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Contents

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SELECTION FACTORS OF PROJECT MANAGEMENT INFORMATION SYSTEMS AND THE PROJECT MATURITY OF AN ORGANIZATION

Abstract

Project management information systems are widely regarded as an extremely important tool for ensuring project success. Choosing the right information system from the ever-growing list of solutions available on the market is a challenge for any organization. The authors undertook to identify and evaluate factors for the selection of information systems supporting project management considering the organization's project maturity. The identification of factors subjected to empirical verification was based on literature reviews and the focus group method. The evaluation process utilised the results of primary empirical research conducted on a sample of 572 respondents. This allowed the evaluation and prioritisation of the identified motives and the identification of latent relationships in their set.

Keywords: project management information systems, PMIS, selection factors, project maturity of an organization.

JEL Classification: M15, O32, L86.

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Introduction

Project management theory provides a set of methods and tools that support the implementation of projects in various phases of their life cycle, enabling the achievement of objectives while balancing the scope, cost, and time of implementation (Kostalova et al., 2015). Numerous research studies confirm that it is possible to increase the probability of success in project management through the use of dedicated solutions (Rahman, 2018; Lappe, 2014). Their use is facilitated by IT tools, which reduce time requirements, simplify the implementation process, and increase the success rate of their use in implemented projects (Spang, 2014).

The use of IT systems in project management can be done in various ways. One of them is the use of office software, spreadsheets, text editors, or time management applications (Bukłaha, 2020). However, these tools are not able to meet the specific requirements related to planning, execution, and changes in projects in a turbulent environment. Dedicated IT systems have been developed to support project managers in making decisions at individual stages of the project life cycle (Teixeira et al., 2016). They allow monitoring the progress of the project from its concept through implementation to the completion of work, providing important information necessary for managing resources, budget, time, suppliers, and quality, as well as assigning tasks and facilitating cooperation between team members (Purohit, 2022).

In addition to the software available on the market, companies use proprietary solutions to support project implementation, which are extensions of their existing IT systems used to manage various functional areas of the organization. This guarantees efficient information flow, high integration with other systems, and the use of common sources for databases (Kostalova et al., 2015). Globalization and internationalization of markets increase the competitive pressure on companies (Raymond, Bergeron, 2008). The implementation of IT tools supporting project management is widely considered to be an important element in increasing the probability of achieving success (Bani, 2008; Fachrizal, 2020). The use of dedicated software is aimed at achieving the intended goals of the implemented project (Nguyen, 2016).

The nature of systems supporting project management has changed significantly over the last decade, from single project management systems to complex, distributed, multi-functional systems that now encompass more than just the planning stage. System designers are therefore faced with a growing number of business processes that are facilitated by project management software. As a result, users have difficulty configuring appropriate organizational systems and selecting appropriate software (Ahlemann, 2009; Ahlemann, Backhaus, 2006).

The main objective of the conducted research was to identify and assess factors in selecting IT systems supporting project management based on the project maturity of the organization. The determination of factors subjected to empirical verification was based on literature studies and the focus group method. The assessment process used the results of primary empirical studies, which were conducted among people declaring that they held managerial roles in at least one project and used software supporting project management.

Project management information systems

Project Management Information Systems (PMIS) are a tool supporting project managers in making decisions at various stages of the project management cycle. They facilitate planning, implementation and completion, especially in complex cases burdened with uncertainty and financial, time or market constraints (Raymond, Bergeron, 2008).

In the last decade, due to the increasing variety and complexity of projects, PMIS have undergone significant changes (Teixeira et al., 2016). They no longer focus solely on managing schedules and resources, but have become comprehensive systems supporting the entire life cycle of projects, programs, and project portfolios, combining project management and strategic management (Ahlemann, 2009; Ahlemann, Riempp, 2008). Project Management Institute (PMI) defines PMIS as systems consisting of tools, techniques, and methods used to collect, integrate, and disseminate the results of project management processes (PMI, 2017). According to Ahlemann and Riempp, PMIS are sociotechnical systems that integrate people and processes to ensure that information is available to the right people at the right time (2008). PMIS provide managers with support in making decisions needed to plan, organize, and monitor projects (Weinert, Banaś, 2024). The basic functions of PMIS include providing essential information on the cost and time parameters of the project and the interrelationships between these parameters (Gelbard et al., 2002).

Project Management Information Systems enable individuals or teams to track projects from concept to completion, providing project managers and other team members with essential information and supporting them in various aspects such as resource planning, budget management, supplier management, time management, task allocation, quality control, decision-making, and stakeholder collaboration and communication (Braglia, Frosolini, 2012; Caniëls, Bakens, 2012; Raymond, Bergeron, 2008). PMIS are primarily supporting tools. The scope of their use should be determined based on the specific requirements set by the project manager and the general concept of the methodology or internal project management procedures of the organization (Kostalova et al., 2015). The advantages of PMIS will be particularly appreciated in the implementation of more extensive

and complex projects, where the schedule, budget, reporting, migration, integration, and communication functions will support the project team in project execution (Banaś, 2023).

Project maturity

Project maturity is perceived as the ability and degree of integration of available project management methods, tools, and techniques by organizations. It refers to the development of the organization's skills in enhancing the timeliness of project execution, organizational efficiency, or cost reduction (de Souza, Gomes, 2015). The study of project maturity serves both diagnostic and prognostic functions. The diagnostic function consists in precisely determining the current state of project activity in the organization. The diagnosis is based on a detailed analysis of the use of good practices in various areas of project management. The description of the achieved project maturity, confronted with the desired level resulting from the characteristics of the implemented projects, allows for the determination of actions to improve project management in the organization (Trocki, Juchniewicz, 2023).

Project maturity models can be treated as methods for assessing the level of completeness and excellence of project management, as well as indicators of the development and growth of the organization's competences in this area. They allow for the identification of organizational structures and processes that must be implemented to achieve a specific level of maturity and provide guidelines for standardizing and systematizing these activities. These models are used not only to assess the level of maturity of the organization, but also to identify strengths and weaknesses, identifying areas for improvement (Woźniak et al., 2023). The project maturity of an organization can be analyzed and described using various models, which are presented in detail in the literature. However, no consensus has been reached on the indication of a single, universal maturity model that would be universally acceptable by practitioners and researchers of project management (Trocki, Juchniewicz, 2023; Woźniak et al., 2023).

The model proposed by H. Kerzner – The Kerzner Project Management Maturity Model (PMMM) is commonly used in the research on the project maturity of organizations. Its significant advantage is its simplicity and the ease of the associated assessment process. The author of the model distinguished five levels of project maturity of an organization (Kerzner, 2001, p. 109):

- level 1 (Common language) – the organization may have some knowledge of project management and be able to distinguish projects from current activities or may not have such knowledge,
- level 2 (Common processes) – the organization recognizes processes related to project management that are common to all projects,

- level 3 (Singular methodology) – the organization sees the benefits resulting from the synergy of processes and their control, developing a uniform methodology, replacing individual methods, tools, and techniques,
- level 4 (Benchmarking) – the organization applies a uniform methodology, at the same time realizing the possibility of its improvement based on the experience of the best organizations in the environment,
- level 5 (Continuous improvement) – the organization effectively uses the knowledge gained through benchmarking and itself becomes a model to follow.

In the literature on the subject, in addition to well-established approaches to project maturity management, there are also models describing the scale and scope of support for the implementation of project management processes by IT systems. As the level increases, the diversity and prevalence of IT systems increases (Woźniak, 2021; Gasik, 2020; Ramabulana, 2015).

Selection factors

Project Management Information Systems are characterized by features and functions that set them apart from competing solutions, affecting their usability. Selecting the right software from the constantly growing list of solutions available on the market, differing in the scope of offered functions and alignment with project management standards and methodologies, is a major challenge for every organization (Capterra, 2024). An incorrectly selected system, even correctly implemented, may not meet expectations, which in turn may negatively affect the assessment of the entire project. Therefore, decisions made at this stage are extremely important and should be made with caution, considering all relevant criteria (Czupryna-Nowak, 2016). Researchers attempt to categorize them by specifying functional factors, technical factors, and factors for evaluating system suppliers (Trzaskalik, 2014, p. 216-218).

The selection of a PMIS should take into account a set of important features that affect the positive or negative evaluation of the IT system by its users, which include (Trocki, 2012, p. 424) high functionality, flexibility, ease of use, cost of the system or access to it, security, and time and costs of implementation. The selection of an appropriate IT system should also depend on the features characterizing individual users (position, experience, certification) (Nahotko, 2014) and organizational users (approach to project management, project management methodology, project maturity, or industry) (Kaiser, Ahlemann, 2010).

Research results

The results of an empirical study conducted using the CAWI electronic interview technique were used to assess the significance of factors in selecting IT systems supporting project management. The study involved 572 respondents (N=572). The empirical research areas included the following scopes:

- subjective – people performing managerial functions in at least one project who use programs supporting project management,
- objective – determinants of selecting IT systems supporting project management,
- spatial – Poland,
- temporal – 2024.

Table 1 presents the structure of the study population, taking into account the following criteria: gender, professional experience, employment level and the sector of operation of the respondent's organization.

Table 1. Structure of the research sample

		N	%↕
Sex	female	297	51,9
	male	275	48,1
	total	572	100,0
Work experience	up to 1 year	32	5,6
	over 1 year	46	8,0
	over 3 years	91	15,9
	over 6 years	403	70,5
	total	572	100,0
Company size	self-employed	45	7,9
	2 to 9 persons	111	19,4
	10 to 49 persons	178	31,1
	50 to 249 persons	130	22,7
	250 to 499 persons	38	6,6
	more than 500 persons	70	12,2
	total	572	100,0
Sector	public	160	28,0
	private	375	65,6
	non-governmental	37	6,5
	total	572	100,0

Source: Own research

The statistical package PS IMAGO Pro 10 (IBM SPSS Statistics 29) was used to analyze the obtained results. A four-point Likert scale was used to assess the significance of factors in selecting IT systems supporting project management, where individual values represented: 1 – definitely not important, 2 – rather not important, 3 – rather important, and 4 – definitely important. Additionally, when assessing individual variables, respondents could choose the answer 'I have no opinion'. For the purposes of the calculations, it was assumed that there were equal distances between categories on the ordinal scale, which allowed for calculating mean values and using the exploratory factor analysis method and variance analysis (Malarska, 2005).

In the first step of the research procedure, the average significance of factors in selecting IT systems supporting project management was assessed. The highest rated factors include primarily: system security – including protection against viruses and threats, two-step verification, data encryption, ability to manage permissions, data security, etc. ($\bar{x}$ = 3.65), alignment of the system with project features – including project implementation time, project size and scope, importance for the organization, project management methodology, etc. ($\bar{x}$ = 3.57), and system stability – including reliability, availability, update frequency, and system development ($\bar{x}$ = 3.57). In turn, the lowest rated elements include: supplier's market position – including supplier's market share, image, system popularity, user opinions, etc. ($\bar{x}$ = 3.27), system architecture – including technology used to build the system, data management methods, data transmission protocols used, supported interfaces, etc. ($\bar{x}$ = 3.38), and system innovation – how a given system stands out from others in terms of using new solutions that increase its efficiency, functionality, and flexibility ($\bar{x}$ = 3.43) – see Table 2.

Table 2. Importance of selection factors for project management information systems

Catalogue of functional factors	Mean	Catalogue of supplier assessment factors	Mean
F1. Alignment of the system with organizational characteristics	3,53	D1. Time and methodology of system implementation	3,46
F2. Matching the system to the project features	3,57	D2. Cost of purchasing, implementing and maintaining the system	3,56
F3. Matching the system to the characteristics of the user	3,44	D3. Market position of the system provider	3,27
F4. Flexibility of the system	3,53	D4. Conditions of cooperation with the system provider	3,51
F5. System friendliness/ergonomics	3,52	D5. Support from the system provider	3,56
F6. Stability of the system	3,57		
F7. Functional scope of the system	3,50		
Catalogue of technical-technological factors	**Mean**		
T1. System security	3,65		
T2. Innovation of the system	3,43		
T3. System architecture	3,38		
T4. Adaptation of the system to the technical needs of the organization	3,55		

Source: Own research

For the purposes of the empirical research, respondents also assessed the project maturity of the organization on a nominal scale, where it was possible to choose one of five maturity levels and a neutral answer – difficult to say. The project maturity levels of the organization include:

- level 1 – unorganized, ad-hoc processes,
- level 2 – repeatable processes,
- level 3 – defined standards,
- level 4 – managed processes and projects,
- level 5 – organizational improvement.

The distribution of results assessing the project maturity of the respondents' organizations is presented in Table 3.

Table 3. Assessment of the organization's project maturity

Project maturity of the organization	N	%↕
Difficult to say	82	14,3
Level 1 – unstructured, ad-hoc processes	67	11,7
Level 2 – repeatable processes	166	29,0
Level 3 – defined standards	144	25,2
Level 4 – managed processes and projects	84	14,7
Level 5 – organizational improvement	29	5,1
Total	572	100,0

Source: Own research

In order to reduce the multi-variable set for selecting IT systems supporting project management, the exploratory factor analysis method was used. Its results allowed for the identification of latent relationships between the studied variables and the reduction of the original set of 16 variables to 2 components[3]. The first one contains all the original variables related to the set of functional factors and system security from the set of technical and technological factors – component: 'system adjustment and stability'. The second component includes the remaining variables from the set of technical and technological factors and all variables from the set of factors assessing the supplier – component 'architecture, costs and system support' (Table 4).

[3] The minimum value of factor loadings qualifying primary variables as components was set at 0.600.

Table 4. Results of exploratory factor analysis in the set of factors for selecting IT systems supporting project management

Constructs	Total mean	Loadings	Variables
System adaptation and stability	3,54	0,793	F1. Alignment of the system with organizational characteristics
		0,834	F2. Matching the system to the project features
		0,672	F3. Matching the system to the characteristics of the user
		0,789	F4. Flexibility of the system
		0,761	F5. System friendliness/ergonomics
		0,797	F6. Stability of the system
		0,756	F7. Functional scope of the system
		0,619	T1. System security
System architecture, costs and support	3,47	0,601	T2. Innovation of the system
		0,575	T3. System architecture
		0,600	T4. Adaptation of the system to the technical needs of the organization
		0,748	D1. Time and methodology of system implementation
		0,704	D2. Cost of purchasing, implementing and maintaining the system
		0,748	D3. Market position of the system provider
		0,656	D4. Conditions of cooperation with the system provider
		0,666	D5. Support from the system provider

Source: Own research

The analysis of the average values of the extracted components allows for their ranking – respondents rated the importance of system availability and stability ($\bar{x}$ = 3.54) higher than the importance of system architecture, costs and support ($\bar{x}$ = 3.47). Nevertheless, it should be noted that the average values are high, taking into account the applied measurement scale.

In the last step of the research procedure, the importance of factors determining the choice of IT systems supporting project management was compared with respect to the project maturity of the organization, using variance analysis.

Table 5. Comparison of the average importance of components of the selection of IT systems supporting project management with respect to the project maturity of the organization

Components of choosing information systems	Total mean	Project maturity TP | POZ1 | POZ2 | POZ3 | POZ4 | POZ5	ANOVA
System adaptation and stability	3,54	$3,28^{1} \approx 3,28^{1} < 3,62^{2} \approx 3,62^{2} \approx 3,63^{2} \approx 3,59^{2}$	$8,780^{***}$
System architecture, costs and support	3,47	$3,30^{1} \approx 3,35^{1} < 3,52^{2} \approx 3,50^{2} \approx 3,57^{2} \approx 3,45^{2}$	$3,818^{**}$

Legend:
Statistical significance (p-Value): ***p≤0.001, **p≤0.01, *p≤0.05
TP – difficult to say; POZ1–POZ6 – the organization's project maturity levels
$^{1, 2, 3}$ – group membership - the higher the value, the higher the group average

Source: Own research

The analysis of the obtained results indicates that the importance of both components of the selection of IT systems supporting project management is lower in the group of respondents assessing project maturity at level 1 or having difficulty making such an assessment. Statistically higher average values occur among organizations in which the project maturity of the organization was assessed at level 2 to 5 (see Table 5).

Summary

The analysis of the obtained results indicates the most important determinants of the selection of IT systems supporting project management. In this respect, the most important thing is the security of the system and the adjustment of the system to the features of the project. Criteria such as the time of project implementation, its size and the project management methodology are also of great importance when selecting a system, which indicates the need for flexibility and adaptation of the system to the specifics of the project and the needs of the user. Additionally, attention should be paid to the differences in the perception of the importance of the system depending on the project maturity of the organization – organizations with a higher level of project maturity assess the factors of system selection as more important, which suggests that maturity is related to the expectations regarding the functionality of the system.

The conclusions from the conducted study may also be useful for developers of systems supporting project management. From the perspective of identifying key elements of competitive advantage, the following are of particular importance:

- data security aspect – focus on system security,
- ease of adaptation to various projects and changing organizational requirements – meeting user needs,

- support for the organization in developing project maturity – which can increase the effectiveness of project management (education and development in the field of project maturity).

Directions of further research in the analyzed scope should include, among others, the role of organizational culture in the selection of systems (the impact of cultural differences in the organization on preferences and decisions regarding IT systems) and long-term effects of implementing different systems (the impact of system selection on long-term project efficiency and user satisfaction). The role of the international environment also seems interesting – in this respect, an international comparison can be conducted to understand global trends and differences in technological choices.

The results of the analyzed study provide valuable tips on how to make decisions on the selection of IT systems, taking into account different needs and expectations of users (organization project maturity) in the context of project management.

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ARTICLES

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WINNING THE INNOVATION RACE: INSIGHTS FROM GAME THEORY AND MICROECONOMICS

Abstract

This study examines the impact of first-mover advantage on firms' innovation processes from a microeconomic perspective, with a particular focus on game theory and the game of chicken. The primary research question is to ascertain how the timing of innovation affects a firm's competitive advantage. The objective of the study is to gain insight into the factors that contribute to a successful first-mover strategy and to elucidate the manner in which these factors interact within the framework of game theory.

Methodologically, the study employs game theory to analyse strategic decision-making in innovation, with a particular focus on the game of chicken to illustrate conflict scenarios in which firms compete for market advantage. The research examines the characteristics of firms, markets and products through a review of the literature in order to identify the key variables that contribute to first-mover advantage.

The findings demonstrate that a number of internal factors (such as managerial capacity for innovation and the firm's overall innovation capability), external factors (including participation in innovation networks and market orientation) and product characteristics (such as product class

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and environmental awareness) are significantly associated with an increased likelihood of a firm achieving first-mover advantage.In conclusion, the study confirms that firms that effectively manage these factors gain a competitive advantage by being the first to market.

Keywords: Innovation; Microeconomics; Game Theory; Companies; Management; Innovation Management.

JEL Classification: O32; O12; C72.

1. Introduction

It is evident that innovation plays a pivotal role in determining the success of a company, particularly when microeconomic factors are taken into account. The interaction of companies in the innovation process is of vital importance for reducing time to market, cutting costs and increasing profits (Rudyk, 2022). It is crucial for contemporary firms to comprehend the innovation process, associated risks and the conditions that facilitate successful innovation (Trachuk & Linder, 2022). In the context of the digital society, the importance of continuous product innovation is underscored, with particular emphasis placed on the influence of the information space and consumer behaviour on the trajectory of product development (Fernandez-Pol & Harvie, 2020). From a microeconomic perspective, game theory occupies a distinctive position in the context of innovation. The application of game theory has been shown to have a beneficial impact on the analysis of the innovation process in companies (Baniak & Dubina, 2012), as well as on the optimisation of product strategies or profit maximisation (Yurynets et al., 2017). A particular case is that of the chicken game and the associated first mover advantage. The following article will address the following research questions:

- Does first-mover advantage in innovation affect firm performance?
- What characteristics does a firm need to pay attention to in order to gain first-mover advantage in innovation relative to market competitors?

2. Research methodology

This study employs a qualitative research design, utilising game theory as the primary analytical framework to investigate strategic decision-making processes within the context of innovation, with a particular focus on the concept of first-mover advantage.

The study is grounded in game theory, a mathematical framework that is used to model strategic interactions between rational decision-makers. Game theory has been pivotal in understanding various economic and social phenomena, including competitive business strategies. Within this framework, the "game of chicken" is employed to illustrate conflict scenarios

where firms decide whether to pursue a first-mover advantage. This model is particularly relevant for analysing situations where firms must balance the benefits of early market entry against the risks of being a pioneer.

The research methodology is primarily based on a comprehensive literature review and secondary data analysis. The literature review encompasses seminal and contemporary works on game theory, innovation management, and competitive strategy. This review identifies key theoretical constructs and empirical findings related to first-mover advantages and innovation dynamics.

From the literature, the study identifies critical variables influencing first-mover advantage, including:

- The capacity of a firm's leadership to foster and manage innovation processes in a manner that is conducive to the generation of novel ideas and the implementation of new strategies.
- The role of external collaborations and networks in enhancing a firm's innovation capabilities.
- The extent to which a company is responsive to market trends and customer needs.
- The company's approach to integrating environmental considerations into its innovation strategies.

The conceptual analysis employs game theory to analyse the strategic decisions made by firms with regard to innovation. By modelling these decisions through the game of chicken, the study examines the conditions under which first-mover advantages emerge, the associated risks, and the potential for competitive gains. Furthermore, this analysis incorporates insights on external factors, such as national culture and market dynamics, which can influence strategic choices and outcomes.

The study synthesises findings from the literature and conceptual analysis to offer a nuanced understanding of the factors that contribute to successful first-mover strategies in innovation. The discussion addresses the practical implications for management, particularly in enhancing innovation capacity and navigating the complexities of early market entry.

This methodological approach provides a robust framework for exploring the strategic dimensions of innovation and offers valuable insights for both academic researchers and industry practitioners.

It should be noted that the article is not without certain research limitations, which may have an impact on the extent to which the conclusions presented can be regarded as generalisable and applicable in other contexts. Firstly, the analysis is primarily theoretical in nature, focusing on the concepts of first-move advantage and the chicken game. This may limit its applicability to the full complexity of real-world markets and consumer behaviour. Secondly, the study is based

on available data and examples from the literature, which may not reflect current technological and market trends. Furthermore, the context-specific to different industries may lead to a variety of results, meaning that the conclusions may not be universally applicable across sectors. Finally, future research could benefit from more empirical methods, such as quantitative surveys or case studies, to better understand the dynamics of first mover advantage in practice.

3. Literature analysis

As defined in the literature, game theory is a “mathematical theory of economic and social organization based on games of strategy, used to analyze various real-world phenomena” (Rapoport & Chammah, 1966; von Neumann et al., 1944). Game theory has a profound impact on a number of academic disciplines, including economics, political science, sociology and philosophy (Bruin, 2005). From the perspective of management science, game theory has had a significant impact on decision-making processes due to the strategic dimension of this theory and its utility in facilitating decision-making. According to the literature, game theory enables the identification of problematic areas and situations, as well as the assessment of the impact of a decision on a company and its surrounding environment (Dufwenberg, 2011; Schelling, 2010).

The chicken game is a concept within the field of game theory. The theory concerns situations of conflict, where two parties seek to gain an advantage, but simultaneously risk losing if neither of them relents. It is a zero-sum game, meaning that one side's gain is the other side's simultaneous loss. The matrix of this theory is as follows:

Table 1. The Chicken Game Matrix

	Player B: Cooperate	**Player B: Defect**
Player A: Cooperate	(0,0)	(-1,1)
Player A: Defect	(1,-1)	(-10,-10)

Source: (von Neumann et al., 1944)

In the game of Chicken, there are two Nash equilibria:

- Player A gives way and Player B continues (-1,1).
- Player A continues and player B gives way (1,-1).

In addition to the aforementioned equilibria, there is also a mixed equilibrium (0,0) where each player chooses to concede and adopt continuation strategies with certain probabilities. This equilibrium is more complex to calculate, but provides insight into more realistic behaviour where players are uncertain about their opponent's decision.

The indicated matrix demonstrates that in a chicken game, there is a phenomenon known as the "first-mover advantage." This is a situation in which one of the players attains a higher pay off by initiating a new

game (Ordóñez, 2017). Entering a market as a pioneer can confer substantial advantages, including cost savings, the acquisition of strategic locations, technological advantages, differentiation from competitors, and the acquisition of political support (Sammut-Bonnici & Channon, 2015). Nevertheless, it is important to note that the concept of a first-mover advantage is not an absolute reflection of reality. The impact of first-mover advantage is contingent upon market dynamics and may persist for an extended or abbreviated period, contingent upon the prevailing market conditions and the rate of technological advancement (Suarez & Lanzolla, 2005). It is also noteworthy that being the first to enter the market can on occasion, result in inefficiency due to delays. However, having superior information can mitigate this, rendering it more advantageous to be the second to act (Rasmusen & Yoon, 2012).

Notwithstanding these constraints, it is indubitable that a pioneering position confers a distinctive advantage on companies. An examination of the extant literature reveals a number of factors that are pivotal to the success of a first-mover enterprise in the implementation or creation of innovations. The three principal characteristics, as delineated by Chavez and Chen (2021), are as follows:

- Firm characteristics,
- Market characteristics,
- Product characteristics.

The following table sets forth a proposed internal development of the characteristics of each of the aforementioned characteristics, accompanied by a discussion of the same.

Table 2. The development of characteristics

Characteristics	The evolution of the given characteristics	References
Firm characteristics	The manager's capacity for innovation	(de Mel et al., 2009; Kremer et al., 2019; Mishra, 2023)
	The innovation capacity of companies	(Lawson & Samson, 2001; Mendoza-Silva, 2020)
	Innovation management	(Babaeva & Grigorieva, 2020; Lendel et al., 2017)
Market characteristics	Innovation networks	(Öberg, 2019; Yaqub et al., 2020)
	Market orientation	(Atuahene-Gima, 1996; Verhees & Meulenberg, 2004)
	Open Innovation approach	(Greco et al., 2016; Hung & Chou, 2013)
	National culture	(Evanschitzky et al., 2012; Nakata & Sivakumar, 1996)
Product characteristics	Product class	(Sun et al., 2004; Taylor, 1977)
	Environmental familiarity	(Danneels & Kleinschmidt, 2001)

Source: Own work

The relationship and advantage gained by being the first to market with respect to the listed characteristics will be extracted based on the given variables. The capacity of managerial personnel to introduce and oversee innovation exerts a considerable influence on a company's first-mover advantage. The financial performance of a company is positively impacted by managers who actively seek innovation (Chen et al., 2015; Wang & Dass, 2017). Nevertheless, it would be erroneous to assume that financial performance is the sole consequence of a manager's capacity for innovation. The extant literature suggests that additional factors influenced by the manager are absorptive capacity and human capital (Pradana et al., 2020). The conventional interpretation of absorptive capacity in the extant literature is the capacity to evaluate and utilise external knowledge (Cohen & Levinthal, 1990). Further theoretical development has led to an expansion of the definition of absorptive capacity to include the firm's understanding of the boundaries that arise both inside and outside the firm (Easterby-Smith et al., 2008). It is the responsibility of the manager to respond to opportunities and market constraints in order to facilitate innovation within the company. The second aspect of the manager's role is to foster an organisational culture that encourages innovation, thereby ensuring that responsiveness is not solely driven by top-down management decisions, but also emerges from the bottom up. This is consistent with the subsequent characteristic, namely human capital. The extant literature demonstrates that a firm's human capital exerts a considerable influence on innovation, particularly when the firm has the opportunity to augment its knowledge base through engagement with external entities within the cluster (You et al., 2021). Furthermore, the superior quality of human capital serves to mitigate impediments to innovation, such as deficiencies in the firm's knowledge base or market uncertainty and facilitates the streamlining of the firm's innovation processes (D'Este et al., 2014).

The advancement of the company's innovative capabilities also exerts an influence on the first-mover advantage. The advancement of entrepreneurial capabilities within an organisation markedly enhances its capacity to identify and actualise novel innovations (Jiao et al., 2016). The responsiveness of an organisation to emerging innovations is contingent upon a multitude of factors, the analysis of which is beyond the scope of this study. A review of the literature indicates that the alleviation of organisational rigidity or the balanced introduction of organisational ambidexterity within the company has a favourable impact on the company's responsiveness to market innovations (Chan et al., 2019). It has been highlighted that a company's entrepreneurial skills, such as the ability to identify novel approaches to business processes or solutions to organisational challenges, are a crucial determinant of future innovation and growth (Korobov et al., 2019). Furthermore, the company must develop the capacity to allocate resources in an appropriate manner in order to effectively manage the innovation process (J. (Jon) Liao et al., 2009).

The distribution of resources towards research and development has the potential to enhance a company's competitive advantage and to positively influence its financial performance (Boadi-Sarpong et al., 2023).

The management of innovation can confer a competitive advantage on a company. This is achieved by the careful management of processes related to market observation, the innovation process itself, the structure of the innovation and the leadership involved. This approach can result in the company gaining a first-mover advantage (Van de Ven, 1986). Moreover, the enterprise must demonstrate flexibility and adaptability in managing the innovation process in accordance with the prevailing market situation (Beckman & Barry, 2007). One potential approach to developing a bespoke innovation management strategy is to utilise the concept of the Innovation Value Chain. This methodology allows for the identification of areas requiring improvement within a company's innovation processes, thereby facilitating the implementation of targeted enhancements (Hansen & Birkinshaw, 2007). Adoption of this approach to innovation enables a company to enhance its market position and competitiveness vis-à-vis other market actors (Erceg et al., 2021). Furthermore, this has a beneficial effect on the value of the company's shares on the stock market (Knežević et al., 2022).

The advantages of innovation networks can be attributed to the sharing of risks among participants, access to new markets and technologies, and the acceleration of the time to market for new products (Pittaway et al., 2004). A substantial body of evidence demonstrates that engagement in innovation networks yields considerable benefits, including the ability to access crucial innovation personnel who were previously inaccessible (Qiao et al., 2014). Moreover, the entire workforce of enterprises also benefits considerably from participation, as it has a significant positive impact on productivity and offers the opportunity to engage in other innovation networks (Daly, 2018). Such benefits afford companies that are members of innovation networks a competitive advantage over those that do not participate in such networks. In addition to the advantages for the firm, innovation networks and collaboration with other firms and customers have the potential to enhance the novelty of the products offered (Nieto & Santamaría, 2007). Furthermore, active participation in the open innovation movement may confer a first-mover advantage to a company. Open innovation has the potential to enhance a company's competitive position in the market (Bigliardi et al., 2020). The extant literature indicates that open innovation may be a more effective means of influencing a company's performance than market or resource management (Cheng & Huizingh, 2014). Nevertheless, involvement in the open innovation movement can yield benefits of varying magnitudes for diverse organisations. Small and medium-sized enterprises (SMEs) frequently derive greater advantages from open innovation practices than their larger counterparts, particularly with regard to the introduction of novel products to the market.

The innovative performance of SMEs is propelled by intellectual property protection, whereas large firms tend to benefit more from diverse search strategies (Spithoven et al., 2011).

National culture has been demonstrated to play a significant role in facilitating the generation of innovative ideas (Efrat, 2014). The innovativeness of companies is contingent upon the specific characteristics of the culture of the country in which they operate.

For instance, research indicates that societies characterised by individualism and a long-term orientation, coupled with a relatively low level of power distance, are more conducive to fostering an environment that enables companies to innovate (Boubakri et al., 2021; Handoyo, 2018). This is applicable to all types of companies, including small and medium-sized enterprises (van Everdingen & Waarts, 2003). The prevalence of indulgent cultures, which permit the gratification of desires and the enjoyment of life, has been demonstrated to correlate with higher levelsof innovation (Boubakri et al., 2021; Khan & Cox, 2017). Comparative studies between different cultural groups (e.g., Germany, Austria, Switzerland vs. the Czech Republic) have demonstrated that cultural aspects, including trust, cooperation, and openness, exert a significant influence on innovation activities (Papula et al., 2018). However, the impact of cultural factors on the extent of innovation is merely one among numerous contributing elements. It is similarly possible to enhance the overall level of innovation through direct inputs and efforts by the state, irrespective of the prevailing cultural context. Furthermore, the impact of national culture on innovation is intensified by the extent of support for innovation, which highlights the crucial role of a supportive environment in fostering innovation (Santos et al., 2020).

Active entrepreneurs are more likely to innovate products with a higher degree of uniqueness than their more passive counterparts when it comes to innovation (Avlonitis & Salavou, 2007). The implementation of product innovation has been demonstrated to result in increased sales, profits and rates of return for the companies in question (Cooper, 1984). The uniqueness of a product is a crucial factor in enhancing a company's innovativeness and overall product performance (Avlonitis & Salavou, 2007; Lindman, 2000). While high product innovativeness can lead to significant competitive advantages, it also requires careful management of customer familiarity and internal complexities (Calantone et al., 2006; Kleinschmidt & Cooper, 1991). The design of new products and the incorporation of new technologies are critical dimensions that drive market success (Talke et al., 2009), particularly when supported by cross-functional teams and strategic orientations focused on technology and learning (Sethi et al., 2001). Companies aiming for innovation should strive to achieve a balance between these factors in order to optimise the success of their new products (Paladino, 2007; Salavou, 2005).

Furthermore, environmental awareness has been demonstrated to exert a beneficial influence on innovation and organisational performance, as well as on managerial innovativeness and employee participation in innovation (Chege & Wang, 2020). Furthermore, the literature indicates an enhanced environmental performance among companies (Z. Liao et al., 2021). It is of great consequence that environmental awareness among those in positions of authority and responsibility within organisations should facilitate innovation within the company. Such awareness gives rise to augmented investment in research and development, the implementation of eco-innovation practices, and the advancement of green products and processes (Huang et al., 2019). External factors, such as government regulations and stakeholder pressure, serve to further amplify these effects, thereby resulting in improved environmental and economic performance (Borsatto & Amui, 2019; Fang et al., 2021; Seman et al., 2019). The incorporation of environmental concerns into innovation strategies provides companies with a competitive advantage and a foundation for long-term sustainability (Fernando et al., 2019; Meidutė-Kavaliauskienė et al., 2021).

4. Discussion

The chicken game is an exemplar of a game of game theory, in which two parties compete to force a concession from each other while avoiding a disastrous outcome for both. In the context of business and innovation strategy, this game illustrates a situation in which companies are faced with the dilemma of taking the risks involved in being the first to bring a new technology or product to market. In the chicken game, two companies must determine whether to assume the risk of being the first to enter a new market (which entails significant costs and uncertainty) or to await the actions of a competitor. Should both companies elect to proceed with the venture, they may suffer substantial financial losses, particularly if the market is not yet prepared to accommodate the new technology or if demand proves to be lower than anticipated. Being the first to market can confer significant benefits, including gaining an early competitive advantage, attracting loyal customers and setting market standards. However, this decision carries inherent risks that must be managed deftly. In the chicken game, companies that choose to be first are granted potentially greater profit, but only if competitors refrain from taking the same risks simultaneously. The chicken game serves to illustrate the necessity for advanced risk management and strategic decision-making. Companies that are able to effectively assess the risks associated with innovation are better placed to plan their activities and decide when to take risks and when to exercise caution. In order to achieve this effect, companies can apply the set of characteristics proposed in the model to which they should pay attention so as to minimise risk as well as increase certainty of success.

The concept of first-mover advantage pertains to the advantages that a company may derive from being the first to market a novel product, technology, or innovation. In the context of the chicken game, the decision to be first involves a high level of risk, but also the potential for significant rewards. A discussion of these benefits in conjunction with company characteristics can facilitate an understanding of why some companies are more willing to take this risk than others. The first-mover advantage can be defined in multiple ways. A company that is the first to innovate can quickly capture a significant share of the market (Makadok, 1998; Robinson et al., 1994). Pioneers often gain loyal customers who may be less likely to switch to competitors when the latter introduce similar products. The advantage of early market entry is that it allows a company to achieve economies of scale more rapidly than its competitors. This results in lower unit costs and greater profitability. However, in order to reap the benefits indicated, it is essential for the company to pay close attention to the characteristics identified in the literature analysis.

Organisations that possess robust research and development (R&D) departments and foster an environment of innovation are more adept at discerning and capitalising on market opportunities. Such organisations are able to draw upon the requisite resources to conduct research, develop new products and bring them to market in a timelier manner than their competitors. It is imperative that leaders possess a vision for the future and the capacity to inspire their organisations to embrace risk in order to ensure the success of a pioneering venture. Effective risk management and the capacity to make strategic decisions are indispensable for navigating the uncertainty inherent to new technologies. A robust financial foundation enables companies to better withstand the costs associated with developing new technologies and launching them onto the market. Furthermore, access to capital allows them to invest in marketing, expand production and construct the infrastructure essential to support the new product. Participation in innovation networks and strategic partnerships can provide additional resources, knowledge and technology that are critical to the success of early innovators. Companies that effectively manage their relationships with partners can bring new products to market faster and better respond to changing market conditions.

The decision to become a market pioneer with a new technology or product entails a significant degree of risk. In addition to the uncertainty surrounding market adoption, companies must also consider the potential for high costs and competitive reactions. In the context of the 'chicken' game, these challenges can be conceptualised as analogous to the strategic decisions that companies must make when determining whether to assume a pioneering role in innovation or to await the actions of others. The substantial financial commitment required for the research and development of new technologies poses a considerable risk. The financial outlay required for pioneering projects may

be considerable before any revenue is generated, which can place significant strain on a company's budget. One of the most significant risks is the lack of guarantee that a new product or technology will meet market acceptance. The market may not be prepared for the introduction of a new product or technology, which can result in low sales and a poor return on investment. The advent of new technologies may give rise to instability and incompleteness, which can give rise to a number of issues, including product quality problems, delays in launch and even the necessity for product recalls. The rapid pace of technological development can render an innovative solution obsolete before it has had the opportunity to gain significant market share. Furthermore, the actions of other companies may negate the first-mover advantage by launching competing products in a timely manner. This is particularly the case when competitors have greater resources or more effective distribution channels.

In order to effectively mitigate the aforementioned risk, a company may implement a range of risk management strategies. The diversification of investments in disparate innovation projects can assist companies in achieving a more balanced risk profile. The investment of capital in a diverse portfolio of technologies and products can serve to mitigate the potential adverse consequences of the failure of a single initiative. The capacity to adapt swiftly and effectively is a key determinant of an organisation's ability to navigate market and technological uncertainty. This applies to both decision-making processes and the ability to alter strategic direction in response to new information. Forming strategic partnerships can assist in the sharing of costs and risks, as well as the implementation of innovations in a more expedient manner. Partnerships can also facilitate access to new markets and technologies. In conclusion, risk management is a pivotal aspect of strategy related to first-mover advantage. Companies must consider both internal and external risk factors and implement suitable strategies to optimise the benefits of innovation while minimising potential losses.

An understanding of the dynamics of the chicken game and associated first-move strategies is of significant practical importance for managers. The decision-making process surrounding innovation requires a delicate equilibrium between the inherent risks and potential rewards, with significant implications for strategic planning, resource allocation, and team management. It is of the utmost importance to allocate sufficient resources to research and development in order to maintain competitiveness. It is incumbent upon managers to ensure that the company has the requisite financial, technological and human resources to support innovation. In addition to R&D funding, managers must also manage working capital in order to be able to scale production and distribution of new products in a timely manner once they enter the market. Furthermore, the creation and maintenance of a culture that fosters innovation is critical to the success of market pioneers. This includes

encouraging creative thinking, openness to risk and a willingness to adapt quickly to change.

It is incumbent upon organisational leaders to possess the capacity to anticipate future market and technological trends. Visionary leadership plays an instrumental role in mobilising teams to achieve ambitious innovation goals. Furthermore, collaborations with academic institutions, research organisations and other businesses can facilitate the innovation process. Partnerships can facilitate access to the knowledge, resources and technologies that are essential for the development of new products. Furthermore, in dynamic markets, the capacity to adapt expeditiously is of paramount importance. Managers must be prepared to modify strategies in response to changing market conditions, including unexpected actions by competitors or alterations in customer preferences.

In conclusion, managing for first-mover advantage necessitates a comprehensive approach encompassing strategic planning, effective resource allocation, appropriate leadership and collaboration with partners. Managers must be prepared to make audacious decisions, but at the same time must manage risks effectively to optimise the benefits of innovation.

In the context of discourse pertaining to the advantages inherent in the initial stages of a business venture and the strategies that may be employed to foster innovation, the 'chicken' game was introduced as a metaphor for the decisions that companies are compelled to make. The analysis demonstrates that first-move advantage can confer substantial benefits, including the acquisition of market share, the establishment of industry standards and the reinforcement of innovation leadership. However, the associated challenges, such as high R&D costs, market uncertainty, technology risks and competitive reactions, require careful management. Key strategies include effective risk management, organisational flexibility, fostering a culture of innovation and collaboration within innovation networks. For managers who decide to be a pioneer, it is important to balance the potential benefits with the risks of innovation and to adapt to a dynamically changing market environment.

5. Conclusions

The article presents a comprehensive analysis of the intricate nuances associated with strategic decision-making in the context of innovation, employing a multifaceted approach that integrates insights from game theory and microeconomics. A fundamental aspect of this analysis is the examination of the 'chicken' game as a metaphor for the competitive landscape faced by firms. These firms must decide whether to take a risk and be the first to market with a new technology or product, or to wait for a competitor to make the first move. The study demonstrates that a first-mover advantage can confer substantial benefits, including the acquisition of loyal customers, the establishment of market standards, and the securing of key resources.

Conversely, such a strategy carries with it a number of significant risks, including the potential for high costs, uncertainty regarding market reaction, and the possibility of substantial losses in the event that the innovation is not adopted.

The findings emphasise that effective innovation management necessitates a comprehensive understanding of the internal and external factors that influence the success of an innovation. These include the managerial capacity to oversee the innovation process, participation in innovation networks, market orientation, and consideration of environmental aspects. In the pursuit of competitive advantage, contemporary companies must strike a delicate balance between the potential benefits and the risks associated with being a pioneer. Consequently, it is crucial for companies to possess the agility, creativity, and resilience to navigate the ever-changing dynamics of the market.

Further research may be conducted in the following areas: innovation management from a behavioural economics perspective; risk reduction in innovation; and the issue of the prisoner's dilemma in innovation management. Additionally, further lines of research may include a quantitative analysis of the aforementioned issues.

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ARTICLES

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PROMOTION AS AN INSTRUMENT FOR DEVELOPING DEMAND FOR TRANSPORTATION SERVICES TAKING INTO ACCOUNT SUSTAINABLE DEVELOPMENT

Abstract

The transport sector is a key sector for sustainable development due to the benefits it brings both to society and to the economy as a whole, which can be achieved while minimizing its negative effects on society, economy and the environment.

The main purpose of this article is to analyse the promotional instruments used in the transport service market to shape demand with sustainability in mind. These topics are extremely important because access to information is very fast and it is easy to develop a good and bad opinion in society about the proposed solutions. A growing public not only pays attention to the quality of the services provided, but also to environmental protection measures, charitable activities organized or support for local initiatives. Awareness among the public is growing and everyone pays attention to equal treatment and rewards for commitment to not only economic, but also social or environmental objectives. Competition is growing, and building a good image and lasting relationships with satisfied consumers can change their motivations.

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Introduction

Transportation is one of the most important drivers determining the economic development of a country. The highly developed transport infrastructure of the country has an impact on strengthening the country's social, economic and spatial cohesion and contributes to improving the competitiveness of the economy. The development of infrastructure, as well as a functioning transport system, significantly affects the country's economic growth, because the country's location on international transport routes is an important aspect of competitive advantage. A well-functioning transport system can generate economic development incentives, provided it can meet the new development opportunities created, such as:

- increasing the availability of transport services (both for domestic and foreign users);
- reducing the cost and time of transport, with a synchronous and gradual improvement of energy efficiency and the reduction of specific emissions indicators;
- greater expansion of multimodality.

In order to analyze the development directions, we can conclude that in Poland, it is necessary to improve and develop a coherent and well-functioning transportation system that will be integrated with the European and global systems. The highly developed transport infrastructure in the country has an impact on strengthening the country's social, economic and spatial cohesion and contributes to increasing the competitiveness of the economy.

Sustainable development of transportation in Poland

The 2030 Sustainable Development Agenda, adopted in 2015 by 193 United Nations countries, including 17 Sustainable Development Goals (SDGs), has become the global roadmap for sustainable development. The SDGs are a useful tool for global representation of the values and development objectives of countries and provide a common reference framework useful for international partnerships (www.gov.pl).

Sustainable development is intergenerational solidarity, whose main task is to find solutions that ensure greater growth and enable the active integration of all social groups in the development processes while giving them the opportunity to benefit from economic growth. Firstly, sustainable development mainly concerned the need to reduce the negative impact

of economies on the natural environment. Over time, this concept gained a broader meaning, focusing on the three factors of development: respect for the environment, social progress, and economic growth. Today, the concept of sustainable development is increasingly applied to transport, which is very important for socio-economic development and which has become a horizontal principle reflected in all country development policies. Figure 1 shows the objectives of sustainable development.

Figure 1. The 17 Sustainable Development Goals (SDGs)
Source: https://www.welthungerhilfe.org/our-work/focus-areas/civil-society-and-advocacy/sustainable-development-goals [access: 01.12.2022 r.]

The sustainable development of transport is closely linked to three important aspects of industry: increased mobility, energy resources, i.e. fuels, and atmospheric emissions. As early as the 1960s in Western Europe, it was noted that rapidly increasing transport has brought various environmental and social costs. The very large increase in mobility brings with it completely new challenges for transport, the most difficult of which seems to be the overriding inefficiency of the transport system resulting from the increased mobility of societies and the uncontrolled and uncoordinated development of transport itself. The use of the principle of sustainable development in transportation, which was formulated in 1987 in a report by the World Commission for Environment and Development, was proposed as a solution to this growing problem: "sustainable development is development aimed at meeting the developmental aspirations of the present generation in such a way that future generations can achieve the same aspirations" (Report of the World Commission..., 1991, p. 67).

In the future, our country's transport system and that of Europe must take into account all expectations of social economic development

Therefore, three basic features of sustainable transport development can be distinguished (Fig. 2).

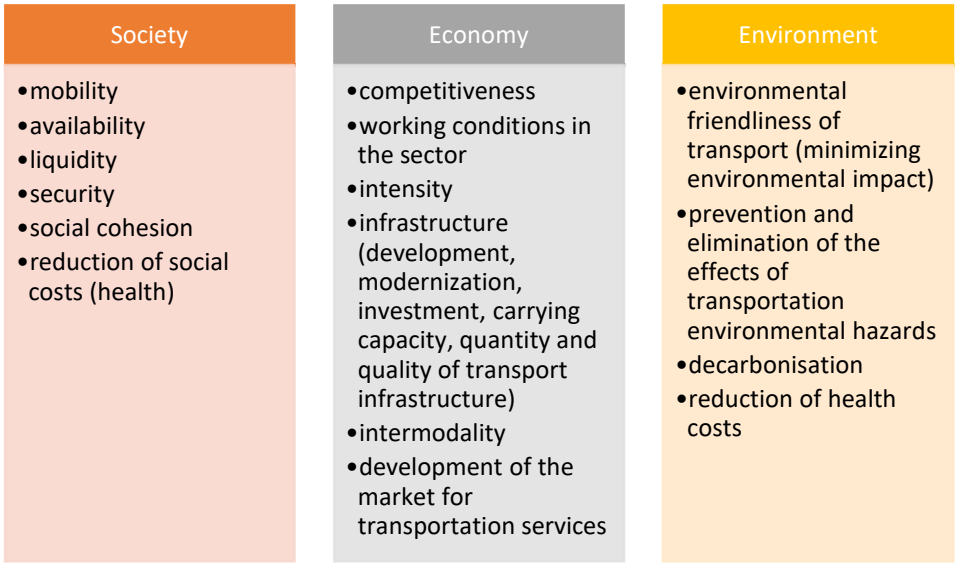

Figure 2. Features of sustainable transport development
Source: Own study based on (Strategy for Sustainable Development of Transportation until 2030 (M.P. 2019 item 1054))

In practice, the idea is that the development of transport should take place in such a way that, on the assumption of greater mobility, transport networks – both locally and globally – can meet the transportation needs of society. At the same time, transport development should lead to a reduction in the consumption of non-renewable energy resources, mainly oil and coal. It is also necessary to reduce pollutants produced by transport to a level where the impact of transport on the environment will not threaten to cause irreversible changes with negative consequences for the future. The most important measures for sustainable transport development are shown in Figure 3.

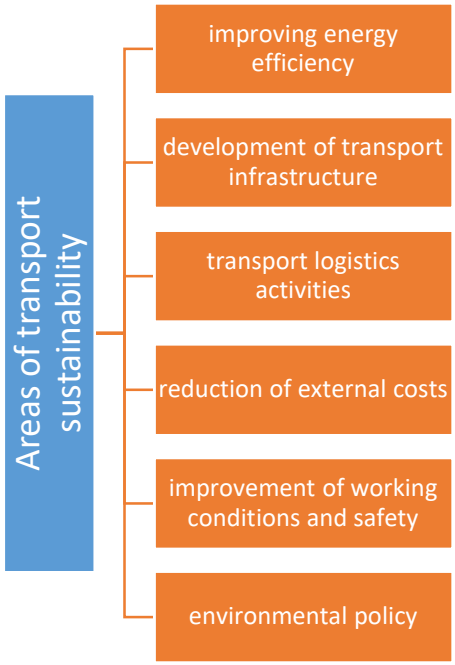

Figure 3. Measures for sustainable transportation
Source: Own study based on (Strategy for Sustainable Transport Development until 2030 (M.P. 2019 item 1054))

Sustainable transport development should meet the environmental, economic and social conditions and political responsibility. This creates a requirement:

- planning for environmental consideration in its development,
- detailed consideration of economic benefits and surface effects,
- defining the true costs of their production at the prices of the services provided,
- providing users with an adequate level of access to transport services, public acceptance of the activities carried out, which is a transparent decision-making process and responsible management of financial resources.

Sustainability issues in the transportation sector are very complex to achieve. Many times, they force actions that are not always popular in the social sphere. Institutions operating at various levels are systematically pursuing objectives aimed at reducing the adverse effects on the environment, creating social and environmental costs (www.funduszeeuropejskie.gov.pl).

In the EU's assumptions on transport, the greatest limitations arise from the motives that are the most important from the point of view of efficiency

and structure of the transport system, namely insufficient harmonization of competitive conditions in the transport service market, lack of global industry consistency in imposing costs for the use of infrastructure facilities, and the concept of mobility in urban agglomerations (www.gov.pl/web/fundusze-regiony/).

In the Transport Assumptions until 2050, it is determined that the future objectives of balancing transport activities in Poland will be:

- the establishment of a unified transport space,
- the establishment of a fully competitive transport system,
- a development programme for rail and multimodal transport,
- the further minimization of harmful environmental emissions,
- the need to develop infrastructure facilities with a low environmental degradation effect,
- the use of ultra-modern and rationalization technologies for the distribution of traffic in transport.

It is also important to take into account the diverse and degrading environmental impacts of some modes of transport. The most burdensome branch is road transport, which creates the element of the highest social costs, external costs.

The sustainable development of transportation requires, above all, the rational use of transportation capacity in urban areas – the so-called economies of scale, which can be achieved by transporting a large number of different loads in common directions by railways, the use of public transport for passengers, etc., as well as the search for alternative, environmentally friendly propulsion sources.

The elements of forming demand for transportation services

Mobility in general is closely linked to the need for movement and movement, which has always accompanied humanity. People's movements at different stages of their civilization have evolved under the influence of many factors. Factors contributing to the growth of modern mobility in societies are linked to a number of phenomena, including: the growth of state industrialization, cohesion with other countries' economies, spatial development, modern transport infrastructure, the expansion of transport services, the quality of transport services offered, the level of society's wealth, the amount of income earned, the disposal of free time, improved size and demographic structure of modern society, an increase in urbanization.

It should also be noted that there is a strong dependence between the satisfaction of the needs of the individual for mobility and the level of existence of modern societies, i.e. the standard of living and social security of societies, as well as the possibilities for further socio-economic development.

Therefore, the question of the proper formation of contemporary mobility and the assumed mobility is of interest to various types of actors who can influence the management and development of the pan-European transport system. Such assumptions should ensure the highest level of satisfaction for meeting various mobility needs in the right scope and at the right standards (Frajczak-Kowalska, 2012).

Modern transportation must, above all, meet the demands of time, taking into account, as the most important criterion of its provision, the movement at ever higher travel speeds. Another very important element for the lifestyle of modern society that affects transport is the great importance of free time, as well as its use for leisure activities or tourism.

The choice of travelling by air or by driving your own car stimulates travellers' needs for comfort and travel; the situation is similar in railway transport. The spread of ultramodern communication methods, using ICT systems, makes travellers certainly expect to use these media to convey information or facilitate travel [28]. Customers in the modern world are characterized by very diverse and increasingly demanding requirements for transportation services.

The requirements of travellers to be taken into account in designing and implementing new transport options are:

- short travel times, which can also be used for work or rest,
- high frequency of trains, either in regional or agglomeration services,
- expected door-to-door service by good travel arrangements, i.e. connection with other means of transportation,
- the cost of travel, measurable in relation to the offer and the traveler's ability,
- access to information through the use of modern media such as telephone lines, the Internet, electronic media,
- diversity of information, announcements and publications about train times, as well as bus transport carriers, public transport, transmission of announcements about tariffs, ticket prices and other accomodation services,
- ability to read, remember connections, (time departs on time when cyclical traffic is carried out),
- easy availability of tickets, (purchase via the Internet) and a large variety of payment forms,
- sufficient travel comfort and aesthetic comfort, climate surrounding the passenger (interior of the vehicle, station),
- travel safety,
- accompanying services, including baggage, parking, food and hotel services.

Customer requirements are related to transportation service, and they refer not only to the transportation process itself from destination A to destination B, but also to expectations of the way of transportation. In addition to the expectations above, other requirements should be taken into account in the travel offer provided, so that you can obtain additional satisfaction from the trip you take (Mindur, 2004).

The expectations of transport providers appear to be clear. An element of transport proposals, such as travel speed, punctuality, frequency of transport modes and travel reliability, refers to the established timetable or the spatial arrangement of transport lines.

The creation of functional and effective transport systems that meet the needs of modern society must cooperate at many levels and with many means of transport, in transport processes management systems, and in travel services. In addition, it is important to use solutions that do not harm the environment. Therefore, in line with the concept of sustainable transport development, it would be necessary:

- strive to reduce automobile traffic in cities by changing the proportion of public and individual traffic use,
- improve or develop attractive forms of public transport, characterized by desirable accessibility, reliability, speed and low travel time,
- locate mixed-functional development complexes along public transport routes,
- locate new service centres at transport hubs with convenient access by public transport,
- introduce pedestrian transport routes (so-called promenades) and designate areas designated exclusively for pedestrian traffic,
- promote the development of bicycle (Rucińska, 2014).

These issues indicate the necessity of taking measures that are related not only to influence branch markets, but also to assessing the understanding of those involved in transport services and society in the area of sustainable transport development. In this context, measures must be taken to support and promote the development of more environmentally friendly means of transport.

Examples of promotional instruments for sustainable transport services

The negative impact of not applying the concept of sustainability to transport is the first to be felt in large cities. In metropolitan areas, it is becoming increasingly common that local communities are unable to meet their transportation needs due to a lack of capacity in the transportation system or constraints caused, among other things, by heavy air pollution caused by transport. The reason for this situation is mainly due to the huge increase

in social mobility and the increasing availability of individual motorization. The car is no longer a luxury item, but in Poland it remains a symbol of social status for most of society.

The promotion of a transport service is an activity aimed at defining both the volume and range of this service from the point of view of market needs, taking into account the basic objectives of transport policy. Promotion is closely linked to the marketing of transport services, which is a system of continuously studying and stimulating the market of transport needs, specifically through the use of promotion, as well as inspiring the production of transport services and providing buyers with maximum services at the right time, at the right place and at the right competitive prices (Makarski, Kuźniar, 2012).

This definition focuses on the action taken to improve the methods to meet the demand for transport services in the means at our disposal, as well as on existing regulations. The consumer orientation is related to the strong competition in the transport market, as well as to surplus production in all segments. In order to analyze the possibility of increasing the provision of transport services, the concept of modern marketing and promotion, often referred to as active or dynamic marketing, should be used (Rosa, 2013).

Promotion is an extremely effective tool for a company (enterprise) to communicate with the buyer of services and the entire environment. Promotion activities are mainly based on providing information, encouraging and making promises that influence the purchase of services offered. Promotion activities play a very important role in the modeling of the image and brand not only of companies but also of individual transport branches.

The main objective of promotional instruments used in the transport service market is:

1. To consolidate, through consistent and mutually complementary information and promotional tools, the promotion of knowledge and public awareness of sustainable transportation.
2. The dissemination of comprehensive and enforceable information about the new rollstock, its advantages consisting of improved comfort and safety of movement and improved accessibility for people with reduced mobility.
3. Creating a positive image for public transport.
4. Modeling a positive image for intermodal transportation.
5. To highlight the role of EU institutions involved in the financing and purchase of new rolling stock, as well as to raise public awareness of the infrastructure and environment of The Operational Programme and the accessibility, role and potential benefits resulting from it.

The implementation of the concept of sustainable transport development and the formation of pro-environmental beliefs requires the development of methods and techniques of market communication with an informative,

educational, persuasive and reminder nature. The target audience of this promotion is the public, the businesses, the institutions, their cells and the organizational units. On the other hand, the senders of promotional messages are governmental organizations, local governments, other non-governmental organizations, local organizations and the media.

One of the most important forms of promotion of sustainable transport development is advertising. It is the most popular form of promotion, as it uses various types of mass media extensively. Advertising activities are a relatively cheap and fast form of customer acquisition. Advertising is a duty to inform contractors of the services offered and convince them to buy. Thanks to good advertising, the company and its activities have a positive image (Rucińska, Ruciński, Wyszomirski, 2005).

Often railway operators convince potential customers through advertising activities by referring to the ecological (Fig.4) and economic (Fig.5) advantages of the means of transport, i.e. a train. PKP Intercity, the national carrier, raises awareness among passengers about the environmental impacts of various modes of transport. To achieve this goal, in 2021 it introduced information for passengers in its online sales system on the carbon footprint that will leave their train journey and how much more environmentally friendly it will be to drive a car or fly a plane. The same information is also contained in electronic tickets generated from PKP Intercity's online system. (https://www.teraz-srodowisko.pl/aktualnosci/-PKP-Intercity-kolej-jako-srodek-transportu-numer-jeden-11479.html)

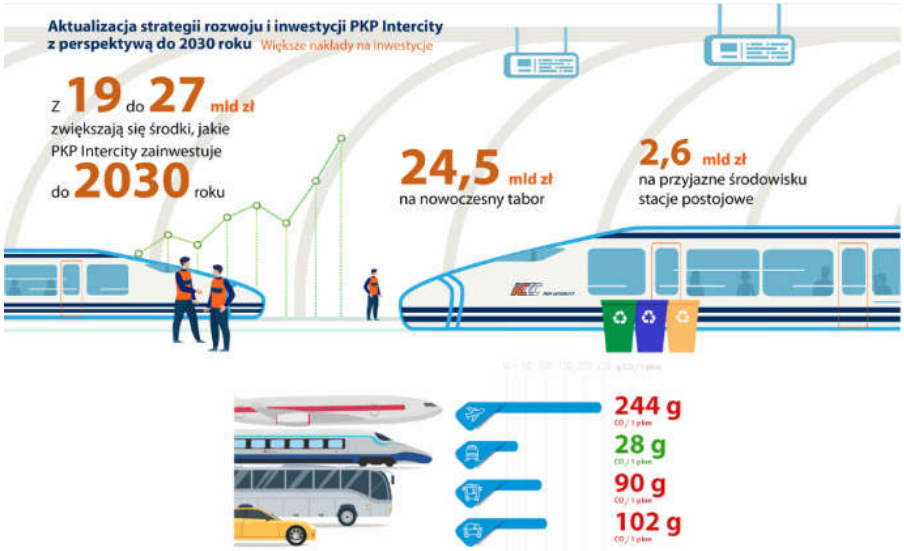

Figure 4. PKP Intercity campaign – Scale of investment and comparison of travel carbon footprint

Source: https://www.intercity.pl/pl/ekopodroz/ [access: 07.01.2023 r.]

Figure 5. Examples of rail promotion
Source: https://koleje-wielkopolskie.com.pl/paliwo-drozeje-wybierz-koleje/ [access: 07.01.2023 r.]

The EU has designated 2021 as the “European Year of Railways” to promote rail as a safe and sustainable means of transportation. In 2021, several rail-related events were held in Europe. As part of the project, the Connecting Europe Express trains passed through 26 European Union member states in 36 days. The Connecting Europe Express journey was one of the most symbolic events of the European Year of Railways. The project aimed at education and the creation of a positive image of the railways. The activities realized were to effectively promote railways, so that Polish and European railways could achieve record passenger and freight traffic. "Railways should be the means of transportation that we all choose," he said. The Polish events related to the European Year of the Railways were coordinated by the Chairman of the Railway Transport Office. (www.rokkolei.pl) (http://utk.gov.pl/pl/europejski-rok-kolei/aktualnosci-europejskie/17900,Connecting-Europe-Express-juz-w-Polsce.html)

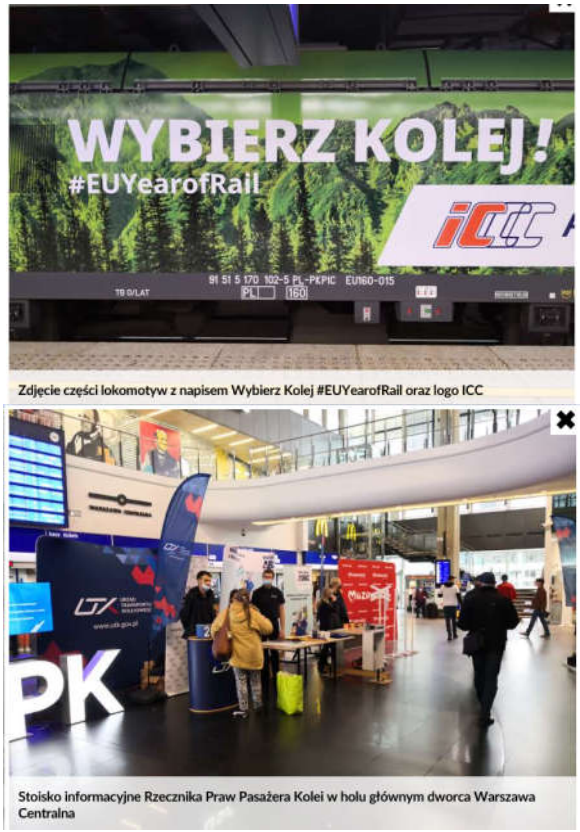

Figure 6. "European Year of Railways" project in Poland
Source: https://utk.gov.pl/pl/europejski-rok-kolei/aktualnosci-europejskie/17900,Connecting-Europe-Express-juz-w-Polsce.html [access: 20.01.2023 r.]

In connection with the European Railway Year, which takes place in 2021, PKP S.A. has announced a competition for elementary school students entitled "I choose railways because I care about the environment" (Fig. 7). These initiatives aimed at the younger generation are intended to build behavioural motivations regarding the choice of means of transport from an early age.

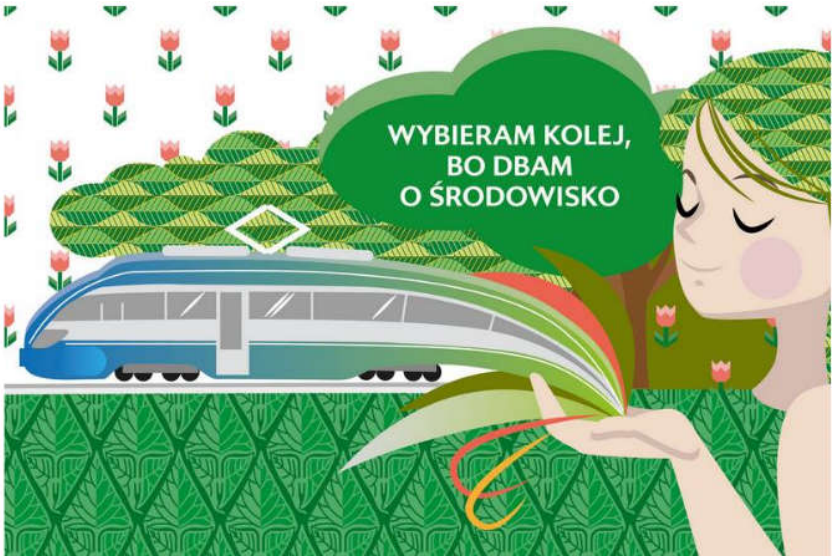

Figure 7. PKP PLK S.A. competition
Source: https://kolejowyportal.pl/konkurs-dla-uczniow-szkol-podstawowych-wybieram-kolej-bo-dbam-o-srodowisko/ [access: 23.01.2023 r.]

At present, the promotion of public transport is considered to be the most popular solution to the transport problem in cities. The purpose of public transport promotion is to encourage people who use individual motorization to change their transport preferences. However, through the promotion of public transport, we should understand the entire programme of activities carried out mainly by the authorities: the EU, the government and local governments. Its main elements are advertising in the mass media, as well as outdoor advertising in the form of posters, signs and also placed on buses. The main task is to highlight the benefits of public transport through them and to persuade more residents to use public transport. Therefore, on World Car Free Day, a free public transport journey for drivers is organized on the presentation of a registration card. Some local governments go even further, announcing that on the first day of each month drivers will be able to travel free on city buses on the presentation of their registration card. An example of such a campaign poster is shown in Figure 8.

Figure 8. World Car Free Day - ZTM promotional campaign in Kielce
Source: https://www.kielce.eu/resource/image/1/5/2829/6750/0x0.jpg [accessed: 30.01.2023 r.]

A way to encourage residents to change their transportation preferences can also be, for example, the regular organization – through the local media – of competitions in which season tickets are available, and the participants in these competitions can only be people who have not previously held such tickets. Public transport operators are also looking for new customers among participants in various cultural, entertainment or sports events. For example, the local government airline Przewozy Regionalne, which launched for the Woodstock Festival in Kostrzyn – among other things – a "Train to the Blues" from Bialystok to the Suwalki Blues Festival (tickets could be purchased at the cultural centre that organizes the event). PR also offered discounts on ticket prices on scheduled trains for Halfway Festival Pass holders. It is also worth noting that PKP S. A. has made Bialystok station available for concerts accompanied by the Suwalki music event. (http://www.transport-publiczny.pl/wiadomosci/nowy-trend-w-promocji-transportu-zbiorowego-50142.html)

In the field of freight transportation, the most famous campaign is to move trucks on the tracks (Fig. 9).

Figure 9. "Trucks on the Tracks" civic campaign
Source: https://tirynatory.pl/ [access: 25.01.2023 r.]

"Trucks on the Tracks" is a campaign carried out by the Civil Affairs Institute. In 1996, they organized the first demonstration in front of the Ministry of Transport under the slogan "Trucks on the tracks". This was the beginning of the civic campaign, whose main activities were the transfer from road to rail of goods transported by TIRs through Poland in transit, and called for the introduction of principles in the transport of goods: “User pays” and “Polluter pays”. They also advocated reducing rail access rates for intermodal transport. The campaign received strong support from the public (https://tirynatory.pl/).

Information and education campaigns alone are not enough to persuade the public to abandon individual car transport. The lack of a comprehensive approach to adapting Western land use patterns (i.e., the location of commercial and service centres or technical and industrial clusters on the outskirts of cities, but without ensuring the accessibility of public transport there, the construction of new residential developments in the suburbs, but without the creation of local service centres and rail/tram lines that provide fast connections to other areas of the city) results in an additional increase in the use of private vehicles.

There is still a lot of work to be done to implement the principle of sustainable transportation in urban agglomerations.

Conclusions

Realizing the assumptions of economics and sustainable development policy in transport can be seen as an important course of action aimed at achieving a balance between the further economic and social development of the globalized world economy and the preservation of environmental values and resources. The progressive process of globalization is changing the needs and expectations of society and commercial entities that use the services offered on the transport market. The result of these changes is an increase in transport demand. Car transport has gained a special status in the daily life of society, and its rapid development has highlighted its negative impact, mainly on the state of the environment and society.

To achieve sustainable transport goals in Poland, we must have an attractive alternative to car transport. Ensure public acceptance through all information, promotional and educational activities. In Poland, such large-scale activities are carried out by public transport operators. Changes in attitudes and the creation of awareness of sustainable mobility must be planned for the long term, taking into account various target groups, especially children and young people, as a group that is not yet used to a lifestyle in which the car plays an important role. It should also be emphasized that promotional activities must be carried out continuously and in the long term, not just randomly and selectively.

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ARTICLES

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SUSTAINABLE URBAN MOBILITY – AN IMPORTANT ELEMENT OF EU CLIMATE POLICY

Abstract

Sustainable urban mobility, decarbonisation and improving the mobility of the population itself are among the objectives of European climate policy – commonly referred to as the 'Green Deal'. In order to achieve this goal, the main focus is on public transport, especially rail transport – the most sustainable, environmentally friendly mode. The railway provides a convenient and fast connection between the suburbs and satellite towns and the centre of the agglomeration. It makes it possible to move large numbers of passengers in an efficient, safe and faster way than by car. The railway should form the basis of the transport system of cities, especially agglomerations.

This paper presents a synthetic analysis of the place of railways in the transport service of Polish agglomerations. This issue is presented in the aspect of ecological problems of contemporary cities, and against the background of the main trends of the entire rail passenger transport market in Poland. The analysis covered the years 2010-2022, and on its basis the essential features and trends of the market were identified.

JEL classification: Q010, R410.

Keywords: climate policy, rail passenger transport.

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Introduction

Climate policy is an important part of the domestic and foreign policy that the EU has been pursuing for several decades. Adopted in 2020, the 'Green Deal' is now an essential document with initiatives on climate, energy and transport. The document envisages a fundamental transformation of the economy and society towards a fair, green and prosperous future. The main goal of the actions taken is to reduce greenhouse gas emissions, by at least 55% by 2030, compared to 1990 levels (COM, 2019/640). And in 2050, Europe aims to be the world's first climate-neutral continent. The 'Fit for 55' contains 13 proposals that propose legislative changes to achieve the Green Deal goals.

One important area of climate policy is transport. Although it is vital to the economy and global supply chains, it is responsible for around 25% of total greenhouse gas emissions in the EU. Transport exposes society to negative phenomena: greenhouse gas and pollutant emissions, noise, road accidents and congestion. At the same time, the need for residential mobility is increasing. These two highly interrelated phenomena are contributing to a regression in the quality of life in cities.

Sustainable transport and, in particular, sustainable urban mobility are key to both improving the quality of life of city dwellers and achieving the objectives of the Green Deal. Sustainable development policies favour a transport system that gives priority to public transport and non-motorised traffic. Of the modes of public transport, rail transport is the most environmentally friendly. According to the European Environment Agency, only 0.5% of the EU's total greenhouse gas emissions come from rail transport. Therefore, the development of rail will be the most important factor in achieving the EU's climate targets. It has been assumed that high-speed rail traffic is to increase by 100 per cent by 2030, public transport journeys of less than 500 km should be carbon neutral and 100 European cities are to be climate neutral (COM, 2019/640). It is worth emphasising at this point that the railway is the backbone of the transport system of cities and agglomerations, with the other modes of transport (bus, tram, trolleybus, metro) supporting its operation by playing a feeder role to interchanges. Only collective, public forms of transport are socially efficient and consistent with the efficient functioning and development of the city (Keim, Cermy, 2021).

The main aim of the study was a synthetic analysis of the place of railways in transport services in Polish agglomerations. This issue was presented against the background of the ecological problems of contemporary cities, and against the background of the main trends in the rail passenger transport market in Poland.

The subject and aim of the study imply the use of qualitative and quantitative methods. One of the basic tools of qualitative methods is document analysis – desk research, which involves searching for data and information in available

sources. It has been applied to the study of ecological and spatial problems of Polish cities. Quantitative methods have also been used extensively, which show numerical data on specific research topics and the links between them. Empirical indirect research, i.e. secondary data analysis, consisted of the use of statistical data. With the help of statistical analysis, information was obtained regarding the passenger transport market, especially rail transport. Cause-and-effect analysis, including comparative analysis in time and space, was used to explain the processes taking place in the area of passenger rail transport. The methods used made it possible to increase the accuracy of the results obtained and the conclusions formulated on this basis.

1. Urban problems generated by transport

The urbanisation processes that have been progressing for decades generate the problems that exist in modern cities. Ecological (environmental), social, economic and spatial problems can be distinguished. Environmental problems include: the quality of the urban environment; waste segregation, storage and disposal; and traffic congestion. The group of social problems includes: depopulation and ageing of the population, low flexibility of the labour force, unbalanced labour markets, low housing availability, influx of immigrants (including illegal immigrants), and crime risk. In turn, the group of economic problems includes, inter alia, inadequate budgetary resources, low level of innovation and competitiveness of the economy, increased operating costs of a growing city, inability to exploit endogenous development factors. On the other hand, spatial problems of cities concern in particular: progressing suburbanisation and chaos in spatial development, degradation of the material substance of the city and urban areas, inefficient transport system and difficulties in realisation of sustainable development (Parysek, Mierzejewska, 2009; Sim, 2019).

One of the factors that exacerbate the environmental and spatial problems of cities is transport, especially passenger car transport. Over the last 30 years, individual motorisation has grOwn rapidly in Poland. Between 2000 and 2022 alone, the motorisation rate (number of cars/1,000 inhabitants) increased from 261 to 687, an increase of 2.5 times (Statistics Poland, 2001, 2023). Such dynamics ensured that in 2022 Poland had the highest motorisation rate among the EU countries (Statistical pocketbook, 2023). In practice, this means that almost 7 out of 10 people Own a passenger car. Saturation with passenger cars is even higher in large cities and conurbations. Figure 1 shows the level of the motorisation index in selected cities in 2010 and 2022.

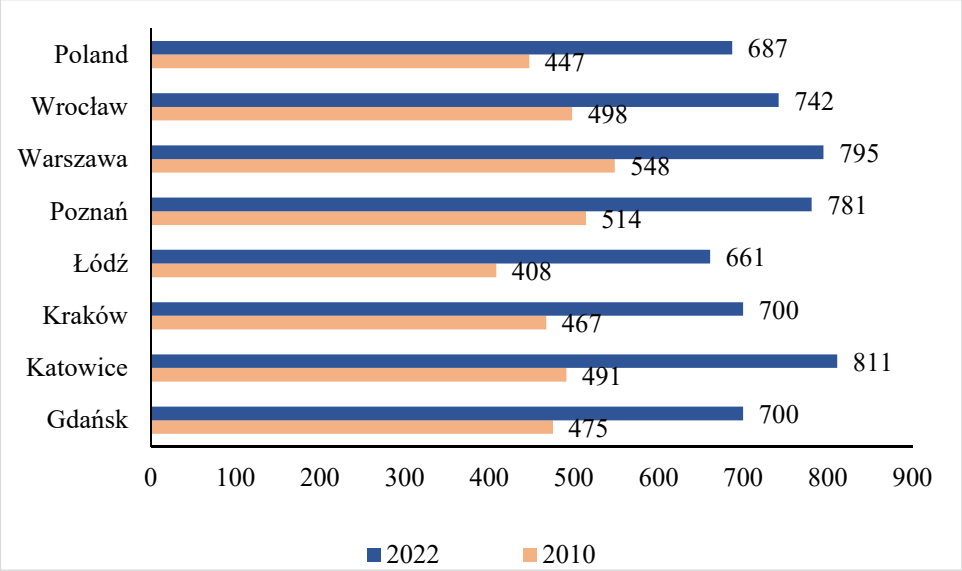

Figure 1. Motorisation index in polish cities 2010, 2022 [number of cars/1,000 inhabitants]
Source: Own analysis based on: Statistics Poland (2011, 2023)

Again, both the high level of the indicator and its dynamics should be emphasised. In 2010-22, the increase ranged from 31% in Warsaw to 39% in Katowice, with an increase of 35% for Poland. In Katowice, Warsaw and Poznań, 8 out of 10 inhabitants have a car. It can be said that the statistical family (two plus two) Owns more than two cars. Passenger car travel generates the highest environmental and social costs. These costs represent as much as 85% of the total costs attributable to passenger transport. This has been a consistent trend in the EU for several decades (Friedrich, Bickel, 2001; External Costs of Transport, 2011). Other modes of transport have significantly lower costs – buses 3%, rail only 2%. (Handbook on the external costs of transport, 2019). Transport is responsible for air pollution, noise emissions, climate change, congestion and the associated loss of time and, crucially for society, accidents. The survey shows that Polish city dwellers recognise these problems. They indicate air pollution as the most important – 70% of respondents. Another is too little greenery and an excess of carriageways and squares - 60% of indications. The third most important problem is traffic congestion generated by a large number of cars – 53% of indications (EKObarometr, 2023).

Air pollution, experienced by most urban communities, is one of the negative consequences of the rapid growth of individual motorisation. The air quality can be observed by everyone using mobile apps, such as Map Airly (https://airly.org/map/pl/). The data from the app is presented in Figure 2.

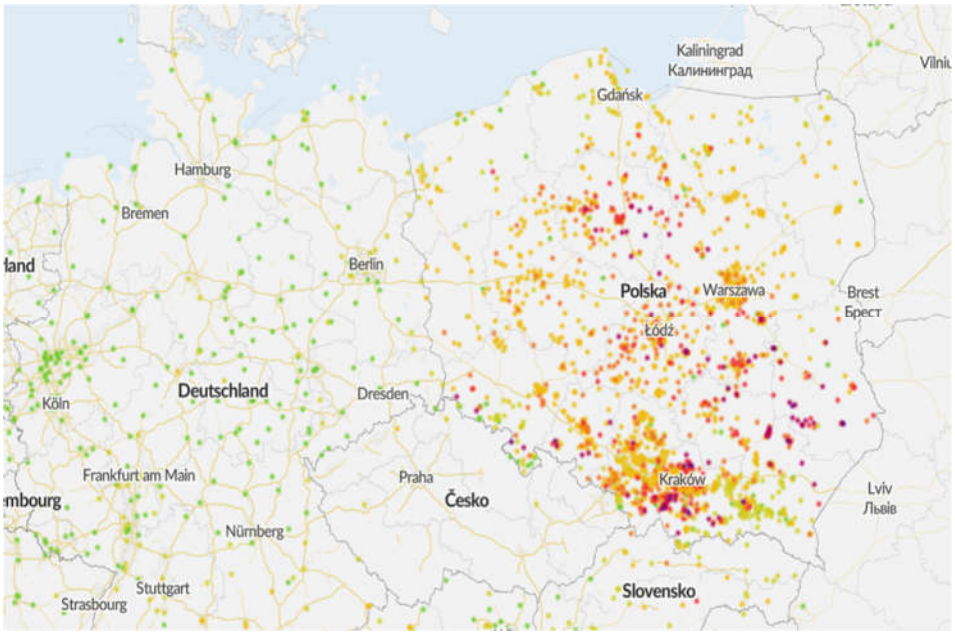

Figure 2. Urban air quality
Source: Map Airly

Polish cities are among the most polluted in the EU. The WHO report shows that 33 of the 55 most polluted cities in the EU are located in our country. Cities with very bad air quality are located in the southern part of the country: Żywiec, Pszczyna, Rybnik (first places in the ranking), followed by Krakow and Katowice. This is confirmed by data collected by Polish institutions – the Chief Inspectorate for Environmental Protection (GIOS, https://powietrze.gios.gov.pl). Places with high levels of air pollution include Silesia, but also the Łódź and Warsaw agglomerations. Pollution comes from a variety of sources, with sulphur oxides being produced mainly by cars. Similarly, nitrogen oxides and carbon monoxides. Polluted air worsens the quality of life in cities, and in particular has a negative impact on the health and lives of the inhabitants.

Another problem perceived by the inhabitants of Polish cities is traffic congestion, the overloading of the road network. Its consequence is a decrease in speed and an increase in travel time. Congestion is commonly felt in the form of traffic jams and the lost time we spend standing in traffic jams. Data on time lost in rush hour congestion (over the year), in European cities with less than 800,000 inhabitants, is shOwn in Figure 3.

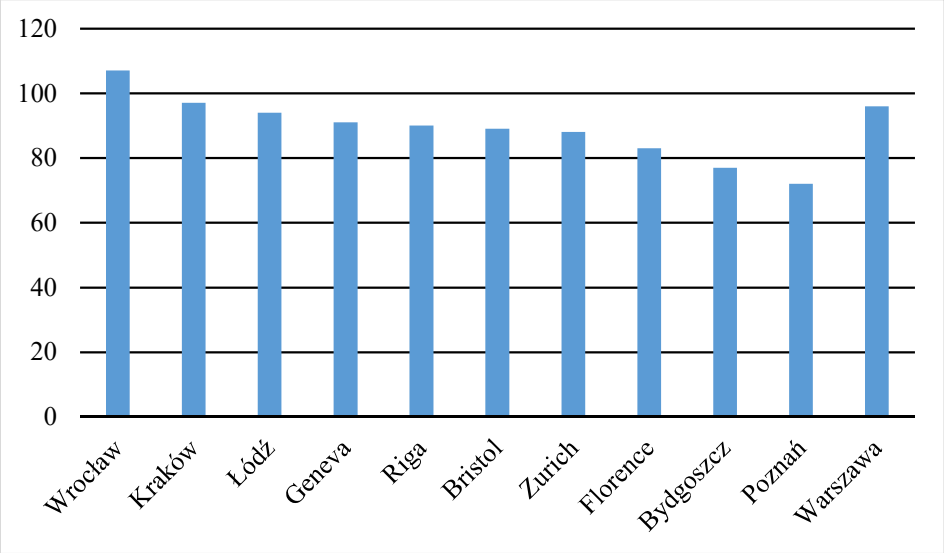

Figure 3. Time lost per year at rush hours in European cities, 2022
Source: TomTom Traffic Index, Ranking 2023

In the group of medium-sized European cities, residents of Polish conurbations spend the most time in traffic jams. In Wrocław it is 4.5 days per year, in Warsaw, Krakow and Łódź – 4 days. The data for Warsaw are shown for comparison, even though the population is over 800,000. The research shows congestion during rush hours, when time losses are greatest. And it is worth noting that congestion also occurs at other times of the day. Consequently, 24-hour time losses are greater. The time that residents spend unproductively in traffic jams could be used for rest or work. For residents of Polish agglomerations, this is at least 4 "extra" days of holiday.

2. Trends in the rail passenger market

Rail is the mode of transport that generates relatively low external and social costs. This environmentally friendly nature of rail is a factor that determines its great importance for sustainable transport. The place of rail in the transport market of agglomerations will be analysed against the background of the fundamental trends of the rail passenger transport market. Trends and changes in the national market imply the functioning of agglomeration railways.

The rail passenger transport market in Poland can be divided into several segments:

- international transport,
- interregional and inter-agglomeration transport,
- regional and agglomeration transport.

The international transport segment is the domain of the railway company PKP IC, which offers transport on long-distance, fast and express trains – IC, EIC, EN. PKP IC trains run to, among others: Berlin, Munich, Prague and Ostrava, Vienna, Bratislava, Budapest. The same carrier also serves the inter-regional and inter-agglomeration transport market. The company provides services between major cities on express trains under the trade marks Express InterCity (EIC) and Express InterCity Premium (EIP, Pendolino). PKP IC's share in this market segment is 97%. In addition, services on express and passenger trains are provided by the Polregio company. The next market segment – regional and agglomeration transport – includes transport services offered by companies: Polregio, Mazowieckie Railways, PKP Szybka Kolej Miejska (PKP SKM) in the Tricity, Szybka Kolej Miejska (SKM) in Warsaw, Śląskie Railways and smaller public companies operating in many urban agglomerations.

The volume of passenger transport in the various market segments, against the background of total rail transport, is shown in Figure 4. While Figure 5 shows the structure of the market in 2022.

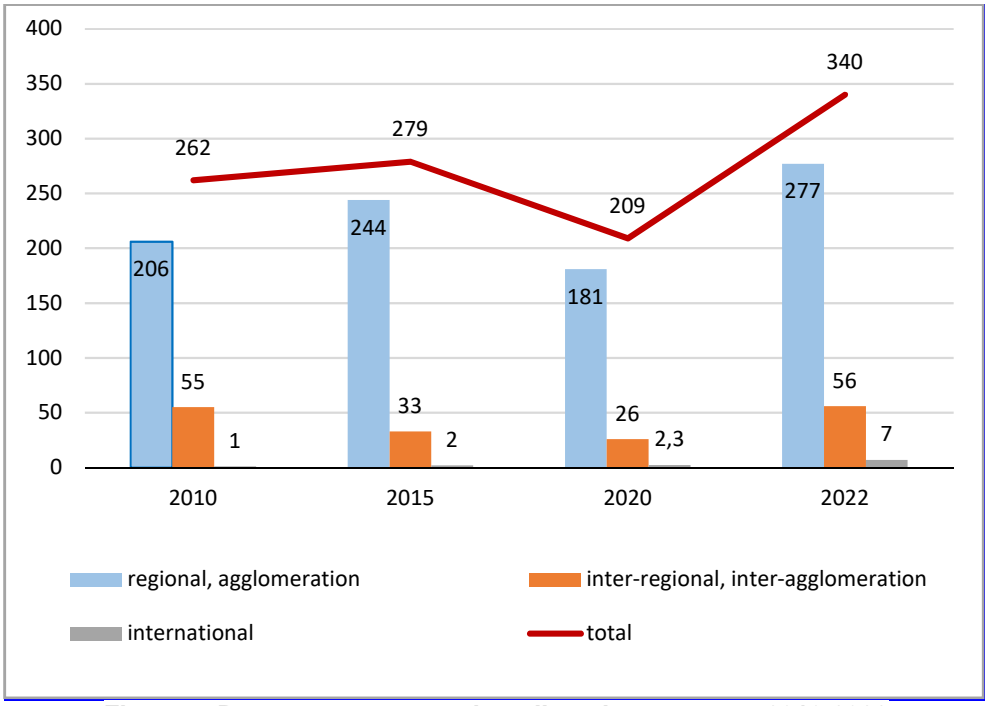

Figure 4. Passenger transport by rail market segment, 2010-2022 [million passengers]

Source: Own analysis based on: UTK (2010, 2015, 2020, 2022)

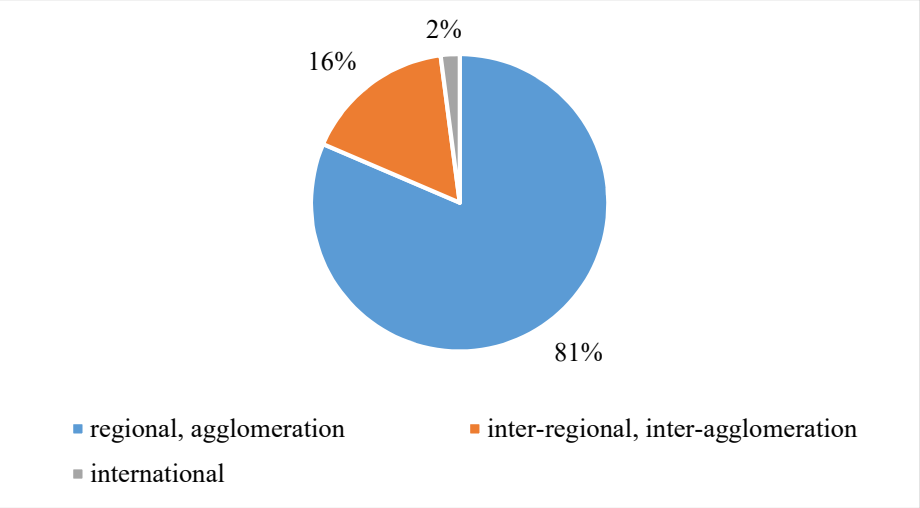

Figure 5. Passenger transport structure by rail market segment, 2022
Source: Own analysis based on: UTK (2022)

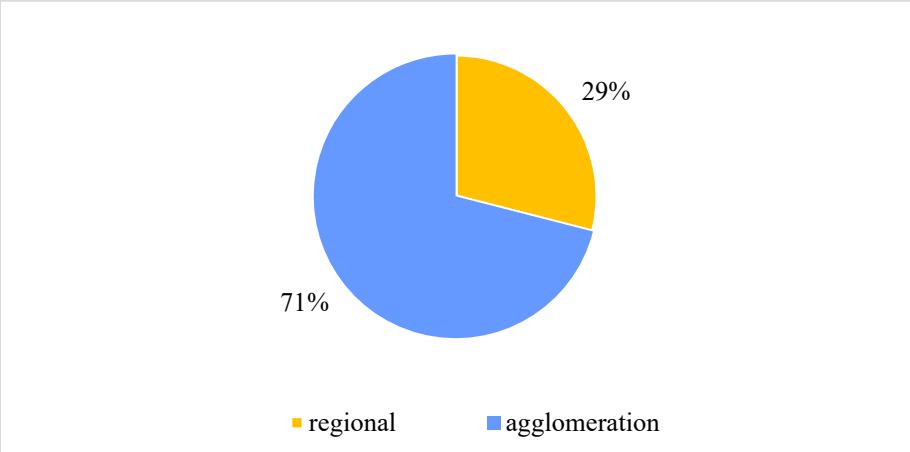

Figure 6. Relationship between regional and agglomeration transport, 2022
Source: Own analysis based on: UTK (2022)

Analysis of the data makes it possible to identify the fundamental trend of the market. This is an increase in the number of passengers carried, which amounted to 23% in the period under review. The growth trend is particularly visible in the segment of international and regional-agglomeration transport. In the latter category of transport, the increase was 25% (Figure 4). When analysing the structure of transport, it is worth noting that this segment covers 81% of the market (Figure 5). The relationships between the individual transport categories in this largest market segment are as follows: regional

services 29%, agglomeration services 71% (Figure 6). This segment has been dominated by agglomeration services due to their obligatory nature, universality and mass character.

The apparent collapse of the haulage market in 2020 was a consequence of the Covid pandemic. The reduction in occupational and social mobility forced by the pandemic naturally triggered a decline in transport. On the other hand, the fluctuation in passenger numbers in the inter-regional and inter-agglomeration transport category was due to the modernisation of railway lines, which meant numerous track works and traffic restrictions on certain sections. At the same time, the lines put into operation after the modernisation are reducing journey times and the railway companies are investing in the purchase of rolling stock, adapting it to the new offer. Passengers are returning to the railways, as can be seen in 2022.

3. Rail in urban transport

The need to move around in cities and conurbations is a natural, existential need for everyone. In particular it concerns home-work or home-school trips, which are a necessity. Transport needs may be fulfilled on foot and by bike, on relatively short distances, by car or by public transport: railway, underground, tram, bus. The modes of movement of residents in selected agglomerations in 2019-22 are shown in Figure 7.

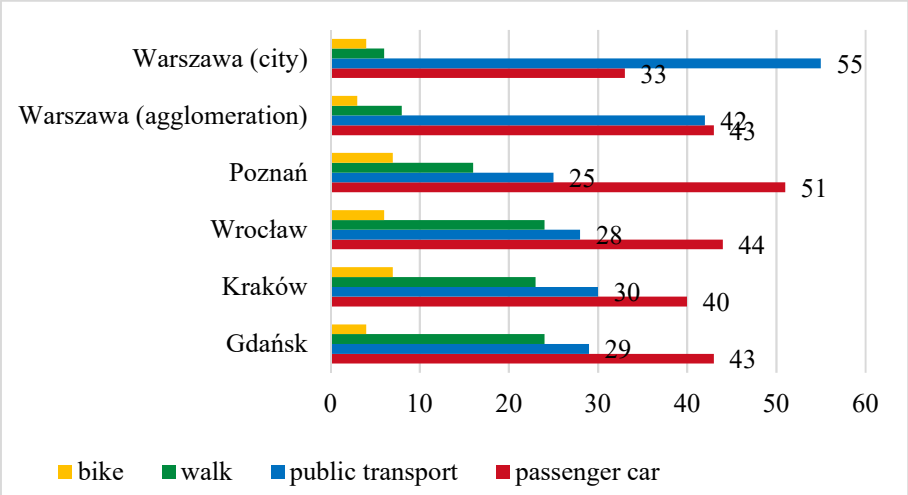

Figure 7. Modes of movement of residents in selected agglomerations, 2019-2022 [share in relation to total movement, in %]

Source: Own analysis based on: Badania ankietowe i aktualizacja modelu ruchu (2019); Beim, Mazur, Pistelok (2023); Diagnoza stanu mobilności w metropolii warszawskiej (2022); Plan zrównoważonej mobilności metropolii krakowskiej i jej obszaru funkcjonalnego (2023); Raport o stanie miasta (2023); Raport z badań (2019)

The agglomeration's transport service is dominated by individual transport, travelling mainly by private car. The exception is the urban area of Warsaw, where 55% of journeys are made by public transport. But already in the Warsaw agglomeration the relations are: 42% public transport, 43% individual transport. In other cities, the share of private cars ranges from 40% in Kraków to 51% in Poznań. The examples of European cities with a comparable number of inhabitants to Warsaw, where the share of private cars is: in Amsterdam 26%, in Barcelona 15%, in Vienna 29%. Experts estimate that a prerequisite for a good quality of life in a city is a share of travel by private car not exceeding 25% (Keim, Cermy, 2021). The consequences of high individual transport saturation have been analysed previously. It suffices here to recall the time lost in traffic jams, the highest among European cities, or the high air pollution.

The solution to this situation is to move towards sustainable mobility. This concept, in practice, means that as often as possible we choose a means of transport other than the private car. Apart from cycling and walking, there is still public transport, where rail is a fundamental part of the system. It provides a convenient and fast connection of the suburbs and satellite towns with the centre of the agglomeration. It allows to move large streams of travellers in an efficient and safe way, independent from traffic congestion. Moreover, as the most environmentally friendly means of transport, it contributes to improving the climate neutrality of cities, without limiting their functioning and development.

Residents of Polish agglomerations are increasingly using rail. Between 2010 and 2022, transport increased by 30% (Figure 8). An in-depth analysis covering passenger transport in individual agglomerations, graphically, is presented in Figure 9.

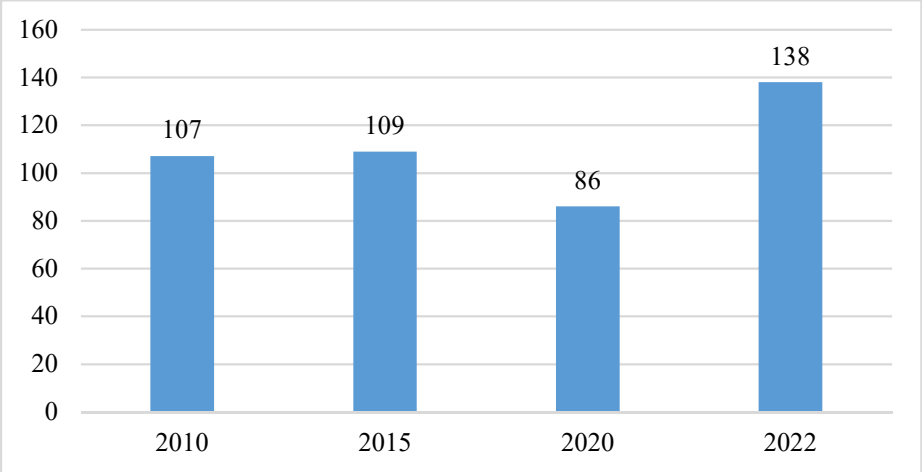

Figure 8. Agglomeration rail transport, 2010-2022 [million passengers]
Source: Own analysis based on: UTK (2010, 2015, 2020, 2022)

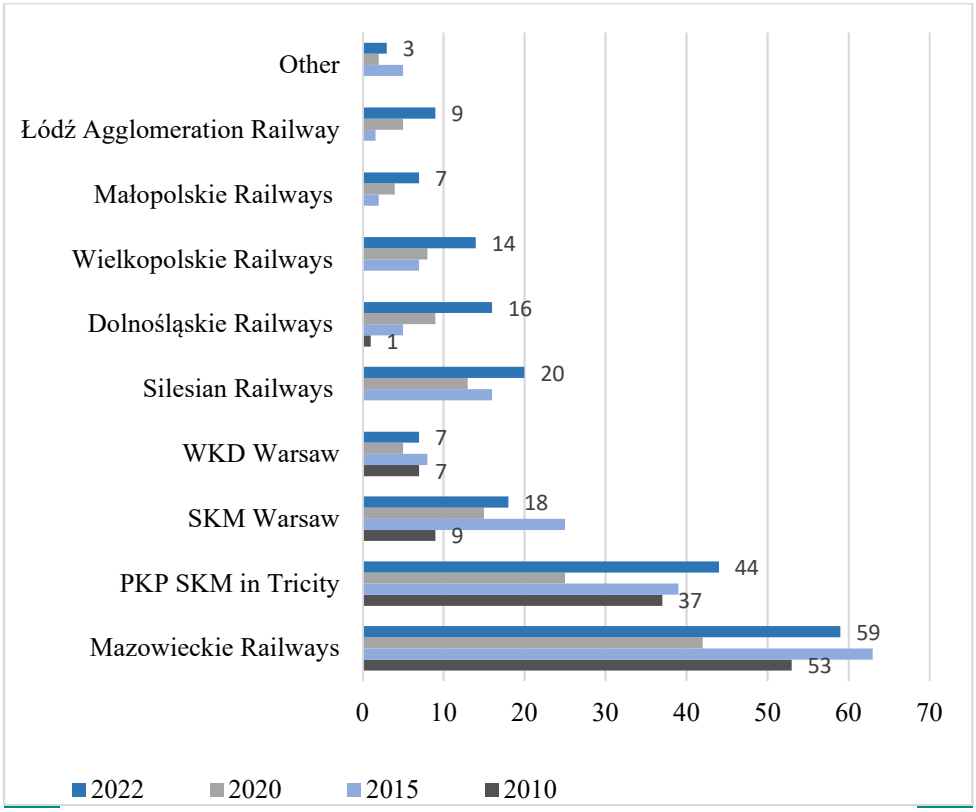

Figure 9. Passenger transport in agglomerations, by carrier, 2010-2022 [million passengers]

Source: Own analysis based on: UTK (2010, 2015, 2020, 2022)

The development of agglomeration railways was linked to the establishment of local government railway companies. In 2004, as a result of new legal regulations, provincial self-governments became responsible for the organisation of rail transport on their territory, including the financing of transport and the preparation of the transport offer. There was also an increase in EU funding for railways. At the same time, urban agglomerations were strongly affected by individual motorisation: congestion and air pollution. All these factors led to local authorities seeking solutions to improve transport services and to restore the role of the railways as the 'backbone' of the transport system. The first companies were created in 2004 by the local government of the Mazovian Voivodeship – Mazowieckie Railways and SKM Warsaw. At the end of 2007, the Lower Silesian regional assembly established the Dolnośląskie Railways company. In 2009, the Wielkopolskie Railways company was established, which operates transport services in Wielkopolska and partially in the Łódzkie and Lubuskie voivodeships. In subsequent years,

companies were established: Śląskie Railways and Łódź Agglomeration Railway – 2010, and Małopolskie Railways in 2013.

The number of passengers of individual railway companies depends on a number of factors. One of the main ones is the size of the area served and the population. Therefore, the position of leader in agglomeration transport is held by Mazowieckie Railways, which provides services not only in the Warsaw agglomeration, but also in the entire Mazovian Voivodeship. However, within the agglomeration itself, the most important carrier is SKM Warsaw, followed by WKD. In recent years, these companies have been operating under difficult conditions as a consequence of major infrastructure investments. In 2015, the reconstruction and modernisation of the Warsaw Railway Node, an important railway infrastructure node in Poland and Europe, began. Its key element is the cross-city line, between West Warsaw and East Warsaw stations, which runs through the very centre of Warsaw. As a natural consequence of the works being carried out, especially on the cross-city line, train traffic is reduced or some connections are temporarily suspended. For passengers, this means reduced time and space availability, delays in services, and information chaos. Residents are giving up on the railways, as can be seen by comparing 2015 and 2022 services on the rail companies: SKM and WKD. This is a temporary situation, as the completion of investments, new lines and technical solutions, will generate an increase in transport.

PKP SKM in Tricity holds a stable position in the transport market. The high number of passengers transported is due to the layout of lines adapted to the spatial urban and economic structure of the agglomeration and to the transport offer, which is characterised by a high frequency of connections, an efficient travel information system and modernised rolling stock. In 2015, the Pomeranian Metropolitan Railway (SKM) was put into service, connecting Gdańsk with Gdynia and the airport. It is also worth noting that the SKM has been operating in the Tricity since the 1950s. Over such a long period of time, it has become a permanent part of the transport system, and thus of the behaviour and transport choices of residents.

Silesian Railways, which only began operating as a company in 2012, also occupies an important position. The increasing number of passengers shows the dynamics of their development and their adaptation to the transport needs and preferences of local residents. There was also an increase in transport in the Wrocław (Dolnośląskie Railways), Poznań (Wielkopolskie Railways), Krakow and Łódź agglomerations.

The analyses carried out show a growing trend in the agglomeration rail market. Residents looking for faster, time-reliable modes of transport are choosing rail. The environmental awareness of the public is also changing, and consequently the perception of public transport. According to research carried out by the Ministry of Climate and Environment, in 2013, 57% of the public used public transport or a bicycle if possible, and in 2022,

such a group of people will increase to 67% (Ministerstwo Klimatu i Środowiska RP, 2022). Research into consumer habits shows that in 2023, cycling – 43% of respondents and public transport – 35%, were identified as the most environmentally friendly ways of getting around (Deloitte, 2023).

Conclusions

Sustainable urban mobility, an important element of climate policy, addresses the problems of agglomerations. It is a course of action that strikes a balance between the increasing need for mobility and the preservation of a good quality living environment for residents. It favours a transport system that gives priority to public transport and non-motorised traffic.

The basis of the city's transport system is the rail network, to which other modes of transport are subordinated. Railways can guarantee better service quality at low external and social costs. Polish agglomerations have rediscovered the potential of the railway as a fast and reliable means of transport, independent of traffic congestion. The revitalisation of agglomeration railways has contributed to an increase in demand, and the agglomeration transport segment is characterised by sustained growth dynamics. It can be concluded that the railways are well positioned in the transport market, which is in line with sustainable urban mobility policy. There is also a slow change in modes of transport due to the environmental awareness of the population.

The challenge for central decision-making centres and transport managers is to improve the transport offer, covering its various aspects. Public transport only fulfils its function in a sustainable mobility system if it is spatially, temporally and economically accessible.

The study provides a diagnosis of the current conditions of urban mobility and the level of development of agglomeration railways and their place in a sustainable transport system. The subject of further research may be the monitoring of trends in the rail passenger transport market and the identification of challenges arising in the implementation of climate policy assumptions. One such research area may be the accessibility of public transport, mentioned earlier.

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