Andrzej HANUSIK

The sharing renaissance: Insights from research on urban logistics networks

Wydawnictwo Uniwersytetu Ekonomicznego
w Katowicach

Andrzej Hanusik

THE SHARING RENAISSANCE: INSIGHTS FROM RESEARCH ON URBAN LOGISTICS NETWORKS

Katowice 2023

Scientific publication

Reviewer

Tomasz Kwarciński

Publishing editor

Beata Kwiecień

Typesetting

Marzena Safian

Cover design

Emilia Gumulak

Cover picture © ARTYuSTUDIO – Photogenica

ISBN 978-83-7875-866-2

doi.org/10.22367/uekat.9788378758662

Publishing House of the University of Economics in Katowice
ul. 1 Maja 50, 40-287 Katowice, tel.: +48 32 257-76-33
www.wydawnictwo.ue.katowice.pl, e-mail: wydawnictwo@ue.katowice.pl
Facebook: @wydawnictwouekatowice

Table of contents

Introduction

Sharing economy and sharing mobility are concepts that are gaining popularity year by year and have become an integral part of the landscape of practically every larger city. However, it should be emphasized that sharing economy is not a new concept, and its manifestations can already be observed in the behaviour of primitive peoples. Nevertheless, sharing is currently undergoing a kind of renaissance and is becoming one of the directions of development for contemporary society. This situation makes sharing economy a very good subject for economic research, and its apparent novelty means that many of its aspects remain unexplored.

The sharing economy has an undeniable impact on shaping urban logistics networks. Shared mobility plays a primary role in this case, although other forms of sharing will also affect network connections in cities. The research focuses on the main nodes of the sharing economy occurring in the urban logistics network. In order to determine the asymmetry of solutions, the decision was made to conduct research in the Metropolis GZM. Limiting the research to one study area will allow for a thorough analysis of the sharing economy in the selected urban logistics network. Additionally, the obtained results may serve as a basis for further research in this area.

The research methods and techniques used in the work are based on the so-called methodological triangulation – analysis of existing data, qualitative research, and quantitative research. Such a research structure will allow for a thorough analysis of the problem and obtaining reliable conclusions.

This book consists of three chapters. The first two provide the theoretical basis of the study, while the third chapter presents the results of the conducted research.

Chapter one provides a detailed overview of the concept of the sharing economy, its theoretical foundations, and a description of the genesis of sharing and the historical evolution of sharing-based solutions. The chapter concludes with a characterization of key concepts based on the assumptions of the sharing economy. The chapter is based on a review of Polish- and English-language literature on the sharing economy, economic history, and online resources.

The second chapter is an attempt to apply the sharing economy to the theory of urban logistics networks. However, it should be noted that the theory of urban logistics networks is not strongly established in the literature, so the entire chapter is based on a query of both Polish- and English-language literature on the subject, as well as information obtained through individual in-depth interviews. The chapter also characterizes the asymmetry that may occur in the sharing economy in urban logistics networks – addressing the problem of information asymmetry as well as solution asymmetry.

Chapter three consists of two parts – the first one concerns the asymmetry of individual solutions, while the second one is a taxonomic analysis of cities and municipalities affiliated with the Metropolis GZM. These parts are also divided according to the period of the conducted research, which is 2020 (baseline period) and 2021 (reference period). The chapter presents both the methodological assumptions of the conducted research and the obtained results.

This book is directed towards individuals interested in the topics of the sharing economy, urban logistics networks, and information asymmetry and its evaluation methodology. The results of the conducted research can be useful for both platform managers in shaping their offerings, as well as public administration authorities in integrating the sharing economy with the city's transport policy. The thesis may also serve as a foundation for further in-depth research and become a stimulus for starting an academic debate.

1

Sharing as an important part of paradigm of economics

1.1. The concept of sharing economy

The development of the sharing economy concept is determined by the modern market, which is undoubtedly a highly dynamic entity, requiring the search for increasingly new and innovative solutions. The current situation brings many changes, both related to the practical business environment and to the field of economic sciences. It can be safely assumed that creativity and innovation are the hallmark of the modern world, driven by economic entities and consumers, as well as innovation in the social (primarily individual and group) and governmental sectors [Paulus and Dzindolet, 2008]. The determinants of these changes can be attributed to globalization and the extremely rapid development of technology, which is pushing the world towards a more homogeneous community. These changes affect not only the way of communication, progressing mobility, or standardization of offered products [Levitt, 1999], but also the way of thinking (both economic, social, and cultural). It should also be noted that a free market is not a necessary condition for the emergence of innovative solutions. Moreover, it can be assumed that far-reaching regulations can increase the creativity of economic entities, especially in the area of activity in the grey zone or searching for legislative gaps. However, in the author's opinion, only a free market allows for the full release of business innovation, understood as the search for new ways of competing or satisfying (and even creating) consumer needs, rather than trying to respond to demand by bypassing artificial barriers created by the state. Globalization, apart from significant benefits, also contributes to the exacerbation or even initiation of many negative phenomena. The growing social inequality, progressing degradation of the natural environment, or the breakdown of social ties [Piasecki, 2007] can be observed. Such a situation requires the search for solutions that allow for better use of available resources, and thus for the improvement of the economic situation of modern society – on the one hand, global and increasingly homogeneous, and on the other hand, individual and heterogeneous. This peculiar divergence is directly related to the network nature of relationships between entities and is also one of the strongest and weakest points of contemporary relations (both between people, businesses, and entire countries).

It can certainly be stated that economics has developed from practical needs – it is a response to the fundamental problem of how to best use limited resources to maximize the satisfaction of human needs [Wilkin, 2019]. However, this is not an unchanging field of science. Economics is still subject to changes, adapting to new challenges of the market reality – an example of such adaptation is precisely the sharing economy.

Defining the concept of "sharing economy" is not a simple task, as there is no generally accepted definition of this phenomenon yet. Furthermore, it should be noted that in both scientific and business environments, there are different terms referring to the described phenomenon – often overlapping or exclusive. Therefore, currently functioning definitions can be described as conceptually ambiguous or even contradictory [Sobiecki, 2016]. A good example of this conceptual inaccuracy can be documents and reports prepared by various institutions or organizations, as presented in Table 1.

Table 1. Ambiguity in the concept of sharing economy

Term	Examples of usage
Sharing economy	• Federal Trade Commission [FTC, 2015a; FTC, 2015b] • Organisation for Economic Co-operation and Development [OECD, 2015a; OECD, 2015b], • European Commission [EC, 2015a; EC, 2015b] • European Economic and Social Committee [EESC, 2014] • European Parliament [EP, 2014] • Business Innovation Observatory [Dervojeda et al., 2013]
Collaborative economy	• European Commission [Cadagone and Martens, 2016] • Business Innovation Observatory [Probst et al., 2015a; Probst et al., 2015b]

Source: Own elaboration based on sources indicated in the table.

The examples presented above regarding the lack of a clear conceptual framework referring to the sharing economy are just the tip of the iceberg. Therefore, it is necessary to systematize the concepts occurring in the literature and to synthetically present the similarities and differences between the various approaches, which is presented in Table 2.

Table 2. Sharing economy – concept classification

Term	Characteristics
Sharing economy	• Sharing of material resources • Non-transactional character • Discretion in terms of remuneration
Collaborative economy	• Resources can take the form of material goods (everyday objects), immaterial goods (services, skills, information or even time) or financial resources (joint investments, peer-to-peer lending) • Dispersed, networked relationships between individual units • Cooperation mainly on virtual markets – platforms
Collaborative consumption	• Shared consumption of certain goods for better utilization [Botsman and Rogers, 2012] • Group purchasing of a product by a community of interested individuals
Access economy	• Focused not on sharing, but on the aspect of access [Stokes et al., 2014] • Streaming services
Peer economy	• The relationship between individual entities must be direct • Equality of entities [Witt, Suzor, and Wikstrom, 2015] • Most common relationships are P2P, B2B, C2C, B2C
Rental economy	• The scope is identical to that of the "sharing economy" • Payment for sharing
Gift economy	• The scope is identical to that of the "sharing economy" • Sharing without compensation
On – demand economy	• Receiving the required service (or product) directly after reporting the need for it
Gig economy	• Providing specific services in exchange for a predetermined fee [Mandl et al., 2015] • The worker is an independent contractor [Jolley, 2019] – there is no permanent relationship with the employer
Circular economy	• Evolution of the concept of sustainable development • Slowing down, closing and narrowing material and energy loops • Co-creating value through inter-entity cooperation [Jolley, 2019]

Source: Own elaboration based on sources indicated in the table.

As the considerations show, concepts related to collaboration and sharing are currently widely discussed in both academic and business circles. It can also be questioned whether sharing can be recognized as a new paradigm of economics. The popularity of various platforms enabling cooperation speaks to the importance and relevance of such an approach. However, in order for resource and knowledge sharing to bring tangible economic benefits, several conditions must be met. It is also necessary to identify the entities involved in sharing (both directly and indirectly) as well as stakeholders of this concept.

1.2. Relationships in the sharing economy

Sharing economy and shared mobility are characterized by a highly developed system of relational structures. Moreover, these relationships have a network character. However, it is worth noting that network relationships are not only the domain of the sharing economy – we observe transformations of existing networks and the emergence of new structures on the market every day, such as various types of franchises, bank networks, restaurants, mobile phone networks or large stores. Network ties are therefore the foundation of the functioning of the modern economy, as they determine the efficiency of the market, are the creator of added value, initiate innovative actions related to the creation of new technologies or management methods, greatly facilitate knowledge transfer, and increase the flexibility of economic entities in practically every aspect of their functioning. Network ties are also present in social relations. While a few decades ago social and economic networks were mainly limited by geographic space, nowadays these barriers practically do not exist. In current times, practically the only limitation associated with the creation of network relationships is the policy of a given state (e.g. protection of its own industry), wars or other types of social unrest, and the market itself, which verifies the usefulness and effectiveness of the relationships entered into. The 21st century society is undoubtedly a network society [Castells, 2007].

As much as large network structures, encompassing many entities from virtually all over the world, are a product of globalization and the progress of information technology that occurred at the end of the 20th and the beginning of the 21st century, local communities, which undoubtedly include urban centres, have been characterized by network relationships since their inception. Analysing cities in terms of network structure is not an easy task, as it is related to identifying and evaluating the relationships that exist between hundreds of thousands of entities that differ significantly from each other in many ways. Entities that should be taken into account when conducting an analysis include city residents, authorities, public utilities, commercial, industrial, IT and service companies, non-governmental organizations, schools and universities, entities responsible for safety (police, fire brigade, ambulance) and cleanliness in the city (municipal companies), religious associations, entities influencing public opinion (media), criminal organizations, and many others. Moreover, individual entities often have their own internal network structures. This situation practically makes it impossible to conduct a holistic, network analysis of urban centres – it requires a precise selection of the research area, which includes at most a few groups of entities operating in the city. Moreover, the use of heuristic techniques and methods is often necessary to conduct such an analysis, as a full analysis is practically impossible – to verify the hypotheses put forward, certain simplifications must be made. The research hypotheses themselves must also significantly narrow the research area. It should also be noted that heuristic techniques often influence the way the research problem is defined – at the very beginning of the research process, valuation is made, which can significantly affect the later results of the analysis [Slovic et al., 2007]. All of these factors have a significant impact on the results of the study conducted and indicate the difficulties that are inseparably linked to the analysis of urban centres. An example criterion of the type of relationships presented in Table 3.

Table 3. Sharing economy – interrelationships between entities

Category	Description
Direct connections	• Supply side – entities that share their resources (both continuously and sporadically) • Demand side – entities that express a demand for certain products or services
Indirect connections	• Entities serving as intermediaries between suppliers and recipients (e.g. companies responsible for the functioning of platforms) [Pietrewicz and Sobiecki, 2016]
Stakeholders	• Entities that are interested in the functioning of the sharing economy market, other than direct and indirect links (such as institutions involved in the development of science and technology, institutions supporting development, public administration) • Defining the conditions for the emergence and development of entrepreneurship, such as economic policy, various economic mechanisms, legal regulations or infrastructure • Possible cooperation arrangements (simultaneous cooperation and competition) [Pakulska, 2016] • Strengthening civil society and local governance [Kilbu, 2014] • Public opinion – one of the biggest opportunities and threats in the development of the sharing economy
Natural environment	• Conditions related to its protection and minimizing negative impact on the environment • Internalization of external costs

Source: Own elaboration based on sources indicated in the table.

It should be noted that sometimes it is practically impossible to separate the supply side from the demand side, as these are entities that both offer and seek certain services or products. Such a situation indicates a very complex, networked character of relationships between entities participating in the sharing economy. Microeconomic networks can be distinguished between individual platform users, microeconomic networks between individual platforms, mesoeconomic networks between individual local and regional markets, and macroeconomic networks between individual national and international markets. Furthermore, all groups of entities functioning in urban centres are interconnected to a greater or lesser extent. The decisions made by one entity affect other participants in the network, both those directly associated with it and those with whom it does not have direct relationships. The connections between different groups of entities have diverse characters – from simple relationships like seller-consumer, through more complex forms of cooperation (such as employment), to long-term and complicated projects (such as research consortia or strategic alliances). It should also be noted that the city is an example of a multinet, as both micro-structures (such as individual companies), mesostructures (already mentioned strategic alliances or supplier-consumer relationships), and macrostructures (entire industries or all entities operating in a given city) function within it. This situation means that very rarely is one entity a part of only one network – in reality, individual actors are components of many networks. Urban centres are therefore highly complex systems in which even small decisions within one micro network can cause changes on a much larger scale. It is also extremely difficult to determine all types of entities operating in cities because urban centres are very dynamic and complicated structures where relationships are constantly changing, and some entities belong to several groups simultaneously. All of these factors make the analysis of urban networks a very difficult and time-consuming task.

As shown above, the sharing economy is mainly based on a highly complex network of relationships between individual, often dispersed entities. Such conditions do not favour the development of long-term business relationships. Parties are usually not interested in maintaining contact or creating deeper relationships, as the chance of meeting again is very small. Furthermore, creating lasting relationships between users is not in the interest of the platform owner [Pietrewicz and Sobiecki, 2016]. The basic principle of the sharing economy is therefore to build trust between entities and eliminate anonymity, which contributes to increasing users' sense of security and the frequency of transactions. One of the best ways to ensure transparency in such complex networks is to provide users with the ability to leave feedback about other users or the quality of the service or product received. This form of communication between participants in a given platform allows for the elimination of dishonest or low-quality service providers and distinguishes the most efficient ones. It can be assumed that trust, security, and transparency of activity are fundamental to the sharing economy, which seems to be confirmed by research conducted by PwC in the American market, according to which as many as 69% of respondents would not be able to trust another entity offering sharing services without receiving a positive review from a trusted person. The situation is similar in the Polish market, where as many as 60% of respondents consider opinions from people they know to be the most important factor [PwC, 2016]. It can be noted that respondents identified trusted individuals as a source of information, probably from their immediate environment. However, trust does not have to be related solely to personal relationships. The solution to authenticate comments may be so-called trust engineering, which creates models and systems that allow for the evaluation of the credibility and quality of posted comments [Wyrzykowska and Sadowska, 2012]. Comments can be positioned from the most active, verified, or those with good reviews. However, relying on opinions left by other users operating in very extensive and complex networks is associated with the risk of receiving unreliable information (even despite the existence of advanced rating verification systems). It is impossible to verify all users, which creates a basis for manipulation. This can give consumers an incorrect picture of a company's credibility and is a very dangerous tool for fighting competitors. These are not ethical actions, but they are often used in practice, as evidenced by the huge number of stores offering such services. Buying reviews (which increasingly come from real users rather than so-called bots [Buyfans, 2019]) can also lead to a decrease in customers' trust in the comment system, which is one of the foundations of the functioning of the sharing economy. It can certainly be stated that this is one of the most serious threats to this concept.

In the contemporary, rapidly changing world, access to the Internet is a necessary condition for the functioning of most businesses, as it enables relatively easy and inexpensive acquisition of new customers. It is also a necessary condition for the concept of sharing economy [Nowicka, 2016]. All modern platforms that allow for sharing of underutilized resources operate on the Internet. It should be noted that the Internet itself is also a platform [Gawer and Cusumano, 2014], serving as a foundation for other, more complex solutions. One of the more interesting tools that can be used for the purposes of the sharing economy, while also being a part of this concept, is cloud computing. Cloud computing is a network model that allows for convenient access to a shared pool of configurable computing resources (such as servers, mass storage, applications, and services) that can be quickly provisioned and released with minimal management effort or service provider interaction [Mell and Grance, 2011]. Currently, cloud computing is the foundation of the operation of most internet platforms, and its development also determines the development of the sharing economy.

The sharing economy is a very broad concept based on complex networks of relationships between individual participants. This situation makes it impossible to define a single coherent business model for all enterprises operating on the principles of cooperation and sharing – they will differ, for example, in the area of cooperation, the scale of their operations, their market orientation (profit-oriented or non-profit-oriented), and the assets (tangible and intangible) they use [Poniatowska-Jaksch, 2016]. Therefore, in order to determine possible business models that can be used, it is necessary to divide the subject matter of the sharing economy – the sharing economy is the result of tangible material goods, intangible assets, and information that defines the relationships between the entities. Table 4 presents the business models that can be used for entities in the sharing economy.

Table 4. Sharing economy – business models

Model	Description
Recirculation of goods	• Auction sites enabling the sale of unused goods • Platforms designed for product exchange (barter) • The narrowest model, including only some of the assumptions of the sharing economy concept
Service exchange	• Offering a service taking into account the time needed to perform it – the time spent on work becomes a kind of currency • The time of all users is valued at the same level
Increasing the utilization of fixed assets	• Consumption-oriented actions • Providing access to a good to third parties • Increasing the productivity of a good • Minimizing costs associated with maintaining a good
Increasing utilization of production assets	• Actions focused on production [Schor, 2014] • Principle of operation identical to the previous point.

Source: Own elaboration based on sources indicated in the table.

The effectiveness of the presented models depends primarily on the scale of the activity. This is a huge opportunity for the development of both large corporations and small businesses. However, the development of the concept of sharing economy can be problematic. Small, purely social grassroots initiatives can begin to transform into large international companies focused primarily on profit. On the one hand, this is a good phenomenon as it is associated with the development of platforms that allow for cooperation and achieving economies of scale. On the other hand, the original non-commercial nature of the concept may be lost.

It should also be noted that the sharing economy encompasses various aspects related to the offering of services or products, finances, and even time. Such a wide range of activities is a definite advantage for this concept. However, all business models implemented in accordance with the sharing economy have a common denominator. It is the additional value that is received not only by the supply and demand side, but in some cases, also by the environment. This value primarily has an economic character, but it can also concern ecological, social, or even psychological categories. Thus, the sharing economy can be an alternative direction for the development of the contemporary economy, which, on the one hand, brings benefits of an economic nature, and on the other hand, corresponds with contemporary civilization problems such as environmental pollution or inequality in access to goods or services.

1.3. Sharing economy – historical overview

The sharing economy is often incorrectly perceived as a new concept. This is probably due to the dynamic development of collaborative solutions observed since the beginning of the 21st century. This development is mainly associated with profound social and economic changes – the average wealth of people is growing, which can lead to new social attitudes, including a "green" lifestyle or purposeful reduction of consumer spending. The political transformation also had a significant impact on social changes in Poland – the opening of the economy to Western markets led to its dynamic development and a change in the population's approach to ownership, which is increasingly less perceived as a synonym of social status. This chapter attempts to define the origins of the concept of the sharing economy and provide a synthetic overview of its development.

Manifestations of the sharing economy can be observed as far back as prehistoric times. The first humanoid creatures who were able to use tools likely appeared on Earth about 2 million years ago. Initially, the tools they used were very primitive, and technological and social development proceeded extremely slowly. Humans achieved a relatively advanced level of development only at the end of the last ice age (20,000-30,000 years ago) – the basic unit of social organization at that time was a group or clan, which consisted of several families [Cameron and Neal, 2016]. It is in these small communities that one can observe some of the first signs of sharing. Tools were used collectively, meals were prepared together, and hunts were organized jointly. This situation was caused by a very high level of danger and low efficiency in practically every area of human activity. Sharing from the beginning was dictated by economic motives, as it allowed for greater benefits to be derived from the same amount of resources. The society of early humans continued to develop and change its character – from a nomadic to a settled way of life. Permanent settlements began to be established, and greater importance was attached to agriculture. It should also be noted that about 3,000 years before our era, a division of labour, or specialization, emerged [Cameron and Neal, 2016].

The sharing economy, like every aspect of human life, undergoes continuous evolution. The basis of these transformations is the process of constant change, the accumulation of which leads to the emergence of new solutions, and thus also new quality. It should be noted that these changes are very similar to evolutionary processes observed in nature – all contemporary species have a very long lineage and originate from earlier, less advanced forms [Darwin, 2013].

Charles Darwin's theory not only explains biological heterogeneity, but also provides a very good foundation for economic theories [Polowczyk, 2018].

Evolutionary systems are undoubtedly very complex systems. Their basic characteristic is the fact that various interactions that take place on a micro scale, in result lead to the creation of certain regularities and new, widely used solutions on a macro scale [Błaszczak and Polowczyk, 2018] – new solutions (innovations) have their source in a very narrow group of entities (single communities or species), and if they prove to be effective – they are widely used. Moreover, evolution has an adaptive-convergent character – similar conditions that appear in completely different places will lead to practically the same results (hence situations arise where something is invented in different places at exactly the same time, without communication between inventors). However, evolution is not a deterministic process, it is largely subject to random factors [Błaszczak and Polowczyk, 2018], which makes it extremely difficult to predict future changes.

Sharing also underwent evolution. As mentioned, initially, objects were shared primarily – weapons, tools for agricultural work, clothing, food, or living space (common caves, or later huts). However, humans continued to develop and invent new ways to facilitate life. Small, simple, and homogeneous agricultural settlements developed, which also required technological, economic, and legal progress. Private property began to be defined, but strategic goods, upon which the survival of the community depended, still remained common (e.g. land and livestock) [Cameron and Neal, 2016]. Settlements continued to develop, and the first cities and later empires were formed. Although the development of production methods did not progress significantly, the empires developed economically. Expeditions began to be organized – initially for purely exploratory and expansive purposes, and later also for commercial purposes. One of the greatest achievements of those times, which significantly contributed to economic development (and at the same time to the development of the sharing economy), was the formulation and codification of civil law. Initially, this law was very fragmented, but over time it covered larger and larger areas, which had an impact on the development of trade contacts. A very good example of such development is the Roman Empire [Cameron and Neal, 2016].

One of the first examples of risk sharing can be traced back to around the 3rd century BC with the Rhodian Maritime Law (Lex Rhodia de iactu), which allowed for the equalisation of losses (therefore constituting a community of danger) [Nawrot, 2019]. This law defined the captain's powers in order to save the ship. If any carried cargo had to be thrown overboard to save the ship, crew or the entire cargo from danger, the loss was to be borne jointly by all persons using the ship at that time, including the crew, cargo senders, or even the ship owner. This solution allowed for the distribution of costs associated with the loss of cargo, which was sacrificed for the common interest [Wojciechowski, 2018]. Therefore, Rhodian Maritime Law can be considered a precursor to insurance. Its principles are utilised in modern maritime law, where the concept of general average arose, which is defined as extraordinary sacrifices or expenditures intentionally and reasonably made for the common safety for the purpose of preserving from peril the property involved in a common maritime transportation [Dz.U.2018.0.2175]. This is a very good example of the evolution of an economic phenomenon – a concept developed in ancient times that was subsequently refined over the years. Modern maritime law specifically defines the scope of general average, the conditions that must be met in order to use it, and the methods of subsequent settlement (disbursement). Over time, the details of this concept have been perfected, its name has been changed, but the main assumption remains the same – to protect the interests of those who have lost their goods. Therefore, this is a very good example of an evolutionary approach in economics.

One sign of the sharing economy that is not driven by economic motives but by religious ones is the concept of monastic orders. Monastic life is based on communal work (co-creation of goods, such as food items – baked goods, honey, lard, beer; simple pharmaceuticals – herbs and herbal products; clothing and many others), collective living, group prayer, and more. The supraindividual character of monasteries can be seen (to some extent) as a precursor to time banks – each person from the congregation deals with what they have the best skills in, while also using things produced by others (thus there is an "exchange" of time spent on work). Such a character of monastic life also fostered the emergence of specialization, which increased their economic efficiency and self-sufficiency. On the other hand, very distinct hierarchical structures and central planning of the work of monks (by the prior or abbot, and in female monasteries – by the abbess) allow for some similarities to be found with socialism. However, it should be noted that socialism is a macroeconomic concept, whereas in the case of monastic orders, we are talking about a microeconomic approach. This is not a close resemblance, only some principles are shared, such as the lack of private property or central planning. Moreover, monastic orders are found to be less restrictive than socialist states. The first known and documented manifestations of monastic life appeared in Egypt, at the turn of the 3rd and 4th centuries. Then coenobitism arrived in Europe, where it was popularized by the Eastern Catholic Churches. The first monastic congregation in Western Europe was the Order of Benedictines. However, it is worth noting that there were already other monastic rules before that, such as the Celtic Rules of Columbanus of Bagnor [Clark, 2014]. Monastic congregations (or very similar forms of organization) also appeared in other parts of the world, mainly in Asia. They were mainly associated with Hinduism and later with Buddhism. Monastic orders, through their foundations and values, can be considered to correspond to the concept of the sharing economy. However, this is not a very obvious connection, as their goal is not to improve economic efficiency, but to serve God.

Another example of sharing a commodity is the concept of a fictitious purchaser, developed in the 15th century. Cities at that time were seeking new ways of development, and one of them was to establish the so-called "ius stapulae", which obligated merchants passing through the city to exhibit their goods there [Rajman, 2006]. This situation could be very disadvantageous if the transported goods were intended to reach a specific recipient or if there was no demand for them in the city, as the merchant would only waste time and money exhibiting their goods. Furthermore, the ius stapulae was often closely related to forced transport, a regulation that imposed on merchants the transport of their goods along specific routes, where customs and tolls were often collected at customs houses [Witkowski, 2008]. However, these routes were usually well protected, so moving goods along them was relatively safe. The solution to the problems generated by the ius stapulae was the fictitious sale of the entire commodity, with the fictitious purchaser being the merchant. They acquired the property rights to the goods, which still remained the property of the original merchant and were sent on their behalf to the designated location at their cost. The fictitious purchaser charged an appropriate fee for this service, which was still more beneficial than staying in the city for a longer period. Over time, the services offered by the fictitious purchaser were enriched with advice on selecting the best means of transport, optimizing the route, preparing and securing the cargo, or escorting it [Ficoń, 2010].

The real beginnings of freight forwarding can be traced back to the 19th century, when the steam engine was invented. This new way of transportation contributed to the rapid development of trade. Entrepreneurs often couldn't fully utilize the possibilities related to the mechanization of transport, and they also lacked knowledge about the technical aspects of transportation. This forced them to seek support from third-party entities, namely freight forwarders. The turbulent development of trade led to the intensification of new legal regulations and trade regulations, which further consolidated the position of freight forwarders – they were involved in planning and organizing the entire transportation process, commercial mediation, filling out necessary documents, coordinating control processes, or carrying out customs formalities [Ficoń, 2010]. Freight forwarders also used carriers' vehicles to carry out their clients' transportation. Shipments were consolidated and entire freight cars were rented, minimizing costs and reducing empty runs. Therefore, freight forwarding corresponds well with the principles of sharing economy – different senders (clients), through a freight forwarder (platform), send consolidated goods together, thus jointly utilizing the carrier's services. The result is lower prices. The use of freight cars is also rationalized, which increases their economic efficiency.

Another example of using the sharing economy in the past is the Royal Society of London, founded in 1667. The main goal of this society was to promote and disseminate scientific knowledge. This example is significant because the Royal Society of London is considered a precursor to the open knowledge movement, which promotes the sharing of knowledge, its openness, the possibility of reusing it (with respect to copyright laws), and ensuring full transparency and reliability of the information provided [García-Peñalvo, García de Figuerola, and Merlo, 2010]. The impulse given by the Royal Society of London led to the creation of subsequent similar societies. The peak of the development of this concept was at the end of the 20th and the beginning of the 21st century, when, among others, David Wiley, Eric Raymond, and Tim O'Reilly, inspired by the concepts of Open Source software, started the Open Content project in 1998. This project was directed at the academic world – scientists could share the results of their research and other intellectual property (such as textbooks or scientific monographs) using an open public license (Open Publication License). In the following years, additional projects were created, which developed from previous ideas, including the Connexions Project, Open Educational Resources, OpenCourseWare, and the currently very popular Creative Commons license [García-Peñalvo, García de Figuerola, and Merlo, 2010]. In the analysed case, the evolutionary approach is very well visible, where new, often very innovative solutions are still being created based on the concept initiated in the 17th century.

The sharing economy is also present in concepts related to social systems. One of the most notable examples is Marxist economics. Karl Marx believed that capitalism was a very good engine for economic progress, but he emphasized that sooner or later private property would become an insurmountable obstacle, leading to significant contradictions between the productive forces and the relations of production (technological requirements of the system – institutional structure of the system), which would cause an economic recession. Therefore, it is necessary to completely abandon private property in favour of sharing all resources or workplaces. Furthermore, the dynamic development of technology in capitalism leads to complex and more complicated relationships between companies, which become increasingly difficult to manage and coordinate. Efficient functioning of these networks is further hindered by private property, as according to Marx, there is no possibility of efficient coordination of a dispersed network by dispersed integrators – the introduction of a single body, i.e., central planning, is necessary [Marx and Engels, 2018]. Such a solution is nothing more than sharing duties and cooperation of people to coordinate inter-entity. It should also be noted that Marxist economics is not a concept detached from economic reality – it draws its foundations from classical economics and has become the basis for institutional economics. Paradoxically, in Marx's case, the inspiration of the classical school is decidedly greater than in the case of neoclassical economics – in both Marx and Smith, production was placed at the centre of the economy (in contrast to neoclassical economics, where consumption is the most important). Marxist economics and classical economics perceive the economy as a system composed of classes, which again stands in opposition to the neoclassical view, where society is made up of individual units. Marx's economic base is made up of productive forces (possessed technology and machines, employee competencies) and relations of production (division of labour, labour relations, or property rights). However, this base is not detached from the environment – above it is the entire "superstructure", i.e., cultural conditions, politics, social norms, and everything else that affects the economy. Marx was thus the first economist to study economic institutions, so Marxist economics can be considered a precursor to institutional economics. Before Marx, Robert Owen tried to conceptualize a society based on co-ownership – people who shared similar views were to organize work together and live in communities [Owen, 2018].

Another example of the evolution of the concept of sharing is closely related to technological advancements. In the past, innovations were directly associated with individual inventors, as evidenced by the names of specific inventions, such as Watt's steam engine, the Haber-Bosch process, Kay's flying shuttle, and others. Nowadays, it is very rare for a single person to be solely responsible for creating an innovation – new technologies are usually developed by teams composed of hundreds of individuals working together, for example within a single company or a scientific consortium. This example perfectly illustrates the evolutionary nature of the concept of the sharing economy, the wide range of its applications, and the possibilities it offers.

The concept of sharing has also been adopted by other sciences unrelated to economics. A good example of this is the cryptographic protocol called "secret sharing". In this protocol, a certain piece of information is divided into fragments and distributed among a group of users. The key feature of this information is that it can only be reconstructed by a strictly defined subgroup of users, rather than by all those who possess a piece of the information. In secret sharing, "n" participants are involved, and a certain number "t" is defined, which is necessary to reconstruct the secret ($n > t$). If any combination of information is smaller than "t", it is not possible to reconstruct the information. This protocol was developed independently by two scientists, Adi Shamir [1979] and George Blakley [1979].

Sharing has become increasingly popular and widely used by private individuals. In 2003, Couchsurfing was founded (then as a non-profit organization). Interestingly, sharing has also become a challenge for operators in the access economy. A great example of this is the sharing of accounts on streaming platforms and attempts by their owners (such as Netflix) to limit this practice.

The examples presented clearly demonstrate that the sharing economy is not a new concept. Its origins can be traced back to the Palaeolithic era, with its development over thousands of years, during which this concept was refined and new areas for its application were sought. In order to organize the events related to the development and evolution of the sharing economy presented in this chapter, a simple timeline (Table 5) has been created.

Table 5. Sharing economy development timeline

Time period	Description
2 000 000 BC	• First instances of early human ancestors using tools
≈ 30 000 – 20 000 BC	• Early manifestations of sharing within small social groups
≈ 3 000 BC	• Emergence of division of labour (specialization)
≈ 300 BC	• Formulation of Rhodian maritime law (Lex Rhodia de iactu) – precursor to common pool resource management
≈ 300 – 400 AD	• First manifestations of monastic life
529 AD	• Establishment of the first European monastery (Order of Benedictines)
≈ 1500 AD	• Emergence of the institution of the so-called "ostensible acquirer" – precursor to modern freight forwarding
1667 AD	• Establishment of the Royal Society in London – precursor to open knowledge movements
1763 AD	• Invention of the steam engine, contributing to the development of freight transportation (evolution of the institution of ostensible acquirer)
1820 AD	• Robert Owen publishes his major work – "The Book of the New Moral World"
1848 AD	• Marx and Engels publishes the Communist Manifesto
1864 AD	• Definition and codification of the concept of "tragedy of the commons" (evolution of Rhodian maritime law)
1979 AD	• Development of the cryptographic protocol of "secret sharing"
1998 AD	• Open Content Project
2001 AD	• Establishment of Creative Commons organization • Emergence of Wikipedia
2003 AD	• Founding of Couchsurfing as a non-profit organization
2011 AD	• Transformation of Couchsurfing into a for-profit organization
2021 – 2022 AD	• Netflix introduces measures to restrict account sharing.

Source: Own elaboration based on sources indicated in the chapter.

The concept of sharing economy has evolved over the years, and its principles have found applications in various areas of human activity. This present study does not exhaust the topic of the development of sharing economy – there are still many examples where its principles are present. However, the purpose of this chapter was not to provide a detailed presentation of the history of the development and evolution of the concept of sharing economy, but to confirm the thesis that it is not a new phenomenon, and its manifestations can be traced back to many millennia ago.

1.4. Generic classification of shared solutions

It is impossible to create a comprehensive and complete study that would encompass all permutations of solutions corresponding to the assumptions of cooperation and sharing, as the very assumptions of the sharing economy allow for a wide range of practical applications of this concept. However, it is necessary to create a relatively exhaustive study that presents the most popular and scientifically described, as well as practically used, concepts based on the assumptions of the sharing economy. The classification of shared solutions presented in this chapter starts with concepts functioning at the microscale, then smoothly transitions to the mesoeconomic scale, and concludes with the macroeconomic scale. It should be noted, however, that rigidly assigning a given concept to a specific group is practically impossible – this division is only a simplified model. It can also be argued whether a group of concepts related to global impact on the entire economy, and thus referring to the macroeconomic scale, can be achieved in reality. This situation arises from the fact that, in the author's opinion, there is no concept that would encompass the entire market in terms of impact, at most – some part of it. However, it should be noted that such an impact can be achieved through the simultaneous application of multiple concepts, where their influence on the entire market will be the result of their interactions on individual markets. Nevertheless, there are concepts that encompass multiple countries worldwide in terms of their impact, and therefore can be classified as macroeconomic. Table 6 presents a classification model for shared solutions.

Table 6. Classification model for shared solutions

Microeconomic scale	
Concept	**Description**
1	*2*
X-sharing	Sharing underutilized resources by their owners. This term has been coined for the purpose of this study. The letter "x" can be replaced with any word that describes the object intended for sharing, for example: • Carsharing – access to vehicles based on one-time or periodic payments (mainly for short and local trips) [Bardhi and Eckhardt, 2012] • Bikesharing – free, deposit-based, or paid systems [Shaheen, Guzman, and Zhang, 2010] • Scootersharing – short-term rental of two-wheeled vehicles, increasingly with electric power. These vehicles do not require special docking stations for operation • Placesharing – sharing of accommodation space in private homes or apartments with unknown individuals [Lauterbach et al., 2009]
Carpooling	Sharing unused space in a vehicle. Increasingly, individuals who travel together in a car can enjoy many benefits, such as using high-occupancy vehicle lanes or bus lanes. However, one of the biggest challenges for carpooling may be the societal mindset, as many people prefer to travel alone or with acquaintances. Carpooling with strangers can be associated with discomfort or concerns about safety. However, shared rides also present an opportunity for building new social connections. It is worth noting that people are increasingly relying on online contacts as the dominant way of developing relationships, rather than traditional methods [Brignall III and van Valey, 2005]. Lack of willingness or ability to establish new contacts can be a significant barrier to the concept of carpooling
Linking the demand side with the supply side	Platforms allowing entities seeking a service to quickly find its provider. Such services may include transportation, home improvement, tutoring, and many others. It is worth noting that while Uber is often cited as a classic example of the sharing economy and is well-anchored in the public consciousness as a concept related to the sharing economy [Hanusik, 2019], in reality, it is not a shared solution – Uber (and similar apps) is rather a variation of a taxi service
Holocracy	A change from the traditional hierarchical approach to relationships within a business towards co-management. Decisions are not made top-down – the business is divided into smaller units (so-called "holons") that have specific tasks to fulfil and possess full autonomy in their actions. Such a structure is intended to ensure better organizational functioning and flexibility in adapting to changing market situations [Robertson, 2007]. This model of organizational structure aligns with the principles of cooperative economics. However, despite the many opportunities it offers, it may also give rise to certain organizational problems. Decentralization and shifting decision-making authority to smaller units may result in situations where decisions are made without a holistic view of the entire business, leading to suboptimal optimization of individual activities rather than optimizing the entire enterprise. This can result in improvement in one area but deterioration in another
Bookcrossing	Individuals leave their books in various public places. The book left behind is intended as a gift for whoever finds it, an encouragement to read, and an invitation to participate in the initiative. Bookcrossing is thus an alternative, completely free and selfless book exchange system that opposes traditional market-based exchange. It can be seen as a metaphor for collective solidarity, although it creates a highly asymmetrical system [Dalli and Corciolani, 2008] – situations are common where some parties decide to pass on a book without receiving anything in return, while others appropriate titles intended for the entire community. The initiator of the free book exchange was American programmer Ron Hornbaker, who created the first bookcrossing platform in 2001 [Hornbaker, Pedersen, and Mehra-Pedersen, 2023]. The concept of "free book" aligns perfectly with the principles of the sharing economy, or more specifically, the "gift economy"

Table 6 cont.

1	*2*
Time banking	Various types of community-based programs where participants offer services in exchange for a special type of time-based currency that represents the time they dedicate to performing the service. These accumulated credits can then be exchanged for services provided by other participants in the network [Seyfang, 2004]. It should be noted that each hour is equal to any other hour, regardless of the market value of the services provided. After performing a service, the corresponding number of credits is recorded in the user's account, which can be spent on services provided by other entities (thus reducing the available balance). This situation is similar to traditional market-based exchange – the credits earned for providing services to one person can be spent on receiving services from a completely different person. Time banks thus create a type of local currency that functions in parallel with the official monetary system. "Timedollars", or exchangeable units of time, can be considered as the precursor of the idea of time banks. This concept was created in 1980 by Edgar Cahn [2004]
Hackerspace (DIY movement)	In recent years, a significant and rapid increase in Do It Yourself (DIY) culture has been observed. Common interests form distinct communities based on self-production of goods. Such groups share their manufacturing skills, patterns, code libraries, schematics, etc. The internet or dedicated workspaces and meeting places [Toombs, Bardzell, and Bardzell, 2014] can serve as platforms for exchange, where individuals interested in a particular area of goods production can meet, discuss, and create items together. Both skills and the physical space for crafting are shared in these communities
Coworking	The work of various individuals, with different education and professions, in a shared workspace. The main premise of coworking is the belief that working together can lead to significantly better results than working individually. Furthermore, using a shared office space can be a viable alternative to renting separate offices, as monthly coworking fees can be several to several dozen times lower than traditional lease arrangements [Spinuzzi, 2012]. Potential issues can arise from interpersonal interactions. It is not possible for everyone in a coworking space to collaborate fully. Moreover, the habits of some individuals may be unacceptable to their coworkers. Data security also becomes a concern, as security systems tend to work more effectively in closed user groups
Crowdfunding	It allows for obtaining external funding from a large group of recipients, where each individual provides a small amount of support [Belleflamme, Lambert, and Schwienbacher, 2014]. This support can be given either altruistically (often through various charitable actions) or in exchange for predetermined benefits, such as receiving a copy of the product (pre-order), being listed as a patron, meeting with the creators, etc. The reward received by the supporter depends primarily on the amount they decided to contribute to the funded goal. Another type of crowdfunding is supporting a particular initiative in exchange for a share in future profits (e.g. shares based on Blockchain technology such as Non-Fungible Tokens) – in this case, the investor does not have to be a consumer of the product [Belleflamme, Lambert, and Schwienbacher, 2014]. Crowdfunding is thus a solution that can contribute to the creation or development of initiatives that would not have a chance to emerge in any other way in the market. Like any investment, crowdfunding involves risks for investors. However, it can be assumed that inexperienced investors who allocate small funds to a particular goal (which includes the majority of those who participate in crowdfunding) may analyse the profitability and future prospects of the solution to a lesser extent, and therefore may more frequently make mistakes or accept the risk of making a potential mistake due to its low cost
Crowdsourcing	The form of outsourcing (a business practice that involves delegating certain areas of a company's operations to an external entity – currently, there are companies that outsource virtually all of their operations, so their role is limited to integrating individual processes [Grossman and Helpman, 2002]) is directed not to a predefined entity, but to a loosely identified crowd (for example, through an open call query) [Arolas and Ladrón-de-Guevara, 2012]. This approach to outsourcing, on the one hand, allows for cost reduction and obtaining more innovative solutions (responses

Table 6 cont.

1	*2*
	to queries come from different individuals, allowing for comparison and selection of the best solution or permutation of several solutions to achieve the best possible outcome). On the other hand, it exposes the company to significant risks of sensitive data loss – information about each process can be crucial for competition, which is why it seems natural to place agents in a crowdsourcing network to obtain such information. This situation again highlights the extraordinary importance of trust and transparency in establishing relationships within the concept of the sharing economy. Another very popular form of crowdsourcing is various types of social projects carried out within the framework of citizen budgets or platforms facilitating communication on the resident level
Mesoeconomic scale	
Concept	**Description**
Smart city	The main goal of a smart city is to significantly improve the efficiency of all components of its infrastructure, primarily through the use of modern information technologies and increasing the awareness of society, which can result in greater participation in development activities [Azkun, 2012] (this area offers the widest possibilities for utilizing the concept of the sharing economy). Within the concept of smart cities, six dimensions can be distinguished, which should be directly influenced by the tools offered by smart city solutions, namely economy, governance, social capital, transportation and communication, way of life, and environment. It should also be noted that a smart city, like any other urban centre, is not a closed system, and its functioning is determined not only by solutions implemented directly within its boundaries but also by external factors [Hanusik and Kozień, 2016]. Furthermore, the concept of Smart City itself can be a threat to the objective assessment of the direction of urban development – by definition, every city aims to be smart, creative, and developmental, which can lead to uncritical public stance towards urban development in marketing activities [Hollands, 2008]
Mobility as a Service (MaaS)	Integration of various modes of transportation in order to offer an efficient, transparent, and tailored mobility package to residents – where mobility is treated as a single service, rather than a chain of smaller trips involving different modes of transportation operated by different providers. This concept includes, in addition to the ability to purchase a single ticket in one application, various complementary services such as trip planning, satellite navigation, vehicle reservations, and various tools for analysing travel patterns [Jittrapirom et al., 2017]. Furthermore, MaaS applications often integrate short-term bikesharing and carsharing services, making them a very suitable platform for sharing economy solutions, while significantly increasing their competitiveness and efficiency. However, it should be noted that the main advantage of the Mobility as a Service concept can also be one of the biggest barriers to overcome – the need to integrate various entities (public and private) may prove to be a very challenging, sometimes even impossible task
Co-design	This is a concept based on co-creation and open design, most commonly used in the public sector. The origins of this concept can be traced back to participatory design techniques that were widely used in the 1970s, particularly in Scandinavia. Co-design changes the primary principles of the designer-client relationship, as it allows stakeholders to have direct input in formulating and solving problems. It should also be noted that this approach goes far beyond ordinary social consultations – it is primarily based on equal collaboration between citizens and authorities. Citizens in this concept are perceived as experts who draw on their own experiences and are directly connected to a particular issue, making them key players in the design process. Co-creation therefore involves jointly creating solutions using creative techniques. Co-design is of paramount importance for the design of services or products, as it allows for the use and effective integration of various perspectives – both demand-side, supply-side, and contextual – which significantly improves the innovation of the actions undertaken [Steen, Manschot, and de Koning, 2011]

Table 6 cont.

1	2
Macroeconomic scale	
Concept	**Description**
Open knowledge	Openness of knowledge primarily involves free access to reliable sources of information, full potential for their utilization or modification. This is an important issue, especially for scientific data, where in some cases they are publicly available (e.g., through online databases), but not licensed for reuse [Molloy, 2011]. Another solution in line with the concept of open knowledge are services that allow for free utilization and creation of databases. However, the credibility of the collected data may pose a threat, and the challenge is to create a system that allows for their verification and ensures transparency of the changes made. It should also be noted that there are organizations whose statutory task is to promote open knowledge. Such organizations are usually affiliated with an academic institution, e.g., the Open Knowledge Foundation, which started its activities at the University of Cambridge [OKF, 2023]
Open innovation	It assumes that companies, in order to maintain their ability to compete and better adapt to customer needs, should make use of external ideas, solutions, and technologies. These solutions should be analysed and incorporated into the organization's strategy [Bogers, Chesbrough, and Moedas, 2018]. This concept is therefore based on the principle of co-creating innovative solutions – similar to open knowledge, utilizing the experience and knowledge of multiple entities, often from very different industries, allows for the synergistic effect and the creation of highly innovative concepts. A threat may arise from the focus of individual entities only on utilizing innovations from third parties, while lacking willingness to share their own ideas with others. This has led to the emergence of companies whose main goal is to create new solutions, patterns, or patents and offer them on the market. Platforms that enable the sale of solutions can also be observed. It is a kind of innovation exchange that connects large corporations with small businesses or start-ups into a network. The concept of open innovation was first introduced by Henry Chesbrough in 2003 [Chesbrough, 2003]
Streaming	This solution allows users to access various types of content (movies, music, games) without the need to possess files. The processes operate on a single, shared server – only the image and sound are transmitted to individual users. Sometimes communication occurs in both directions, for example in the case of computer games, where users send information about their moves to the server, which responds with information about the consequences of the player's actions. In the case of streaming, server space and computing power are shared, resulting in cost savings and significantly increased capabilities and flexibility for platform users

Source: Own elaboration based on sources indicated in the chapter.

Thanks to simple and beneficial principles, the sharing economy finds reflection in numerous contemporary economic concepts. It should also be noted that these are not stagnant concepts – individuals, businesses, and governments often actively utilize them in practice. Due to the wide application of the sharing economy, it is impossible to create an exhaustive catalogue of all concepts derived from it. Nevertheless, the most popular and commonly used ones have been presented here. The literature studies conducted for the purpose of this chapter indicate that the sharing economy is currently undergoing a renaissance, and there are significant opportunities for its dynamic development in the future. This confirms that it is a highly relevant concept that requires further in-depth research.

2

Sharing in urban logistics networks

2.1. The role of sharing in urban logistics networks

Urban logistics network is a complex system of infrastructure, services, and organizational activities designed and managed to facilitate efficient transportation, distribution, and management of goods and services within urban areas. It is a critical aspect of urban functioning, particularly in the context of increasing urbanization and the need for effective management of the flow of goods and information within densely populated areas. The urban logistics network is a key component in ensuring the smooth operation of cities by providing access to goods and services, minimizing disruptions in traffic, and positively impacting the quality of life for residents. As cities continue to grow and evolve, the development of effective and sustainable logistics systems becomes increasingly important.

The sharing economy is closely related to network structures – they define its scope, allow for the establishment of new relationships, and determine the efficiency of individual platforms as well as entire clusters. The inseparable relationship between the sharing economy and network structures is therefore a determinant of further development of this concept. It should also be noted that platforms associated with the sharing economy concept do not operate in a vacuum – they are closely linked to specific urban centres. This situation is mainly due to the limitations associated with the mobility of residents – while knowledge can be shared with anyone in the world, sharing things is significantly limited by geographical distances, and therefore will take place within urban network structures. This is why the links between the sharing economy and urban logistics networks are so significant. Additionally, it is important to mention key phenomena that occur in network relationships associated with the concept of the sharing economy, such as coopetition and synergy.

Contemporary urban centres are often perceived through the lens of infrastructure projects – street layouts are redefined, innovative concepts for spatial development are created, transportation networks are designed, and so on. The reason for such a situation is the desire to achieve greater efficiency of urban centres and significantly reduce negative phenomena occurring in them [Shark, Toporkoff, and Lévy, 2014]. Unfortunately, urban centres are very rarely perceived as network structures – relationships that occur at the level of individual participants are not only a source of additional value, but very often also a place of conflicts, the creation of bottlenecks, problems related to the efficiency of flows (both material and immaterial), and so on. Although infrastructure projects are a kind of foundation of urban logistics networks and largely define their ultimate efficiency, actions related to the optimization of the network structure itself are also necessary. Innovative investments in infrastructure are beneficial for urban centres, but the scope of contemporary investments is often limited mainly to very popular intelligent solutions that are consistent with the concept of "Smart City", such as building technology parks, transforming industrial or post-industrial properties into centres of modern technology, or modernizing telecommunications infrastructure [Al-Hader and Rodzi, 2009]. It is an undeniable fact that creating intelligent infrastructure is a good direction for the development of modern cities, but other areas of their functioning, including the aforementioned network structures, cannot be forgotten.

Sharing economy is one of the concepts that can significantly contribute to increasing the efficiency of urban logistics networks. Furthermore, incorporating sharing economy platforms into urban network structures seems natural as their functioning mainly relies on information flow, hence on network relationships. As already mentioned, the city itself is a network of connections of various strengths and characters, which perfectly corresponds to the assumptions of the sharing economy concept. It should be noted that network structures are already present in cities – and in order to implement the sharing economy concept into urban logistics networks, it is necessary only to organize and develop these structures, define clear rules determining the functioning of network connections, and provide entities with a simple and intuitive place for information flow and possible transactions (platforms).

In order to understand the role of a platform as a necessary element for the functioning of the sharing economy in urban logistics networks, it is first necessary to define exactly what it is. The concept of a platform has evolved with the development of science – however, three main, successive trends in its evolution can be identified, starting from the product itself, through technological systems, and ending with transactions [Gawer, 2009]. The evolution of platforms is presented in Table 7.

Table 7. Evolution of platforms

Phase	Description
First wave of evolution	The overall aim of the projects was to create a new generation or family of products for a specific audience. These products were intended to meet the basic needs of customers, however, they were designed with the easy modification in mind, by adding, replacing or removing certain functions [Wheelwright and Clark, 1992]
Second wave of evolution	Platform as key points of control over processes. The effectiveness of platforms was equated with the effectiveness of the given enterprise on the market. General frameworks for managing platforms in rapidly evolving market systems were formulated – the concept of "platform leadership" was defined, related to gaining a market advantage through the use of platforms [Gawer and Cusumano, 2002]
Third wave of evolution	Directly related to industrial economics, where the term platform refers to various products, services, companies or institutions that act as intermediaries in transactions between two or more entities [Rochet and Tirole, 2003]. Thus, the platform's role is to enable and structure transactions that occur between different entities

Source: Own elaboration based on sources indicated in the table.

Platforms in the concept of sharing economy as an element of urban logistics networks are a result of the following concepts:

- they offer a new product that is tailored to the requirements of individual customers and can be easily modified (wave I),
- the functionality of individual platforms determines the market success of companies related to the sharing economy (wave II),
- they enable sharing transactions between entities (wave III) – however, to make this possible, a critical mass must be reached, meaning a sufficiently large number of entities participating in the structure.

Figure 1 illustrates the role of a platform related to the concept of the sharing economy in urban logistics networks.

Description of the non-platform structure (I) and the structure with an integrator in the form of a platform (II) is presented in Table 8. The discussed structure takes into account an example situation in which entity A has a good that they would like to share with others. In the structure, two other entities (B and C) would decide to use entity A's good.

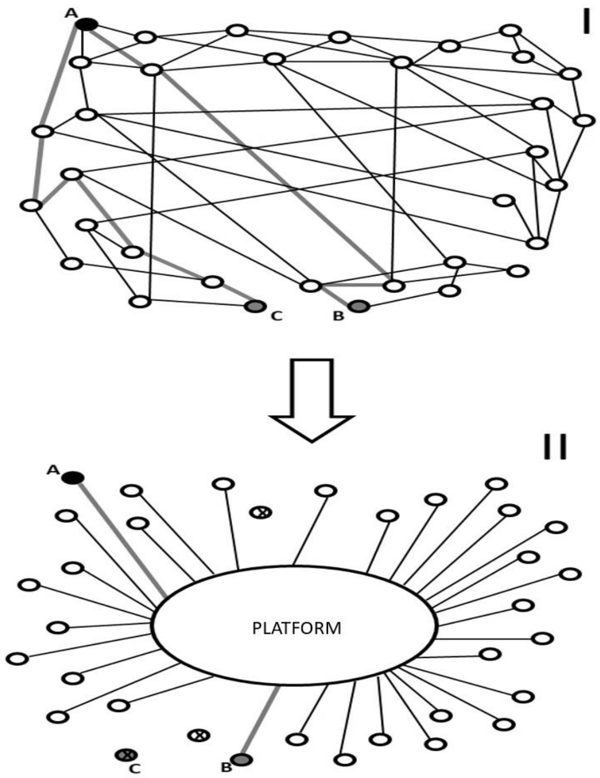

Figure 1. Sharing platform in urban logistics network

Source: Own elaboration.

Table 8. Comparison of structure without and with a platform

Type of structure	Description
Without a platform (variant I in Figure 1)	• Entity A has many possibilities to reach potential counterparts (for the A-B and A-C relationships) • There is a lack of information about the needs of other participants in the structure • There are indirect connections between each entity and any other entity • The transaction will probably never take place – even if entity A receives information that another network participant needs the offered good, it will be practically impossible to reach them
With a platform (variant II in Figure 1)	• Entity A shares information about the good it wants to share with the platform. This information is now available to all other entities connected to the platform • Entity B obtains information about A's offer and there is a chance of a sharing agreement (provided there is a convergent interest between A and B) • Entity C does not obtain information about A's offer because it is not connected to the platform • It is important to achieve critical mass for individual platforms, as it enables the realization of interests of individual participants

Source: Own elaboration.

It should also be noted that the existence of a platform does not replace traditional network relations between individual entities – in parallel to structure II, structure I also functions. Such a situation has a positive impact on the overall market within a given urban area by enabling transactions that would otherwise be impossible to carry out – thus, the efficiency of the entire market increases. Moreover, the platform can be used to verify information and ensure its transparency (e.g. through a comment system, ratings, service history, etc.).

2.2. Shared relationships in urban logistics networks

It is impossible to share resources (both material and immaterial) without accompanying relationships. It should also be noted that sharing itself creates various network relationships. Despite the fact that this increases the complexity of the urban logistics network, it also has a positive impact on its efficiency and improves the flow of information. Table 9 presents example relationships that are created in urban logistics networks through the operation of sharing economy platforms.

Table 9. Platform relationships

Type of relation	Description
Between entities and platforms	Directly related relationships to the functioning of the sharing economy. Each entity that decides to participate in the sharing economy must operate within a platform. Moreover, individual entities often use several platforms at the same time, as specific platforms are dedicated to one specific solution, or the user decides to use multiple platforms offering the same functionality (for example, due to the failure to reach critical mass by individual platforms or due to differences in quality, price or type of services offered)
Between individual entities	The functioning of users within a platform also creates new network relationships. This is particularly visible in the case of applications allowing for time sharing or sharing of accommodation – users deciding to participate in such initiatives get to know new people. Moreover, in addition to the usual relationships typical for a given platform, personal relationships are also formed – new friends spend time together, get to know each other's acquaintances, etc. This situation is beneficial both socially and economically – it expands both the personal network of relationships of a given individual and the possibilities of carrying out eventual business activities
Between individual platforms	In certain areas, multiple platforms offering the same services often coexist. This situation contributes to the formation of network relationships – these entities compete for customers, seeking new ways to gain a competitive advantage. Cooperative relationships also occur. This situation can be beneficial when none of the companies has reached critical mass. Joining forces provides added value to the customer in the form of greater availability and contributes to the increased profits of both operators. However, the formation of new network relationships between individual platforms is much more common among operators offering different services. Companies that offer shared living space also inform potential customers about the locations of bike rental points or car sharing operators in the area, thereby increasing the attractiveness of the area and resulting in an increase in the number of people using each platform. This situation is beneficial for all operators. Furthermore, such network relationships can be either formal (individual companies enter into agreements to inform each other about the services provided – often with a exclusivity clause, meaning no collaboration with other entities is possible) or informal (informing about the activities of other entities is not a result of any agreements and is an autonomous decision of each platform)

Source: Own elaboration based on [Hanusik, 2021].

Equally important are the relationships between individual platforms and their environment. These relationships can be characterized by various aspects, as shown in Table 10.

Table 10. Relations between platforms and their environment

Aspect	Description
Economic	Individual platforms decide to cooperate with other companies operating in different industries. A very good example are agreements between carsharing operators and large companies. In this case, the company gives up its own fleet of vehicles in favour of a subscription to a carsharing service. The company can gain access to publicly available vehicles or a certain pool of cars for its own use. Such a solution is characterized by a very high degree of flexibility, both in terms of the contract being concluded and potential opportunities for its change. This solution allows for a reduction in costs associated with maintaining a fleet and an increase in flexibility in adapting to the market situation
Social	These relationships may concern certain social issues observed in a given area. Individual operators may decide to engage in paid or charitable cooperation with non-governmental organizations or city authorities to minimize the problems that arise. The potential area of action is very wide – from an information campaign on a specific issue, through providing services at a lower price in exchange for public subsidies (e.g. city bikes), to charitable actions
Environmental	Connections with various environmental organizations or lobbying groups. These entities largely influence existing solutions (e.g. through changes in the legal environment of a given country or region) and have an impact on the perception of certain solutions or certain companies by the public (e.g. through online campaigns, organizing various events, or giving lectures on a particular topic). It is impossible to unambiguously define the main goals of various environmental movements, but in a shallow understanding of this phenomenon, all of them directly relate to limiting pollutant emissions, protecting natural resources, or improving quality of life [Naess, 1973]. Network relationships between entities associated with ecology and companies associated with the concept of the sharing economy can both positively affect their reception by customers or shape the legal environment in the region, as well as negatively limit, and sometimes even prevent their activities. Modern social trends indicate the very high importance of relationships with entities associated with the natural environment, which should be taken into account when creating a development strategy for a given company
Legal	The type of these relationships is mainly related to the currently functioning legal regulations in a given country – these are all kinds of relationships with customers, competitors, partners or other entities in the environment that are to some extent regulated by the existing regulations
Political	These relationships are primarily related to the authorities (both at the local, regional, and central levels). They may involve supporting certain political options or creating lobbying groups to obtain favourable regulations for the company. One can elaborate on the ethics of such behaviours, but it is not the subject of this paper

Source: Own elaboration based on conducted research.

It is also worth mentioning another phenomenon that can often be observed in concepts related to the sharing economy functioning in urban logistics networks, namely the synergy of individual solutions. Synergy refers to the ability of several cooperating or coexisting entities to generate greater value than they could achieve separately [Goold and Campbell, 1998]. Synergy most often occurs on one or several levels. These levels are presented in Table 11.

Table 11. Synergy dimensions

Dimension	Description
Know-how	Entities operating in networks often decide to share knowledge or skills. Such a situation leads to an overall improvement in results, efficiency, or the emergence of new ways of coordinating processes, functions, or geographic areas. In the case of the sharing economy, synergy in the field of know-how can manifest itself, for example, through the use of a common customer database. However, nowadays, know-how is one of the main sources of competitive advantage, which is why it is unwillingly shared with other entities
Coordination of strategies	Commonly determining the development directions for various economic entities can contribute to reducing competition between them while maintaining an appropriate level of interested customers. Furthermore, the solutions offered by individual entities can be complementary to each other – an increase in interest in one will automatically contribute to an increase in interest in the other entity. In the case of the sharing economy, such a situation can be observed, for example, in the creation of joint development strategies for different neighbouring cities, where various projects are jointly developed (infrastructure, transportation, education, etc.). Moreover, complementary solutions can also be achieved, for instance, by using a shared car to reach the interchange hub, continuing the journey to the city centre using public transportation, and moving within the city centre using a shared bike (thus creating a carsharing, public transportation, and bikesharing chain)
Material resources	Individual entities can achieve significant savings through shared use of certain physical resources. These can include shared production lines, workshops, or research centres. In the case of the sharing economy, an example of this could be the shared use of electric vehicle charging stations, where building and maintaining them would be disadvantageous for a single enterprise. Moreover, collaborating can lead to a significantly greater availability of such charging points, which is beneficial for all entities involved
Vertical integration	Coordinating product flow or jointly providing certain services can contribute to reducing costs, accelerating the development of the enterprise, and improving access to the market. An example of vertical integration in the sharing economy could be the joint use of a single platform to provide different services, such as a city card or an application that allows access to services from different operators. However, this situation is difficult to achieve within a single service category, as there is often one larger operator and several smaller ones in a given market. Large entities do not want to share their critical mass with other companies, as their profits in such cases will be negligible. The chances of vertical integration are greater in the case of entities providing complementary rather than competitive services. Nevertheless, far-reaching integration can lead to a significant reduction in the innovation of individual entities, as full structuring of operations significantly hinders individual actions
Negotiating power	Companies operating in similar areas can jointly exert pressure on their suppliers, create lobbying groups influencing authorities, or jointly manage relationships with stakeholders. In the case of the sharing economy, it is possible to talk about negotiating better conditions for operating in a given city or creating a better offer. The role of the city in relations with sharing economy suppliers is their creation and participation in their organization. The local government can initiate certain solutions (creation), and then participate in their financing or providing conditions for the service to develop in the public space, e.g., by reducing its cost for residents (participation). The stronger the joint negotiating power of the suppliers, the more favourable conditions can be obtained
Creating new business relationships	Collaboration can contribute to the formation of new business relationships and sometimes even new economic entities. This situation can occur when a gap in the market is observed and a joint effort is made to fill it – this can manifest in the creation of new departments or even separate business entities, as well as the implementation of projects under joint venture agreements. Examples in the sharing economy may include new services related to the core activities of the entities or financing of certain solutions for marketing purposes

Source: Own elaboration based on conducted research.

Sharing is closely related to network structures. This relationship is evident at both the level of individual platforms and their users, as well as on a larger scale, at the level of entire urban centres. In these structures, a specific type of connection between individual entities is of key importance, namely cooperation. It should also be noted that well-organized and synchronized networks of connections present in the concept of the sharing economy are a very good source of added value, which can be further enhanced by the synergy effect.

2.3. Asymmetry of sharing in urban logistics networks

The sharing economy naturally creates very extensive and complex networks of relationships, which contributes to the formation of a highly diversified relational structure between individual entities. Moreover, the entities participating in the sharing economy differ significantly from each other. Additionally, the object of sharing may have various characters – it can be both everyday objects, services, and even intangible goods, such as time. Such a character of the sharing economy means that different entities (belonging to different groups, e.g. suppliers, consumers, stakeholders, authorities, and participants of individual groups) have a different range of available information. This situation is called information asymmetry [Akerlof, 1970]. It is not a phenomenon related exclusively to the concept of the sharing economy – it occurs practically in every aspect of market functioning. It should be noted that the networked nature of relationships between entities participating in sharing significantly multiplies this phenomenon.

As mentioned in previous chapters, achieving critical mass, i.e. a sufficiently large number of active users (recipients), is necessary for the efficient functioning of sharing platforms. Each platform user has different needs, possesses different information, and is motivated by different factors. Very often, information that is crucial for one person turns out to be insignificant for others. Moreover, the awareness of the existence of certain solutions or benefits that can be achieved through their use varies among individual users, confirming the occurrence of the discussed phenomenon.

Information asymmetry also occurs between the users of a given platform and the entities responsible for its operation (suppliers). Very often, consumers have different expectations or visions of how a particular system should function compared to those responsible for it. This situation may result from the lack of an effective system for information flow (such as poor contact with the customer service department), a lack of current market research, individual goals set by the supplier that do not correspond to market needs, and many other reasons, which would be impossible to list and discuss. Asymmetry on the consumer--supplier level will lead to a reduction in the effectiveness of the entire system and sometimes even the need to close the business.

Differences in information held are particularly visible in the relationship between citizens (in this case, the recipients of the sharing economy) and authorities. Decisions made by public administration bodies (both at the local and central level) often seem to contradict the interests of citizens, and their economic efficiency is questionable. Although authorities sometimes decide to consult the public on individual projects, they very often do not achieve the intended results. Moreover, there are situations in which the voice of citizens seems to be ignored by authorities [Losik, 2019]. There is also a risk that social consultations will be ignored by residents [Gasłowska and Berkowska, 2016]. In the case of the sharing economy, information asymmetry will primarily concern projects financially supported by authorities. A very good example can be a bikesharing system, which can certainly be an initiative supported by citizens, but the implementation of the investment, the selection of locations for docking stations, or the range of available vehicles for rent may prove to be inconsistent with the requirements of citizens, and thus the direct recipients of this solution. Such a situation may arise precisely from the phenomenon of information asymmetry, where the scope of investments carried out may be different in the understanding of citizens and authorities of a given city. Moreover, the needs of individual recipients may also be different, which further increases the scale of the information asymmetry phenomenon.

Asymmetry of information is also present between consumers of the sharing economy and other stakeholders, such as non-governmental organizations (NGOs). Many NGOs are designed to represent a certain group of citizens before public administration bodies, employers, or providers of various services (including shared services). Differences in the information available to these parties can result in the actions of NGOs not being well correlated with the expectations or needs of the people they represent. In the case of the sharing economy, this category of information asymmetry is currently the least significant because, to the best of the author's knowledge, there are no organizations in the market that solely focus on the interests of consumers of shared solutions. However, entities whose scope of activity also includes recipients of the sharing economy can be identified, such as the Office of Competition and Consumer Protection [UOKiK, 2023].

The unevenness of information possessed will also manifest in relationships between individual providers, as presented in Table 12.

Table 12. Information asymmetry in shared relationships

Dimension	Description
1	*2*
Between providers operating within one platform	Such a situation may apply to entities that provide their goods within the participation in a platform, where it will manifest in the form of a lack of information about other similar offers in the area (however, it should be noted that in the case of free exchange of goods, it will not be particularly harmful) as well as in relationships between large economic entities that have decided to integrate their services within one application. In the latter case, information asymmetry can be very harmful – on the one hand, the mentioned entities cooperate with each other to improve the quality of shared services, increase their availability or achieve the necessary critical mass, on the other hand, they still compete for the customer (coopetition). The uneven possession of information may result in certain entities being privileged over others. Moreover, a problem may arise related to the cooperation of several entities in order to minimize competition in the market. On the other hand, the integration of different entities within one platform is a desirable solution for consumers, and the functioning in one common environment contributes to reducing the scale of information asymmetry. However, the problem may be the creation of legal and institutional frameworks that would contribute to the inclusion of many market entities in the platform's structures – significant complications may arise, e.g. in the case of profit sharing or cost participation, which may hinder integration activities and thus also increase the phenomenon of information asymmetry
Between providers operating across multiple platforms	In this case, the scale of information asymmetry is significantly greater. Each entity possesses different information about the market, customers, and their needs. Moreover, some consumers choose to operate only within one platform, while others participate in multiple structures, which significantly increases the range of information diversity among different suppliers. However, common information includes legal conditions, cultural norms of the society, and the economic situation of the region
Between providers and public administration entities	Differences may relate, for example, to the perception of societal needs or the definition of potential directions for development. Moreover, the distribution of motivations will also be asymmetric, where in the case of authorities, they will be pro-social actions, while decisions of economic entities will most often be determined by economic calculations – however, they should not be completely detached from social needs, but rather to some extent take into account this multi-aspect element of the modern world [Amin, 1992]. Furthermore, very often decisions of public administration bodies may significantly affect (even unintentionally) the activity of entities providing solutions in the field of sharing economy – this influence may have both a positive character, where certain solutions will contribute to the development of shared services, as well as negative – it may even lead to a situation where certain activities that have so far successfully functioned on the market will become either unprofitable or even illegal
Between providers and stakeholders	Stakeholders' actions will be related to exerting influence on providers of shared services in order to gain benefits for the represented groups. Information asymmetry will affect these relationships in terms of the actions taken – stakeholders and providers will have different information about the functioning of the enterprise offering shared services, which will lead to different evaluations of its actions. Such a situation may lead to significant differences between the actual state and the subjective assessment of the activity of the entity providing the service, which will not be without impact on the nature of the relationship between the group of providers and other stakeholders. Actions taken by pro-consumer organizations may prove inadequate to the nature of activities related to the sharing economy, significantly hindering the development of this concept in the future
Between public administration entities	Such a situation is most often observed in the area of lack of cooperation in defining and implementing the adopted development strategy. Individual cities often have different information, which determines their final development plan. In large agglomerations, where many urban centres coexist, the problem of information asymmetry and the associated lack of joint investments or development planning is most visible.

Table 12 cont.

1	2
	The heterogeneity of information significantly affects the effectiveness of urban investments, where coordination of individual systems into one integrated system would positively affect the efficiency of all existing solutions. Such a situation is caused by a very complex network of connections between individual cities, where investment decisions of one centre affect others. Such a high dependence is determined by the residents themselves, who often share their travel motivations between different cities (e.g. living in one city and working or studying in another). Therefore, information asymmetry among public administration entities also concerns knowledge about the needs of residents. It should also be noted that heterogeneity of information can be observed between vertical structures of power, as central authorities making nationwide decisions do not have full information about the situation in the country – this knowledge is concentrated among local governments, which further multiplies the level and complexity of the problem of information asymmetry between public administration units
Between public administration entities and stakeholders	They are not directly related to the concept of sharing economy, however, it is in their interest to influence other entities deciding to share and shape the final structure of sharing systems. Both groups of entities should aim to carry out such actions so that the groups they represent can derive various benefits. In the case of public administration bodies, the target group will be residents, while the interests of other stakeholders will include residents, providers, platform coordinators, authorities, or other entities deciding to participate in the structures of the sharing economy. Information asymmetry can lead to a lack of cooperation between authorities and other stakeholders, even if their goals are converging. The reason for such a situation may be a lack of effective communication, using different sources of information or even different ways of processing it. Other stakeholders are usually various types of organizations, which means that their power in relations with authorities is significantly greater than that of individual providers or consumers, which can lead to a large scale of conflicts that can be further publicized by the media. It should be noted, however, that despite the potentially significant power of these entities, they do not directly participate in sharing economy systems, which means their influence on them will be secondary
Between stakeholders	It is definitely a challenging task to determine the scale and potential consequences of information asymmetry between entities belonging to the group of other stakeholders. This situation is caused by the high heterogeneity of this group – significant diversification, diversity of goals, different forms of organization of activities (both legal, organizational and cultural), and often opposing target groups. These factors will cause a significant difference in the information possessed by each entity. Furthermore, the interpretation of the same message may look completely different for individual entities. The result of such a significant asymmetry in information will be various conflicts, lack of cooperation, or actions that harm other entities, which will not remain without a negative impact on the concept of the sharing economy itself. Each activity is largely conditioned by external factors, and therefore, the organization's environment, which undoubtedly includes other stakeholders. Adverse conditions created by these entities can significantly limit the development of the sharing economy in a given area. On the other hand, well-organized stakeholders can contribute to the improvement of the development of this concept

Source: Own elaboration based on conducted research.

In the sharing economy, information asymmetry is a common phenomenon. This situation results from the very assumptions of this concept – the presence of many diverse entities leads to the creation of a complex network structure of relationships between them, which favours the development of significant differences in the information possessed. On the other hand, sharing itself can prove to be a tool for minimizing the phenomenon of information asymmetry [Clarkson, Jacobsen, and Batcheller, 2007]. Sharing information allows for minimizing the negative effects of the phenomenon of information asymmetry. It should also be noted that shared information can be with both peer entities and those occupying a different position in the given structure. Various platforms increasingly provide the opportunity to share information, for example, through dedicated internet forums. Moreover, in the absence of an appropriate tool offered by the solution provider, users often decide to independently organize a group for exchanging information.

Information asymmetry in the sharing economy is a highly undesirable phenomenon. Although there are solutions that contribute to reducing the scale of this phenomenon, they are not able to completely solve the problems it generates. This situation makes it crucial to examine the extent of information asymmetry that occurs in the sharing economy. It would be practically impossible to investigate information asymmetry among all groups of entities. However, it should be noted that it is the consumers of shared services who constitute the main market force determining the directions of development in the sharing economy, so potential research should start with this group.

The issue of asymmetry pertains not only to the information possessed by individual entities, but also to the solutions operating in a given area. Some areas will be characterized by a higher level of shared services offered compared to others [Hanusik, 2020]. Furthermore, the scope of sharing, the number of available solutions, the diversification of offerings within individual platforms, and the availability of shared services will also vary in different areas. This situation is more pronounced in areas with more complex urban logistic networks (such as large cities, agglomerations, or metropolises), compared to smaller urban centres.

Asymmetry of solutions in the field of sharing economy can encompass various aspects. Moreover, individual elements often exhibit strong correlation – the occurrence of one case is very likely to be accompanied by another. Therefore, it is crucial to create a catalogue of elements that are susceptible to experiencing asymmetry of solutions. Table 13 presents possible cases of asymmetry of solutions in the context of urban logistic networks.

Table 13. Asymmetry of solutions in shared relationships

Case	Description
Lack of equilibrium in supply-demand dimension	This situation can have a dual character – individuals interested in sharing are unable to access the required product due to insufficient supply in the market, or entities offering shared products are unable to find interested individuals to share with
Uneven distribution of products within a platform	This situation is often observed in carsharing services, where the distribution of vehicles is determined by the transportation needs of residents, resulting in the flow of vehicles from one area to another. In the absence of corrective actions from the vehicle owner, certain areas may have an abundance of available vehicles at certain times of the day, while others may experience significant shortages. Another situation related to this type of asymmetry in solutions may occur with stations for renting city bikes as part of bikesharing services – some regions may have higher availability of this solution compared to other areas. This situation can be caused by the spatial characteristics of the city (such as the distribution of workplaces or residential neighbourhoods), actions of private companies (so-called sponsored rentals), or the strategy adopted by a particular city team
Asymmetry of different categories of complementary solutions	Some platforms offering shared services can be considered complementary, such as minute-based vehicle sharing (carsharing, bikesharing, scootersharing) and services enabling the sharing of accommodation (homestay). Travelers visiting a city for business or tourism purposes will have demand for both transportation services and lodging. A well-organized sharing system within a city's logistics network should ensure seamless access to such services. However, it should be noted that in practice, these solutions are often characterized by significant asymmetry, for example, there may be many shared vehicles available for rent, but a shortage of shared lodging options (and vice versa)
Asymmetry of competitive solution structures	The situation of a monopoly can occur primarily in the case of sharing economy platforms that require substantial upfront investments for their operations. In certain areas, there may be only one provider offering a particular service, making them a monopolist. However, it's important to clarify the nature of monopoly in the sharing economy. In the vast majority of cases, if it occurs, it would be a natural monopoly, which arises when there are exceptionally high fixed costs associated with the distribution of a good or the necessary infrastructure for the operation of a business [Sharkey, 1983]. Natural monopolies in the sharing economy may occur, for example, in the case of bikesharing services, where typically only one provider offers bikesharing services in a given area. However, in the sharing economy, the occurrence of monopolies is rare, as it is usually driven by very low costs (or even no costs) associated with sharing relationships. Instances of monopoly may be more visible in large, city-wide initiatives such as bikesharing or carsharing services

Source: Own elaboration based on conducted research.

Asymmetry of solutions can cause various problems, both directly experienced by the entities involved in sharing (mainly consumers, providers, and potentially platform service providers) and other participants in urban logistics networks who do not participate in sharing. Furthermore, the phenomenon of asymmetry of solutions has the characteristic of a so-called "vicious circle", which leads to self-propagation and exacerbation of this phenomenon in a given area. The concept of the vicious circle of asymmetry of solutions in the field of sharing economy has been presented in Figure 2.

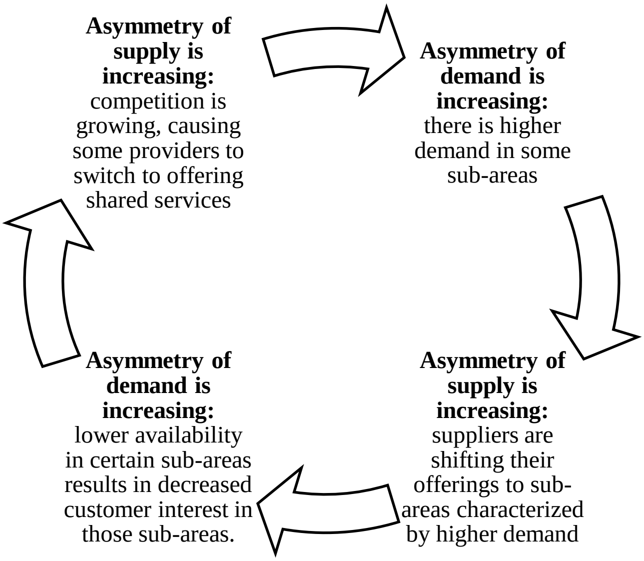

Figure 2. The concept of the vicious circle model of asymmetry of solutions in the field of shared solutions

Source: Own elaboration.

According to the proposed model, the main cause of asymmetry of solutions in the field of sharing economy in urban logistics networks is the lack of balance between demand and supply. This situation initiates a cycle of continuous changes in the dominant market force. Furthermore, this model will look similar when expanding operations, with the exception that initially the changes will be of a growth nature, which will be eventually broken by a downward trend at some point. However, it should be noted that the occurrence of such asymmetry may also be influenced by other factors, such as legal regulations, cultural conditions, or even the mission adopted by a particular platform operator (especially in the case where the platform is owned by public administration bodies), which further increases the complexity of the described phenomenon.

The issue of asymmetry of solutions in the field of sharing economy can occur not only between different cities within one urban cluster, but also between individual districts of a city or even different areas within one district. This situation can be caused by many factors, the identification of which seems to be crucial for understanding the scale of the phenomenon and implementing potential corrective actions. As presented in the proposed model, the problem of asymmetry of solutions has a self-perpetuating cycle of a vicious circle. However, there must be some factor or group of factors that contributed to the initial imbalance in the demand-supply plane, which triggered the entire cycle. These factors are presented in Table 14.

Table 14. Factors contributing to the initial imbalance in the demand-supply plane can include

Factor	Description
Non-uniform growth of needs in different urban areas	The demand structure evolves at different rates in different regions, leading to the emergence of initial demand asymmetry. This situation can be caused, among other factors, by uneven flow of information, wealth disparities among regions, or differential ownership of the shared good by different entities
Uneven initial distribution of supply within a given platform	The supply side exhibits varying levels of activity in different areas, leading to the emergence of initial supply asymmetry. This situation can be caused, similar to the previous case, by uneven flow of information or decisions of individual entities to join the structures of the platform. Furthermore, the causes of the asymmetry of solutions can also include actions of the platform itself (e.g. in cases where the platform owner is also the owner of shared goods, such as carsharing or bikesharing), where investment decisions will depend on the adopted development strategy or cooperation with public administration bodies and their guidelines for the overall development of the sharing system
Disruption in the flow of shared goods	Such a situation is particularly likely to occur in the case of mobile products, where the place of rental and return may vary and depend primarily on consumer decisions. The main demand hubs may significantly differ from the supply hubs, resulting in a disruption of the entire system structure. This situation is particularly evident in the case of shared vehicles, where a large number of vehicles may be observed in some areas, while shortages may occur in others, leading to the resignation of some interested entities from sharing (thus creating demand asymmetry)
Imbalance among different providers of shared services	The existence of a monopoly is one of the manifestations of asymmetry of solutions. Market monopolization can be caused, for example, by public administration bodies that decide to provide shared services to residents (e.g., through subsidies to entities offering such services) – in such cases, often only one platform is supported, which further exacerbates the monopoly phenomenon. This situation can also occur in the case of natural monopolies – in a free market, there is a chance for competitive solutions to emerge even in the presence of a natural monopoly – it is enough for increased demand to appear, which would allow other entities to operate in the market. Grants provided by urban authorities can significantly contribute to solidifying the position of a monopoly supplier. A very good example of such a phenomenon is city bike sharing systems, where usually only one provider of this solution operates in a given area. Furthermore, other companies often decide to invest in this system – a sponsored bike rental station is built for a certain amount (usually near the sponsor's offices), which also increases the bargaining power of the current monopolist

Source: Own elaboration based on conducted research.

One problematic aspect of the proposed model is the situation where an equilibrium point is established in the market – the question is whether such a situation can occur at all, and if so, whether it will be a long-term or short-term phenomenon. According to the author, the complexity of the network relationships between individual entities will cause the entire system to tend towards an unbalanced state, and temporary equilibrium can only be achieved through constant corrective actions, as presented in Table 15.

Table 15. Actions correcting the asymmetry of shared solutions in urban logistics networks

Action	Description
Monitoring the asymmetry of distribution	For the efficient functioning of a shared system, a platform is necessary that allows for receiving up-to-date information about the distribution of products in the system. The operator of the platform can then make corrections to the distribution of goods in the system. A good example of such actions is carsharing or bikesharing, where vehicles are regularly transported from areas with excess to areas with shortages
Optimizing information flow channels	In some cases, the presence of both demand-side and supply-side asymmetry may be related to a lack of well-coordinated flow of information. In such situations, many entities that could potentially be interested in participating in the sharing economy system do not receive information about such opportunities, which leads them to not participate in the discussed structures. However, it should be noted that this asymmetry does not solely depend on the flow of information, and in some cases, even highly effective channels of information flow may not be sufficient tools to limit the phenomenon of asymmetry of solutions in a given area
Increasing the attractiveness and scope of offered services	These actions may include, for example, improving the quality of services offered or increasing the variety of available options, which may contribute to greater, more homogeneous interest in a given platform. In the case where a platform offers only one type of service, the chances of asymmetric distribution of demand are relatively high, as the offered product may not appeal to all consumers. Increasing the diversification of the offering is likely to contribute to greater interest in the platform, which inherently reduces the scale of the asymmetry phenomenon. A similar situation arises when increasing the attractiveness of shared solutions – authorities may, for example, decide to allow vehicles with a certain number of occupants to use bus lanes (carpooling) [Yanga and Huang, 1999]. In this way, more people who were previously not interested in sharing may decide to participate in platforms, resulting in a more even distribution of demand in a given area. It should also be noted that such actions can have a positive impact on the situation in the city, such as reducing traffic congestion, which can translate into the economic well-being of the region
Limiting the use of non-shared goods.	Such a situation may be evident, for example, in the city centres of large cities, where private cars are subject to various restrictions (such as entry fees or complete bans on entry, paid parking zones, etc.) [Bylinko, 2017]. However, authorities may decide to exempt shared vehicles from some or all of these restrictions, which should result in greater popularity of such solutions. As a result, even residents of wealthier neighbourhoods may choose to use car sharing instead of private cars. This situation may also contribute to reducing the asymmetry of information. Nevertheless, there is a possibility that the actions outlined in the previous point may have a different effect – the utilization of shared solutions may increase in less affluent neighbourhoods and remain unchanged in wealthier neighbourhoods, thus exacerbating the asymmetry of solutions phenomenon

Source: Own elaboration based on conducted research.

As presented in the chapter, asymmetry in the sharing economy is not only related to the scope or quality of information possessed by individual entities, but is also evident in the solutions offered themselves. The main cause of asymmetry in solutions can be attributed to the lack of balance between demand and supply, leading to a cycle of deepening this phenomenon (known as a vicious circle). Although there are various tools available for mitigating the asymmetry of solutions, it is impossible to completely counteract this phenomenon. Moreover, the cyclical nature of asymmetry means that any remedial actions must be continuous, with constant monitoring of the scale and scope of the phenomenon.

While the existence of platforms in the sharing economy significantly facilitates monitoring of activities within shared structures, it remains a challenging and costly task. Therefore, it can be assumed that asymmetry of solutions is a phenomenon inherent in the concept of the sharing economy, and the subject of research can only be the scale of this phenomenon.

3

Shared mobility in urban logistics networks of Metropolis GZM

3.1. Research methodology

The subsection describes the research methodology used to study the scale of asymmetry in shared mobility solutions in the Metropolis GZM. The study directly relates to the concept of urban logistics networks, and thus its subject matter was the solutions of shared mobility in a broad sense. The data necessary for conducting the research were obtained from publications of the Central Statistical Office, websites of individual shared mobility service operators, as well as from our own research conducted in the Metropolis GZM.

In the first step, the variables of interest were defined. Then, the data collected during the research were aggregated in a form that allowed for further processing and analysis. Based on this data, indicators were created to determine the state of shared mobility solutions in individual municipalities within the Metropolis GZM.

The next step of the research involved synthesizing the defined indicators in order to enable their comparison. It should be noted that all created indicators are stimulants (their values tend towards the maximum), which is why the construction of the synthetic indicator takes the form of:

Equation 1. Synthesis of indicators

$$\boldsymbol{S_i} = \frac{\boldsymbol{1}}{\boldsymbol{k}} \times \sum_{\boldsymbol{j=1}}^{\boldsymbol{k}} \frac{\boldsymbol{x_{ij}} - \mathbf{min}(\boldsymbol{x_{ij}})}{\mathbf{max}(\boldsymbol{x_{ij}}) - \mathbf{min}(\boldsymbol{x_{ij}})}$$

$$S_i \in < 0; 1 >$$

where:

- x_{ij} – value of a particular variable,
- max(x_{ij}) – value of a particular variable,

- $\min(x_{ij})$ – minimum value of the given indicator,
- k – number of indicators (depending on the individual assessment).

The synthesized indicators allowed for the calculation of the asymmetry of the distribution of individual solutions [Doane and Seward, 2011]:

Equation 2. Classical coefficient of asymmetry based on the third central moment

$$NA_{(Si)} = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_{Si} - mx_{Si})^3}{\left(\frac{1}{N}\sum_{i=1}^{N}(x_{Si} - mx_{Si})^2\right)^{3/2}}$$

where:
- n – number of observations,
- x_{Si} – value of the synthetic indicator for a given municipality,
- mx_{Si} – average value of the synthetic indicator.

The results of the calculated coefficient of asymmetry should be interpreted as positive (indicating right-skewed distribution, where a larger proportion of the studied population takes on values below the average) or negative (indicating left-skewed distribution, where a larger proportion of the studied population takes on values above the average). A value of 0 indicates a symmetric distribution (in a population with a uniformly distributed characteristic, the distribution of a given feature is evenly spread throughout the population).

Next element of the analysis was to calculate the Kurtosis index, which allows for determining the degree of concentration of results around the mean. The Kurtosis index is based on the fourth central moment. Moreover, it should be noted that the Kurtosis index for a normal distribution is 3, so for the purpose of simplifying the analysis, a measure called Kurtosis excess was used, which is defined as [DeCarlo, 1997]:

Equation 3. Kurtosis excess

$$NEK_{(Si)} = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_{Si} - mx_{Si})^4}{\left(\frac{1}{N}\sum_{i=1}^{N}(x_{Si} - mx_{Si})^2\right)^{4/2}} - 3$$

A positive value of Kurtosis excess indicates a leptokurtic distribution (with a more peaked shape compared to a normal distribution – values are more concentrated around the mean), while a negative value indicates a platykurtic distribution (with a less peaked shape compared to a normal distribution – values are less concentrated around the mean). A Kurtosis excess value of 0 indicates a mesokurtic distribution (similar to the shape of a normal distribution).

The next step of the analysis was to repeat the entire research process, this time considering only the municipalities where the analysed systems are in operation. This approach will allow for the assessment of individual systems within the Metropolis GZM and their evenness of development in different municipalities where the respective systems operate.

Next, the composite indicator for the entire area was calculated, taking into account the population of municipalities with and without access to the analysed system:

Equation 4. Composite indicator

$$wS_i = \left[\left(pa_{\%} \times mS_{i(pa)}\right) + \left(pn_{\%} \times mS_{i(pn)}\right)\right] \times 100\%$$

where:

- $pa_{\%}$ – percentage of the population with access to the analysed system,
- $mS_{i(pa)}$ – average value of the synthetic indicator for areas with access to the analysed system,
- $pn_{\%}$ – percentage of the population without access to the analysed system,
- $mS_{i(pn)}$ – average value of the synthetic indicator for areas without access to the analysed system.

This research procedure allows for a precise determination of the degree of asymmetry in the solutions of individual shared systems. It should also be noted that the synthesis of individual indicators allows for practically unlimited comparison of the obtained results, which can be helpful in creating comparisons related to the development of individual solutions, comparing different urban logistics networks, or continuously monitoring a given area (e.g., on an annual basis).

Next, cities and municipalities were grouped based on the similarity of individual objects using the Euclidean metric. The same variables that were used to determine the asymmetry of solutions in the analysed area were used in the study. Cities and municipalities where shared mobility solutions were not present were excluded from the analysis. It should also be emphasized that all variables are stimulants. The study was conducted for two periods – baseline (2020) and reference (2021).

The coefficient of variation was calculated for each variable in order to exclude variables with low variability (those that have a value smaller than the assumed threshold) [Grabiński, Wydymus, and Zeliaś, 1989]:

Equation 5. Coefficient of variation

$$V\left(x_j\right) \leq \varepsilon$$

$$\varepsilon = 0{,}1$$

where:

- ε – threshold value.

The next step of the analysis was to determine the correlation between variables. A correlation matrix was created and then inverted. The critical value of the diagonal elements was also determined [Szkutnik, Sączewska-Piotrowska, and Hadaś-Dyduch, 2015]:

Equation 6. Critical value of the diagonal elements

$$\check{r} = 10 \; for \; R^{-1}$$

where:

- R^{-1} – inverted correlation matrix.

Variable selection using the inverted correlation matrix is an iterative procedure [Pośpiech and Mastalerz-Kodzis, 2016]. All variables that exceed the critical value on the diagonal should be excluded from further analysis. In the first iteration, the variable with the highest value is removed. Then a new matrix is calculated with the identified variable omitted. The procedure is repeated until all variables have diagonal values below the adopted critical value [Dziechciarz, ed., 2002].

The next step in the analysis was the normalization of variables. The classical standardization method was used [Młodak, 2006]:

Equation 7. Normalized value of the *j*-th variable in the *i*-th object

$$z_{ij} = \frac{x_{ij} - \mathrm{mx}_j}{S_{dj}}$$

where:

- x_{ij} – value of the *j*-th variable in the *i*-th object,
- mx_j – average value of the *j*-th variable,
- S_{dj} – standard deviation of the *j*-th variable.

Next, similarity between objects was measured using the Hellwig's development measure. A reference object was determined [Krakowiak-Bal, 2005]:

Equation 8. Reference object

$$z_o = \begin{bmatrix} z_{o1} & z_{02} & \cdots & z_{oj} & z_{om} \end{bmatrix}$$
$$z_{0j} = max\{z_{ij}\}$$

where:

- z_{oj} – the formula for determining the coordinates was used, considering only the version for maximum values, as all identified variables in the model are stimulant.

For each city/municipality, the distance from the reference object was calculated using the Euclidean metric [Łogwiniuk, 2011]:

Equation 9. Distance from the reference object

$$d_{i0} = \sqrt{\sum_{j=1}^{m} \left(z_{ij} - z_{0j}\right)^2}$$

Next, for each city/municipality, a synthetic measure of development was calculated [Lipieta et al., 2000]:

Equation 10. Synthetic measure of development

$$s_i = 1 - \frac{d_{i0}}{d0}$$

$$d_0 = md_0 + 2 \times S(d_0)$$

$$md_0 = \frac{1}{n}\sum_{i=1}^{n} d_{i0}$$

$$S(d_0) = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_{i0} - md_0)^2}$$

The next step of the analysis was to divide the cities/municipalities in the GZM into groups. The standard deviation method was used, which determines the number of created groups [Nowak, 1990]:

Equation 11. Grouping procedure

$$first\ group\ (very\ good\ objects) \rightarrow s_i \geq ms + S(s)$$

$$second\ group\ (good\ objects) \rightarrow ms + S(s) > s_i \geq ms$$

$$third\ group\ (bad\ objects) \rightarrow ms > s_i \geq\ ms - S(s)$$

$$fourth\ group\ (very\ bad\ objects) \rightarrow ms - S(s) > s_i$$

where:

- ms – average value of the synthetic measure,
- $S(s)$ – standard deviation of the synthetic measure.

The final step of the conducted analysis was to create a tree diagram using the Ward's method. This method combines clusters in such a way as to minimize the sum of squares of deviations of all objects from the centre of gravity of the new cluster [Pociecha et al., 1988]:

Equation 12. Error sum of squares

$$SSB = \sum_{i=1}^{k}(x_i - mx)^2$$

where:

- x_i – value of the variable used as the segmentation criterion for the i-th object,
- mx – average value of the variable [Balicki, 2013].

The formation of new clusters was carried out using the formula [Panek, 2009]:

Equation 13. Formation of new clusters

$$d_{r'''r''} = \alpha_r d_{r'''r} + \alpha_{r'} d_{r'''r'} + \beta d_{rr'} + \gamma |d_{r'''r} - d_{r'''r'}|$$

$$\alpha_r = \frac{n_r + n_{r'''}}{n_r + n_{r'} + n_{r'''}}$$

$$\alpha_{r'} = \frac{n_{r'} + n_{r'''}}{n_r + n_{r'} + n_{r'''}}$$

$$\beta = \frac{-n_r'''}{n_r + n_{r'} + n_{r'''}}$$

$$\gamma = 0$$

where:

- d – distance between the new cluster and other clusters,
- α_r; $\alpha_{r'}$; β; γ – parameters of transformations,
- n – number of individual objects.

A dendrogram of agglomeration process (a plot of linkage distances against linkage stages) was created for cities and municipalities in Metropolis GZM. The first significant increase in linkage distance, indicating the formation of city and municipality groups, was also marked on the plot.

Last stage of the analysis was to calculate the comparison indicator (for both, baseline and reference period):

Equation 14. Comparison indicator

$$cs_i = \frac{s_i}{max(s_i)}$$

This indicator allows for the comparison of results for both analysed periods by unifying their values. Additionally, these values can be presented in the form of a heat map.

3.2. Analysis for the baseline period (2020)

In the baseline period in the Metropolis GZM, four carsharing operators were identified, but for further analysis, data from three of them will be used (Traficar, GreenGo, and eCar from Tauron). CityBee is a completely different category of operator as it only offers delivery vans and its zones are limited to areas directly adjacent to shops. This situation means that the platform is not used for regular rides – the focus has shifted towards return trips from the store or possible relocations (the vehicle still has to be left in the designated zone). Furthermore, the characteristics of the zones, which are small but operate in many places, practically make it impossible to include this operator in the analysis, which is why CityBee was not taken into account in the assessment of solution asymmetry.

To identify the scale of asymmetry in carsharing solutions, the obtained data needs to be aggregated first. The results concerning the average number of vehicles per thousand inhabitants were summed, while in the case of the coverage indicator, the arithmetic mean was used to obtain comparable data. Table 16 presents the aggregated data and synthetic indicator values for the Metropolis GZM and only for cities with carsharing systems.

Table 16. Carsharing – data set for baseline period

Aggregated data		
City	**Average number of available vehicles per thousand inhabitants**	**Average level of city coverage by operating zones**
Chorzów	0.15	16.67%
Katowice	0.27	80.00%
Ruda Śląska	0.02	0.00%
Siemianowice Śląskie	0.01	1.67%
Świętochłowice	0.18	3.33%
Synthetic indicator for the entire Metropolis GZM		
City	**Synthetic number of available vehicles**	**Synthetic coverage level of the city by zones**
Chorzów	0.54	0.21
Katowice	1.00	1.00
Ruda Śląska	0.08	0.00

Table 16 cont.

Siemianowice Śląskie	0.05	0.02
Świętochłowice	0.65	0.04
Other cities (36)	0.00	0.00
Synthetic indicator limited to cities with described system		
City	**Synthetic number of available vehicles**	**Synthetic coverage level of the city by zones**
Chorzów	0.51	0.21
Katowice	1.00	1.00
Ruda Śląska	0.03	0.00
Siemianowice Śląskie	0.00	0.02
Świętochłowice	0.63	0.04

Source: Own elaboration based on conducted research.

The next step of the analysis was to synthesize the obtained results in order to determine the asymmetry of the solutions. Figure 3 shows the values of the synthetic indicator for the entire Metropolis GZM.

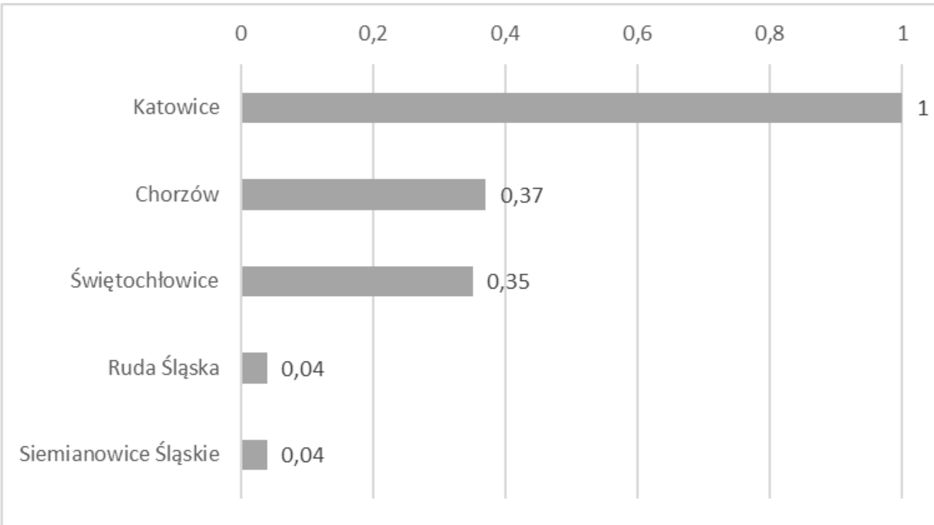

Figure 3. Carsharing – synthetic indicator for the entire Metropolis (baseline period)

Source: Own elaboration based on conducted research.

The city of Katowice was selected as the reference city for the entire Metropolis, both in terms of the synthetic index and individual variables. The asymmetry of carsharing solutions in the Metropolis GZM is characterized by strong right-skewedness ($NA(S_i) \approx 4.83$). Furthermore, the distribution of results is highly leptokurtic ($NEK(S_i) \approx 25.16$). Additionally, the mean value of the synthetic index is very low (mS_i = 0.04), making the high concentration of results around the mean a decidedly negative phenomenon. From these results, it can be inferred that the development of carsharing in the Metropolis GZM is highly uneven. However, it should be noted that the Metropolis is a complex entity consisting of a large number of municipalities characterized by varying levels of prosperity or population.

It is also necessary to carry out the entire research procedure, this time limited only to cities where carsharing is available. Such an approach will allow for obtaining significantly more accurate and realistic results. The results of the obtained indicator are presented in Figure 4.

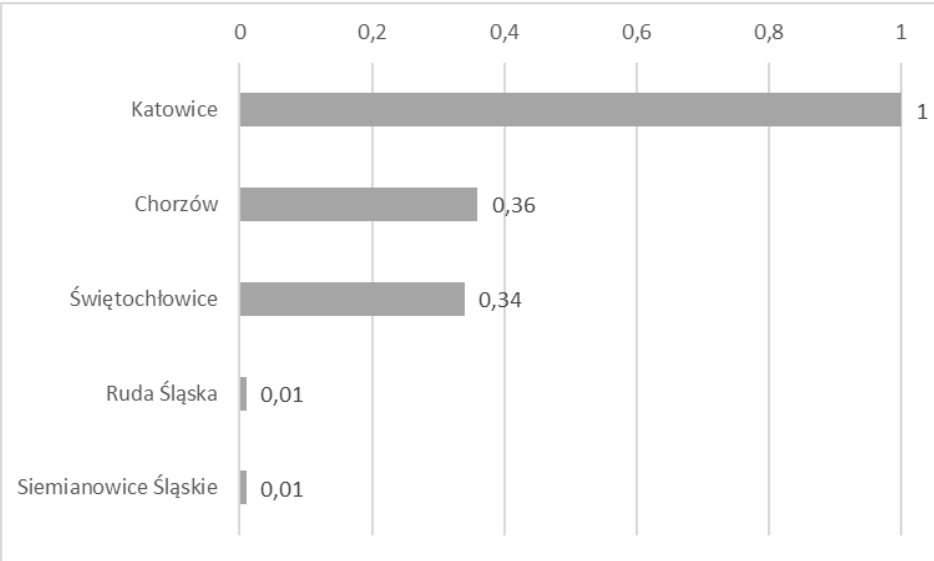

Figure 4. Carsharing – synthetic indicator limited to cities with described system (baseline period)

Source: Own elaboration based on conducted research.

In the case of analysis considering only cities that have a carsharing system, the obtained results are significantly better. Although a strong right-sided asymmetry can still be observed ($NA(S_i) \approx 1.32$), the result is much better than for the entire Metropolis (the asymmetry coefficient is 75.82% smaller). The situation is similar with the kurtosis excess – a leptokurtic distribution still occurs ($NEK(S_i) \approx$ ≈ 1.88), but it is much less slender. In the case of analysing only cities that have a carsharing system, the average value of the synthetic indicator is about 0.34, which is a significantly better result. However, it still indicates opportunities for the development of the entire system.

The final step was to calculate the impact indicator for the carsharing system. According to the presented methodology, the percentage of the population that has access to the carsharing system was taken into account, along with information on the average value of the synthetic indicator for these areas and the percentage of the population without access to this system (in this case, the average value of the indicator is 0). The value of the discussed indicator is 9.99%, which means that, referring to the reference city (in this case, Katowice), carsharing in the entire Metropolis GZM can still be developed by 90.01% (ceteris paribus). However, the obtained result is significantly overstated because, in reality, the municipalities that make up the Metropolis differ significantly from each other – both in terms of size, population, and overall economic situation, which means that such a system may never be created in many of them.

In the Metropolis GZM, the asymmetry of carsharing solutions can be observed. This situation occurs both in the case of analysing all municipalities that make up the Metropolis and in the case of analysis limited only to cities that have access to carsharing services. It should also be noted that in both cases, the identified asymmetry has a right-sided character.

In the area of Metropolis GZM, a bikesharing system was present in 7 cities (Chorzów, Gliwice, Katowice, Siemianowice Śląskie, Sosnowiec, Tychy and Zabrze) in 2020. In the past, Świętochłowice also had a bikesharing system, but it was a pilot program and was closed after a year of operation. For the purpose of this study, the number of stations and the number of bikes available in each city were examined. The results were then related to the population of the city (in the case of the number of bikes) and its area (in the case of the number of stations). This allowed for comparable data to be obtained, which can be further analysed. Table 17 presents aggregated data and synthetic indicator values for the entire Metropolis GZM and only for cities with a bikesharing system.

Table 17. Bikesharing – data set for baseline period

Aggregated data		
City	**Average number of stations per square kilometre**	**Average number of bicycles per thousand residents**
Chorzów	1.36	4.22
Gliwice	0.11	0.83
Katowice	0.46	2.13
Siemianowice Śląskie	0.43	1.656
Sosnowiec	0.11	0.64
Tychy	0.09	0.47
Zabrze	0.10	0.37

Table 17 cont.

Synthetic indicator for the entire Metropolis GZM		
City	**Synthetic number of stations**	**Synthetic number of bicycles**
Chorzów	1.00	1.00
Gliwice	0.08	0.20
Katowice	0.34	0.51
Siemianowice Śląskie	0.32	0.39
Sosnowiec	0.08	0.15
Tychy	0.06	0.11
Zabrze	0.07	0.09
Other cities (34)	0.00	0.00
Synthetic indicator limited to cities with described system		
City	**Synthetic number of stations**	**Synthetic number of bicycles**
Chorzów	1.00	1.00
Gliwice	0.02	0.12
Katowice	0.29	0.46
Siemianowice Śląskie	0.27	0.33
Sosnowiec	0.02	0.07
Tychy	0.00	0.02
Zabrze	0.01	0.00

Source: Own elaboration based on conducted research.

These data allow for their synthesis, which will allow for a precise determination of the asymmetry of bikesharing solutions in the analysed area. Figure 5 shows the results of the calculated synthetic index for all entities affiliated with the Metropolis GZM.

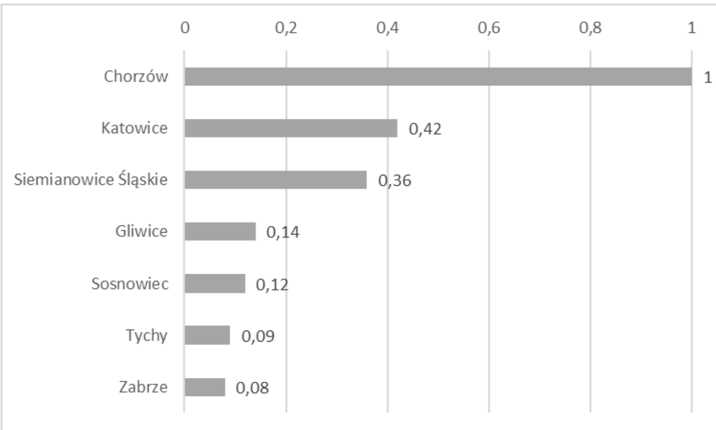

Figure 5. Bikesharing – synthetic indicator for the entire Metropolis (baseline period)

Source: Own elaboration based on conducted research.

The analysis shows that the development of the bikesharing system in the Metropolis GZM is very uneven. Chorzów achieved the best results in the Metropolis and can serve as a model. The development of bikesharing is highly asymmetric – the asymmetry coefficient for the analysed case is 4.32, indicating a very strong right-skewed asymmetry and thus uneven development of the entire system. To determine the degree of development of the system, an assessment of the distribution of values around the mean was made. The kurtosis excess obtained during the analysis is 19.50 – this is a result indicating a very strong leptokurtic distribution (the distribution is more slender than the normal distribution, which means a greater concentration of values around the mean). Such a result of excess kurtosis, with a low mean value of the synthetic index (mS_i = 0.05), shows that the system is in a very early stage of development. The asymmetry of development is also confirmed by the structure of cities with and without bikesharing systems – 34 areas do not have systems, and only 7 areas have such a system.

A complement to the analysis was to determine the above coefficients only for cities where bikesharing systems are being developed. The fact that many municipalities within the Metropolis GZM are relatively small territorial units, in which the development of their own bikesharing system would be unprofitable, speaks in favour of such an approach. The Metropolis GZM is a highly diversified area, with a strongly monocentric character, where several largest cities constitute the main strength (a polycentric agglomeration). Seven cities with bikesharing systems cover about 25.7% of the Metropolis' area and account for 49.3% of the population of the entire agglomeration (about 1,160,000 people). Figure 6 shows the synthetic value of measures of the development of bikesharing limited only to the cities where such a system is developing.

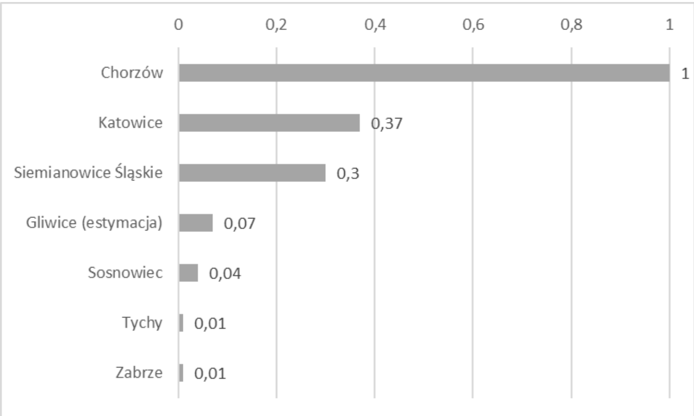

Figure 6. Bikesharing – synthetic indicator limited to cities with described system (baseline period)

Source: Own elaboration based on conducted research.

The conducted analysis shows that the development of the city bike system limited only to cities that have such a system (rather than the entire metropolitan area) is more uniform. The asymmetry coefficient for the analysed group is 1.42, which is 67.2% lower than in the case of the entire Metropolis. However, the right-skewed asymmetrical development of the city bike system in individual cities can still be observed, although it is not as extreme. The situation is similar in the case of kurtosis excess, whose value is 0.70, which is nearly 28 times lower than in the case of the entire metropolis. This is a weak leptokurtic distribution, but still, there is a greater concentration of values around the mean than in the case of a normal distribution. The average value of the synthetic index for the analysed case is 0.26, which still shows a weak development of the entire system in relation to excess kurtosis.

The last element of the analysis was the creation of a resultant relative indicator of the development of city bike systems. The value of this indicator is 12.71%, which means that according to the benchmark for the model city (Chorzów), the city bike system across the entire metropolis could still be developed by 87.29% (ceteris paribus). This is, of course, an overestimated result, as mentioned earlier, the municipalities that make up the Metropolis GZM differ significantly from each other.

The Metropolis GZM does not have a coherent and well-developed city bike system. However, it should be noted that it is a relatively new creation, which means that it has great development potential. Moreover, the very concept of city bikes is still a relatively new concept, which implies that it will dynamically develop in the future. This assumption is also supported by contemporary social trends related to the so-called "green" lifestyle, reducing the carbon footprint, and working towards improving the quality of life in cities – the city bike system fits perfectly into the assumptions of these concepts.

In the Metropolis GZM in the baseline period, five providers of scootersharing solutions were identified (in this case, electric scooters and electric kick scooters). These solutions operate in cities such as Katowice, Gliwice, Dąbrowa Górnicza, and Sosnowiec. The variable used to determine the asymmetry of scootersharing solutions was the number of available vehicles in each city (divided into scooters and kick scooters) per capita. It is practically impossible to determine the degree of coverage of a city by zones, as they are very unevenly distributed, and typically include the city centre and the most important traffic generators, such as shopping malls, universities, or places related to culture. This situation makes it practically impossible to determine the degree of coverage, and the results obtained would be practically the same for all cities. Asymmetry does not occur in the case of zones themselves, but cities differ significantly from each other in terms of the number of available vehicles. Table 18 presents aggregated data and synthetic values of indicators for the entire Metropolis GZM and only for cities with a scootersharing system.

Table 18. Scootersharing – data set for baseline period

Aggregated data		
City	**Number of available scooters per thousand inhabitants**	**Number of available electric scooters per thousand inhabitants**
Dąbrowa Górnicza	0.21	0.25
Gliwice	0.20	0.18
Katowice	0.26	1.45
Synthetic indicator for the entire Metropolis GZM		
City	**Synthetic number of available scooters**	**Synthetic number of available electric scooters**
Dąbrowa Górnicza	0.78	0.17
Gliwice	0.75	0.13
Katowice	1.00	1.00
Other cities (38)	0.00	0.00
Synthetic indicator limited to cities with described system		
City	**Synthetic number of available scooters**	**Synthetic number of available electric scooters**
Dąbrowa Górnicza	0.12	0.05
Gliwice	0.00	0.00
Katowice	1.00	1.00

Source: Own elaboration based on conducted research.

The next step in the analysis of scootersharing in the Metropolis GZM was to synthesize the obtained data. This procedure will allow determining the asymmetry of solutions. Figure 7 presents the results of the calculated synthetic indicator for scootersharing for the entire Metropolis.

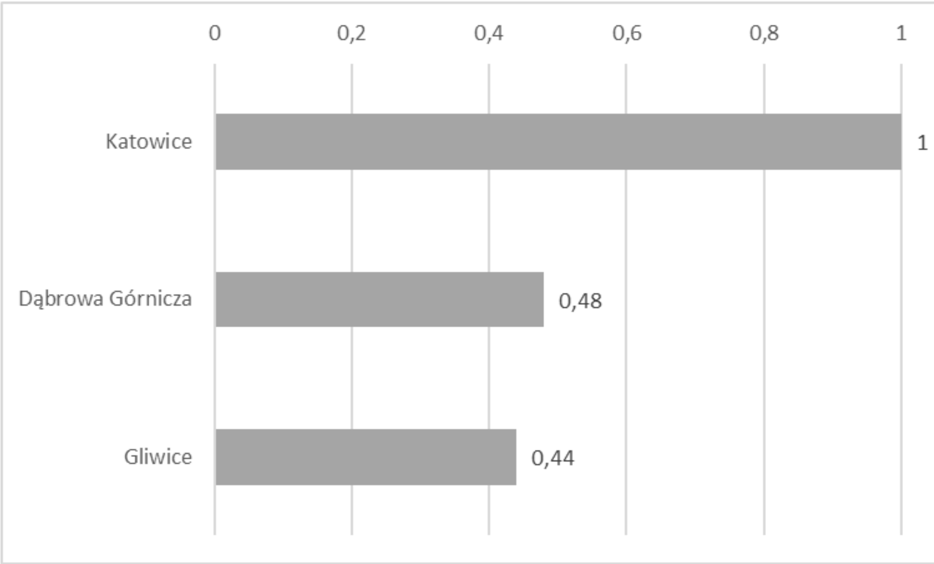

Figure 7. Scootersharing – synthetic indicator for the entire Metropolis (baseline period)

Source: Own elaboration based on conducted research.

The conducted analysis allows to conclude that the development of systems offering scootersharing solutions in the area of the Metropolis GZM is, similarly to carsharing and bikesharing, very uneven – the asymmetry of scootersharing solutions is strongly right-skewed ($NA(S_i) \approx 4.34$), and the distribution of obtained results is strongly leptokurtic ($NEK(S_i) \approx 19.94$). It should also be noted that the comparison of the kurtosis excess result with the average value of the synthetic indicator ($mS_i = 0.05$) allows us to conclude that the entire system is very poorly developed. Such a situation may be caused by both the early stage of development of the entire system and the very large diversity of individual municipalities that are part of the Metropolis GZM. The asymmetry of solutions was also confirmed by the structure of scootersharing – as many as 38 out of 41 municipalities do not have access to this system.

The last element of the analysis of scootersharing in the Metropolis GZM will be the calculation of the coefficient of asymmetry and kurtosis excess only for the cities that have such solutions. This requires the recalculation of the synthetic indicator values. Figure 8 presents a synthesis of the number of electric scooters and electric scooters for cities where such systems are being developed.

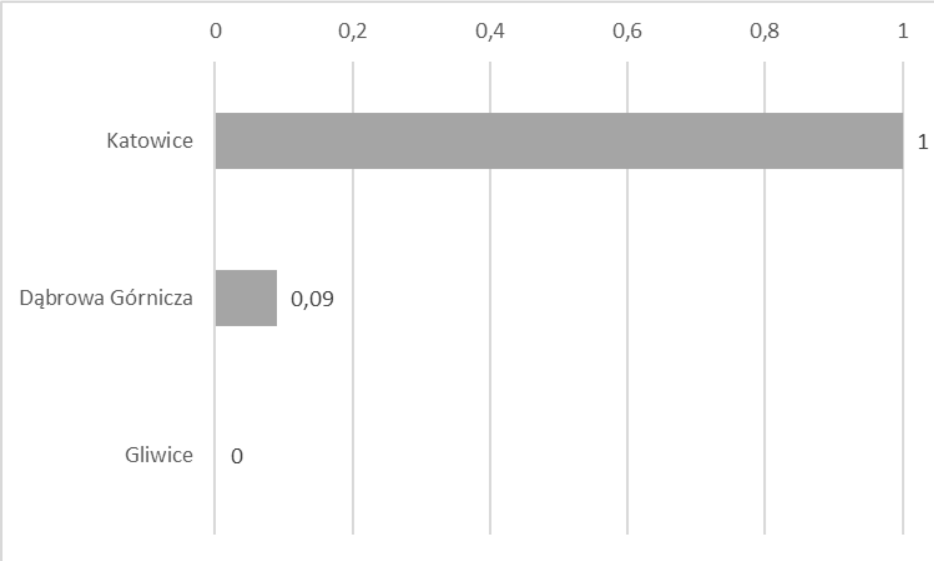

Figure 8. Scootersharing – synthetic indicator limited to cities with described system (baseline period)

Source: Own elaboration based on conducted research.

The analysis indicates that the development of scootersharing in the cities of the Metropolis GZM, limited only to those with such systems, is significantly more homogeneous and less asymmetric. The obtained coefficient of asymmetry is 1.68, which is a value about 61% lower than in the case of the entire metropolis. There is still a significant right-skewed asymmetry, although the situation is not as extreme in the analysed case. The obtained value of kurtosis excess is also significantly lower, namely 1.50 (which is a result more than 13 times lower than in the case of the entire metropolis). However, the observed distribution still has a leptokurtic character. The mean value of the obtained synthetic index is about 0.36, which in relation to the value of excess kurtosis shows that the entire system is relatively poorly developed (compared to the benchmark city, which is Katowice). The value of the resultant indicator was also calculated, which informs about the potential range of development of this system in the Metropolis GZM. The value of the discussed indicator is 9.51%, and thus, by relating the entire metropolis to the benchmark city (in this case, Katowice), the potential for the development of the scootersharing system is 90.49% (ceteris paribus). However, it should be emphasized again that this result is certainly inflated, as it results from the significant diversity of municipalities included in the Metropolis GZM.

Similarly to carsharing and bikesharing, the Metropolis GZM does not have a well-developed and evenly distributed system of scootersharing. However, it should be noted that the concept of short-term rental of electric scooters and kick scooters is relatively new. On the other hand, one can wonder whether it is only a temporarily popular social trend that will soon disappear or a solution that will permanently become a part of the landscape of modern cities. The latter option seems to be supported by an increasing awareness of society regarding human impact on the natural environment. The next few years will determine the future of this concept, but it is worth noting that there is great potential for its further development in the Metropolis GZM.

The research conducted in the study indicates that sharing economy solutions in the Metropolis GZM are characterized by significant asymmetry. Furthermore, this situation occurs both in the case of analysing the entire urban area (including smaller, poorer, and less economically developed cities and municipalities, where the asymmetry of solutions compared to larger urban centres seems natural and justified) and in the case of analysing only centres that have such systems and are continuously developing them. Table 19 presents the synthetic results of the conducted research on the asymmetry of sharing economy solutions in the Metropolis GZM in baseline period – both in a broad approach (the entire metropolitan area) and in a narrow approach (analysis limited only to areas developing a given category of solutions).

Table 19. Summary of the obtained results for baseline period

Perspective	Asymmetry coefficient – $NA_{(Si)}$	Kurtosis excess – $NEK_{(Si)}$	Composite indicator – wS_i
Carsharing (broad approach)	4.83	25.16	9.99%
Carsharing (narrow approach)	1.32	1.88	n/a
Bikesharing (broad approach)	4.32	19.50	12.71%
Bikesharing (narrow approach)	1.42	0.70	n/a
Scootersharing (broad approach)	4.34	19.94	9.51%
Scootersharing (narrow approach)	1.68	1.50	n/a

Source: Own elaboration based on conducted research.

As the results of the conducted study show, there is significant right skewness and leptokurtic distribution in each case. These results are significantly higher in the analysis of the entire Metropolis GZM (as particularly evident in the obtained kurtosis excess results). In a broader perspective, carsharing shows the greatest right skewness, followed by bikesharing and scootersharing in a virtual tie. However, it should be noted that these differences are relatively small. The situation is reversed in the narrower analysis – scootersharing shows the greatest skewness, followed by bikesharing, while carsharing has the least skewed distribution. As with the broader analysis, the differences in the narrower analysis are also small.

The structure of the obtained kurtosis excess results is very similar – all the analysed solutions are characterized by a leptokurtic distribution, which is always significantly higher in the broader perspective of the study. In the analysis of the entire Metropolis GZM, the strongest leptokurtic distribution was observed in carsharing services, followed by scootersharing and bikesharing at a very similar level. These high kurtosis excess results (indicating a significantly more slender distribution) are related to a very large number of municipalities in which none of the analysed sharing economy solutions occur. Interestingly, even when analysing only the cities that develop such systems (narrower perspective), a leptokurtic distribution was obtained – however, it should be noted that it is significantly less slender. In the narrower perspective, the structure of the obtained distribution remains unchanged – carsharing solutions still have the strongest leptokurtic distribution, followed by scootersharing and bikesharing.

The final element of the asymmetry analysis was to determine the accident rate indicator, which informs about the level of development of a given system and its potential for further expansion. The most extensive system turned out to be bikesharing, which is due to the fact that the most cities decided to implement it, resulting in a relatively high percentage of the population having access to city bikes. Carsharing and scootersharing solutions obtained worse results. Nevertheless, assuming ceteris paribus assumption, each of these systems still has very significant potential for development.

To finally determine the level of asymmetry of solutions in the field of sharing economy in the urban logistics networks of the Metropolis GZM, it is necessary to calculate the averages for the obtained results. The average values of individual coefficients are presented in Table 20.

Table 20. Average values of obtained indicators for the baseline period

Perspective	Asymmetry coefficient – $NA_{(Si)}$	Kurtosis excess – $NEK_{(Si)}$	Composite indicator – wS_i
Broad approach	≈ 4.50	≈ 21.53	≈ 10.74%
Narrow approach	≈ 1.47	1.36	n/a

Source: Own elaboration based on conducted research.

The average values of the obtained indicators for the base period clearly confirm the existence of asymmetry in the solutions of the sharing economy in the urban logistics networks of the Metropolis GZM in baseline period. This is evidenced by both the asymmetry coefficient and very high excess kurtosis results (which, in relation to the average values of individual synthetic measures, indicate a relatively low level of development of individual solutions). The obtained accident rate indicator also informs about the uneven distribution of these solutions – a large potential development area for the entire system clearly shows that in many places, the sharing economy system can be further developed (in relation to benchmark results), which also seems to confirm the existence of asymmetry in these solutions.

Next, data on shared mobility solutions for the Metropolis GZM area in the baseline period was used for analysis. Cities and municipalities where no shared mobility solutions exist were excluded from the analysis. It should also be noted that there are varying numbers of solutions within each city/municipality in the analysed area. All variables are stimulants:

- X_1 – carsharing – average number of available vehicles per thousand inhabitants,
- X_2 – carsharing – average city coverage level with zones [%],
- X_3 – bikesharing – number of bikes per thousand inhabitants,
- X_4 – bikesharing – number of stations per thousand inhabitants,
- X_5 – number of available scooters per thousand inhabitants,
- X_6 – number of available electric scooters per thousand inhabitants.

Table 21 shows aggregated data representing the values of variables for all solutions in the analysed area.

Table 21. Shared mobility in Metropolis GZM (baseline period)

City	X_1	X_2	X_3	X_4	X_5	X_6
Chorzów	0.15	16,67	4,22	1,36	0,00	0,00
Dąbrowa Górnicza	0,00	0,00	0.00	0.00	0.21	0.25
Gliwice	0	0	0.83	0.11	0.20	0.18
Katowice	0.27	80	2.13	0.46	0.26	1.45
Ruda Śląska	0.02	0.00	0.00	0.00	0.00	0.00
Siemianowice Śląskie	0.01	1.67	1.66	0.43	0.00	0.00
Sosnowiec	0.00	0.00	0.64	0.11	0.00	0.00
Świętochłowice	0.18	3.33	0.00	0.00	0.00	0.00
Tychy	0.00	0.00	0.47	0.09	0.00	0.00
Zabrze	0.00	0.00	0.37	0.10	0.00	0.00
Coefficient of variation	1.48	2.34	1.22	1.49	1.55	2.28

Source: Own elaboration based on conducted research.

All variables exhibit high level of coefficient of variation ($V(x_j) > 0.1$), therefore none of them was rejected at this stage of analysis. The next step was to determine the correlation between variables. A correlation matrix was created and then inverted (R^{-1}). The variable that has the highest value on the diagonal of the inverted correlation matrix and exceeds the established critical value should be discarded – this procedure (first iteration) is presented in Table 22.

Table 22. Analysis of correlations, first iteration (baseline period)

	Correlation matrix (first iteration)					
	X_1	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**
X_1	1.00	0.83	0.48	0.44	0.30	0.69
X_2	0.83	1.00	0.46	0.35	0.58	0.95
X_3	0.48	0.46	1.00	0.98	0.03	0.24
X_4	0.44	0.35	0.98	1.00	–0.08	0.11
X_5	0.30	0.58	0.03	–0.08	1.00	0.77
X_6	0.69	0.95	0.24	0.11	0.77	1.00
	Inverted correlation matrix (first iteration)					
	X_1	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**
X_1	15.20	–100.33	11.98	3.85	–23.51	99.64
X_2	–100.33	876.47	–43.12	–102.76	219.06	–910.38
X_3	11.98	–43.12	79.42	–72.02	–8.67	28.34
X_4	3.85	–102.76	–72.02	90.24	–27.71	123.53
X_5	–23.5129	219.0553	–8.67139	–27.7148	58.10571	–231.48
X_6	99.64	–910.38	28.34	123.53	–231.48	**954.87**

Source: Own elaboration based on conducted research.

Variable X_6 should be discarded. Table 23 shows the subsequent iterations of the discussed procedure.

Table 23. Analysis of correlations, next iterations (baseline period)

	Correlation matrix (second iteration)				
	X_1	**X_2**	**X_3**	**X_4**	**X_5**
X_1	1.00	0.83	0.48	0.44	0.30
X_2	0.83	1.00	0.46	0.35	0.58
X_3	0.48	0.46	1.00	0.98	0.03
X_4	0.44	0.35	0.98	1.00	–0.08
X_5	0.30	0.58	0.03	–0.08	1.00

Table 23 cont.

	Inverted correlation matrix (second iteration)				
	X_1	X_2	X_3	X_4	X_5
X_1	4.81	–5.33	9.03	–9.04	0.64
X_2	–5.33	8.51	–16.09	15.02	–1.64
X_3	9.03	–16.09	**78.58**	–75.69	–1.80
X_4	–9.04	15.02	–75.69	74.26	2.23
X_5	0.64	–1.64	–1.80	2.23	1.99

	Correlation matrix (third iteration)			
	X_1	X_2	X_4	X_5
X_1	1.00	0.83	0.44	0.30
X_2	0.83	1.00	0.352492	0.58
X_4	0.44	0.35	1.00	–0.08
X_5	0.30	0.58	–0.08	1.00

	Inverted correlation matrix (third iteration)			
	X_1	X_2	X_4	X_5
X_1	3.77	–3.48	–0.35	0.85
X_2	–3.48	5.21	–0.48	–2.01
X_4	–0.35	–0.48	1.36	0.50
X_5	0.85	–2.01	0.50	1.95

Source: Own elaboration based on conducted research.

The third iteration does not result in the rejection of any variable. The next stage of the analysis was the normalization of variables. The resulting matrix of normalized diagnostic variable values is presented in Table 24.

Table 24. Normalization of variables (baseline period)

City	Variable			
	X_1	X_2	X_4	X_5
Chorzów	0.88	0.27	2.75	–0.65
Dąbrowa Górnicza	–0.68	–0.43	–0.67	1.35
Gliwice	–0.68	–0.43	–0.39	1.28
Katowice	2.23	2.94	0.49	1.90
Ruda Śląska	–0.45	–0.43	–0.67	–0.65
Siemianowice Śląskie	–0.52	–0.36	0.42	–0.65
Sosnowiec	–0.68	–0.43	–0.39	–0.65
Świętochłowice	1.22	–0.29	–0.67	–0.65
Tychy	–0.68	–0.43	–0.45	–0.65
Zabrze	–0.68	–0.43	–0.42	–0.65

Source: Own elaboration based on conducted research.

The next step of the analysis was to measure the similarity of objects using the Hellwig development measure, and to group the cities/municipalities in GZM accordingly. The results are presented in Table 25.

Table 25. Ranking of cities / municipalities (baseline period)

City	d_{i0}	s_i
Chorzów	3.92	0.48
Dąbrowa Górnicza	5.63	0.25
Gliwice	5.47	0.28
Katowice	2.25	0.70
Ruda Śląska	6.05	0.20
Siemianowice Śląskie	5.51	0.27
Sosnowiec	6.01	0.20
Świętochłowice	5.44	0.28
Tychy	6.04	0.20
Zabrze	6.023	0.20
Group		s_i
First group (very good objects)		$s_i > 0.46$
Second group (good objects)		$0.46 > s_i \geq 0.31$
Third group (bad objects)		$0.31 > s_i \geq 0.15$
Fourth group (very bad objects)		$0.15 > s_i$
City	s_i	Group
Katowice	0.70	First
Chorzów	0.48	First
Świętochłowice	0.28	Third
Gliwice	0.28	Third
Siemianowice Śląskie	0.27	Third
Dąbrowa Górnicza	0.25	Third
Sosnowiec	0.20	Third
Zabrze	0.20	Third
Tychy	0.20	Third
Ruda Śląska	0.20	Third

Source: Own elaboration based on conducted research.

It is worth noting that no cities/municipalities belonging to second group (good objects) and fourth group (very bad objects) were observed. The data from the table were also presented on the map of the Metropolis GZM (Figure 9). Additionally, cities/municipalities that do not have any shared mobility systems are marked in white.

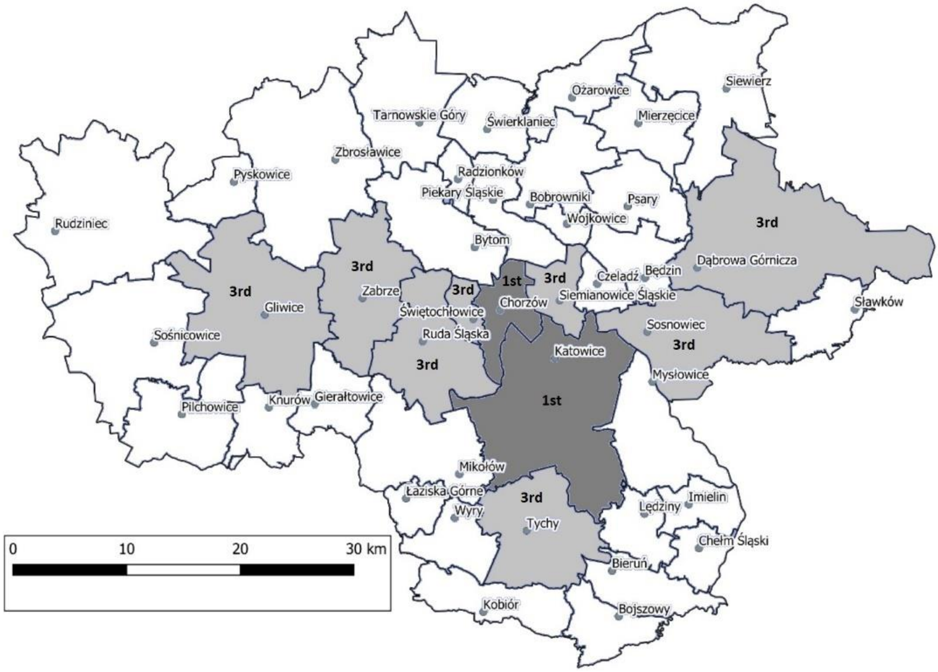

Figure 9. Shared mobility in baseline period – division of cities/municipalities according to the standard deviation method

Source: Own elaboration based on conducted research and [GZM, 2021].

According to the division of cities and municipalities in Metropolis GZM using the standard deviation method, they are characterized by a relatively weak level of development of shared mobility solutions. However, it should be noted that all identified areas that have shared mobility solutions belong to the core of the metropolis. As a complement to the analysis, a division of cities/municipalities was also made using the Ward method. The obtained dendrogram and agglomeration plot are presented in Figure 10.

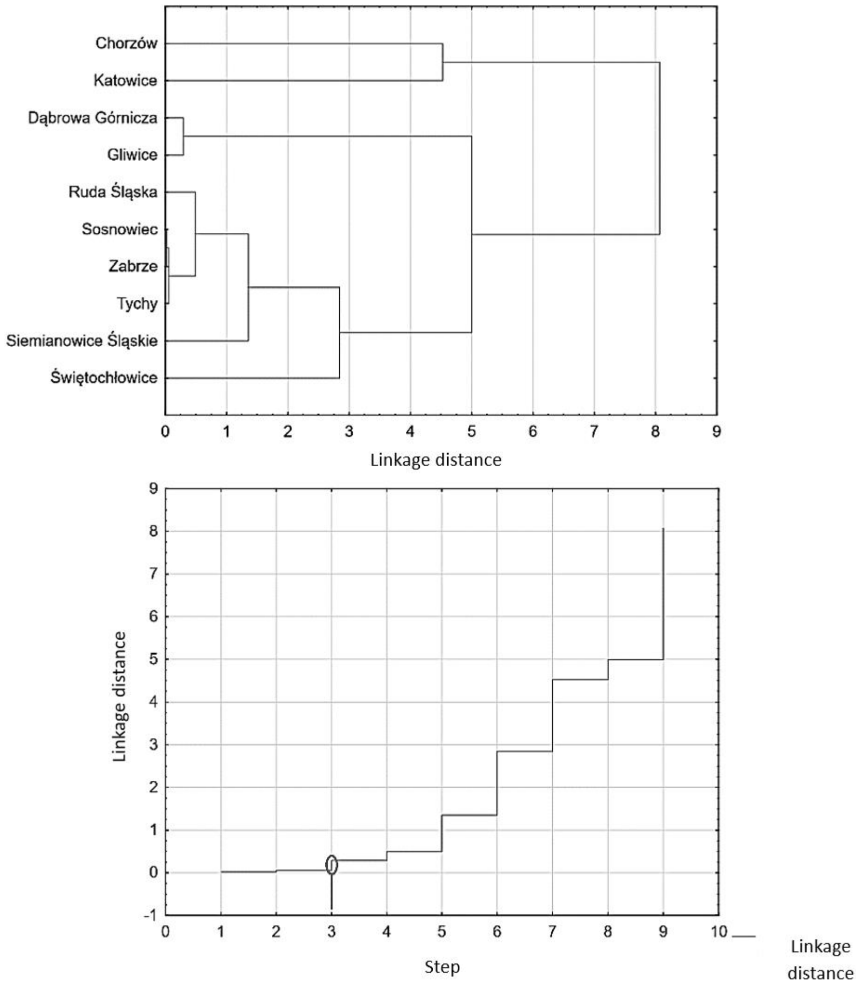

Figure 10. Shared mobility in baseline period – dendrogram and agglomeration plot

Source: Own elaboration based on conducted research.

Step 3 is the point of division according to the ratio formula (maximum value for the linkage distance ratio at the level of 5.27). However, it is worth noting that the differential formula indicated the division of the tree after step 9 (maximum value for the linkage distance differences at the level of 3.07) – but dividing the tree after the last step would be pointless as it would result in only one group. Therefore, 5 groups of cities/communes were created, as presented in Figure 11.

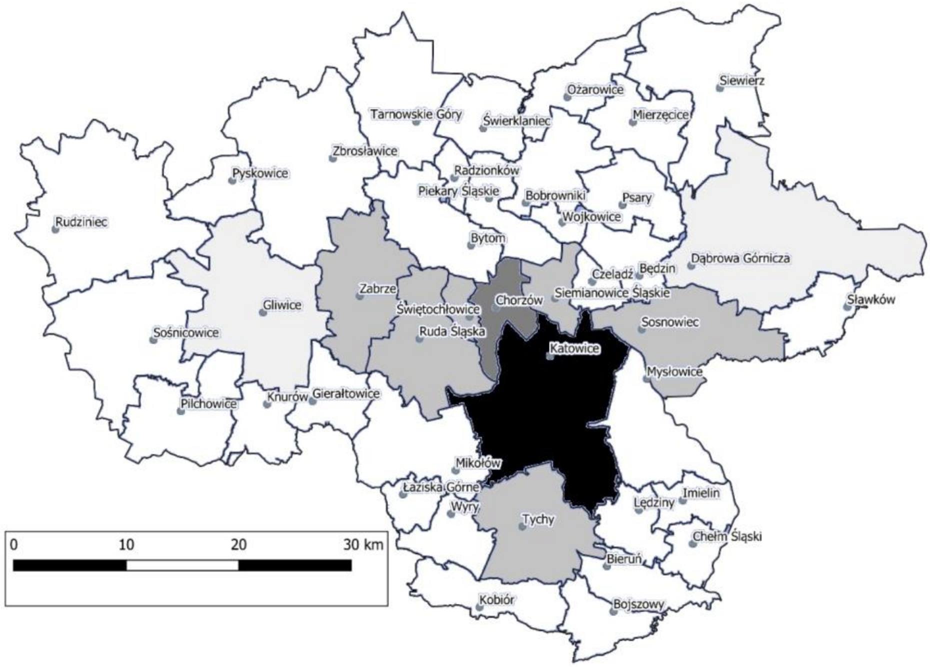

Figure 11. Shared mobility in baseline period – division of cities/municipalities according to the Ward's method and the agglomeration plot

Source: Own elaboration based on conducted research and [GZM, 2021].

The results of dividing the cities and municipalities of Metropolis GZM according to the Ward method and the agglomeration process once again confirm the existence of asymmetry in solutions within the Metropolis area. Moreover, a higher degree of development of the Metropolis GZM core area in terms of shared mobility solutions can be observed compared to other municipalities and cities of the Metropolis. However, it should be noted that the overall level of development of both the entire Metropolis and its core is still relatively weak.

3.3. Analysis for the reference period (2021)

Carsharing in the Metropolis GZM has changed significantly between the baseline period and the reference period. Although there were no significant differences in the number of operating operators, their areas have significantly expanded. Table 26 presents the aggregated data, synthetic indicator values for entire Metropolis GZM and only for cities with carsharing systems.

Table 26. Carsharing – data set for reference period

Aggregated data		
City	**Average number of available vehicles per thousand inhabitants**	**Average level of city coverage by operating zones**
Będzin	0.04	5.00%
Bytom	0.01	5.00%
Chorzów	0.22	45.00%
Czeladź	0.16	22.50%
Dąbrowa Górnicza	0.030	5.00%
Gliwice	0.02	20.00%
Katowice	0.26	72.50%
Knurów	0.03	20.00%
Łaziska Górne	0.05	5.00%
Mikołów	0.05	5.00%
Mysłowice	0.03	7.50%
Piekary Śląskie	0.02	2.50%
Ruda Śląska	0.03	5.00%
Siemianowice Śląskie	0.24	22.50%
Sosnowiec	0.16	40.00%
Świętochłowice	0.24	45.00%
Tarnowskie Góry	0.02	2.50%
Tychy	0.04	7.50%
Zabrze	0.01	5.00%
Synthetic indicator for the entire Metropolis GZM		
City	**Synthetic number of available vehicles**	**Synthetic coverage level of the city by zones**
Będzin	0.14	0.07
Bytom	0.05	0.07
Chorzów	0.86	0.62
Czeladź	0.62	0.31
Dąbrowa Górnicza	0.10	0.07
Gliwice	0.09	0.28
Katowice	1.00	1.00
Knurów	0.10	0.28
Łaziska Górne	0.17	0.07
Mikołów	0.19	0.07
Mysłowice	0.10	0.10
Piekary Śląskie	0.07	0.03
Ruda Śląska	0.11	0.07
Siemianowice Śląskie	0.92	0.31
Sosnowiec	0.62	0.55
Świętochłowice	0.93	0.62

Table 26 cont.

Tarnowskie Góry	0.06	0.03
Tychy	0.15	0.10
Zabrze	0.02	0.07
Other cities (22)	0.00	0.00
Synthetic indicator limited to cities with described system		
City	**Synthetic number of available vehicles**	**Synthetic coverage level of the city by zones**
Będzin	0.12	0.04
Bytom	0.03	0.04
Chorzów	0.86	0.61
Czeladź	0.61	0.29
Dąbrowa Górnicza	0.08	0.04
Gliwice	0.07	0.25
Katowice	1.00	1.00
Knurów	0.08	0.25
Łaziska Górne	0.15	0.04
Mikołów	0.17	0.04
Mysłowice	0.08	0.07
Piekary Śląskie	0.05	0.00
Ruda Śląska	0.09	0.04
Siemianowice Śląskie	0.92	0.29
Sosnowiec	0.61	0.54
Świętochłowice	0.93	0.61
Tarnowskie Góry	0.04	0.00
Tychy	0.13	0.07
Zabrze	0.00	0.04

Source: Own elaboration based on conducted research.

The next step of the analysis was to synthesize the obtained results in order to determine the asymmetry of the solutions. Figure 12 shows the values of the synthetic indicator for the entire Metropolis GZM.

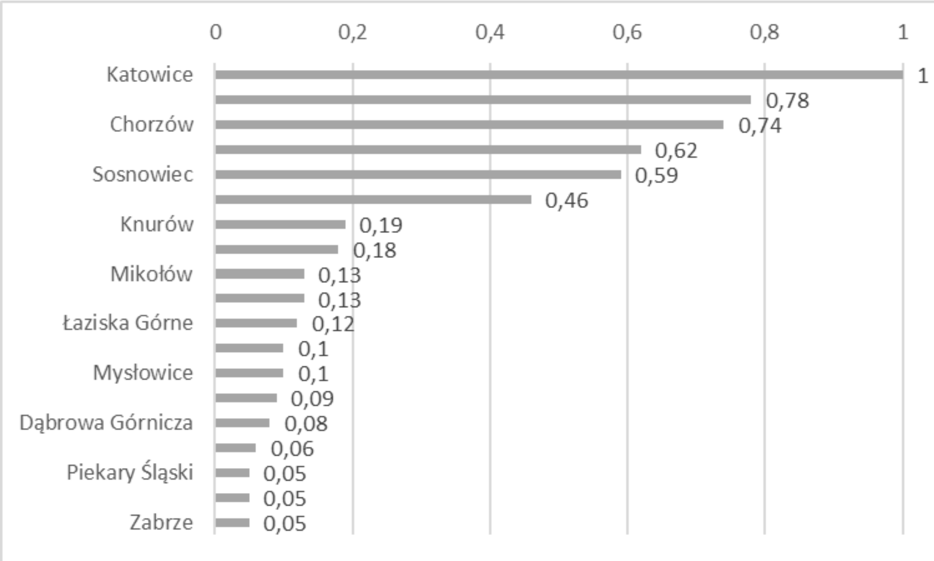

Figure 12. Carsharing – synthetic indicator for the entire Metropolis (reference period)

Source: Own elaboration based on conducted research.

After conducting the analysis, Katowice once again proved to be the reference city. Carsharing solutions in the Metropolis GZM still exhibit right-sided asymmetry ($NA(S_i) \approx 2.21$), but this is a lower result than in the analysis for 2020 (where $NA(S_i) \approx 4.83$). Therefore, it can be assumed that this system will strive towards a symmetrical distribution, but it will probably never achieve it (ceteris paribus). The distribution of obtained results is again leptokurtic ($NEK(S_i) \approx \approx 4.00$) – however, this is a result significantly lower than in the previous analysis (where $NEK(S_i) \approx 25.16$). This situation confirms that the system is moving towards a normal distribution. The last step of the updated analysis was to perform the entire research procedure again, this time limiting it to cities and municipalities that have carsharing solutions (Figure 13).

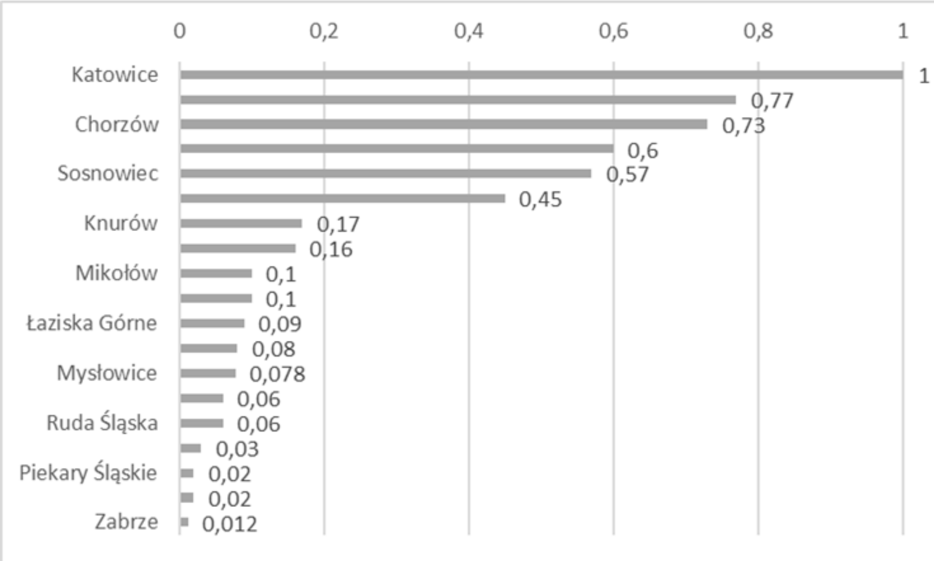

Figure 13. Carsharing – synthetic indicator limited to cities with described system (reference period)

Source: Own elaboration based on conducted research.

Based on the supplementary analysis that only took into account cities and municipalities with a carsharing system, the skewness index ($NA(S_i) \approx 1.18$) decreased compared to both the updated analysis of the entire Metropolis and the analysis from 2020 ($NA(S_i) \approx 1.32$). The situation is very similar in the case of kurtosis excess – in the updated analysis, $NEK(S_i) \approx 0.05$, while in the 2020 analysis, $NEK(S_i) \approx 1.88$.

The last element of the updated analysis was to calculate the accident index for the carsharing system, which amounted to 24.27% (compared to the previous value of 9.99%, which gives an increase of as much as 14.28 percentage points – this is how much the development of the entire system has increased since the analysis conducted in 2020). The accident index value at the level of 24.27%, with simultaneous access of cities and municipalities to the carsharing system, which account for 90.24% of the entire population of the Metropolis GZM, still indicates a relatively early stage of development of this system.

In the Metropolis GZM, once again, the presence of right-skewed carsharing solutions can be observed. This situation occurs both in the case of analysing all municipalities belonging to the Metropolis and in the case of analysing only cities that have access to carsharing services. However, it should be noted that in both cases, the identified asymmetry is much weaker than in 2020.

In 2021, as in 2020, the bikesharing system operates in 7 cities in the Metropolis GZM. Table 27 presents the aggregated data, synthetic indicator values for entire Metropolis GZM and only for cities with bikesharing systems.

Table 27. Bikesharing – data set for reference period

Aggregated data		
City	**Average number of stations per square kilometre**	**Average number of bicycles per thousand residents**
Chorzów	1.39	4.31
Gliwice	0.22	1.69
Katowice	0.46	2.14
Siemianowice Śląskie	0.47	1.81
Sosnowiec	0.24	1.37
Tychy	0.09	0.47
Zabrze	0.16	0.35
Synthetic indicator for the entire Metropolis GZM		
City	**Synthetic number of stations**	**Synthetic number of bicycles**
Chorzów	1.00	1.00
Gliwice	0.39	0.16
Katowice	0.50	0.33
Siemianowice Śląskie	0.42	0.34
Sosnowiec	0.32	0.17
Tychy	0.11	0.06
Zabrze	0.08	0.12
Other cities (34)	0.00	0.00
Synthetic indicator limited to cities with described system		
City	**Synthetic number of stations**	**Synthetic number of bicycles**
Chorzów	1.00	1.00
Gliwice	0.34	0.11
Katowice	0.45	0.29
Siemianowice Śląskie	0.37	0.30
Sosnowiec	0.26	0.12
Tychy	0.03	0.00
Zabrze	0.00	0.06

Source: Own elaboration based on conducted research.

Once again, the next step of the analysis was to synthesize the obtained results in order to determine the asymmetry of the solutions. Figure 14 shows the values of the synthetic indicator for the entire Metropolis GZM.

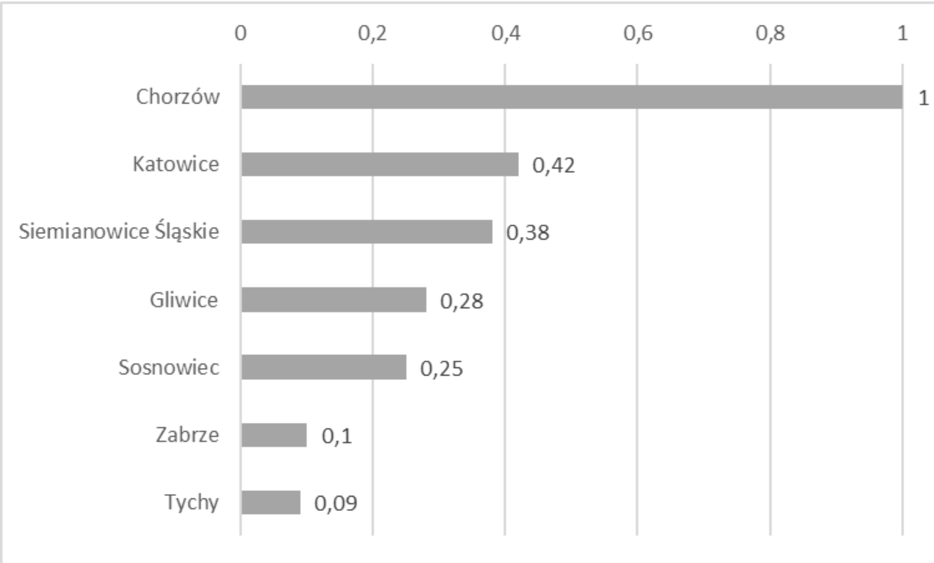

Figure 14. Bikesharing – synthetic indicator for the entire Metropolis (reference period)

Source: Own elaboration based on conducted research.

The analysis confirms once again that the development of the urban bikesharing system in the Metropolis GZM is very uneven. Chorzów achieved the best results in the entire Metropolis once again. The development of bikesharing remains asymmetric – the asymmetry coefficient for the analysed case is 4.01, indicating a strong right-skewed distribution. However, this is a lower result than in 2020 (where $NA(S_i) = 4.32$). The situation is similar with the kurtosis excess, which has a value of 18.33. The result also indicates a strong leptokurtic distribution, but again, this is a lower result than in 2020 (where $NEK(S_i) = 19.50$). The average value of the synthetic index is 0.06, which represents an increase compared to 2020 (where $mS_i = 0.05$). Next step of the bikesharing analysis was to perform the entire research procedure again, this time limiting it to cities and municipalities that have described solutions (Figure 15).

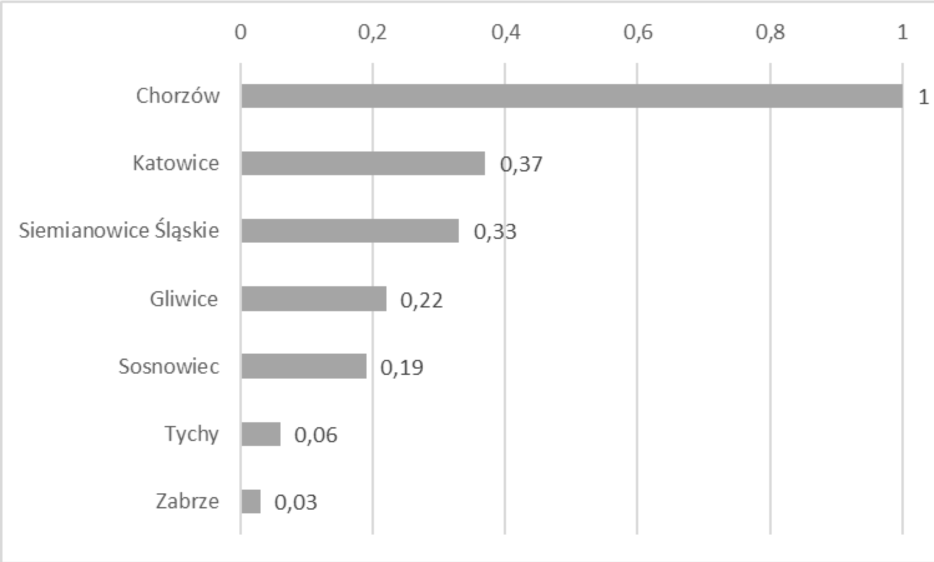

Figure 15. Bikesharing – synthetic indicator limited to cities with described system (reference period)

Source: Own elaboration based on conducted research.

The development of city bike systems limited only to cities that have such a system is more homogeneous. However, it should be noted that the coefficient of asymmetry for the analysed group in 2021 is 1.77. This is a higher value than in 2020 (where $NA(S_i) = 1.42$). The situation looks very similar in the case of kurtosis excess, whose value in 2021 is 3.72 (a further increase compared to 2020, where $NEK(S_i) = 0.70$). The average value of the synthetic indicator for the analysed case is 0.3085 – indicating an increase compared to 2020, where $mS_i = 0.26$. The resulting relative indicator of the development of city bike systems in 2021 is 15.96%, which is an increase of 3.25 percentage points compared to 2020.

In 2021, the Metropolis GZM still does not have a coherent and well-developed city bike system. However, it should be noted that this system is better developed compared to 2020. Interestingly, the coefficient of asymmetry decreased for the entire Metropolis, while it increased for cities that have such a system. This situation may be related to the changing number of people living in individual cities/municipalities. However, the development of the city bike system in the Metropolis is still uneven.

Over the past year, scootersharing in the Metropolis GZM has changed significantly. Table 28 presents the aggregated data, synthetic indicator values for entire Metropolis GZM and only for cities with scootersharing systems.

Table 28. Scootersharing – data set for reference period

Aggregated data		
City	**Number of available scooters per thousand inhabitants**	**Number of available electric scooters per thousand inhabitants**
Bytom	0.00	0.12
Chorzów	0.00	0.47
Dąbrowa Górnicza	0.00	0.34
Gliwice	0.23	0.28
Katowice	0.03	1.55
Sosnowiec	0.05	0.25
Tychy	0.00	0.39
Zabrze	0.00	0.59
Synthetic indicator for the entire Metropolis GZM		
City	**Synthetic number of available scooters**	**Synthetic number of available electric scooters**
Bytom	0.00	0.08
Chorzów	0.00	0.30
Dąbrowa Górnicza	0.00	0.22
Gliwice	1.00	0.18
Katowice	0.15	1.00
Sosnowiec	0.22	0.16
Tychy	0.00	0.25
Zabrze	0.00	0.38
Other cities (33)	0.00	0.00
Synthetic indicator limited to cities with described system		
City	**Synthetic number of available scooters**	**Synthetic number of available electric scooters**
Bytom	0.00	0.00
Chorzów	0.00	0.24
Dąbrowa Górnicza	0.00	0.15
Gliwice	1.00	0.11
Katowice	0.15	1.00
Sosnowiec	0.22	0.09
Tychy	0.00	0.19
Zabrze	0.00	0.32

Source: Own elaboration based on conducted research.

Next, the synthesize of obtained results in order to determine the asymmetry of the solutions was made. Figure 16 shows the values of the synthetic indicator for the entire Metropolis GZM.

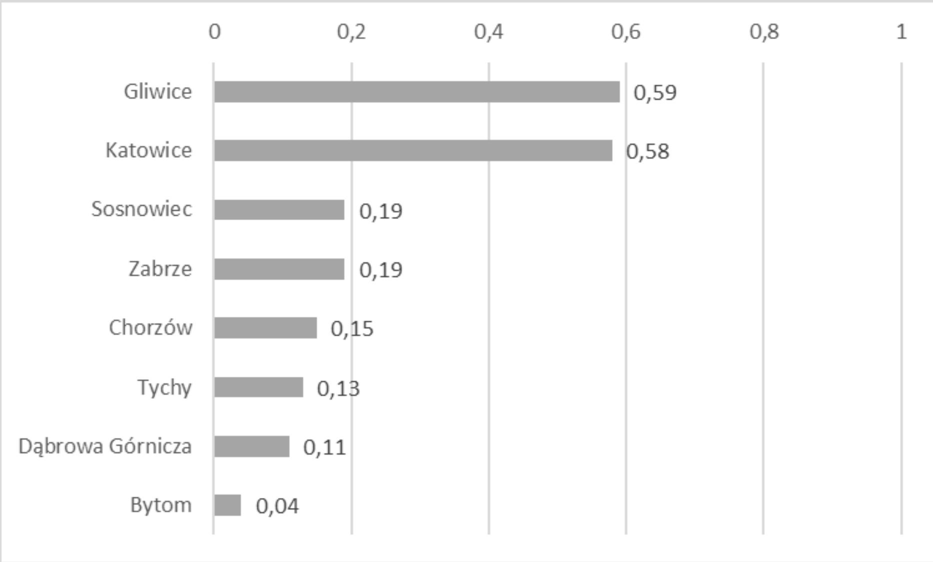

Figure 16. Scootersharing – synthetic indicator for the entire Metropolis (reference period)

Source: Own elaboration based on conducted research.

The development of systems offering scootersharing solutions in the Metropolis GZM is, like in 2020, very uneven – the asymmetry of scootersharing solutions is still strongly right-skewed ($NA(S_i) \approx 3.45$, whereas in 2020 $NA(S_i) \approx$ ≈ 4.34), and the distribution of obtained results is strongly leptokurtic ($NEK(S_i) \approx$ ≈ 11.97, whereas in 2020 $NEK(S_i) \approx 19.94$). However, a significant decrease in both indicators can be observed. It should also be noted that a small increase in the average value of the synthetic indicator was found ($mS_i = 0.048$, whereas in 2020 $mS_i = 0.046$). The asymmetry of solutions was also confirmed by the structure of scootersharing – as many as 33 out of 41 municipalities do not have access to this system (in 2020 it was as many as 38 municipalities). It is also worth noting that no city has achieved the maximum value of the synthetic indicator (i.e., 1) – this situation results from the fact that two different cities serve as a benchmark for two variables describing scootersharing.

The last element of the analysis was the recalculation of indicators, this time only for cities that have scootersharing solutions. The results are presented in Figure 17.

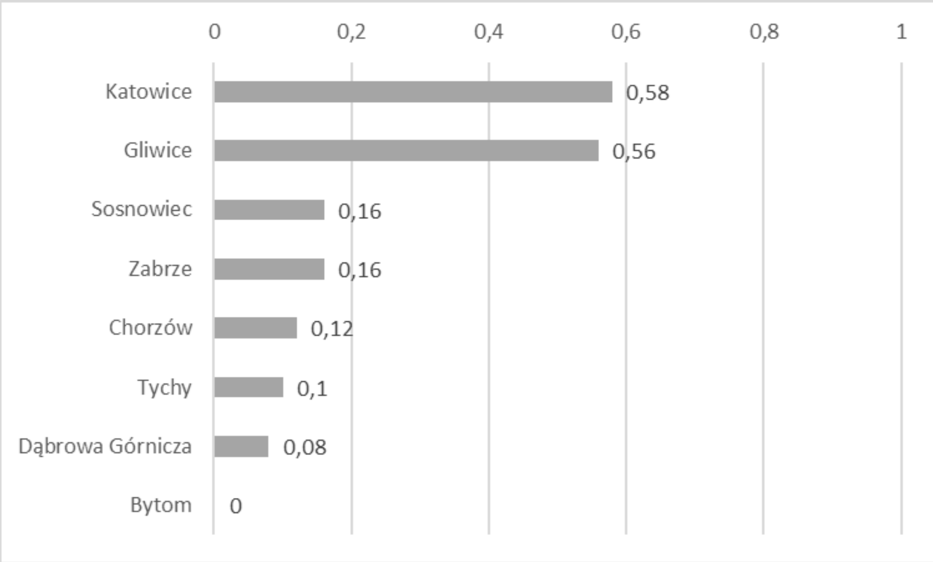

Figure 17. Scootersharing – synthetic indicator limited to cities with described system (reference period)

Source: Own elaboration based on conducted research.

The analysis shows that the development of scootersharing systems in the cities of the Metropolis GZM, limited only to those that have such a system, is, similarly to 2020, significantly more homogeneous and less asymmetric. The obtained coefficient of asymmetry is 1.20 (whereas in 2020 it was 1.68). The result of kurtosis excess is interesting, which in 2021 was –0.22, indicating a platykurtic distribution (in 2020, the distribution was leptokurtic, with a kurtosis excess value of 1.50). There was also a decrease in the mean value of the synthetic index (mS_i = 0.22, while in 2020 it was 0.36). However, it should be noted that despite the decrease in the mean value of this index, an increase in the value of the accident index was observed (wS_i = 13.41%, while in 2020 it was 9.51%). This situation is related to the fact that the number of cities that have solutions in the field of scootersharing has increased, which has also increased the share of the Metropolis population that can benefit from these solutions.

Similarly to carsharing and bikesharing, in 2021, the Metropolis GZM does not have a well-developed and evenly distributed scootersharing system. However, it is worth noting that the asymmetry of the distribution of these solutions has decreased.

The conducted research shows that in 2021, the solutions in the field of sharing economy operating in the Metropolis GZM still exhibit significant asymmetry. This situation once again applies both to the analysis of the entire group and to the analysis of only the cities that have such systems. Table 29 presents synthetic results of the conducted research on the asymmetry of sharing mobility solutions in the Metropolis GZM in 2021. The data concerns both a broad approach (the entire metropolitan area) and a narrow approach (only areas developing a given category of solutions).

Table 29. Summary of the obtained results for reference period

Perspective	Asymmetry coefficient – $NA_{(Si)}$	Kurtosis excess – $NEK_{(Si)}$	Composite indicator – wS_i
Carsharing (broad approach)	2.21	4.00	24.27%
Carsharing (narrow approach)	1.18	0.05	n/a
Bikesharing (broad approach)	4.01	18.33	15.96%
Bikesharing (narrow approach)	1.77	3.72	n/a
Scootersharing (broad approach)	3.45	11.97	13.41%
Scootersharing (narrow approach)	1.20	–0.22	n/a

Source: Own elaboration based on conducted research.

In practically every case, there is right-skewed asymmetry and leptokurtic distribution. The exception is the narrow scope of scootersharing, where a platykurtic distribution was observed. Bikesharing (which is also the most developed system) has the highest asymmetry, followed by scootersharing (the least developed system), and carsharing has the lowest. The final element of the analysis was to calculate the average value of each coefficient, as shown in Table 30.

Table 30. Average values of obtained indicators for the reference period

Perspective	Asymmetry coefficient – $NA_{(Si)}$	Kurtosis excess – $NEK_{(Si)}$	Composite indicator – wS_i
Broad approach	≈ 3.22	≈ 11.43	≈ 17.88%
Narrow approach	≈ 1.38	≈ 1.18	n/a

Source: Own elaboration based on conducted research.

The average results of the obtained metrics once again confirm the existence of asymmetry in shared mobility solutions in the urban logistics networks of the Metropolis GZM in 2021. Similarly, the value of the accident index confirms the thesis of uneven distribution of these solutions. It can therefore be clearly stated that there is still an asymmetry of solutions in the field of sharing economy in the Metropolis GZM in 2021.

Next, data on shared mobility solutions for the Metropolis GZM area in the reference period was used for analysis. Once again, cities and municipalities where no shared mobility solutions exist were excluded from the analysis. All variables are stimulants (same as in the baseline period):

- X_1 – carsharing – average number of available vehicles per thousand inhabitants,
- X_2 – carsharing – average city coverage level with zones [%],
- X_3 – bikesharing – number of bikes per thousand inhabitants,
- X_4 – bikesharing – number of stations per thousand inhabitants,
- X_5 – number of available scooters per thousand inhabitants,
- X_6 – number of available electric scooters per thousand inhabitants.

Table 31 shows aggregated data representing the values of variables for all solutions in the analysed area.

Table 31. Shared mobility in Metropolis GZM (baseline period)

City	X_1	X_2	X_3	X_4	X_5	X_6
Będzin	0.04	5.00	0.00	0.00	0.00	0.00
Bytom	0.01	5.00	0.00	0.00	0.00	0.12
Chorzów	0.22	45.00	4.31	1.39	0.00	0.47
Czeladź	0.16	22.50	0.00	0.00	0.00	0.00
Dąbrowa Górnicza	0.03	5.00	0.00	0.00	0.00	0.34
Gliwice	0.02	20.00	1.69	0.22	0.23	0.28
Katowice	0.26	72.50	2.14	0.46	0.03	1.55
Knurów	0.03	20.00	0.00	0.00	0.00	0.00
Łaziska Górne	0.05	5.00	0.00	0.00	0.00	0.00
Mikołów	0.05	5.00	0.00	0.00	0.00	0.00
Mysłowice	0.03	7.50	0.00	0.00	0.00	0.00
Piekary Śląskie	0.02	2.50	0.00	0.00	0.00	0.00
Ruda Śląska	0.03	5.00	0.00	0.00	0.00	0.00
Siemianowice Śląskie	0.24	22.5	1.81	0.47	0.00	0.00
Sosnowiec	0.16	40.00	1.37	0.24	0.05	0.25
Świętochłowice	0.24	45.00	0.00	0.00	0.00	0.00
Tarnowskie Góry	0.02	2.50	0.00	0.00	0.00	0.00
Tychy	0.04	7.50	0.471	0.09	0.00	0.39
Zabrze	0.01	5.00	0.35	0.16	0.00	0.59
Coefficient of variation	1.05	1.05	1.75	2.04	3.13	1.74

Source: Own elaboration based on conducted research.

All variables exhibit high level of coefficient of variation ($V(x_j) > 0.1$), therefore none of them was rejected at this stage of analysis. The next step of the analysis was to determine the correlation between variables. A correlation matrix and an inverted correlation matrix were created. The variable with the highest value on the diagonal of the inverted correlation matrix and a value above the established critical value should be rejected. The first iteration of the variable selection procedure is presented in Table 32.

Table 32. Analysis of correlations, first iteration (reference period)

	Correlation matrix (first iteration)					
	X_1	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**
X_1	1.00	0.87	0.62	0.59	–0.05	0.38
X_2	0.87	1.00	0.66	0.57	0.19	0.65
X_3	0.62	0.66	1.00	0.97	0.30	0.51
X_4	0.59	0.57	0.97	1.00	0.09	0.43
X_5	–0.05	0.19	0.30	0.09	1.00	0.18
X_6	0.38	0.65	0.51	0.43	0.18	1.00
	Inverted correlation matrix (first iteration)					
	X_1	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**
X_1	8.80	–7.82	–11.93	9.09	4.10	3.17
X_2	–7.82	9.74	3.17	–2.31	–2.32	–3.53
X_3	–11.93	3.17	98.91	–85.06	–21.78	–7.61
X_4	9.09	–2.31	–85.06	74.84	18.53	6.02
X_5	4.10	–2.32	–21.78	18.53	6.14	2.01
X_6	3.17	–3.53	–7.61	6.02	2.01	3.02

Source: Own elaboration based on conducted research.

Variable X_3 should be discarded. Table 33 shows the subsequent iterations of the discussed procedure.

Table 33. Analysis of correlations, next iterations (reference period)

	Correlation matrix (second iteration)				
	X_1	**X_2**	**X_4**	**X_5**	**X_6**
X_1	1.00	0.87	0.59	–0.05	0.38
X_2	0.87	1.00	0.57	0.19	0.65
X_4	0.59	0.57	1.00	0.09	0.43
X_5	–0.05	0.19	0.09	1.00	0.18
X_6	0.38	0.65	0.43	0.18	1.00

Table 33 cont.

	Inverted correlation matrix (second iteration)				
	X_1	X_2	X_4	X_5	X_6
X_1	7.36	–7.44	–1.17	1.47	2.25
X_2	–7.44	9.64	0.41	–1.63	–3.29
X_4	–1.17	0.41	1.69	–0.20	–0.52
X_5	1.47	–1.63	–0.20	1.34	0.34
X_6	2.25	–3.29	–0.52	0.34	2.43

Source: Own elaboration based on conducted research.

The second iteration does not result in the rejection of any variable. The next stage of the analysis was the normalization of variables. The resulting matrix of normalized diagnostic variable values is presented in Table 34.

Table 34. Normalization of variables (baseline period)

City	Variable				
	X_1	X_2	X_4	X_5	X_6
Będzin	–0.56	–0.69	–0.49	–0.32	–0.57
Bytom	–0.82	–0.69	–0.49	–0.32	–0.24
Chorzów	1.51	1.42	3.77	–0.32	0.70
Czeladź	0.82	0.24	–0.49	–0.32	–0.57
Dąbrowa Górnicza	–0.67	–0.69	–0.49	–0.32	0.35
Gliwice	–0.70	0.10	0.20	4.10	0.20
Katowice	1.92	2.87	0.93	0.35	3.65
Knurów	–0.66	0.10	–0.49	–0.32	–0.57
Łaziska Górne	–0.46	–0.69	–0.49	–0.32	–0.57
Mikołów	–0.42	–0.69	–0.49	–0.32	–0.57
Mysłowice	–0.66	–0.55	–0.49	–0.32	–0.57
Piekary Śląskie	–0.75	–0.82	–0.49	–0.32	–0.57
Ruda Śląska	–0.63	–0.69	–0.49	–0.32	–0.57
Siemianowice Śląskie	1.70	0.24	0.96	–0.32	–0.57
Sosnowiec	0.83	1.16	0.25	0.67	0.12
Świętochłowice	1.73	1.42	–0.49	–0.32	–0.57
Tarnowskie Góry	–0.77	–0.82	–0.49	–0.32	–0.57
Tychy	–0.52	–0.55	–0.23	–0.32	0.50
Zabrze	–0.89	–0.69	0.01	–0.32	1.02

Source: Own elaboration based on conducted research.

The next step of the analysis was to measure the similarity of objects using the Hellwig development measure, and to group the cities/municipalities in GZM accordingly. The results are presented in Table 35.

Table 35. Ranking of cities / municipalities (reference period)

City	d_{i0}	s_i
Będzin	8.62	0.14
Bytom	8.54	0.15
Chorzów	5.52	0.45
Czeladź	7.98	0.21
Dąbrowa Górnicza	8.24	0.18
Gliwice	6.26	0.38
Katowice	4.70	0.53
Knurów	8.36	0.17
Łaziska Górne	8.59	0.15
Mikołów	8.58	0.15
Mysłowice	8.60	0.15
Piekary Śląskie	8.73	0.13
Ruda Śląska	8.64	0.14
Siemianowice Śląskie	7.23	0.28
Sosnowiec	6.38	0.367
Świętochłowice	7.59	0.25
Tarnowskie Góry	8.74	0.13
Tychy	7.94	0.21
Zabrze	7.82	0.22
Group		s_i
First group (very good objects)		$s_i > 0.35$
Second group (good objects)		$0.35 > s_i \geq 0.23$
Third group (bad objects)		$0.23 > s_i \geq 0.12$
Fourth group (very bad objects)		$0.12 > s_i$
City	s_i	Group
Katowice	0.53	First
Chorzów	0.45	First
Gliwice	0.38	First
Sosnowiec	0.367	First
Siemianowice Śląskie	0.28	Second
Świętochłowice	0.25	Second
Zabrze	0.22	Third
Tychy	0.21	Third
Czeladź	0.21	Third
Dąbrowa Górnicza	0.18	Third

Table 35 cont.

Knurów	0.17	Third
Bytom	0.15	Third
Mikołów	0.15	Third
Łaziska Górne	0.15	Third
Mysłowice	0.15	Third
Będzin	0.14	Third
Ruda Śląska	0.14	Third
Piekary Śląskie	0.13	Third
Tarnowskie Góry	0.13	Third

Source: Own elaboration based on conducted research.

It is worth noting that no cities/municipalities belonging to fourth group (very bad objects) were observed. The data from the table were also presented on the map of the Metropolis GZM (Figure 18). Additionally, cities/municipalities that do not have any shared mobility systems are marked in white.

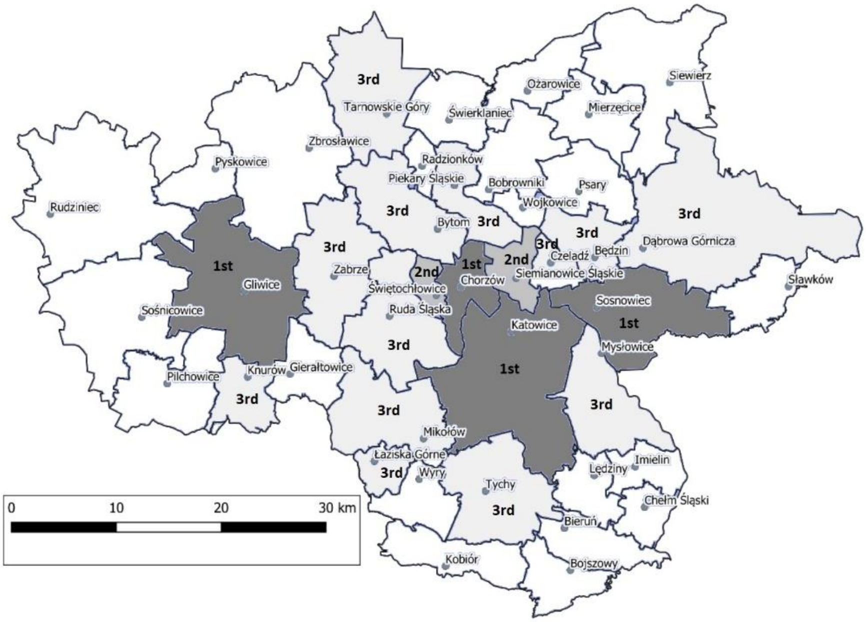

Figure 18. Shared mobility in reference period – division of cities/municipalities according to the standard deviation method

Source: Own elaboration based on conducted research and [GZM, 2021].

As per the division of cities and municipalities in the GZM according to the standard deviation method, the cities of Metropolis GZM are characterized by a relatively low level of development, although this result is better than in 2020. To verify this, a division was also made using the Ward method. The obtained dendrogram and agglomeration plot are presented in Figure 19.

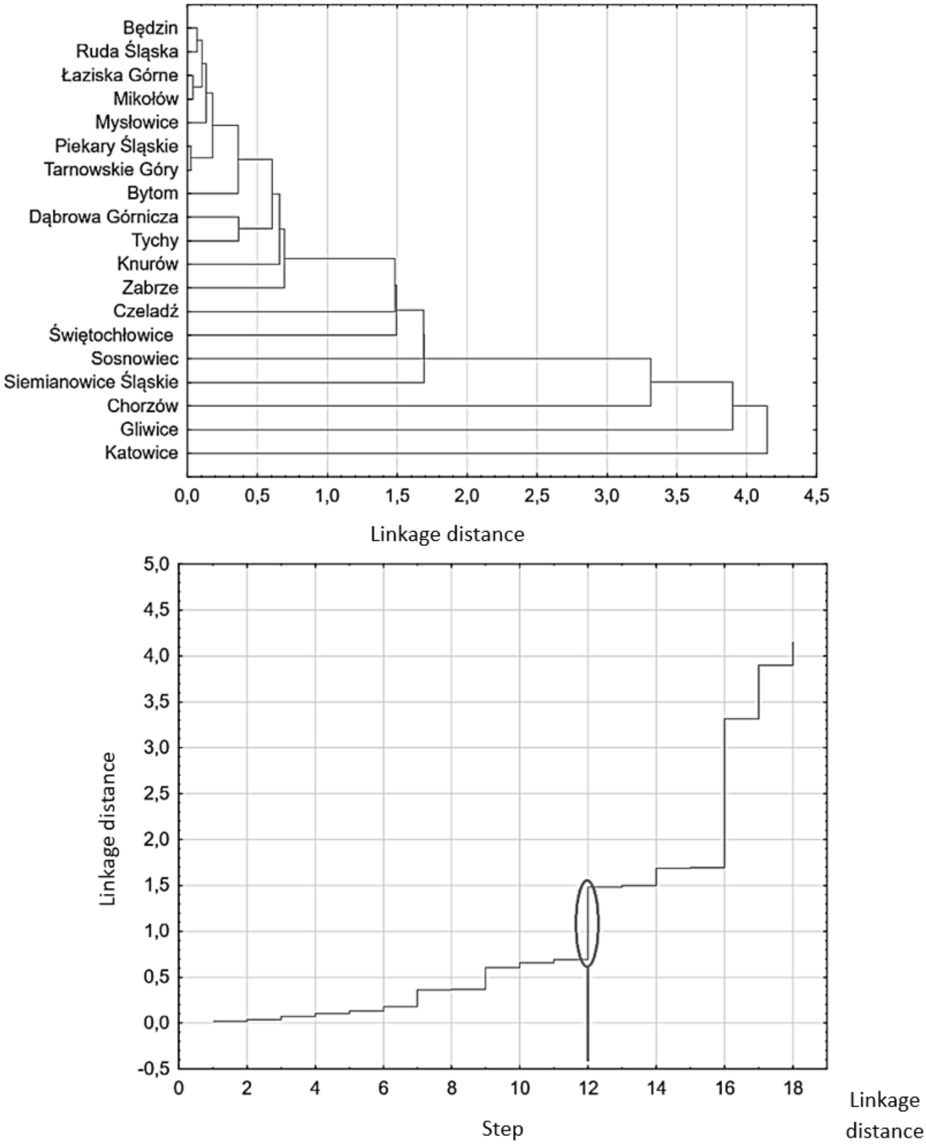

Figure 19. Shared mobility in reference period – dendrogram and agglomeration plot

Source: Own elaboration based on conducted research.

Step 12 is the point of division according to the ratio formula (maximum value for the linkage distance ratio at 2.14). However, it is worth noting that the differential formula indicated the tree division at step 16 (maximum value for the linkage distance difference at 1.62). To make the results comparable to those from 2020, it was decided to use the ratio formula. Therefore, 5 groups of cities/communes were created, as presented in Figure 20.

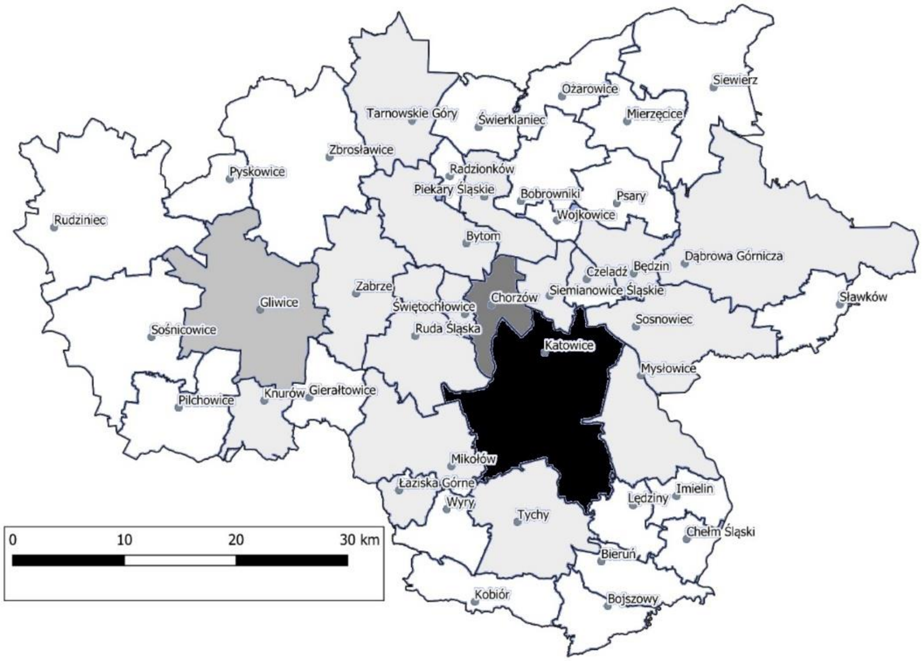

Figure 20. Shared mobility in reference period – division of cities/municipalities according to the Ward's method and the agglomeration plot

Source: Own elaboration based on conducted research and [GZM, 2021].

The results of dividing the cities and communes of GZM according to the Ward method and the agglomeration plot once again confirm a greater development of the Metropolis GZM core in the field of shared mobility solutions than the remaining communes and cities of the Metropolis. However, the overall level of development of the core is relatively weak. It also should be noted, that there is a significant improvement compared to 2020. An interesting direction for future research may be a further analysis of changes in the development of communes and cities over time, as well as a comparison of different Polish urban centres. Another potential direction for further research is the analysis of differences between individual countries.

3.4. Baseline and reference period comparison

In this subsection, a synthetic comparison of the results obtained from the analysis of the asymmetry of shared mobility solutions in the Metropolis GZM between baseline and reference period was made. The first step was to calculate the differences in individual indicators, in order to determine the direction of changes. Table 36 presents the results of the analysis.

Table 36. Baseline and reference period comparison

Perspective	Change in asymmetry coefficient – $\Delta NA_{(Si)}$	Change in Kurtosis excess – $\Delta NEK_{(Si)}$	Change in composite indicator – ΔwS_i
Carsharing (broad approach)	–2.62	–21.16	+14.28%
Carsharing (narrow approach)	–0.14	–1.83	n/a
Bikesharing (broad approach)	–0.31	–1.17	+3.25%
Bikesharing (narrow approach)	+0.35	+3.02	n/a
Scootersharing (broad approach)	–0.89	–7.97	+3.90%
Scootersharing (narrow approach)	–0.48	–1.72	n/a
Holistic (broad approach)	–1.28	–10.1	+7.14%
Holistic (narrow approach)	–0.09	–0.18	n/a

Source: Own elaboration based on conducted research.

In practically every case, a decrease in the asymmetry of shared mobility solutions was observed. The exception is the development of bikesharing in areas limited to cities that have solutions in this area (narrow approach) – in this case, an increase in asymmetry was observed. It should also be emphasized that in the case of a holistic approach (both in a broad and narrow sense), a decrease in the asymmetry of shared mobility solutions was observed. It is also worth noting the positive change in the accident indicator, which indicates the development of shared mobility in the Metropolis area. However, it should be noted that right-skewed asymmetry and leptokurtic distribution still exist in the analysed area (the exception being the narrow approach to scootersharing, where a platykurtic distribution was observed in 2021).

Comparison indicator was also calculated for all cities and communes associated with the GZM Metropolis. Entities without shared mobility solutions automatically received a value of 0 for this indicator. The results for the baseline and reference period are presented in Table 37.

Table 37. Comparison indicator for baseline and reference period

City	Baseline period cs_i	Reference period cs_i
Będzin	0.00	0.26
Bieruń	0.00	0.00
Bobrowniki	0.00	0.00
Bojszowy	0.00	0.00
Bytom	0.00	0.28
Chełm Śląski	0.00	0.00
Chorzów	0.69	0.85
Czeladź	0.00	0.40
Dąbrowa Górnicza	0.36	0.34
Gierałtowice	0.00	0.00
Gliwice	0.40	0.72
Imielin	0.00	0.00
Katowice	1.00	1.00
Knurów	0.00	0.32
Kobiór	0.00	0.00
Lędziny	0.00	0.00
Łaziska Górne	0.00	0.28
Mierzęcice	0.00	0.00
Mikołów	0.00	0.28
Mysłowice	0.00	0.28
Ożarowice	0.00	0.00
Piekary Śląski	0.00	0.25
Pilchowice	0.00	0.00
Psary	0.00	0.00
Pyskowice	0.00	0.00
Radzionków	0.00	0.00
Ruda Śląska	0.29	0.26
Rudziniec	0.00	0.00
Siemianowice Śląskie	0.39	0.53
Siewierz	0.00	0.00
Sławków	0.00	0.00
Sosnowiec	0.29	0.69
Sośnicowice	0.00	0.00
Świerklaniec	0.00	0.00
Świętochłowice	0.40	0.47
Tarnowskie Góry	0.00	0.25
Tychy	0.29	0.40
Wojkowice	0.00	0.00
Wyry	0.00	0.00
Zabrze	0.29	0.42
Zbrosławice	0.00	0.00

Source: Own elaboration based on conducted research.

Based on the data from Table 37, two heat maps were created, as presented in Figure 21.

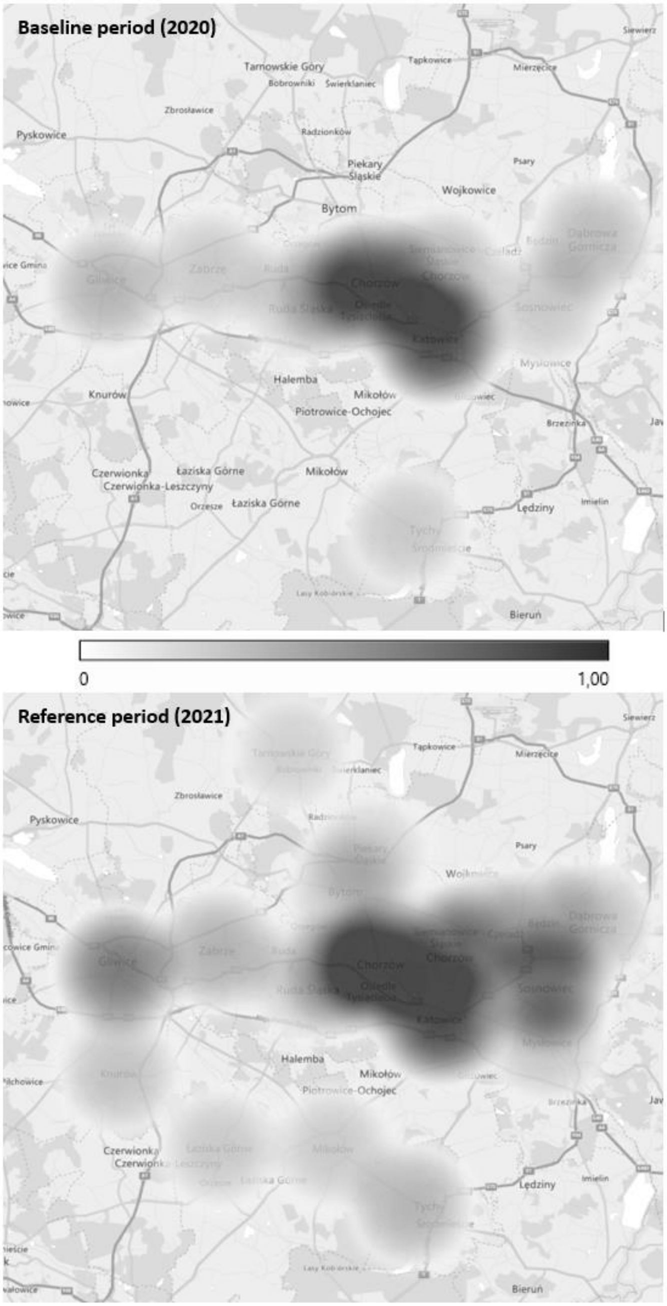

Figure 21. Period comparison heat map

Source: Own elaboration based on conducted research.

The attached map clearly shows the development of shared mobility solutions in the Metropolis GZM. It is also easy to distinguish the core cities of the metropolis (marked in dark colours). However, it is worth noting that the development of these solutions is not limited only to the core – a dynamic development has also been observed on the outskirts of the metropolis.

Summarising, the conducted analysis suggests the development of shared mobility in the Metropolis GZM and a decrease in the asymmetry of solutions in this area. However, it should be noted that shared mobility is still a relatively new element of the market, which is characterized by very dynamic changes. This situation means that further research in this area will be necessary in the future.

Conclusion

This book provides a characterization of the sharing economy (especially sharing mobility), its genesis, and stages of development. It identifies and describes concepts based on the sharing model, and implements them into network models and urban logistics network concepts. The place of the sharing economy in network relationships is identified, and potential problems that may arise are characterized. This part of the book allowed for the identification of key relationships in logistics networks, with particular attention paid to the sharing mobility.

For the purposes of this book, a model was developed to evaluate the asymmetry of sharing economy solutions in a selected area, and methods for grouping urban centres based on the level of sharing economy development were presented (using the Hellwig development measure, standard deviation method, and Ward's clustering method). The proposed model allowed for the development of tools for effective evaluation of the sharing economy in urban logistics networks.

Using the proposed model, an analysis of the Metropolis GZM was conducted in terms of the asymmetry of sharing economy solutions and the similarity of entities associated with the metropolitan system. This part of the paper allowed for the determination of the current state of shared mobility solutions in the Metropolis GZM.

A reliable analysis of shared mobility has not been conducted in the Metropolis GZM so far. Although this area has been occasionally mentioned in strategic documents, the concept of shared mobility was usually treated as an additional element and only a small part of the whole document. Therefore, this study is a very good supplement to this research gap.

The research conducted in the Metropolis GZM confirmed the existence of asymmetry in shared mobility solutions. This phenomenon was observed in both 2020 and 2021, in each of the analysed concepts (carsharing, bikesharing, scootersharing), and in each case, it was right-skewed asymmetry. It should also be noted that the distribution of analysed solutions was practically always leptokurtic in nature. This situation is due to the fact that a very large number of municipalities do not have shared mobility solutions. It is also worth noting that the conducted research included both a broad approach (all entities associated with the Metropolis GZM) and a narrow approach (only cities that have shared mobility systems). In each case, very similar results were obtained – however, in the case of the narrow approach, the distribution is more slim and the asymmetry is less pronounced. As a supplement, an author's accident index was also calculated, which informs about the level of development of a given system and its potential for further expansion. In 2020, bikesharing systems were the most developed, while in 2021, carsharing solutions were the most developed. However, it should be noted that these systems developed over the course of one year – their development potential in 2020 was 87.5%, while in 2021 it was 82.1% (ceteris paribus).

Another stage of research allowed for the creation of groups of cities and municipalities affiliated in the Metropolis GZM in terms of development of solutions in the field of shared mobility. In both 2020 and 2021, using the Hellwig development measure and grouping by standard deviations, 4 groups of cities were obtained, while using the Ward method resulted in 5 groups. It should be emphasized, however, that both methods indicated a similar structure of shared mobility development in the analysed area. The highest results were achieved by the core cities of the Metropolis (13 cities with powiat rights, where the highest degree of social and economic activity concentration occurs). However, it should be noted that despite the fact that the core of the Metropolis is characterized by a higher level of development of solutions in the field of shared mobility, the overall level of development of the entire Metropolis as well as the core itself is relatively weak. This conclusion corresponds very well and confirms the results obtained in the previous study (composite indicator).

However, the conducted research is not free from imperfections. The main limitation of the analysis is the very dynamic nature of the analysed solutions, which often undergo changes (e.g., in terms of serviced zones, number of available vehicles or operators present in the area). Such a situation means that all indicators concern only the so-called "current state", i.e., the period in which the analysis was conducted. Although two analyses were carried out in this study (in 2020 and 2021), solutions related to shared mobility are subject to continuous changes. It should be noted, however, that these changes do not always have a developmental character – they are often related to limiting the serviced area, minimizing the number of available vehicles or even completely abandoning the service of a given area by the operator. Another limitation of the study was the availability of data – companies are reluctant to share information about their platforms. This problem was solved by analysing the offer of individual operators, but it should be noted that the data obtained in this way may differ to some extent from the actual state of affairs. It is also important to note that the analysis concerned only the area of the Metropolis GZM, which means that the conclusions cannot be generalized to all urban areas. However, it should be emphasized that the proposed model for evaluating the development of shared solutions can be successfully used to analyse other urban areas and their subsequent taxonomic analysis. In this way, a potential direction for future research in the analysed scope was identified.

This book constitutes a theoretical and practical contribution to the field of economics and finance. The proposed model for evaluating the asymmetry of sharing economy solutions can be used for further research and applied to other research areas. The obtained results allowed for defining the key developmental factors for sharing economy in urban logistics networks. It should also be noted that the topic studied in the paper is so broad that the existing research gap has been only partially filled. The issues discussed in the paper can therefore be seen as an impulse and a guide for further research in this area.

It should also be noted that the results of the research conducted for this book can be utilized by a wide range of potential recipients. The entities interested in this work include both companies offering shared solutions (e.g. to shape their offers in terms of different consumer groups or manage information), public administration bodies (e.g. by utilizing the methodology proposed in the paper to identify areas with a lower degree of development and shape the implemented transport policy), and individuals interested in the topic of sharing economy and urban logistics networks (e.g. scientists, journalists, residents involved in implementing civic initiatives, etc.).

Literature

Akerlof G.A. (1970), *The Market for „Lemons”: Quality Uncertainty and the Market Mechanism*, „The Quarterly Journal of Economics”, 80(3).

Al-Hader M., Rodzi A. (2009), *The Smart City Infrastructure Development and Monitorning*, „Theoretical and Empirical Researches in Urban Management”, 2(11).

Amin S. (1992), *Can Environmental Problems Be Subject to Economic Calculations?* „World Development”, 20(4).

Arolas E.E., Ladrón-de-Guevara F.G. (2012), *Towards an Integrating Crowdsourcing Definition*, „Journal of Information Science”, 32(2).

Azkun I. (2012), *Smart Cities Study: International Study on the Situation of ICT, Innovation and Knowledge in Cities,* The Committee of Digital and Knowledge-based Cities of UCLG, Bilbao.

Balicki A. (2013), *Statystyczna analiza wielowymiarowa i jej zastosowania społeczno-ekonomiczne*, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk.

Bardhi F., Eckhardt G.M. (2012), *Access-Based Consumption: The Case of Car Sharing*, „Journal of Consumer Research”, 39(4).

Belleflamme P., Lambert T., Schwienbacher A. (2014), *Crowdfunding: Tapping the Right Crowd*, „Journal of Business Venturing”, 29(5).

Blakley G.R. (1979), *Safeguarding Cryptographic Keys, Managing Requirements Knowledge, International Workshop*, AFIPS 1.

Błaszczak M., Polowczyk J. (2018), *Ewolucja w naukach społecznych – dwugłos* [in:] *Podejście ewolucyjne w naukach społecznych*, eds. J. Polowczyk, H. Witczak, M. Błaszczak, CeDeWu, Warszawa.

Bogers M., Chesbrough H.W., Moedas C. (2018), *Open Innovation: Research, Practices, and Policies*, „California Management Review”, 60(2).

Botsman R., Rogers R. (2012), *What’s Mine is Yours. How Collaborative Consumptions is Changing the Way We Live*, Majeure Alternative Management – HEC Paris, Paris.

Brignall III T.W., van Valey T. (2005), *The Impact of Internet Communications on Social Interaction*, „Sociological Spectrum”, 25(3).

Buyfans (2019), https://www.buyfans.pl/ (access: 27.03.2019).

Bylinko L. (2017), *Koncepcja i narzędzia ograniczania ruchu pojazdów w miastach w kontekście ekologicznym*, „Marketing i Rynek”, 7.

Cadagone C., Martens B. (2016), *Scoping the Sharing Economy: Origins, Definitions, Impact and Regulatory Issues*, Institute for Prospective Technological Studies Digital Economy Working Paper, JRC100369.

Cahn E. (2004), *No More Throw Away People. The Co-Production Imperative*, Essential Books Ltd, Washington.

Cameron R., Neal L.A. (2016), *Concise Economic History of the World. A Concise Economic History of the World*, Fifth edition, Oxford University Press, Oxford.

Castells M. (2007), *Społeczeństwo sieci*, Wydawnictwo Naukowe PWN, Warszawa.

Chesbrough H.W. (2003), *Open Innovation. The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston.

Clark J.G. (2014), *The Benedictines in the Middle Ages*, The Boydell Press, Woodbridge.

Clarkson G., Jacobsen T.E., Batcheller A.L. (2007), *Information Asymmetry and Information Sharing*, „Government Information Quarterly”, 24(4).

Dalli D., Corciolani M. (2008), *Releasing Books into the Wild. Communal Gift-Giving at Bookcrossing.com*, University of Pisa.

Darwin C. (2013), *The Descent of Man*, Wordsworth Editions Ltd. Ware, Hertfordshire.

DeCarlo L.T. (1997), *On the Meaning and Use of Kurtosis*, „Psychological Method”, 2(3).

Dervojeda K., Verzijl D., Nagtegaal F., Lengton M., Rouwmaat E., Monfardini E., Frideres L. (2013), *The Sharing Economy. Accessibility Based Business Models for Peer-to-Peer Markets. Case Study 12*, Business Innovation Observatory, Brussels.

Doane D.P., Seward L.E. (2011), *Measuring Skewness: A Forgotten Statistic?* „Journal of Statistics Education”, 19(2).

Dziechciarz J., ed. (2002), *Ekonometria – metody, przykłady, zadania*, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław.

EC (2015a), A Digital Single Market Strategy for Europe, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2015%3A192%3AFIN (access: 20.03.2019).

EC (2015b), Commission Staff Working Document. A Digital Single Market Strategy for Europe – Analysis and Evidence, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Digital Single Market Strategy for Europe, Brussels, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52015SC0100 (access: 20.03.2019).

EESC (2014), Opinion of the European Economic and Social Committee on ‘Collaborative or participatory consumption, a sustainability model for the 21st century’ (own-initiative opinion), Official Journal of the European Union (177/01), https://eur-lex.europa.eu/legal-content/EL/TXT/?uri=uriserv:OJ.C_.2014.177.01.0001.01.ENG (access: 20.03.2019).

EP (2014), New Trends and Key Challenges in the Area of Consumer Protection, European Parliament, Directorate-General for Internal Policies, Brussels, https://www.europarl.europa.eu/RegData/etudes/IDAN/2014/518773/IPOL_IDA(2014)518773_EN.pdf (access: 20.03.2019).

Ficoń K. (2010), *Logistyka morska. Statki, porty, spedycja*, Wydawnictwo Bel Studio Sp. z o.o., Warszawa.

FTC (2015a), The "Sharing" Economy Workshop, Segment 2 Transcript, https://www.ftc.gov/system/files/documents/videos/sharing-economy-workshop-part-2/ftc_sharing_economy_workshop_-_transcript_segment_2.pdf (access: 20.03.2019).

FTC (2015b), The "Sharing" Economy Workshop, Segment 3 Transcript, https://www.ftc.gov/system/files/documents/videos/sharing-economy-workshop-part-3/ftc_sharing_economy_workshop_-_transcript_segment_3.pdf (access: 20.03.2019).

García-Peñalvo F.J., García de Figuerola C., Merlo J.A. (2010), *Open Knowledge: Challenges and Facts*, „Online Information Review", 34(4).

Gasłowska M., Berkowska I. (2016), *Nieudane konsultacje rewitalizacyjne w Tomaszowie Mazowieckim*, Radio Łódź, https://radiolodz.pl/30544-nieudane-konsultacje-rewitalizacyjne-w-tomaszowie-mazowieckim,161559/ (access: 26.02.2020).

Gawer A. (2009), *Platforms, Markets and Innovation*, Edward Elgar Publishing Limited, Northampton Massachusetts.

Gawer A., Cusumano M.A. (2002), *Platform Leadership: How Intel, Microsoft and Cisco Driver Industry Innovation*, Harvard Business School Press, Boston Massachusetts.

Gawer A., Cusumano M.A. (2014), *Platforms of Innovation* [in:] *The Oxford Handbook of Innovation Managements*, eds. M. Dogson, D.M. Gann, N. Phillips, Oxford University Press, Oxford.

Goold M., Campbell A. (1998), *Desperately Seeking Synergy*, „Harvard Business Review", 76(5).

Grabiński T., Wydymus S., Zeliaś A. (1989), *Metody taksonomii numerycznej w modelowaniu zjawisk społeczno-gospodarczych*, Państwowe Wydawnictwo Naukowe, Warszawa.

Grossman G.M., Helpman E. (2002), *Outsourcing in a Global Economy*, „The Review of Economic Studies", 72(1).

GZM (2021), Plan Zrównoważonego Rozwoju Publicznego Transportu Zbiorowego dla obszaru Górnośląsko-Zagłębiowskiej Metropolii oraz gmin, z którymi zawarto porozumienie w sprawie powierzenia Górnośląsko-Zagłębiowskiej Metropolii zadania własnego gmin, tj. pełnienia funkcji organizatora publicznego transportu zbiorowego, https://bip.metropoliagzm.pl/uchwala/127154/uchwala-nr-xxxiii-262-2021 (access: 19.04.2023).

Hanusik A. (2019), *Y-generation's Perception of Sharing Economy* [in:] 12th International Scientific Conference "Analysis of International Relations 2019. Methods and Models of Regional Development. Summer Edition". Conference Proceedings, eds. W. Szkutnik, A. Sączewska-Piotrowska, M. Hadaś-Dyduch, J. Acedański, Publishing House of University of Economics in Katowice, Katowice.

Hanusik A. (2020), *Development Asymmetry of The City Bike System in the Upper-Silesian Zagłębie Metropolis*, [in:] 13th International Scientific Conference Analysis of International Relations 2020. Methods and Models of Regional Development. Winter Edition. Conference Proceedings, eds. W Szkutnik, A. Sączewska--Piotrowska, M. Hadaś-Dyduch, J. Acedański, p. 73-82.

Hanusik A. (2021), *Model układu relacyjnego podmiotów partycypujących w ekonomii współdzielenia* [in:] *Nowe trendy społeczno-ekonomiczne a rozwój przedsiębiorstwa*, eds. P. Antonowicz, E. Malinowska, J. Siciński, U. Zaremba, Aspra, Warszawa – Rzeszów.

Hanusik A., Kozień M. (2016), *Rola Smart Mobility w Koncepcji Inteligentnych Miast Europejskich* [in:] *Ekologia i zrównoważony rozwój transportu w sektorze TSL*, Akademia Morska w Gdyni, Gdynia.

Hollands R.G. (2008), *Will the Real Smart City Please Stand Up? Intelligent, Progressive or Entrepreneurial?* „City", 12(3).

Hornbaker R., Pedersen B., Mehra-Pedersen H. (2023), *Bookcrossing. The Team*, https://www.bookcrossing.com/team (access: 14.04.2023).

Jittrapirom P., Caiati V., Feneri A.M., Ebrahimigharehbaghi S., Alonso-González M.J., Narayan J. (2017), *Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges*, „Urban Planning", 2(2).

Jolley D. (2019), *Myth of the Gig Economy, Corrected*, Harvard Business Review, https://hbr.org/2018/10/myths-of-the-gig-economy-corrected (access: 23.03.2019).

Kilbu P. (2014), *Accountability for Empowerment: Dilemmas Facing Non-governmental Organizations. Asia Pacific School of Economics and Government. Discussion Papers, Policy and Governance*, The Australian National University, Canberra.

Krakowiak-Bal A. (2005), *Wykorzystanie wybranych miar syntetycznych do budowy miary rozwoju infrastruktury technicznej*, „Infrastruktura i Ekologia Terenów Wiejskich", 3.

Lauterbach D., Truong H., Shah T., Adamic L. (2009), *Surfing a Web of Trust: Reputation and Reciprocity on CouchSurfing.com*, International Conference on Computational Science and Engineering.

Levitt T. (1999), *The Globalization of Markets* [in:] *Readings in International Business: A Decision Approach*, eds. R.Z. Aliber, R.W. Click, The MIT Press Cambridge, Massachusetts London.

Lipieta A., Malina A., Papież M., Pawełek B., Wanat S., Zeliaś A. (2000), *Taksonomiczna analiza przestrzennego zróżnicowania poziomu życia w Polsce w ujęciu dynamicznym*, Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków.

Losik J. (2019), *Rewitalizacja parku Sienkiewicza. Mieszkańcy nie chcą placu zabaw pod oknami. Grożą sądem*, „Gazeta Wyborcza", https://lodz.wyborcza.pl/lodz/7,35136, 24742288,rewitalizacja-parku-im-h-sienkiewcza-mieszkancy-beda-mieli.html (access: 17.04.2023).

Łogwiniuk K. (2011), *Zastosowanie metod taksonomicznych w analizie porównawczej dostępu do infrastruktury ICT przez młodzież szkolną w Polsce*, „Ekonomia i Zarządzanie", 1.

Mandl I., Curtarelli M., Riso S., Vargas L.O., Gerogiannis E. (2015), *New Forms of Employment*, Publications Office of the European Union, Luxembourg.

Marx K., Engels F. (2018), *The Communist Manifesto*, Random House, New York.

Mell P., Grance T. (2011) *The NIST Definition of Cloud Computing. Recommendations of the National Institute of Standards and Technology*, NIST Special Publication 800-145, Gaithesburg.

Młodak A. (2006), *Analiza taksonomiczna w statystyce regionalnej*, Difin, Warszawa.

Molloy J.C. (2011), *The Open Knowledge Foundation: Open Data Means Better Science*, „PLoS Biol", 9(12).

Naess A. (1973), *The Shallow and the Deep, Long-Range Ecology Movement. A Summary*, „An Interdisciplinary Journal of Philosophy", 16(1-4).

Nawrot J. (2019), *Międzynarodowe prawo bezpieczeństwa morskiego*, Wydawnictwo C.H. Beck, Warszawa.

Nowak E. (1990), *Metody taksonomiczne w klasyfikacji obiektów społeczno-gospodarczych*, Polskie Wydawnictwo Ekonomiczne, Warszawa.

Nowicka K. (2016), *Cloud Computing – Warunek Sine Qua Non Sharing Economy* [in:] *Sharing Economy (gospodarka współdzielenia)*, eds. M. Poniatowska-Jaksch, R. Sobiecki, Oficyna Wydawnicza SGH, Warszawa.

OECD (2015a), Digital Economy Outlook, OECD Publishing, Paris, https://www.oecd.org/digital/oecd-digital-economy-outlook-2015-9789264232440-en.htm (access: 20.03.2019).

OECD (2015b), Working Party on Measurement and Analysis of the Digital Economy. New Forms of Work in the Digital Economy, OECD Publishing, Directorate for Science, Technology and Innovation Committee on Digital Economy Policy, https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS(2015)13/FINAL&docLanguage=En (access: 20.03.2019).

OKF (2023), Open Knowledge Foundation, https://okfn.org/ (access: 15.04.2023).

Owen R. (2018), *The Book of the New Moral World*, Franklin Classics Trade Press, New Jersey.

Pakulska T. (2016), *Otoczenie przedsiębiorstw a rozwój sharing economy* [in:] *Sharing Economy (gospodarka współdzielenia)*, eds. M. Poniatowska-Jaksch, R. Sobiecki, Oficyna Wydawnicza SGH, Warszawa.

Panek T. (2009), *Statystyczne metody wielowymiarowej analizy porównawczej*, Oficyna Wydawnicza Szkoły Głównej Handlowej w Warszawie, Warszawa.

Paulus P.B., Dzindolet M. (2008), *Social Influence, Creativity and Innovation*, „Social Influence", 3(4).

Piasecki R. (2007), *Ekonomia rozwoju*, Polskie Wydawnictwo Ekonomiczne, Warszawa.

Pietrewicz J.W., Sobiecki R. (2016), *Przedsiębiorczość Sharing Economy* [in:] *Sharing Economy (gospodarka współdzielenia)*, eds. M. Poniatowska-Jaksch, R. Sobiecki, Oficyna Wydawnicza SGH, Warszawa.

Pociecha J., Podolec B., Sokołowski A., Zając K. (1988), *Metody taksonomiczne w badaniach społeczno-ekonomicznych*, Państwowe Wydawnictwo Naukowe, Warszawa.

Polowczyk J. (2018), Ekonomia ewolucyjna [in:] *Podejście ewolucyjne w naukach społecznych*, eds. J. Polowczyk, H. Witczak, M. Błaszczak, CeDeWu, Warszawa.

Poniatowska-Jaksch M. (2016), *Modele biznesu w Sharing Economy* [in:] *Sharing Economy (gospodarka współdzielenia)*, eds. M. Poniatowska-Jaksch, R. Sobiecki, Oficyna Wydawnicza SGH, Warszawa.

Pośpiech E., Mastalerz-Kodzis A. (2016), *Wpływ korelacji kryteriów na wielokryterialną selekcję walorów giełdowych*, „Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach", 301.

Probst L., Frideres L., Pedersen B., Lidé S. (2015a), *Freemium Model: Zero Marginal Cost. Case Study 49*, Business Innovation Observatory, Brussels.

Probst L., Frideres L., Pedersen B., Lidé S. (2015b), *Collaborative Economy. Collaborative Production and the Maker Economy. Case Study 51*, Business Innovation Observatory, Brussels.

PwC (2016), *(Współ)dziel i rządź! Twój nowy model biznesowy jeszcze nie istnieje*, p. 9, https://www.pwc.pl/pl/pdf/ekonomia-wspoldzielenia-1-raport-pwc.pdf (access: 27.03.2019).

Rajman J.W. (2006), *Encyklopedia średniowiecza*, Wydawnictwo Zielona Sowa, Kraków.

Robertson B.J. (2007), *Organization at the Leading Edge: Introducing Holacracy*, http://library.uniteddiversity.coop/Decision_Making_and_Democracy/Holacracy/HolacracyIntro2007-06.pdf (access: 9.04.2019).

Rochet J., Tirole J. (2003), *Platforms Competition in Two-Sided Markets*, „Journal of the European Economic Association", 1(4).

Schor J. (2014), *Debating the Sharing Economy*, Great Transition Initiative: Toward a Transformative Vision and Praxis, https://greattransition.org/publication/debating-the-sharing-economy (access: 9.04.2019).

Seyfang G. (2004), *Time Banks: Rewarding Community Self-help in the Inner City?* „Community Development Journal", 39(1).

Shaheen S., Guzman S., Zhang H. (2010), *Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future*, „Journal of Public Transportation", 12(4).

Shamir A. (1979), *How to Share a Secret*, „Communications of the ACM", 22(11).

Shark A.R., Toporkoff S., Lévy S. (2014), *Smart Cities for a Bright Sustainable Future: A Global Perspective*, Public Technology Institute and ITEMS International, Paris.

Sharkey W. (1983), *The Theory of Natural Monopoly*, Cambridge Books, Cambridge University Press, Cambridge.

Slovic P., Finucane M.L., Peters E., MacGregor D.G. (2007), *The Affect Heuristic*, „European Journal of Operational Research", 177.

Sobiecki G. (2016), *Sharing Economy – Dylematy Pojęciowe* [in:] *Sharing Economy (gospodarka współdzielenia)*, eds. M. Poniatowska-Jaksch, R. Sobiecki, Oficyna Wydawnicza SGH, Warszawa.

Spinuzzi C. (2012), *Working Alone, Together: Coworking as Emergent Collaborative Activity*, „Journal of Business and Technical Communication", 26(4).

Steen M., Manschot, M., de Koning N. (2011), *Benefits of Co-design in Service Design Projects*, „International Journal of Design", 5(2).

Stokes K., Clarence E., Anderson L., Rinne A. (2014), *Making Sense of the UK Collaborative Economy*, Nesta Collaborative Lab, London.

Szkutnik W., Sączewska-Piotrowska A., Hadaś-Dyduch M. (2015), *Metody taksonomiczne z programem STATISTICA*, Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice.

Toombs A., Bardzell S., Bardzell J. (2014), *Becoming Makers: Hackerspace Member Habits, Values, and Identities*, „Journal of Peer Production", 5.

UOKiK (2023), Urząd Ochrony Konkurencji i Konsumenta, https://www.uokik.gov.pl/ (access: 16.04.2023).

Wheelwright S.C., Clark K.N. (1992), *Creating Projects Plans to Focus Products Development*, „Harward Business Review", 70(2).

Wilkin J. (2019), *O potrzebie ekonomii zaangażowanej i sposobach jej uprawiania* [in:] *Ekonomia i polityka wokół teorii Grzegorza W. Kołodko*, ed. E. Mączyńska, Wydawnictwo Naukowe PWN SA, Warszawa.

Witkowski C. (2008), *Słownik pojęć historycznych*, Wydawnictwo Videograf II, Katowice.

Witt A., Suzor N.P., Wikstrom P. (2015), *Regulating Ride-sharing in the Peer Economy*, „Communication Research and Practice", 1(2).

Wojciechowski R. (2018), *Kilka uwag o regulacji prawnej przedsiębiorczości w późnym średniowieczu*, „Acta Universitatis Wratislaviensis", 3833. „Przegląd Prawa i Administracji", CXIV.

Wyrzykowska I., Sadowska M. (2012), *Marka, która będzie wszędzie*, „Marketing w Praktyce", 6.

Yanga H., Huang H. (1999), *Carpooling and Congestion Pricing in a Multilane Highway with High-Occupancy-Vehicle Lanes*, „Transportation Research Part A: Policy and Practice", 33(2).

List of tables

List of figures

List of equations

This book is a comprehensive compendium of knowledge about the sharing economy (in particular shared mobility) and the impact of sharing solutions on the shaping of urban logistics networks. The publication presents the genesis and development of the sharing economy concept and also provides a taxonomy of these solutions. The monograph also presents a set of tools for effective evaluation of the sharing economy in urban areas. It is worth noting that the suggested methods can be used both in small urban areas as well as in metropolitan areas – in this work it was applied to analyse shared mobility in the urban logistics network of the Metropolis GZM. Therefore, this book is an ideal source of knowledge for those interested in the sharing economy, shared mobility, and analysis of urban logistics networks. It will be particularly helpful for students of logistics disciplines, scientists focusing on urban areas in their work, logistics practitioners, and decision-makers working in municipal administration structures.

Andrzej HANUSIK was born in Katowice in 1994. He graduated from the Adam Mickiewicz III High School in Katowice and the University of Economics in Katowice. In 2022, he obtained a PhD degree in the field of "Economics and Finance". His research focuses on urban logistics, logistics networks, and relations within the New Silk Road. He is professionally associated with the Department of Transport at the University of Economics in Katowice, where he holds the position of assistant professor and Logistic program manager. As part of his scientific work, he has collaborated, among others, with the Polish Supply Management Leader non-profit. Association and the Metropolitan Transport Authority in Katowice. In order to popularize science, he conducts lectures and workshops for high school and collaborates with the Logistics Science Club "Dialog" and the Logistics and Transport Alumni Club of the University of Economics in Katowice. In his free time, he is passionate about mountain hiking, climbing, and cycling. Since childhood, he has played the piano and accordion, and is also a member of the "Katowice-Kleofas" Accordion Ensemble, with which he performs concerts both in Poland and the other European countries.

ISBN 978-83-7875-866-2

Uniwersytet
Ekonomiczny
w Katowicach