharing economy includes three groups of participants: providers (who might be private individuals occasionally offering services or professional service providers operating within their professional activities), users and intermediaries, handling transactions and connecting service providers with users through online platforms (Pietrewicz, Sobiecki, 2016). Within the

sharing economy, transactions generally do not result in a change of ownership (European Parliament, 2016).

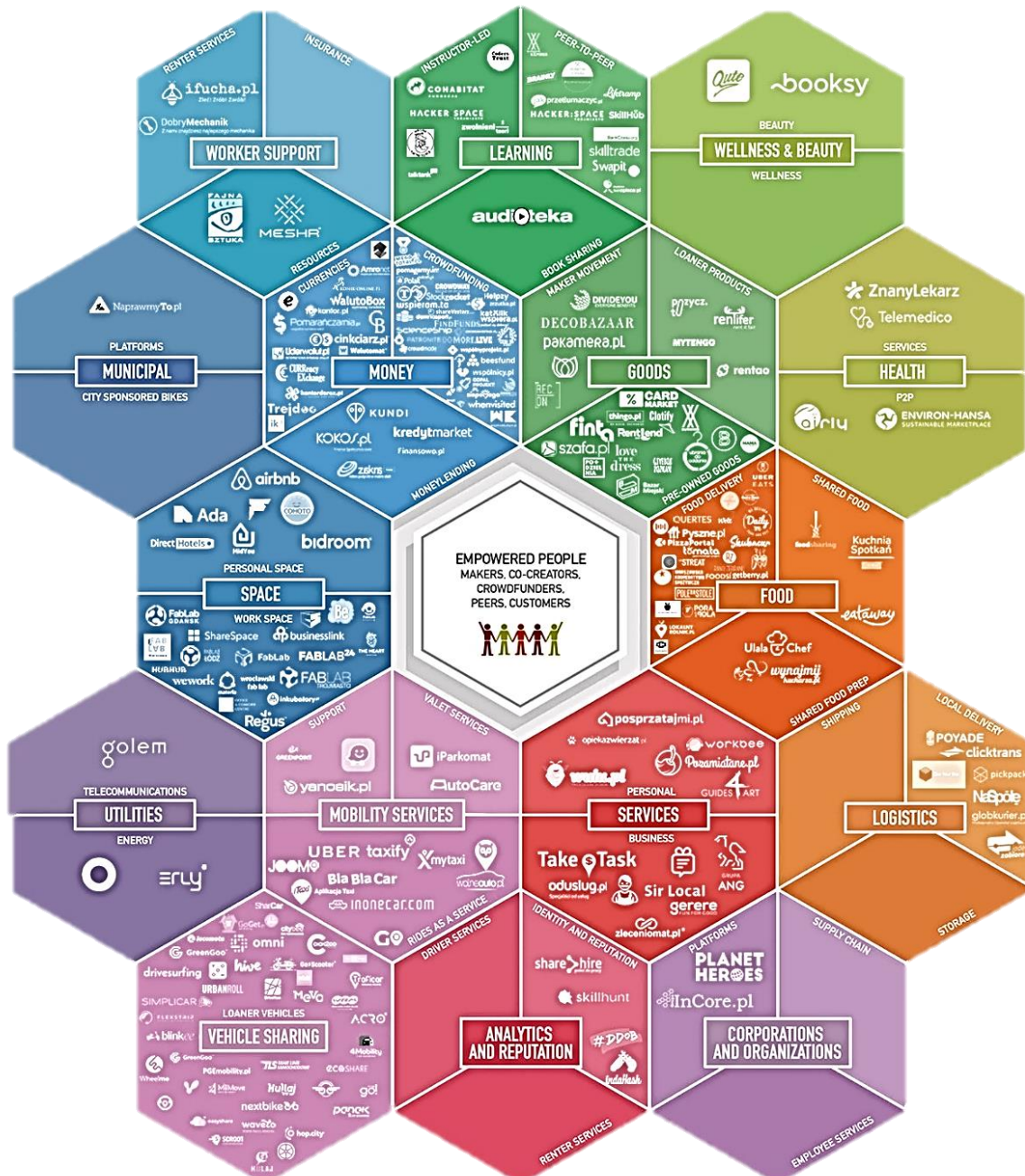
The sharing economy has a significant impact on both the economic and social spheres, as well as on the environment. In these areas, it leads to arbitration, which reduces income inequalities and increases the availability of certain goods and services. In this way, the more intensive use of already available resources can meet needs at relatively low costs and reduces the necessity for new sources, which reduces pressure on the environment. The sharing economy also leads to decreased emission of pollutants and greenhouse gases, reduced energy consumption and improved living conditions in large cities. In this way, the sharing economy contributes to a better allocation of resources in the economy (Pietrewicz, Sobiecki, 2016).

The sharing economy primarily involves transport, accommodation and space (Airbnb, Landshare, JustPark), skills and time (Skillshare, Skilltrade, Khan Academy) and other material resources, such as tools or equipment (Rutkowska, 2018). In the urban passenger transport segment, the sharing economy model has so far been applied in the form of car-sharing, ride-sharing and bike-sharing (Cicharska et al., 2019).

Often in the same set of terms as sharing economy, you can also find access economy, peer economy, peer-to-peer economy, collaborative economy, collaborative consumption (Sobiecki, 2016). Collaborative consumption refers to systems – based on renting, lending, exchanging, sharing, bartering and giving – that emphasise accessibility rather than possession. Not only does it change what we consume but also how we do it. This trend has three important elements: redistribution markets, a shared-use lifestyle and product handling systems (Botsman, 2011). The behaviours described in the Botsman definition are found in all types of business models: C2C, B2C, C2B and B2B. In the case of the B2B model, companies can share unused resources, whereas in the B2C model, the company organises the access to the resources and the service only facilitates their use. Collaborative economy is based on direct connections between individuals that allow direct exchange and shorten the supply chain. This model replaces the traditional branches of the economy, such as production, consumption and distribution of means of exchange. Examples of this trend include office space sharing, direct electricity purchases from manufacturers and on-demand legal services. Examples of collaborative economy solutions available on the Polish market are presented in Figure 1. Peer-to-peer economy models involve renting, lending, exchanging, sharing, bartering, and giving, and are based on temporary sharing rather than possession. Examples include renting a flat to other people or using other people's flats. In turn, the access economy is based on universal accessibility. Examples of this trend include online access to music, films and books instead of owning them, car-sharing instead of owning one's own vehicle, car-pooling or on-demand rides (Sobiecki, 2016).

The sharing economy has emerged as a new solution, capable of meeting the demand for more innovative and flexible logistics (Carissimi, Creazza, 2022). The sharing economy in logistics is a business model based on digital platforms that allows the exchange of untapped

resources (e.g. material goods, skills, information) between suppliers and customers (Acquier et al., 2017, 2019; Atkins, Gianiodis, 2021; Carbone et al., 2017). Depending on the entities involved (individuals or companies) and the type of logistics resources shared, C2B and B2B solutions can be distinguished. The sharing economy in logistics involves delivery, freight and transportation, storage and fulfilment, and handling services (Atkins, Gianiodis, 2021).



**Figure 1.** Polish Collaborative Honeycomb.

Source: <https://zgiep.com/polish-collaborative-economy-honeycomb-3-0/>, 1.04.2023.

Customer-to-Business (C2B) solutions called "crowdlogistics" or "crowdshipping" have often been researched in logistics and they consist in individuals outsourcing logistics activities to companies who own untapped logistics assets, such as vehicles and storage areas (Carbone et al., 2017; Ciobotaru, Chankov, 2021). However, in the case of B2B, sharing economy initiatives involve an exchange of untapped logistics assets between suppliers and customers via a digital platform, which is mostly coordinated by a logistics service provider (LSP) (Carissimi, Creazza, 2022). In contrast to traditional outsourcing services, the sharing economy model enables the utilization of the available logistics assets that are not related to the supplier's core business, which enables the supplier to generate additional income beyond the core business (Tornese et al., 2020).

B2B logistics solutions consist of a full spectrum of logistics services, including storage services (shared warehousing), transportation and freight services (shared transportation), and handling services (shared equipment) (Atkins, Gianiodis, 2021). The operation of B2B sharing logistics initiatives is based on three actors: a service provider who uses available resources, such as storage or transportation sites, to provide the user with a temporary access to those resources; a service receiver who uses the service provider's resources and pays for an access to the service, including a part of the compensation to the service provider and a fee to the entity that enables the service; and a service provider who coordinates the exchange of resources between the other two parties (Carissimi, Creazza, 2022).

The implementation of solutions such as sharing logistics often encounters many obstacles. Therefore, the factors that enable sharing economy logistics solutions are worth mentioning:

- **Reliability:** the implementation of mechanisms based on quality systems, such as feedback and ratings, or based on pre-selection by requiring the users who enter the platform to upload their certificates during registration.
- **Payment security:** monetary transactions are made in a pool of anonymous users via a platform.
- **Digital platform:** thanks to the connection between suppliers and customers, the platform provides efficient offer search and negotiation, enabling them to find the best partner for their goals.
- **Critical mass of participants:** the presence of a significant number of customers and suppliers joining the platform (Carissimi, Creazza, 2022).

### **2.3. The effects of the sharing economy concept**

The benefits of sharing economy logistics solutions are classified according to the beneficiary: customer, activator, supplier or entire chain. With access to flexible and dynamic services, customers can effectively meet their diverse business needs through the quick availability of additional resources. Users can avoid the usual search and negotiation time required to sign a contract with a new logistics partner, or the time it takes to build their own

solutions. The presence of extremely flexible capacity, which can be activated on demand, enables greater diversification and redundancy of options, which in turn reduces the risk of sudden demand fluctuations. In addition, the full process transparency provided by the platform makes the entire chain more reliable and capable of responding to possible threats (Carbone et al., 2017; Ryu et al., 2019; Mittal et al., 2021; Moncef, Monnet Dupuy, 2021). Sharing economy solutions promote cooperation between both customers and suppliers as they gain access to a new chain that can facilitate the creation of new partnerships or help companies mitigate risk and maintain their market position (Atkins, Gianiodis, 2021; Tornese et al., 2020). Thanks to an access to a wider range of options (choosing the best available rate in the case of shared transportation) or switching from a fixed payment to a payment model according to actual consumption (shared warehousing or equipment), users can obtain economic savings by choosing a service at a lower cost. Suppliers can also benefit economically by generating additional income from untapped assets. Meanwhile, the entities that offer this service may receive monetary compensation for the coordination and management, which boosts their own profits (Tornese et al., 2020; Atkins, Gianiodis, 2021; Ciobotaru, Chankov, 2021; Mittal et al., 2021). Sharing economy solutions may also bring environmental benefits by facilitating an improved utilisation and distribution of resources (i.e. transportation, storage, equipment), and consequently preventing the overproduction of additional resources (Klarin, Suseno, 2021; Ryu et al., 2019), resulting in a reduction in overall waste generation. This may have a direct impact on reducing CO<sub>2</sub> emissions along the chain (Govindan, 2018; Rogerson, Sallnaes, 2017; Asian et al., 2019; Ciobotaru, Chankov, 2021; Piecyk, Mckinnon, 2010). Shared transportation reduces the number of empty or half-empty shipments in the chain, and so it also reduces CO<sub>2</sub> emissions (Moncef, Monnet Dupuy, 2021; Piecyk, Mckinnon, 2010; Rogerson, Sallnaes, 2017). The summary of benefits according to the type of beneficiary is shown in Table 1.

**Table 1.**

*The benefits of the sharing economy concept*

<b>BENEFITS</b>	<b>USER</b>	<b>PROVIDER</b>	<b>ENABLER</b>	<b>NETWORK</b>
Access to flexible resources	✓			
Instant availability of resources	✓			
Shorter lead time than traditional service providers	✓			
Access to a new network	✓	✓		
New partners and markets collaboration	✓	✓		
Improvement of relationships	✓	✓		
Improved visibility and reliability	✓			
Responsiveness to changes in demand	✓			
Lower cost of the service	✓			
Pay-as-you-go rather than fixed payment	✓			
Reduction of cost spent on searching for a new supplier	✓			
Additional revenues from underutilized assets		✓		
Efficient search and negotiation		✓		



Cont. table 1.

Transaction fee of the platform			✓	
Reduction of air pollutants by increasing the utilization of vehicles				✓
Use of underutilized assets				✓
Saturation of the warehouse capacity and better assets utilization				✓

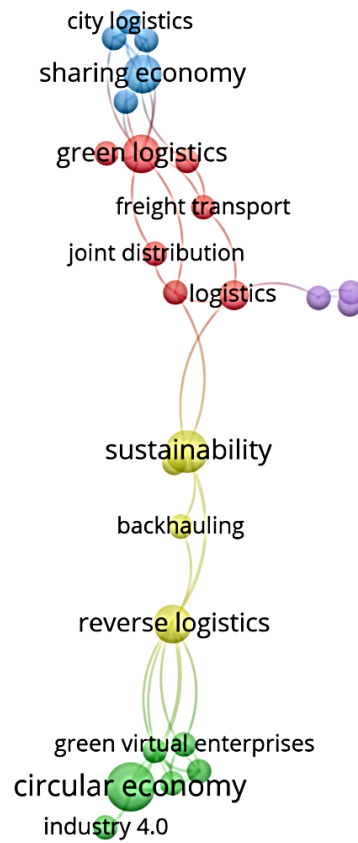
Source: The authors' own elaboration based on (Carissimi, Creazza, 2022).

#### 2.4. The common points of sharing economy and low-carbon logistics concepts have in common

The literature review about the impact and effects of the sharing economy on low-carbon logistics indicates a low number of bibliographic items. The authors conducted a survey of literature items in the Scopus database using an advanced search in the form of a query: ( TITLE-ABS-KEY ( sharing AND economy ) OR TITLE-ABS-KEY ( access AND economy ) OR TITLE-ABS-KEY ( collaborative AND economy ) OR TITLE-ABS-KEY ( collaborative AND consumption ) ) AND ( TITLE-ABS-KEY ( low-carbon AND logistics ) OR TITLE-ABS-KEY ( green AND logistics ) OR TITLE-ABS-KEY ( zero AND emission AND logistics ) ). In the title, abstract and keywords section, the query includes the items with phrases such as: sharing economy, access economy or collaborative economy, in comparison with low-carbon logistics, green logistics or zero emission logistics. This search showed 74 literature items as at 31.03.2023.

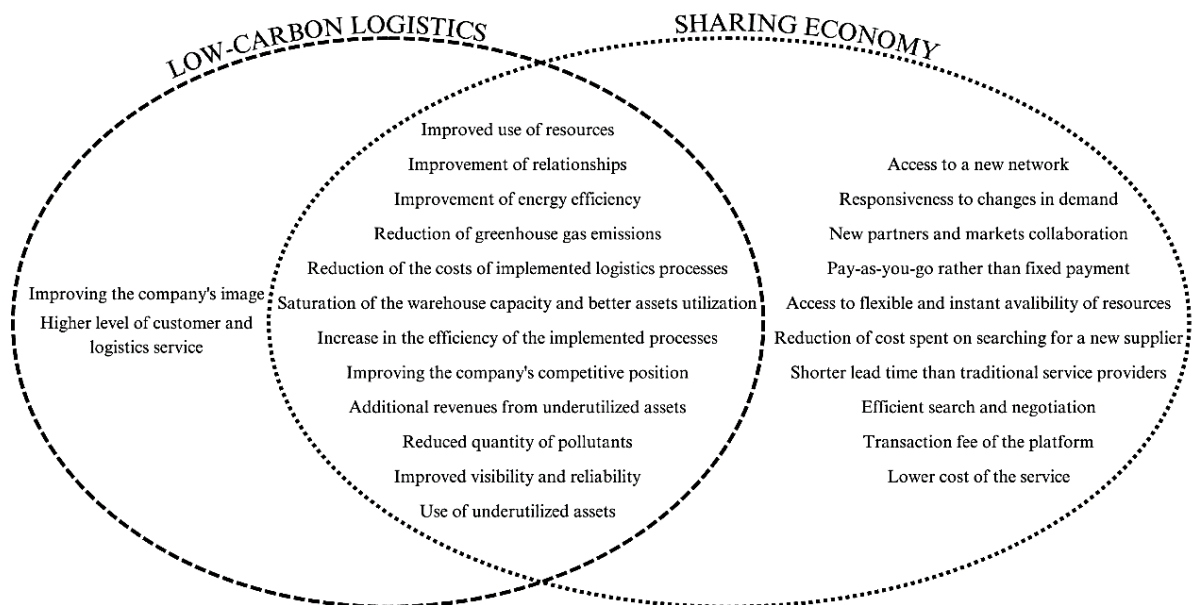
In the further part of the analysis, the mapping of author's keywords was visualised (Figure 2). A minimum 2 occurrences were selected. Out of 29 keywords, 25 were chosen to form the map below. The most common keywords are: sharing economy, green logistics, sustainability, reverse logistics and circular economy. These keywords are actually associated with both low-carbon logistics and the sharing economy.

An important consequence of the analysis so far is a comparison of the benefits of using the sharing economy and low-carbon logistics (Figure 3). It can be seen that these concepts provide similar benefits in a broad sense. The benefits of both concepts can be presented in several subgroups. The main benefit of both the sharing economy and low-carbon logistics is the reduction of transaction costs. First of all, the above-mentioned concepts increase the use of resources. In other words, untapped or even dormant resources are used, from which enterprises gain additional revenues. This means that low-carbon logistics and sharing economy concepts increase the efficiency of processes. Another benefit is the improvement of energy efficiency, while reducing greenhouse gases and pollution. Activities that positively affect the environmental and social aspect improve relations with the company's environment and competitiveness on the market.



**Figure 2.** Keywords map based on Scopus search query dated on 31.03.2023.

Source: own work in VOSviewer application.



**Figure 3.** Comparison of the effects of applying low-carbon logistics vs. participation in sharing economy concept.

Source: The authors' own elaboration.

As a consequence of the analysis, the question arises about the relationship between the use of the sharing economy concept and the achieved economic and environmental effects of enterprises in the area of low-carbon logistics. To answer this question, the authors formulated the following research hypotheses:

- H.1: The level of use of the sharing economy is positively related to the ecological performance of low-carbon logistics.
- H.2: The level of use of the sharing economy is positively related to the economic performance of low-carbon logistics.

### 3. Methodology

In order to achieve the assumed research goal in the first quarter of 2023, empirical research was carried out via an electronic questionnaire. The study included a group of 250 entities – 200 small and medium-sized enterprises (subgroup 1) and 50 large enterprises (subgroup 2). Because of financial and organisational reasons within each particular subgroup, the sample selection was quota-based, taking into account the core business type (according to the Polish Central Statistical Office). This means that the surveyed sample (within subgroups 1 and 2) reflects the population structure of small and medium-sized enterprises and large enterprises operating in Poland, taking this feature into account. The structure of the surveyed enterprises is presented in Table 2.

**Table 2.**  
*Quantitative structure of the surveyed sample*

Business type	Enterprise type by employment volume		
	Subgroup 1 = 200 enterprises		Subgroup 2 = 50 enterprises
	Small (number of employees <50)	Medium (number of employees <250)	Large (number of employees equalling 250 and more)
Industry	41	20	25
Construction	21	4	2
Commerce	41	9	7
Services	51	13	16
Total	154	46	50

Source: The authors' own elaboration.

In order to identify the relationship between the use of the sharing economy and the achieved effects (economic and ecological) of the studied enterprises in the area of low-carbon logistics, a comparative analysis was carried out using descriptive statistics methods (including

measures of the structure of collectivity and interdependence of phenomena) and statistical inference. In order to ensure the cognitive value of the obtained results, a reliability analysis was conducted using Cronbach's alpha coefficient (0.863). It showed good consistency between the respondents' responses regarding the results of using the sharing economy.

It is also worth emphasising that the period when the research was carried out was very difficult for businesses, which may constitute a kind of research limitation. On the one hand, the energy crisis has hit, which is a consequence of the war in Ukraine and the European Union's over-dependence on the supply of Russian energy resources. On the other hand, the so-called European Green Deal is being implemented, which aims to reduce greenhouse gas emissions to 55% below the 1990 level by 2030, and ultimately strives to achieve climate neutrality in Europe by 2050 (European Commission, 2020).

#### 4. Results and discussion

The starting point for achieving the assumed research goal was the division of the surveyed enterprises into two groups. The first group, marked with the *SE* symbol, contains enterprises that have made their unused resources available and/or used the resources of other enterprises. In some cases, these enterprises also act as intermediaries between suppliers and recipients of resources. In total, this group includes 70 enterprises, which represents 28% of all surveyed enterprises. The second group (marked with the symbol *nSE*) consists of 180 enterprises that either act only as an intermediary between the supplier and the recipient of resources, or declare that they have not taken advantage of the opportunities offered by the sharing economy (Table 3).

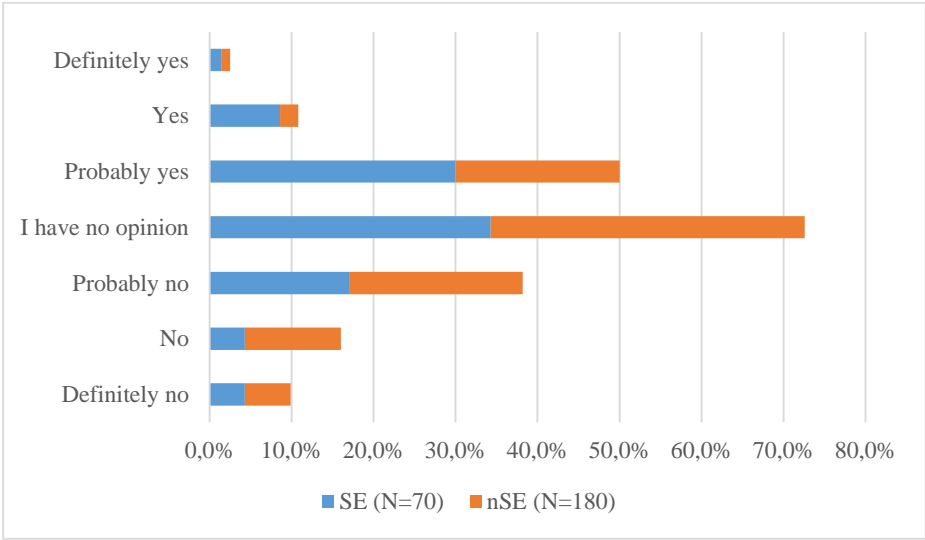
**Table 3.**

*Division of the surveyed enterprises into two groups SE and nSE*

Subgroups studied	Makes its unused resources available	Uses the resources of other companies/ consumers	Is an intermediary between the supplier and the recipient of resources	Does not take advantage of the sharing economy	N = 250
SE (N = 70)	X				20
	X	X			6
	X	X	X		2
		X			38
		X	X		4
nSE (N = 180)			X		30
				X	150

Source: The authors' own elaboration.

The analysis of the obtained results begins with a comparison of the respondents' responses regarding their level of involvement (using a 7-point Likert scale) in the implementation of low-carbon logistics. In other words, the surveyed enterprises declared whether, in addition to submitting to legal regulations and implementing emerging technologies enabling the reduction of emissions of harmful substances into the atmosphere (modern IT systems, modern communication and propulsion technologies, modern energy-efficient technologies, etc.), they cooperate with other entities in order to achieve the assumed effects of low-carbon logistics and conduct an effective policy based on the principles of the low-carbon logistics concept (Figure 4).

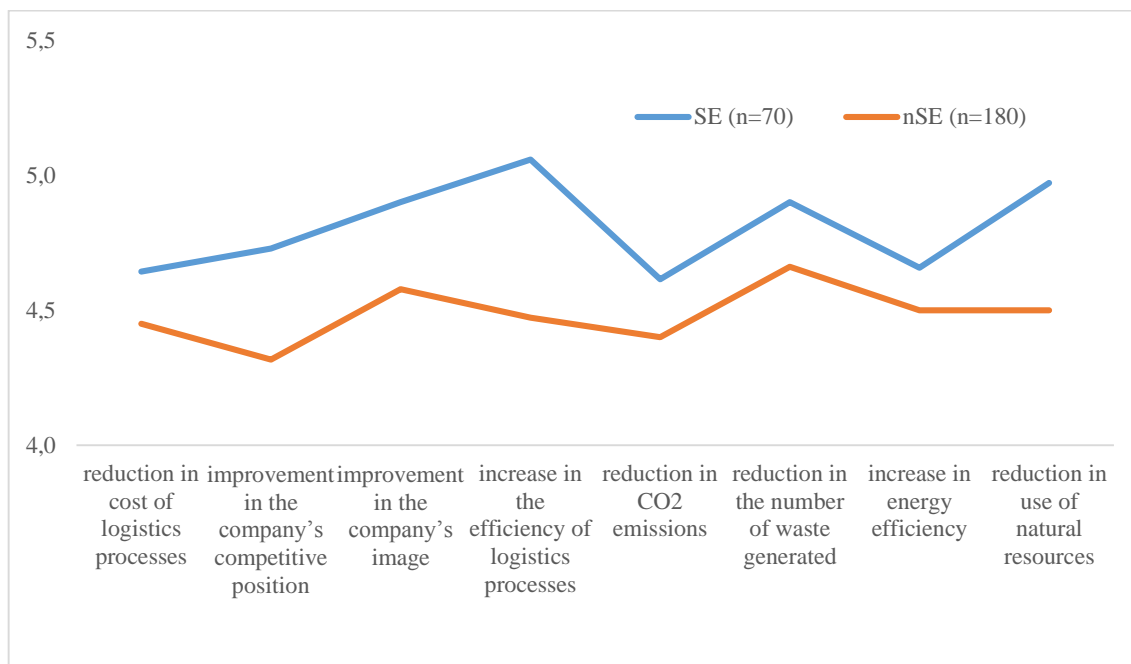


**Figure 4.** Acting as a leader in the implementation of low-carbon logistics in the surveyed enterprises. Source: The authors' own elaboration.

According to the results of the research, most of the surveyed enterprises limit their implementation of low-carbon logistics to the bare minimum. The most common manifestation of such action is compliance with applicable legal regulations. Examples of applicable legal acts include the directives on permissible emission limits successively implemented by the European Union, which aim to eliminate vehicles emitting excessive amounts of harmful substances into the atmosphere. The latest announcements of the European Commission concern the introduction of a total ban on the sale of combustion vehicles by 2035 (European Commission, 2023).

Analysis of the structure of responses given regarding use of the sharing economy indicates that enterprises declaring that they share resources also tend to claim a higher level of involvement in the implementation of low-carbon logistics than enterprises that do not take advantage of the sharing economy. With reference to the research hypotheses, this may mean that resource sharing has a positive relationship with the economic/ecological results achieved by the surveyed enterprises in the scope of action taken towards low-carbon logistics. As a result, a comparative analysis of the economic and environmental results achieved by the surveyed companies (*SE* and *nSE* groups) was carried out for low-carbon solutions

implemented in logistics processes – Figure 5 (average values). The respondents assessed the scope of achieved goals on a scale from 1 to 7, where: 1 – a given result was definitely not achieved, 7 – a given result was definitely achieved.



**Figure 5.** Effects of low-carbon logistics in the surveyed enterprises.

Source: The authors' own elaboration.

An analysis of the data presented in Figure 5 proved that in the area of low-carbon logistics, the economic and ecological results achieved by the surveyed enterprises that use resource sharing are higher in all cases than those achieved by companies not involved in the sharing economy. The greatest differences are visible in terms of increasing the efficiency of logistics processes and reducing the use of natural resources. Statistically significant differences between the two separate groups (SE and nSE) were also demonstrated using the Mann–Whitney U test (Table 4).

**Table 4.**

*The results of the Mann–Whitney U test*

Distribution of the achieved effects regarding:	Statistical significance	Decision
reducing the costs of logistics processes is the same for enterprises using and those not using the Sharing Economy	0.180	Yes
improving the competitive position of the company is the same for enterprises using and those not using the Sharing Economy	0.013	No
improving the image of the company is the same for enterprises using and those not using the Sharing Economy	0.022	No
increase in the efficiency of logistics processes is the same for enterprises using and those not using the Sharing Economy	0.000	No
reduction in CO <sub>2</sub> emission is the same for enterprises using and those not using the Sharing Economy	0.154	Yes

Cont. table 4.

reduction in the amount of waste generation is the same for enterprises using and those not using the Sharing Economy	0.069	Yes
increase in energy efficiency is the same for enterprises using and those not using the Sharing Economy	0.376	Yes
reduction of the natural resources consumption rate is the same for enterprises using and those not using the Sharing Economy	0.005	No

Note. ( $p < 0.01$ ).

Source: The authors' own elaboration.

The results of the test confirmed statistically significant differences in the distribution of economic results achieved by the *SE* and *nSE* enterprises in terms of: *improving the competitive advantage and company image and increasing the efficiency of logistics processes*. As far as ecological effects are concerned, statistically significant differences were demonstrated in the scope of *reducing natural resource exploitation*. As for other effects, no statistically significant differences were observed. Therefore, there are no grounds for rejecting hypothesis H1 in terms of the three economic objectives mentioned above and there are no grounds for rejecting hypothesis H2 in terms of *reducing the use of natural resources*. *Increasing the efficiency of logistics processes* and *reducing the consumption of natural resources* are typical results achieved by the enterprises engaged in resource sharing. It can therefore be concluded that the sharing economy can also be an important tool for achieving selected economic and ecological goals of low-carbon logistics. Moreover, it is worth noting that the level of commitment to the implementation of low-carbon logistics declared by the *SE* group companies translates to a greater extent (as compared to the *nSE* group) into the actual results achieved by these companies – Table 5.

**Table 5.**

*The level of commitment in the process of implementing low-carbon logistics vs the achieved effects of the surveyed enterprises in the area of low-carbon logistics – Spearman's rank correlation table*

Assessment of the level of commitment in the process of implementing low-carbon logistics in individual groups of the surveyed enterprises	Achieved results							
	reduction of the costs of implemented logistics processes	improving the company's competitive position	improving the company's image	increase in the efficiency of logistics processes	reducing CO <sub>2</sub> emissions	reducing the amount of waste generated	increase in energy efficiency	reducing the use of natural resources
SE (n=70)	.398**	.389**	.348**	.268*	.402**	.312**	.317**	.241*
nSE (n=180)	.236**	.250**	.196**	.177*	.322**	.170*	.152*	.286**

\*\* - significant correlation at the level of 0.01 (two-tailed), \* - significant correlation at the level of 0.05 (two-tailed).

Source: The authors' own elaboration.

In the group of the companies sharing resources (SE) the strongest positive correlation between the level of involvement in the process of implementing low-carbon logistics was observed in the case of CO<sub>2</sub> emission reductions (0.402). This result is crucial, considering the assumed goals of low-carbon logistics.

## 5. Conclusion

The use of the sharing economy concept for logistics resources allocation is undoubtedly a tool for achieving the goals of low-carbon logistics. The conducted empirical research confirmed the relationship between the use of the sharing economy and selected economic and ecological effects of enterprises in the area of low-carbon logistics. In Polish circumstances, the use of the sharing economy concept and low-carbon solutions in the field of logistics are not yet a common practice. The authors' research conducted in 2021 (Kamińska, Zowada, 2022) demonstrated that in terms of emissions of harmful substances into the atmosphere, the vast majority of enterprises in Poland merely comply with legal regulations regarding natural environment protection. Secondly, ecological results are more difficult to identify and have a less measurable character, which may be related to the different methodology of calculating the so-called carbon footprint. Furthermore, from the perspective of the enterprises (the micro perspective) the results in the area of low-carbon logistics are not directly noticeable by their managers and owners but are visible from the perspective of the entire economy (the macro scale). Consequently, the lack of visible effects at the micro level does not motivate the owners or managers to take further steps towards developing their business in a low-carbon logistics direction.

The surveyed companies, however, indicated that logistics is an area which offers significant potential for sharing resources. Among the declared practices of the sharing economy, transport and storage was most often mentioned. For example, sharing resources in transport makes it possible to obtain a lower unit cost of delivery as well as to reduce the distances travelled separately and, as a consequence, to achieve goals in terms of low-carbon logistics. This means that achieving the goals of low-carbon logistics is possible without significant capital involvement, a fact that has been indicated so far as a basic barrier to the development of pro-ecological practices in the field of logistics (Murphy, Poist, Braunschweig, 1995; Seuring, Müller, 2008; Tacke, 2014; Govindan, Kaliyan, Kannan, Haq, 2014; Mala, Musova, 2015).

According to the authors, research on the possibility of sharing resources in order to achieve the goals of low-carbon logistics should be continued, as a complement to the advanced and relatively expensive low- and zero-emission technologies. These studies, however, must no longer be carried out on the scale of individual companies, but on the scale of the entire



supply chains from various industries. The research results can also be related to the results of ESG reporting.

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