

Contemporary Research on Polish Road Freight Transport: Literature Review

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Abstract

Aim: The aim of this article was to identify, classify, and critically evaluate the main thematic areas of contemporary scientific research on Polish road freight transport, as well as to assess the extent to which the existing literature reflects the sector's evolving economic, regulatory, technological, and environmental challenges.

Methodology: The research was based on a systematic literature review conducted in accordance with the PRISMA guidelines. Publications were retrieved from the Scopus database using predefined keyword combinations related to road freight transport and Poland. The review primarily covered studies published between 2006 and 2025, with a strong concentration of studies after 2015, adopting a narrative, problem-oriented approach. Following a multi-stage screening and eligibility assessment, 23 peer-reviewed publications out of 133 identified publications were selected for deep analysis and thematic synthesis.

Results: The review revealed that recent research on Polish road freight transport concentrated around four dominant thematic areas: sustainable development and environmental impacts, economic competitiveness and macroeconomic factors, infrastructure and transport safety, digitalisation and logistics technologies. The findings indicated a clear shift in research focus from market liberalisation and expansion toward sustainability, regulatory adaptation, and technological modernisation. Significant research gaps were also identified, particularly regarding holistic cross-sectional analyses, social issues such as the ageing driver workforce, and long-term scenario-based studies.

Implications and recommendations: The results highlight the need for more integrative and interdisciplinary research addressing technological, environmental, economic, and social dimensions. Future studies should focus on long-term development scenarios, social sustainability (especially labour shortages), and the effectiveness of policy instruments supporting decarbonisation and digital transformation. The continuous monitoring of sectoral indicators and expanded empirical research would support evidence-based transport policy and strategic decision-making by companies.

Originality/value: This article provides one of the few comprehensive and systematic syntheses of the literature on Polish road freight transport. By applying a rigorous PRISMA-based methodology and offering a structured thematic classification, it contributes original value by identifying research trends, gaps, and future directions in a sector of critical importance to both the Polish and EU economies.

Keywords: Polish road freight transport, systematic literature review, sustainability, transport economics, digitalisation

1. Introduction

The Polish road transport sector is a unique case within the European Union because it dominates the market inside the EU (Ryguła & Brzozowski, 2024). Recent data confirms its macroeconomic importance – the sector directly contributes 7% (TLP, 2025) and is crucial in generating 51% of Poland's GDP (TLP, 2022). Moreover, it accounts for 6% of total employment, making it one of the most important sectors in terms of employment in Poland (TLP, 2024).

Road transport across the European Union is undergoing rapid and multifaceted transformation (de Abreu et al., 2022; Grzelakowski, 2025; Milewski & Milewska, 2023). The sector must adapt to increasingly stringent environmental regulations, which are reshaping the traditional model of road freight transport, and a major challenge is the ongoing technological revolution.

Given its critical role in the Polish economy and the dynamic changes it faces, the need for research into the current state of Polish road transport is indisputable, yet there remains a notable gap in the literature, particularly in terms of comprehensive analyses that synthesise recent trends and developments in this field. To date, however, no comprehensive systematic literature review has examined the existing research on Polish road freight transport and identified its dominant research directions and research gaps. This study addressed that research gap by providing an integrative overview of the Polish road transport sector. The aim was to conduct a systematic review of the literature on the Polish road transport sector and to identify, classify and critically evaluate the main areas currently covered in scientific research. The following are the central research questions: *What are the key topics and thematic clusters within recent research on Polish road transport?* and *To what extent does the current literature reflect the sector's evolving challenges and strategic priorities?* The literature review adopted a narrative approach, where the literature was discussed problem-wise rather than within predefined thematic clusters. The final section of the article provides a synthesis of the research areas and a critical assessment.

2. Polish Road Transport: Background and Current Challenges

Following the collapse of the Eastern Bloc, Polish road transport began to develop very dynamically (Leończuk, 2011), with the greatest factor in its rapid growth being Poland's accession to the EU, which resulted in virtually unlimited access to the international transport market within the EU. A breakthrough period for Polish road transport was the period from 2017 to 2019, when Polish road freight transport companies began to generate the highest TKM (an indicator of transport performance) in the entire European Union (Eurostat, 2025), overtaking the previous leaders, Germany.

This occurred despite a number of preventive measures taken by countries such as Germany and France to delay or completely prevent such rapid transport (Suproń, 2020; Załoga, 2015). Since then, the number of factors limiting the growth of the share of the Polish road transport sector in transport performance in the European Union has intensified.

At the same time, the sector has been increasingly affected by broader economic and geopolitical changes that have significantly reshaped the European transport market. The outbreak of the COVID-19 pandemic triggered significant macroeconomic changes across the European Union. The consequences of the pandemic are still visible in most sectors of the economy. Immediately after the epidemiological threat was contained, war broke out in Ukraine, which also shook the economic order in Europe to its foundations, primarily in terms of energy prices. All of this was compounded by the European Union's internal policy on sustainable development, also redefining the EU's current economic landscape.

Polish road transport has been facing enormous structural challenges for some time, and rising costs are undoubtedly the most important as they primarily determine business profitability (TLP, 2025). These are inextricably linked to the problems outlined in the first paragraph, but one should also mention the serious shortage of professional drivers, which is causing a significant increase in company labour costs. The average driver age in European Union nations is 47 (CEDEFOP, 2024), clearly indicating that this profession is not in demand among young people. Another factor driving cost increases are the new environmental solutions implemented in the European Union, which increase the costs of purchasing newer means of transport and operating older units due to high road tolls (Grzelakowski, 2025). Another problem particularly affecting road transport in Poland concerns the protectionist policies of Western countries towards the EU's Common Transport Policy (CTP). With the noticeable growth of Polish road transport, solutions aimed at increasing costs for Polish companies have been introduced, which include the German MiLOG Act and the French LoiMacron Act, which were the cornerstones of the changes implemented as part of the so-called Mobility Package (Łącka & Suproń, 2019).

3. Methodology of Literature Review

This systematic literature review was conducted in a problem-oriented and narrative manner, as mentioned above, which allowed for the provision of current and topic-specific knowledge. In the scientific world, literature reviews are considered original and valuable solely because they are created based on rigorous methodological requirements, which enable the extraction of valuable information for future research (Rother, 2007). They require a clear description of the purpose of the review, the methods applied, and the results obtained (Page et al., 2021). In order to fulfil this assumption, the review of the literature was created based on PRISMA, a tool that enables the continuity of research for subsequent researchers with the appropriate required portability of methods and data used in the analysis.

Identifying and grouping research in the field of Polish transport into clusters was crucial for finding gaps that generally exist in research. Classifying gaps allows for the determination of research directions and recommendations that have a key impact on the directions of research in Polish road transport. The main goal of a systematic literature review is to answer the research questions posed in the introduction and to analyse the current research within the research topic.

The systematic literature review was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring a high level of methodological rigour. The review was conducted using the Scopus database, selected due to of its broad coverage of peer-reviewed scientific journals and its widespread use in bibliometric and systematic literature reviews in transport and logistics research. The English language was used to search keywords since most high-impact scientific journals publish in English, the dominant language of scientific communication. The

search included the keywords: "road," "transport," "freight," "polish," and "Poland," using the Boolean operators "AND" and "OR". The final query used in the database was "road AND (freight OR goods) AND transport AND (Polish OR Poland)". The database search engine settings were set to search for keywords in the title, abstract, and keywords of a given article. No specific scientific discipline or document type was selected during the search to maximize the potential for relevant results. The search was conducted in January 2026 and included publications indexed between 1989 and 2025. However, the final sample was strongly concentrated in recent years, particularly after 2015, reflecting the growing scholarly interest in the contemporary transformation of the Polish road freight transport sector. This wide time frame was chosen to capture long-term trends and events in this field. The entire study was supported by data management tools such as Excel and Zotero. This approach, while ensuring consistency and quality of sources, may have limited the inclusion of non-English publications and studies indexed in regional databases. The literature selection process conducted according to the PRISMA guidelines is presented in Figure 1.

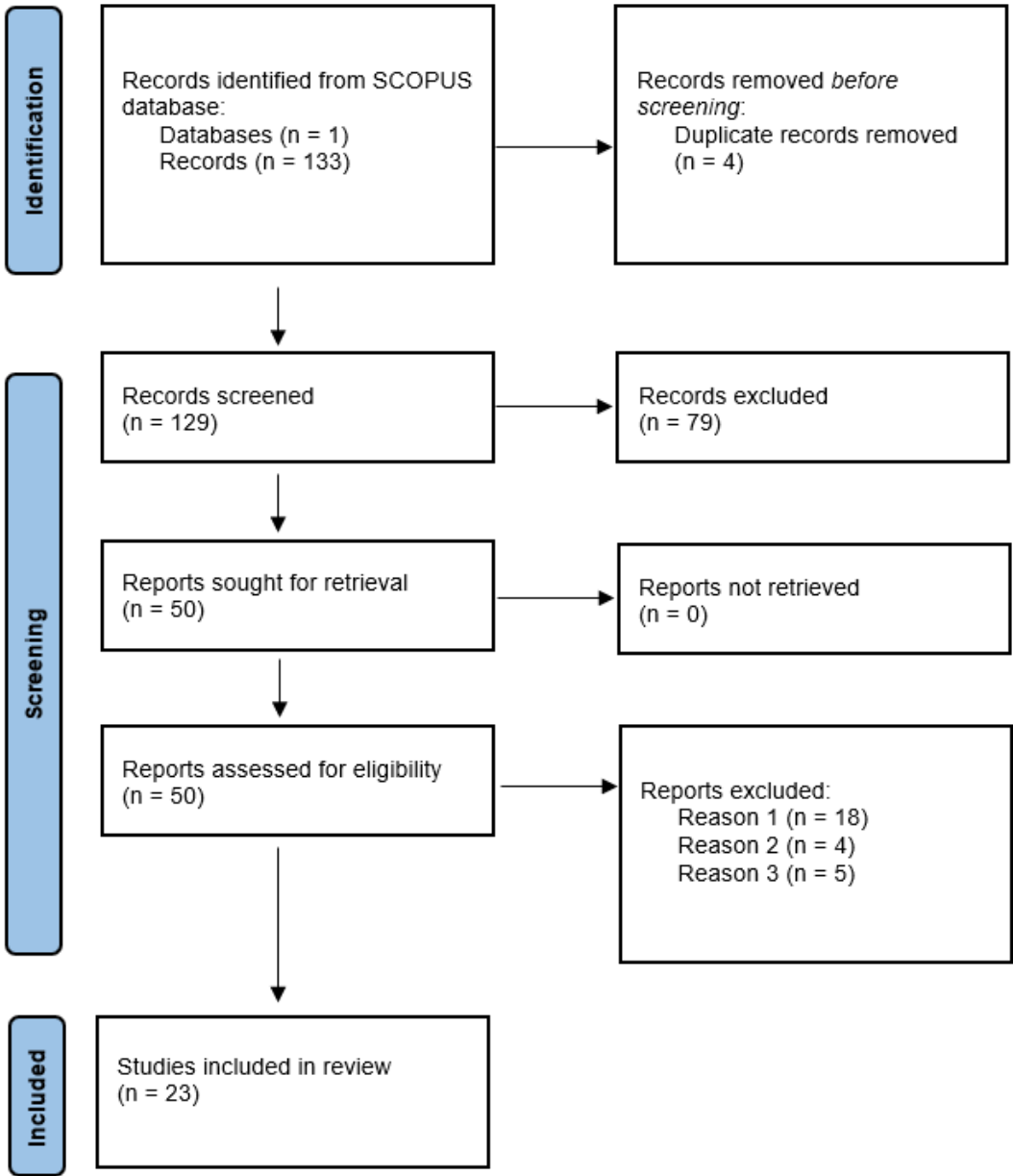


Fig. 1. PRISMA procedure in stages

Source: own work based on (Page et al., 2021).

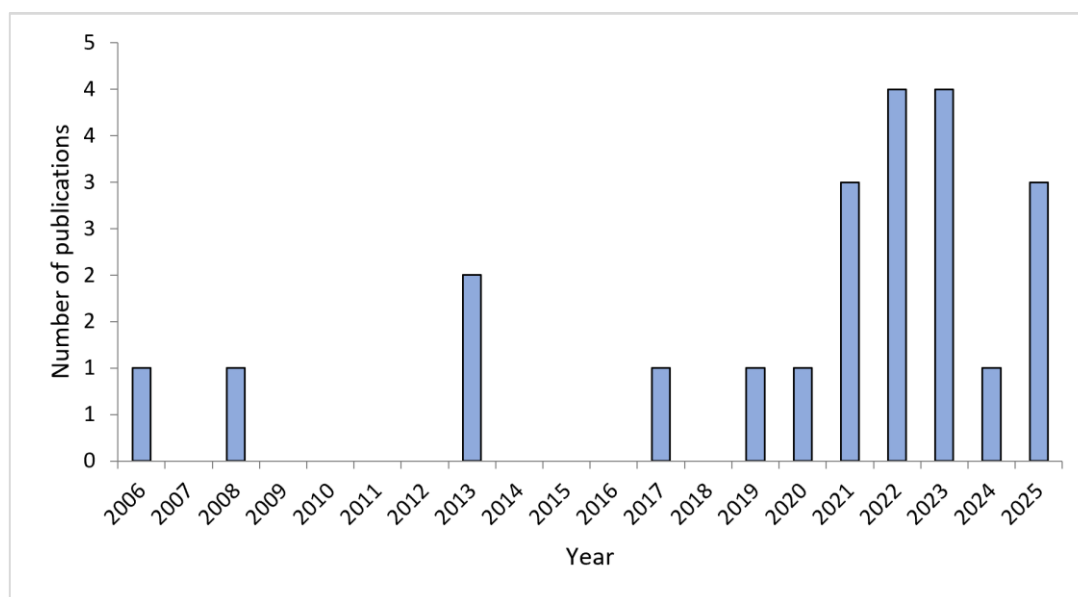


Fig. 2. Number of publications included in the review by year

Source: own work based on (Scopus data).

During the PRISMA literature review, four duplicate records were removed at the identification stage, due to duplicate titles in the SCOPUS database. In the next stage (screening), 129 results were analysed in terms of abstract titles and keywords. After analysis, 50 results qualified for the next stage. A large portion of records were then eliminated due to their very weak relevance to the analysed topic (probably owing to the inclusion of each research area in the database search settings). During the acquisition stage, no articles were rejected for download because all were available in open access sources. Thanks to the full availability of all publications, 50 records were qualified for the eligibility assessment stage. During the final qualification of publications, 27 publications were excluded for three reasons. The first was that the main aim of the research did not focus on Polish road freight transport, 18 were classified to this category. The second reason for the rejection was the narrow research context, focusing on limited geographical scopes within Poland (e.g. individual voivodeships), four were classified to this category. The last reason was the limited contextual nature of the publication (e.g. intermodal transport, transport of dangerous goods, transport of perishable goods), five were classified into this category. After completing the entire PRISMA procedure, a total of 23 publications qualified for the next stage of the research.

4. Literature Review

As shown in Figure 2, the temporal distribution of publications indicates that the majority of the studies were published after 2015, demonstrating a strong concentration of research in recent years. Most of contemporary research on Polish road freight transport was quantitative in nature, with many studies relying on official statistics and industry reports. A thorough analysis of the PRISMA results revealed that the topics covered in the analysed publications can be grouped into four main research areas. The first is sustainable development policy and the ecological aspects and its importance for Polish road freight transport. The second is economic efficiency and macroeconomic factors influencing Polish road freight transport. The third centres on infrastructure and transport safety issues, and the fourth, on new transport technologies that support effective logistics management. The described groups are presented below.

The most prominent research stream is on the environmental impact of road transport and ways to reduce it. These studies focused on pollutant emissions (CO₂, exhaust fumes) and the energy efficiency

of transport (Suproń & Łącka, 2023). Many of them directly addressed European climate policy (Domagała & Kadłubek, 2023; Domagała & Zych-Lewandowska, 2021; Letkiewicz et al., 2023; Matczak & Grzelakowski, 2025; Milewski & Milewska, 2023; Ryguła & Brzozowski, 2024; Szaruga & Zalog, 2022). For example, the impact of the EU decarbonisation strategy (European Green Deal, "Fit for 55" package) on the competitiveness of Polish road carriers was analysed. The results indicated that planned emission restrictions (requirements for zero-emission trucks) could significantly transform the market structure and business model of transport companies (Matczak & Grzelakowski, 2025). A separate study examined the readiness of large and medium-sized Polish carriers to adopt the proposed Green Deal solutions (Letkiewicz et al., 2023), and showed that companies expect regulatory relief that will facilitate their pro-environmental initiatives. The literature emphasises that road freight transport is one of the key sectors with a negative impact on the environment, therefore reducing emissions in this industry is critical to achieving climate goals (Ryguła & Brzozowski, 2024). Several studies measured the external costs of road transport in Poland, for example, the environmental costs (noise, air pollution) generated by trucks (Domagała & Zych-Lewandowska, 2021). Other authors searched for ways to rationalise energy consumption in transport. Technical improvements (aerodynamics, alternative fuels) and organizational improvements (better capacity utilisation, intramodality) were proposed to reduce the energy intensity of transport (Milewski & Milewska, 2023). Generally, the topic of sustainable development permeated most of contemporary publications, and even in studies focusing on other aspects it is common to find environmental or sustainable references.

The second most important cluster regarded research on the economics of transport and macroeconomic changes. This group included competitive analyses of Polish entrepreneurs in road transport in the EU market, particularly in the context of rapid expansion (Macioszek, 2021) and external shocks (Szaruga & Zalog, 2022). The internationalisation process of Polish road transport companies and its impact on service quality and competitiveness was also examined (Kędzior-Laskowska, 2020), an important topic since Polish carriers have a leading position concerning the number of vehicles and transport performance in the EU, which translates into their crucial role in the EU market. The literature also showed negative effects in the economic aspects of Polish road transport companies, introduced by the new EU restrictions (related to environment) and analysed the effects of COVID-19 and the side effects resulting from the financial consequences of transport companies operating near the Ukrainian border (Karaś et al., 2025). The rapid increase in fuel price during 2022 forced companies to economise on their energy consumption. Fuel costs are crucial for transport profitability, hence energy prices serve as a means of ensuring competitiveness. Another frequently analysed topic was market deregulation and regulation. Earlier studies (Hilal, 2006, 2008) warned of the potential consequences of the full liberalisation of transport in the EU (downward pressure on rates and fees). More recent publications showed the effects of corrective actions taken by the European Union, for example the impact of minimum wages for drivers in Western EU countries, and the influence of Mobility Package on competitiveness (Poliak et al., 2024). Studies reported capacity constraints and uneven security standards of truck parking infrastructure, indicating the need for investment and upgrades. The more economic-related literature also addressed the business climate and overall condition of the sector. For example, survey-based methods for assessing business sentiment among transport companies in Poland have been developed, highlighting the cyclical nature of demand and the need for systematic monitoring of the sector to support decision-making processes (cf. Balke, 2013).

Another key theme concerned the infrastructure supporting road transport and issues of transport safety. Several studies addressed shortages in road and parking infrastructure that are crucial for freight transport (Betkier & Macioszek, 2022; Muślewski et al., 2017). For example, research on truck parking facilities along major road corridors identified capacity constraints and the significant variation in the standard of such facilities. Some studies reported capacity constraints and uneven security standards of truck parking infrastructure, indicating the need for investment and upgrade, pointing to the need for investment in new infrastructure and the upgrading of existing facilities to ensure safe and accessible resting places for truck drivers. From a road safety perspective, an analysis of accidents

involving heavy goods vehicles in Poland (Świtła et al., 2025) revealed pronounced regional disparities in both the frequency and severity of collisions, which also generate tangible costs related to damage to road infrastructure. Researchers argued that identifying ‘black spots’ and high-risk regions would allow for the more effective targeting of preventive measures and infrastructure investment. Infrastructure related issues were also addressed in analyses of road toll collection systems (Fazekaš et al., 2013). One of the analysed articles presented comparisons of electronic tolling schemes in Poland and Slovakia relevant to transport operating costs and which may indirectly influence route choice. A distinct research niche focused on new technical solutions in infrastructure and rolling stock, such as assessments of the potential deployment of modular road trains (longer heavy vehicle combinations, LHV) in Poland (Muślewski et al., 2017). The results revealed the need for clearer terminology and regulatory adjustments before such vehicles could contribute to improved transport efficiency.

The last analysed area of research involved the application of new technologies and organizational improvements in road transport. This cluster included studies on Intelligent Transportation Systems (ITS), the digitalisation of logistics processes, and data utilisation (Kadłubek et al., 2022). The research demonstrated that the implementation of modern tools, such as telematics systems, freight exchange platforms, and fleet management applications, can significantly enhance the operational efficiency of transport companies. For example, a substantial impact of ITS applications on customer service levels in transport enterprises was demonstrated in the article by Kadłubek et al. (2022), stating that companies which effectively integrated appropriate ITS applications with their logistics resources achieved better delivery punctuality and reliability. The literature provided a catalogue of ITS solutions critical both for vehicle support and management support. Another important aspect of digitalisation is the growing use of online platforms, e.g. analyses of data from freight exchanges during the COVID-19 pandemic made it possible to assess, in nearly real time, the sharp decline in demand and the subsequent recovery of the freight market. Such large-scale market data represent a valuable source of information on short-term fluctuations as well as broader industry trends. In general, the literature pointed to the increasing importance of digital innovation, ranging from automated documentation and eCMR systems to the emerging potential of autonomous vehicles, which leads to improving productivity and supporting the sustainability of road transport, yet within the analysed studies this research area is still at an early stage of development. Most contributions concentrated on currently implemented digital solutions and their observable effects, while more future-oriented topics, such as vehicle automation and electromobility, were usually mentioned only in connection with climate and environmental policy objectives.

In answering the research questions posed in the introduction, recent studies on Polish road freight transport centred around four main areas: sustainability, economic competitiveness, infrastructure and safety, and digital logistics technologies. These thematic directions closely reflect the sector’s evolving challenges, particularly in relation to environmental policy, cost efficiency, and the need for technological modernisation.

5. Discussion and Conclusions

The literature review showed that research on Polish road freight transport focused on several leading themes that align with broader trends in global transport. Dominant areas include efforts to reduce climate impact, improve energy efficiency, process digitalisation, and regulatory issues, all of which reflect the strategic priorities and challenges faced by the sector. Therefore it can be generally concluded that the research agenda is strongly oriented toward sustainable development and innovation. Nearly all of the analysed works addressed the prospect of improving transport, whether in ecological terms (emission reduction, external costs), economic aspects (competitiveness, operating costs), or technical and organizational aspects (new technologies, infrastructure). A problem-based approach was also characteristic, with researchers focusing on current industry issues, providing

specific knowledge useful for transport policy or for the companies themselves. Based on the literature, the Polish road freight transport sector is perceived as dynamic, yet simultaneously faced with the need to adapt to changing conditions (EU regulations, crises, staff shortages, etc.). The overall conclusion was that the current literature accurately reflects the main strategic challenges, especially those related to environmental protection and the energy transition. It also highlights both the potential threats to the industry (rising costs, emission reduction requirements) and opportunities (innovations that increase efficiency, competitive advantages based on ecology). Interestingly, there was an apparent shift in emphasis in the recent literature (particularly after 2010); while in the period 2000-2010 more attention was paid to market liberalisation, international expansion, and the current economic situation, in recent years, topics related to the long-term sustainable transformation of the sector have taken centre stage.

Despite the dominant trends described above, the analysis also revealed significant research gaps. First, there is a lack of studies that comprehensively summarise the key challenges and directions of change in the road transport sector. Current publications tend to focus only on selected aspects, while attempts at cross-sectional approaches or thematic meta-analyses were essentially absent. Secondly, there is a noticeable shortage of holistic literature reviews that describe the full spectrum of changes taking place in Polish road transport in technological, environmental, economic, and institutional aspects. Thirdly, the social dimension is relatively poorly understood, especially the problem of an ageing driver workforce. There is a lack of analyses of the long-term effects of this phenomenon and scenarios to address this issue. Fourthly, although there have been calls for increasing the share of rail in transport, no studies were found proposing a specific action plan or model for transforming the transport structure towards a greater share of rail. This may partly result from the exclusion of studies focusing on intermodal transport and specific transport segments during the selection process.

The conclusions resulted from an analysis of 23 publications selected and assessed according to the PRISMA methodology, which ensured a systematic approach to the source review, nevertheless several limitations should be acknowledged. First, the selection was limited to the Scopus database and to publications in English, which may have resulted in the omission of relevant studies published in Polish or indexed in regional databases. This limitation is particularly important in the context of earlier research, as the tendency of Polish authors to publish in English has intensified mainly after 2010. Second, the relatively small number of studies meeting the inclusion criteria may have affected the generalisability of the findings. Third, the limited number of publications prior to 2010 restricted the possibility of conducting a robust longitudinal analysis of changes in research trends over time, hence the results should be interpreted as indicative of recent developments rather than a fully comprehensive historical overview.

The results are consistent with international observations on sustainable transport trends. Studies on Polish road freight transport mirror the global increase in scholarly attention to emissions reduction, energy efficiency, and the deployment of digital technologies. Although digitalisation is widely recognised as a future-oriented development pathway, in the Polish context it remains at an early stage of implementation and empirical analysis. Furthermore, assessments of the impacts of EU regulations, including the Mobility Package, climate policy instruments, and wage-related requirements, demonstrate that Poland, as a leading actor in the European road transport market, is among the countries most strongly affected by these systemic changes. Taken together, these findings position Polish road freight transport as both a key beneficiary and also a key example of regulatory and technological transformation, highlighting the need for further research into adaptation mechanisms and long-term competitiveness.

The current research provides valuable insights into key issues and trends shaping Polish road freight transport. The findings indicate that the sector faces the need for a deep transformation, including fleet decarbonisation, investment in new technologies, and adaptation to changing regulations, whilst at the same time the literature identifies areas requiring further research. First, in the social context, in-depth studies are required, addressing issues such as the driver shortage (its causes and solutions),

improving working conditions and safety, and the impact of transformation processes (e.g. automation) on employment. Second, an interdisciplinary perspective would enrich the knowledge base. For example, analyses combining transport economics with public policy to assess the effectiveness of support instruments (subsidies for 'green' trucks, the development of an alternative infrastructure) in the Polish context would be a significant contribution. Third, there is a clear gap in forecasting and scenario-based research, with a lack of model-based assessments of how Polish road transport might evolve over the next 10-20 years under different assumptions (e.g. high or low levels of automation, a strong shift to rail, or a continuation of the status quo). Such research would help outline development paths consistent with sustainable mobility strategies, while the inclusion of new topics, such as automation, digital resource sharing platforms and integration with supply chains, would ensure that future literature can reflect the full range of strategic priorities facing Polish road freight transport in a changing environment. To sum up, there is a clear need to continue and expand research to encompass both current operational challenges and long-term structural changes.

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Współczesne badania nad polskim drogowym transportem towarowym: przegląd literatury

Streszczenie

Cel: Celem badania jest identyfikacja, klasyfikacja oraz krytyczna ocena głównych obszarów tematycznych współczesnych badań naukowych dotyczących drogowego transportu towarowego w Polsce, a także ocena, w jakim stopniu istniejąca literatura odzwierciedla zmieniające się wyzwania ekonomiczne, regulacyjne, technologiczne i środowiskowe sektora.

Metodyka: Badanie oparto na systematycznym przeglądzie literatury przeprowadzonym zgodnie z wytycznymi PRISMA. Publikacje pozyskano z bazy Scopus przy użyciu zdefiniowanych zestawów słów kluczowych odnoszących się do drogowego transportu towarowego oraz Polski. Przegląd obejmuje przede wszystkim prace opublikowane w latach 2006-2025, ze szczególnym uwzględnieniem badań po 2015 r., i ma charakter narracyjny oraz problemowy. Po wieloetapowej selekcji i ocenie kryteriów kwalifikowalności do pogłębionej analizy i syntezy tematycznej zakwalifikowano 23 recenzowane publikacje naukowe ze 133 wyłonionych początkowo.

Wyniki: Przegląd literatury wykazał, że aktualne badania nad drogowym transportem towarowym w Polsce koncentrują się wokół czterech dominujących obszarów tematycznych: zrównoważonego rozwoju i oddziaływania środowiskowego, konkurencyjności ekonomicznej i uwarunkowań makroekonomicznych, infrastruktury i bezpieczeństwa transportu oraz cyfryzacji i technologii logistycznych. Wyniki wskazują na wyraźne przesunięcie akcentów badawczych: od liberalizacji rynku i ekspansji międzynarodowej w kierunku transformacji zrównoważonej, adaptacji regulacyjnej i modernizacji technologicznej. Jednocześnie zidentyfikowano istotne luki badawcze, w szczególności brak ujęć przekrojowych, niedostateczne rozpoznanie problemów społecznych (starzenie się kadry kierowców) oraz deficyt badań scenariuszowych o charakterze długookresowym.

Implikacje i rekomendacje: Uzyskane wyniki wskazują na potrzebę prowadzenia bardziej zintegrowanych i interdyscyplinarnych badań, obejmujących jednocześnie aspekty technologiczne, środowiskowe, ekonomiczne i społeczne. Przyszłe analizy powinny koncentrować się na długoterminowych scenariuszach rozwoju sektora, społecznych uwarunkowaniach zrównoważonego transportu (w szczególności niedoborach siły roboczej) oraz ocenie skuteczności instrumentów polityki publicznej wspierających dekarbonizację i cyfryzację. Stały monitoring kluczowych wskaźników sektorowych może stanowić podstawę dla racjonalnej polityki transportowej i decyzji strategicznych przedsiębiorstw.

Oryginalność/wartość: Artykuł stanowi jedno z nielicznych kompleksowych i systematycznych opracowań literatury dotyczącej drogowego transportu towarowego w Polsce. Zastosowanie rygorystycznej metodologii PRISMA oraz strukturalna synteza tematyczna pozwalają na identyfikację dominujących trendów badawczych, luk poznawczych oraz kierunków dalszych badań w sektorze o kluczowym znaczeniu dla gospodarki Polski i Unii Europejskiej.

Słowa kluczowe: drogowy transport towarowy w Polsce, systematyczny przegląd literatury, zrównoważony transport, ekonomika transportu, cyfryzacja
