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PRO-ENVIRONMENTAL ELEMENTS IN THE BUSINESS MODEL OF MEDIUM AND LARGE POLISH ROAD FREIGHT CARRIERS

Andrzej LETKIEWICZ

Uniwersytet Gdański, Sopot; andrzej.letkiewicz@ug.edu.pl, ORCID: 0000-0001-5305-2312

Purpose: The policy of sustainable development places requirements on businesses to reduce their negative environmental impact. One of the sectors of the economy that is responsible for greenhouse gas emissions is road transportation. Consideration of the European Union's environmental goals is forcing road carriers to have environmental measures built into their business models. The purpose of the study was to learn how road carriers can reduce their negative environmental impact so that they can fit in with the goals of the environmental policy and to learn about the regulatory tools that the road carriers expect to be able to support these activities.

Design/methodology/approach: Data for this study was collected in computer-assisted telephone interviews (CATI). The study was conducted in late 2021 and early 2022 by a Polish company that was responsible for the selection of the sample and the collection of the data. The survey was conducted on a sample of 146 medium and large Polish road freight carriers and was a continuation of a study carried out on the same sample of entities conducted in late 2019 and early 2020 using the same technique.

Findings: As part of their fleet policy, in order to fit in with environmental goals, carriers base their business models on the purchase of new means of transportation that meet increasingly stringent emission standards and reinforce environmentally friendly attitudes by buying means of transportation with smaller engine displacement that is tailored to the needs arising from their operations. Pro-environmental operational activities of medium and large Polish road freight carriers involve the use of solutions that change the composition of exhaust gases (AdBlue) and reduce fuel consumption (lowering rolling resistance – energy-efficient tires and lowering air resistance – fairings), and the acquisition of pro-environmental driving skills (eco-driving). Other environmentally friendly measures are to increase the utilisation of the vehicle capacity (cargo consolidation) and to eliminate empty runs by looking for cargo to be carried on the way back and using route planning software.

Originality/value: The paper indicates the methods to reduce the negative environmental impact considered in the business models of medium and large road freight carriers, so that they fit in with the environmental policy goals, and indicates their expectations associated with the support for the achievement of zero-emission transportation. The results can be useful in the adoption on both the European and Polish level of policies leading to a zero-carbon economy.

Keywords: sustainable business models, road freight transport.

Category of the paper: research paper.

1. Introduction

The policy of sustainable development places requirements on businesses to reduce their negative environmental impact. One of the sectors of the economy that is responsible for greenhouse gas emissions is road transportation. The combination of the organisation of road transport and the European Union's environmental goals forces road carriers to include pro-environmental measures in their business models. The paper indicates the methods to reduce the negative environmental impact that are taken into account by road carriers in order to meet the environmental policy goals and ensure their sustainable existence and expected economic efficiency.

Data for this study was collected in computer-assisted telephone interviews (CATI). The administration of the questionnaire by the interviewer ensures a higher response rate and more complete and accurate answers than surveys completed by respondents on their own. The study was conducted in late 2021 and early 2022 by a Polish company that was responsible for the selection of the sample and the collection of the data. The survey was conducted on a sample of 146 medium and large Polish road freight carriers and was a continuation of a study carried out on the same sample of entities conducted in late 2019 and early 2020 using the same technique. The design of the questionnaire, which is consistent with the purpose of the study, as well as the study's main objective, were developed by the authors of the study.

2. Sustainable business models of businesses

The organisation mechanisms in the activities of business entities boil down to the organisation of processes (the selection of resources and technologies as well as of the timing of the start of the activities), so as to bring about the achievement of the set goals in an efficient manner – one that results in the least possible undesirable effects, such as costs, if the economic dimension of efficiency is adopted. It is clear that the permanent nature of business activities in business entities results in a repetitive selection of resources and technologies, and only the factor of the timing of the begging of the activities depends on the market situation, for example, the timing of the receipt of a transport order in the case of a transport company. Repeatability contributes to the search for measures of efficiency, predictability of effects, and ensured sustainability of the entity's existence, including the identification of areas where competitive advantages can be achieved. Consequently, this gives rise to the need to identify the dimensions of efficiency in a context that is broad and, at the same time, tailored to each entity, through the short-term operational dimension on the one hand and simultaneously the long-term operational dimension on the other. Therefore, it can be said that the characteristic of efficiency is the ability

to repetitively implement the company's strategy and achieve certain long-term goals as part of the strategy. It should therefore be viewed and defined in the long term through (Fryca-Knop et al., p. 10):

- improved competitiveness of the company,
- quick response to the challenges and expectations of the market,
- development that covers the person and the organisation in the context of the phenomena occurring inside and outside the entity.

With such a perception of efficiency, the activities carried out cannot be random, therefore, the long time horizon in particular requires the identification of a model of activities (a business model) that can be called the 'dominant logic' of the performance of activities that guarantee the ability to exist and develop as well as achieve the set goals of the company (Leszczyńska, p. 40). The multiplicity of the definitions of a business model indicates the diversity of the understanding of this conceptual abstract, however, the common feature of the definitions is that they refer to two factors: creation of value and a long perspective, based on resources and operational activities carried out in the company (including those carried out with key partners), and an offer intended for the environment, customers, and finances – including costs and revenues (Janulek, 2022, pp. 60-61). All these components of the business model are correlated with the market model, and more broadly with the socio-economic system (Figure 1), which, as a system superordinate to companies, is able to set functional and market goals for enterprises that are in line with social policies and expectations, for example those relating to pro-environmental activities, and affects the efficiency of management and, consequently, the value of the entity.

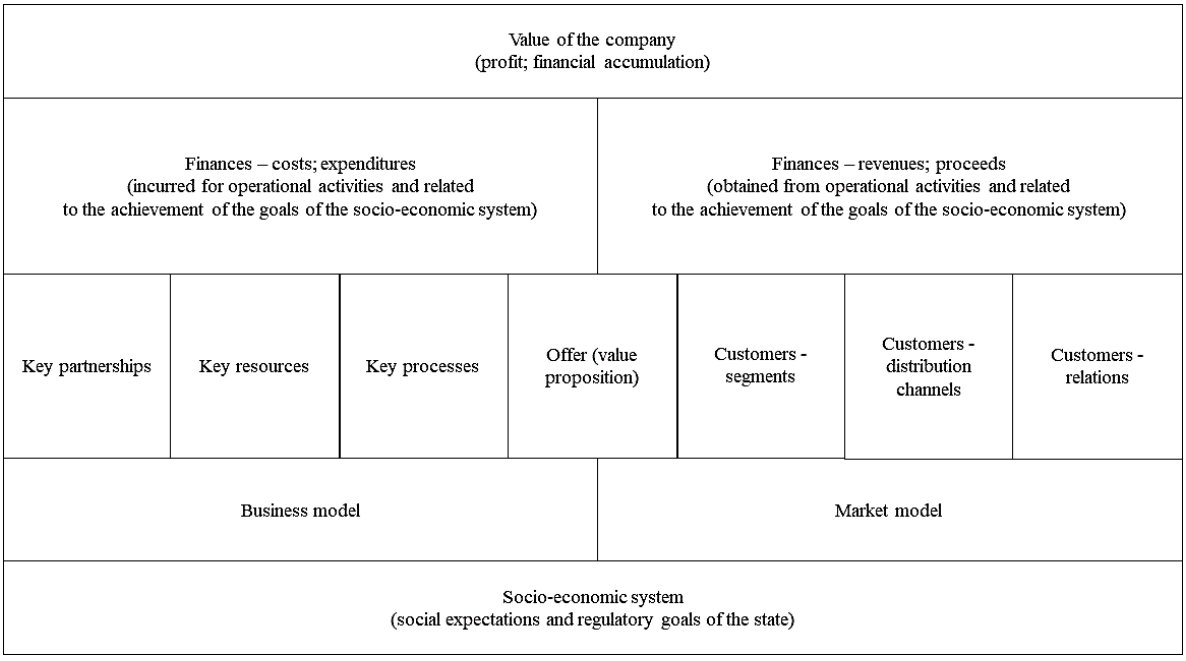

Figure 1. The business model as an element of creation of value of the company.

Source: Prepared by the author based on Janulek, 2022, p. 60.

The traditional concept of the business model is generally described as a tool for companies or organizations to create and add value to their products and services, before delivering them to their customers (Comin, Aguiar, Sehnem, Yusliza, Cazella, Julkovski, 2020, p. 2029) and the creation of company value should be perceived as a long term process (Kurznack, Schoenmaker, Schramade, 2021, p. 2). This process requires a non-random, structured approach that includes not only the identification of that part of the business model that is based on operational creation of value, but also the incorporation of the concept of Corporate Social Responsibility (CSR), that can also lead to improved management results (Dam, Lungren, Sholtens 2019, p. 244). This fits in with the concept of sustainable development and sustainable growth, forming the basis of a sustainable business model. The concept of a sustainable business model includes economic, environmental, and social factors. An entity operating according to a sustainable business model achieves economic results (creates its value), while creating social and environmental values in parallel. Therefore, sustainable organisations need to make a profit to exist, but they do not exist solely to make a profit. In other words, profit is a means to achieve sustainable results. Consequently, a sustainable business model 'helps to describe, analyse, manage, and communicate the sustainable value proposition offered by a company to its customers and other stakeholders, how that value is created and delivered, and how economic value is captured while maintaining or regenerating natural, social and economic capital beyond the boundaries of the organisation' (Szumniak-Samolej, 2022, p. 39), creating an integrated value that goes beyond the value of the entity in strictly financial terms. Thus, it is 'a promise of economic, environmental, and social benefits delivered to customers and the society in general through the company's offer, and takes into account both short-term profit and long-term sustainability' (Szumniak-Samolej, 2022, p. 39).

One of the planes for functioning according to the so-defined sustainable business model is the incorporation of pro-environmental solutions into internal processes – elements of the value chain and in the form of products/services (with pro-environmental characteristics) offered to the market. As a result, this allows entities to achieve economic and environmental benefits in the following form (Leszczyńska, pp. 42-43):

- achievement of favourable environmental results by minimising emissions, saving resources with similar (to other products/services) functionality and usability,
- regeneration, recycling of waste – which lead to a reduction in the demand for resources, closing material cycles,
- improved energy efficiency – including systems based on renewable energy sources, which is justified by high fuel prices and the climate change,
- optimisation of efficiency by using solutions that include the transmission, collection, and processing of data in electronic form (Information and Communication Technologies – ICT), which serves to control the consumption of resources, including energy, and allows the monitoring of resource consumption or redistribution.

3. Towards zero-emission road freight transport

In the second decade of the 21st century (2011-2020), the European Commission adopted a series of documents on strategies aimed to minimise negative environmental impacts. These documents include, among others, the 'White Paper: Roadmap to a Single European Transport Area' (2011), 'Clean Power for Transport: a European Alternative Fuels Strategy' (2013), the 'European Strategy for Low-Emission Mobility' (2016), and the 'Action Plan on Alternative Fuels Infrastructure' (2017). However, a decisive acceleration of energy transition activities, including electromobility, came after the European Commission adopted a strategic document titled 'European Green Deal' (2019). The document is an integral part of the European Commission's strategy to achieve the UN's 2030 Sustainable Development Goals and create a zero-emissions economy in 2050 (Transport 4.0…, pp. 20-21). The Green Deal is premised on the successful marriage of the EU's environmental and climate goals with its economic and social goals (Almeida, Zeben, 2023, p. 1).

As far as road freight transport is concerned, the first emission standards, including those applicable to CO_2, for lorries in the European Union were introduced on August 14, 2019, as part of Regulation (EU) 2019/1242 of the European Parliament and the Council of June 20, 2019. The Regulation set CO_2 reduction targets for new lorries. According to the Regulation, manufacturers are required to reduce the emission values of newly registered heavy vehicles by 15 percent in 2025 and by 30 percent in 2030 relative to the emissions of heavy vehicles first registered between July 1, 2019 and June 30, 2020. To ensure consistency with current environmental goals, on February 14, 2023, the European Commission proposed new greenhouse gas emission targets for new heavy vehicles for the period after 2030, under which it calls for the gradual introduction of stricter CO_2 emission standards compared to the 2019 levels. Thus, the reduction level for 2030 was changed to 45% and reduction levels were introduced for 2035 – 65% and 2040 – 90%. The Regulation is also intended to ensure a smooth transition to zero-emission mobility by 2050 (Miniszewski et al., 2023, pp. 9-10). This policy also includes the adoption of a new EURO 7 (European Standard for Exhaust Emissions) emission standard, scheduled to be introduced in 2025, with a delay of two years for lorries (permissible gross vehicle weight over 16 t) and buses (EURO 7 – nowa norma…).

In EURO 7, the biggest novelty compared to previous versions of the emission standards is the introduction of identical emission standards for all vehicles regardless of the type of fuel they use. The same requirements will therefore have to be met by gasoline and diesel engines, as well as hybrid and electric cars. In terms of diesel engines, which are by far the primary type of engines used in heavy-duty transport, nitrogen oxide emissions have been reduced from the previous 80 mg/km to 60 mg/km, the level set for gasoline units in EURO 6. In addition, another restriction will be imposed on lorries, this time on engine startup emissions. For the startup of a cold engine they are equal to 350 mg/kWh, and for a warm engine the value is 90 mg/kWh.

Provisions have also been added to regulate the emissions of formaldehyde and nitrous oxide for lorries, and ammonia for passenger vehicles, and tailpipe particle emissions are to be reduced by 13%. A surprising new provision is the restrictions on the abrasiveness of tires and brake components, which, after all, also emit particulate matter. The mileage and operating period during which the entire powertrain is expected to meet the new standards has also been extended. In EURO 7, it is supposed to be 200,000 km or 10 years, respectively. Vehicles are also to be equipped with electronic systems for monitoring emissions, so that it will be possible to check in an ongoing manner whether the vehicle still meets EURO 7 standards (Szczegóły normy Euro 7...).

Increasingly stringent emission standards and strategic EU policy goals are leading to a zero-emission economy in 2050 for road freight transport as well. For this type of business, this means first and foremost the conditions associated with the ability of road carriers to purchase zero-emission means of transportation. Vehicle manufacturers are analysing and trying to implement many alternatives leading to the replacement of diesel fuel. It is possible to replace diesel fuel supplied directly into internal combustion engines by using compressed or liquefied natural gas, biogas, biofuels, synthetic fuels, or alcohols, and to change the design of the powertrain by electrifying it (Brach, 2022, p. 56). The latter option – electrification of the powertrain – can take the following forms (Broadbent, Allen, Wiedmann, Metternicht, p. 2; González Palencia, Nguyen, Araki, Shiga, 2020, p. 5):

- hybridisation, or the introduction of an internal combustion – electric system (Hybrid Electric Vehicle – HEV and Plug-In Hybrid Electric Vehicle – PHEV),
- full electrification, based on an electric motor and a battery module (Battery Electric Vehicle – BEV),
- electrification linked to the introduction of an on-board source of electricity in the form of hydrogen fuel cells (Fuel Cell Electric Vehicle – FCEV).

Of the above-mentioned three options for electrification of the powertrain and the resulting reduction of the negative environmental impacts caused by means of transportation, the use of hydrogen fuel cells poses the most problems. The first two ways of electrifying the powertrain are already so technologically advanced that lorry manufacturers are already offering electric vehicles to carriers and are even declaring that they have plans to sell only electric vehicles. The planned levels of the share of the sales of electric lorries in the total sales of leading manufacturers are shown in Table 1.

Table 1.
The planned levels of the share of the sales of electric lorries in the total sales of leading manufacturers

Manufacturer	Years			
	after 2025	after 2030	after 2039	after 2040
Scania	10%	50%		100%
MAN		40-60%		100%
Volvo		50%		100%
Daimler		60%		100%
DAF			100%	
Renault	10%	35%		100%
IVECO				100%

Source: Miniszewski et al., 2023, p. 31.

It should be assumed that a fully zero-emission road freight transport can materialise 15 to 20 years after the introduction of electric-only vehicles, when all means of transportation manufactured before 2040 are taken out of service. However, there is still a long way to achieve that objective since, despite the availability of electric vehicles on the market, according to data from the European Automobile Manufacturers' Association (ACEA), currently about 97% of newly registered lorries run on diesel (New trucks…), while 2,903 electric lorries and 103 hybrid lorries were registered in the European Union between 2021 and 2022. The area is dominated by Germany (1,816 electric lorries registered in 2021–2022), followed by Sweden (226), the Netherlands (220), France (215), and Spain (179), which gives a total of 2,656 electric vehicles. The countries mentioned thus accounted for 91% of all registrations in the EU. In Poland, 11 electric lorries were purchased in 2021–2022: 5 in 2021 and 6 in 2022 (Miniszewski et al., 2023, p. 30). The current sales levels of new electric lorries are primarily due to the price of these vehicles. Even though some European Union countries (e.g., Germany and the Netherlands) have subsidy programs for the purchase of electric lorries, on average, when these are factored in, the price of a new electric lorry is three times that of a conventional, diesel-powered vehicle, although the definitely lower operating costs caused by high diesel fuel prices are emphasised (Ile kosztuje…). In Poland, the subsidies from the National Fund for Environmental Protection and Water Management under the 'My Electric Vehicle' program exclusively cover vehicles designed and built to carry freight and having a maximum gross weight not exceeding 3.5 tons – category N1. It is possible to obtain a subsidy of up to 20% of eligible costs, but not more than PLN 50,000, or up to 30% of eligible costs, but not more than PLN 70,000 if average annual mileage of more than 20,000 km is declared (Nabór…).

The difference in the operating costs is favourable to electric vehicles; however, the availability of infrastructure to replenish the 'energy agent' strongly favours liquid fuels, as the number of fuel stations in Poland, according to estimates by the Polish Organisation of Oil Industry and Trade (POPiHN), was 7,902 at the end of Q1 2023, compared to 7,898 at the end of last year. (Liczba stacji...). Each fuel station has several or even more than ten dispensers that allow simultaneous service of that many vehicles, with the duration of that service equal to from several up to twenty minutes. Assuming that on average there are 8 distributors per fuel

station, it can be calculated that this gives about 63,000 service points, while at the end of 2022 there were 5016 publicly available electric car charging points in Poland. This is 33 percent more than a year earlier, but despite this progress, it puts Poland in the fifth from last place in the European Union in terms of the number of electric car charging points, with less than 1 charger per 100 km of roads (Ciepiela, 2023). This disproportion, although also the speed of change in this area, can also be clearly seen if one considers the data from the integrated financial reports for 2020-2022 of the Orlen Group, which operates in the Polish, German, Czech, Slovak, and Lithuanian markets – see Table 2.

Table 2.
Number of stations by type, owned by the Orlen Group in 2020-2023

Station type	2020		2021		2022	
	ORLEN Group	of which in Poland	ORLEN Group	of which in Poland	ORLEN Group	of which in Poland
Petrol	2,855	1,811	2,881	1,819	3,097	1,920
Electric vehicle charging	114	84	454	372	598	493
Hydrogen charging	2	0	2	0	2	1

Source: Prepared by the author based on: Raport Zintegrowany Grupy Orlen za rok 2020; Raport Zintegrowany Grupy Orlen za rok 2021; Raport Zintegrowany Grupy Orlen za rok 2022.

The number of electric vehicle charging stations owned by the Orlen Group in Poland between 2020 and 2022 increased almost 6 times from 84 to 493. This, of course, fits in with the desired direction of change; however, not every entity has financial capabilities comparable to those of energy-sector corporation. Other entities looking to contribute to the electrification of road transportation expect financial support for the construction of charging stations in particular. As part of the support for the creation of zero-emission road transport in Poland, it is possible (the implementation period is planned for 2021-2028, including the contracting period until December 31, 2025 and the disbursement period until December 15, 2028) to obtain financial support for the construction of a charging station with a power of not less than 22 kW, other than a public charging station, and the construction of a public charging station with a power of not less than 50 kW, in which at least one point allows the provision of DC charging services and has a power of not less than 50 kW. (Infrastruktura…). However, it should be mentioned that the vast majority of the funds allocated for this purpose (PLN 870 million) have already been distributed or are in the process of verification of the submitted applications.

4. Pro-environmental activities in the business model of medium and large Polish road carriers

The unique characteristics of the management and the organisation mechanisms in road transport companies are due to the sector-specific characteristics of this type of business activity. First of all, a transportation company provides services, and second, the transportation

service is spatial in nature, which means that it is carried out outside the company's premises and involves traversing space. This results in the characteristic asset structure of these entities, in which means of transportation make up the vast majority of assets. According to Statistics Poland, in 2021, in companies employing more than 9 people, the share of the gross value of means of transportation in the total assets was about 71% (Figure 2). In absolute numbers, the value of these assets amounted to PLN 40.3 billion; however, much more important information is their wear rate of 53.4% (Road Transport in Poland in the Years 2020 and 2021, p. 26).

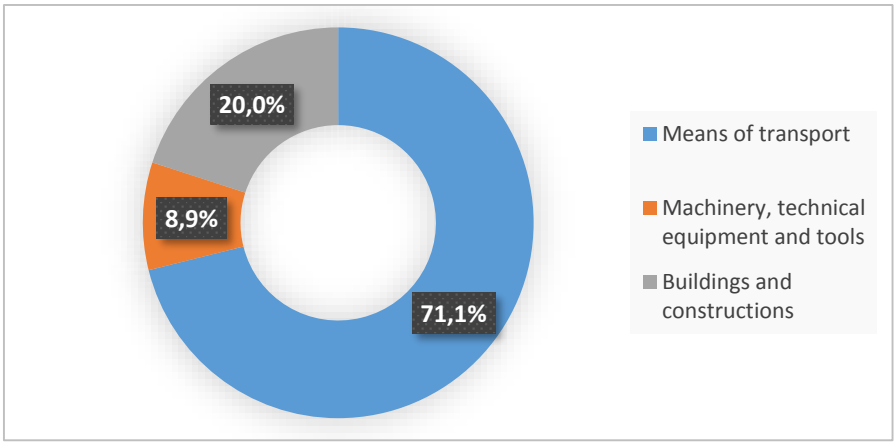

Figure 2. The structure of the gross value of fixed assets in road transport in 2021.

Source: Prepared by the author, Road Transport in Poland in the Years 2020 and 2021, p. 26.

Taking into account the provisions of the Accounting Act and the tax law that define the annual depreciation rates of 14% (tractor units) to 20% (all-purpose lorries) for means of transportation, and assuming a period of their use equal to 7 to 5 years, it is possible to determine the average 'economic' age of these assets as equal to about 3 years; however, one should bear in mind that these vehicles are also used after the end of the period when their depreciation is accounted for. According to data that takes into account the year of manufacture, the average age of lorries in Poland is 13.2 years, which is very close to the EU's average of 13.9 years (Przybylski, 2023). The percentage share of each age group of lorries is as follows (Road transport in Poland in the years 2020 and 2021, p. 52):

- up to 2 years – 5.2%,
- 3-5 years – 6.3%,
- 6-11 years – 14.9%,
- 12-15 years – 13.5%,
- 16-20 years – 15.3%,
- 21-30 years – 22.1%,
- 31 and over – 22.7%.

The transport capacity-building policy inherent in the business model of road transport companies should therefore take into account the age of their means of transportation, but it is also necessary to take into account the regulatory requirements for permissible exhaust

emissions, i.e. the EURO standard. Currently, the most stringent standard in force in Europe is EURO 6, however, the principles of the EURO 7 standard have already been defined, so businesses that provide road transport services in their business model function in a space determined both by the technical condition of their fleets and the legislative conditions that require the adaptation of their fleets to environmental constraints. The survey of a population of 146 medium and large road transport companies, which was conducted in late 2021 and early 2022, shows that for 68.8% of the respondents surveyed reason the means of transport were disposed of was mainly their age or mileage; for 16.7% it was their technical condition (degree of depreciation); for 12.5% it was their high operating costs, and for 2.1%. it was failure to meet EURO emission standards. These results are confirmed by an earlier study of fleet renewal policies conducted on an identical sample of companies. In the earlier study conducted in 2019-2020, a question was asked about pursuing a policy of regular fleet replacement. A regular fleet replacement policy was indicated by 113 respondents; the median number of years for fleet replacement indicated in that group was 3 years, which means that most of them replaced their transportation means after that length of time. Data from Statistics Poland show a positive trend in the renewal of fleets by road carriers, because nearly 48% of newly registered lorries in Poland are up to 2 years old, and thus meet the EURO 6 standard – see Figure 3 (Road transport in Poland…).

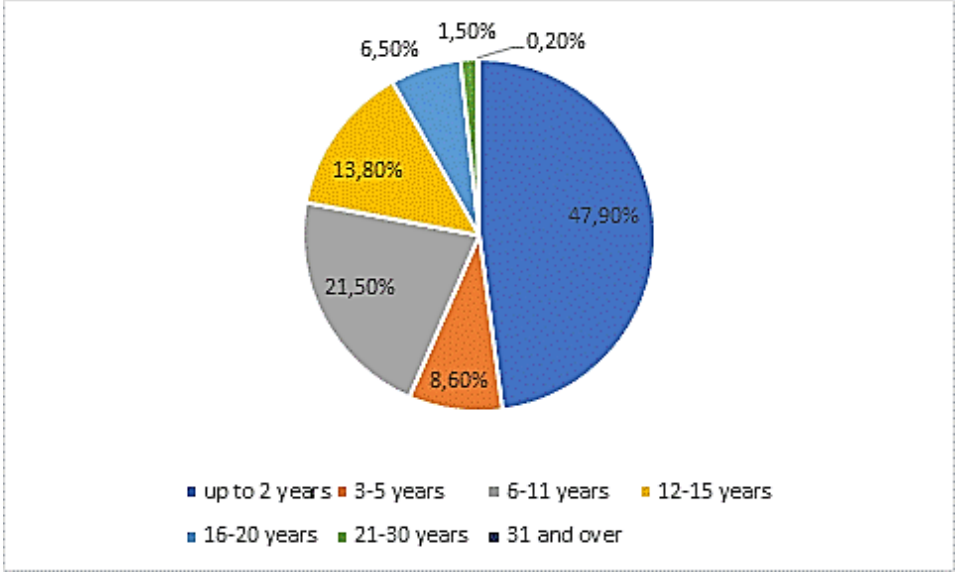

Figure 3. The structure of first-time registered lorries by age groups in 2021.

Source: Prepared by the author, Road Transport in Poland in the Years 2020 and 2021, p. 52.

The age of the vehicles purchased, and thus the compliance with the EURO standards, is one of the formal criteria, and the cost of operating these vehicles is another. In the 2021-2022 survey, one of the criteria considered by companies when purchasing means of transportation was operating costs: 70.5% of the businesses confirmed that they took that criterion into account. These are mainly costs related to fuel consumption: a 25-ton semi-trailer vehicle with a cargo of 25 tons that travels about 120,000 kilometres per year consumes

an average of 35 litres of fuel per 100 kilometres. This accounts for about 30% of the total cost of operation of the vehicle (Czy wiesz…), so one of the possible ways to reduce the negative environmental impact of the fleet purchasing policy is to choose vehicles with smaller engine displacement and consequently with lower exhaust emissions and at the same time lower greenhouse gas emissions. In the study conducted, 21.9% of companies declared that such was precisely the action they had undertaken.

Building a transport capacity compliant with the environmental requirements is a medium- to long-term dimension of the measures implemented by road transport companies. Of equal importance is the short-term dimension, expressed in the daily operation of the means of transportation and the organisation of transportation processes. The daily operation of means of transportation boils down to a direct reduction of the negative environmental impact by use of a fluid (AdBlue) that changes the chemical characteristics of the exhaust gas. AdBlue is a colourless and non-toxic liquid that consists of urea (32.5%) and demineralised water (67.5%). A small amount of AdBlue is injected into the exhaust gas in the exhaust system. Under the influence of heat and urea, harmful nitrogen oxides are transformed into ammonia and carbon dioxide. The exhaust gas then goes to a selective catalytic reduction (SCR) system, where most of the nitrogen oxides are converted into harmless nitrogen and water (Wszystko co musisz…). The use of AdBlue was declared by 61.6% of the surveyed entities.

Another positive direction for transportation companies is to strive to reduce exhaust emissions by reducing the resistance associated with vehicle movement (rolling resistance and air resistance) and using technical means to limit the maximum speed. Rolling resistance is mainly influenced by an efficient drivetrain and braking system. Tires are the component of the drivetrain that, depending on the composition of the rubber compound, can reduce rolling resistance. The use of this method of reducing greenhouse gas emissions was indicated by 43.2% of the surveyed companies. Another direction related to the technical conditions of vehicles that reduce exhaust emissions is the reduction of air resistance by using fairings above and sometimes on the sides of the vehicle's cabin. 65.1% of the respondents reported doing so.

Even tires with the lowest rolling resistance and the use of fairings cannot help achieve fuel economy if the driver has a so-called 'heavy foot'. Therefore, companies emphasising eco-driving in their business models as part of their operations. Eco-driving is a driving technique that limits rapid acceleration and braking, and includes analysing the situation on the road and anticipating the manoeuvres of other road users. The basic principles of eco-driving boil down to driving smoothly, working the gear ratios to keep the engine speed below 3500 rpm, and controlling and maintaining proper tire pressure (Caban, 2021). The primary player in eco-driving is the driver, hence the need to educate and train drivers in eco-driving techniques. Awareness of the positive impact of eco-driving on fuel consumption and the wear of the means of transportation can be observed in the surveyed companies, as 6.8% of the companies send their drivers to relevant training courses. It should be noted at this point that this is done in the smallest number of companies. The techniques used by the surveyed road freight transport

companies to reduce negative environmental impacts, ranked by frequency of occurrence, are shown in Table 3.

Table 3.
The techniques used by the surveyed road freight transport companies to reduce negative environmental impacts, ranked by frequency of occurrence

Techniques used	Share of indications
Buying new/newer vehicles	85.6%
Increasing capacity utilisation (cargo consolidation, carrying cargo on return trips)	81.5%
Buying vehicles that are cheaper to operate	70.5%
Fairings	65.1%
Ad Blue	61.6%
Buying energy-efficient tires	56.8%
Using transportation planning software	39.7%
Buying vehicles with smaller engines	21.9%
Eco-driving training courses	6.8%

Source: Prepared by the author.

The last of the dimensions of transport organisation considered in the environmentally friendly business models of road freight transport companies is the organisation of the transport process. As a general rule, a transport order involves the transportation of a cargo from the point of shipment to the point of destination, implicitly assuming that the principal, by paying the freight, pays for the transportation of the cargo, and the return of the means of transportation to the point of departure is the responsibility of the carrier and generates costs that it covers. Thus, one can imagine a situation in which the return of the means of transport generates a 'useless' negative impact on the environment, and therefore it is reasonable for carriers to search for cargo to carry on the return trip, to consolidate the cargo where the utilisation of the capacity or the cargo space is incomplete. From an environmental point of view, this rationalises the negative environmental impact and reduces it to the negative effects of an action that is useful from a socio-economic point of view. These measures were declared by 81.5% of the surveyed companies. In addition, the spatial scattering of the points of shipment and destination of cargo transportation, as well as of the times of expected pickups and, consequently, the times of the start of the transportation processes, requires planning the sequence and flow of the transportation processes. Humans (the dispatchers, sometimes referred to as fleet coordinators), their experience and knowledge of the road network and the road conditions play a considerable role here. Currently, however, artificial intelligence in the form of specialised software can support this process. In the surveyed group, 39.7% of the companies were using such software, which, according to one of the software's vendors, allows them to complete 30% more transportation tasks with the same fleet, save 80% of the fleet coordinator's time by automating the process, and reduce fleet labour costs by 30%, and enables 100% monitoring of fleet movement (Planowanie…).

Both the long-term and short-term dimensions of incorporating environmentally friendly elements into the business model of large and medium-sized road freight transport companies are part of the trends and conditions prevailing in the environment. One of these conditions for

road transport is the linear and nodal infrastructure, and another is the regulatory environment established by the state, understood as a legislative-administrative entity with the authority to impose the achievement of socially desirable goals (including pro-environmental ones) on the one hand, and to support these activities on the other. These dimensions are the factors affecting the carriers' decisions regarding obstacles on the one hand and expectations of the state on the other, regardless of what actions are taken by the state. As part of the 2020-2021 study, the carriers were asked to rank obstacles to the smooth achievement of environmental goals. The respondents' answers ranked the factors in the following order:

- lack of funding for vehicle purchases was indicated by 57 respondents as the most important factor,
- lack of assistance from the state was indicated as the most important factor by 47 respondents,
- lack of infrastructure (CNG stations, charging stations) was indicated as the most important factor by 42 respondents.

In the same survey, the respondents were asked to rank the state's actions that would motivate carriers to incorporate environmentally friendly measures into their business models. Investment in infrastructure was identified as the most important factor, followed by the introduction of tax systems that differentiate vehicle taxes based on exhaust emissions and by fleet renewal programs (tax reduction, subsidies).

5. Conclusions and discussion

One of the dimensions of environmental degradation is greenhouse gas emissions. The economic sectors with a significant negative impact on the environment include the road freight transport sector. Reducing greenhouse gas emissions from road transportation is one of the European Union's environmental goals, and, due to the share of exhaust gas emissions by motor vehicles in general, one of the goals is to reduce the carbon monoxide and nitrogen oxide emissions by introducing the EURO emission standards and, by 2030, stopping the manufacture of vehicles with engines powered by fossil fuels, specifically gasoline and diesel. In keeping with this goal, lorry manufacturers are already offering lorries with electric engines today, albeit to a limited extent, and are planning to offer only electric vehicles after 2040.

The environmental goals and the trends in the development of zero-emission transportation are not without an impact on road carriers, which must incorporate them into their business models in two areas of their operations. The first is the long-term dimension, related to the policy of replacing vehicles with new ones that meet increasingly stringent emission standards. This dimension requires carriers to make strategic decisions that take into account their

financial capabilities, including those that determine the efficiency resulting from the costs – the fuel costs and the environmental fees– of the operation of these vehicles in the future.

In the course of the survey, the respondents indicated that, as part of their fleet policy, they based their business models on the purchase of new means of transportation that meet increasingly stringent emission standards in order to fit in with the environmental goals. This is evident in the statistics, according to which almost 50% of newly registered lorries in Poland in 2021 were no more than 2 years old. The second measure is to make purchases of vehicles with smaller engine displacement to match the needs arising from the operations.

The operational activities of medium and large Polish freight carrier companies that lead to the satisfaction of transport needs are also characterised by activities that reduce exhaust emissions into the environment. They consist in the application of solutions that change the composition of exhaust gases (AdBlue) and reduce fuel consumption (lowering rolling resistance – energy-efficient tires and lowering air resistance – fairings), and the acquisition of pro-environmental driving skills (eco-driving). The final element is the organisation of processes that consists in an increase in the utilisation of the vehicle capacity (cargo consolidation) and the elimination of empty runs by looking for cargo to be carried on the way back and using route planning software.

Incorporating zero-carbon economy goals into a company's business model involves additional costs. The cost of pro-environmental solutions in the operational dimension of the road carriers' business model is relatively low; however, if one considers the fleet replacement policy, two fundamental barriers can be observed. The first is related to the lack of funding for the purchase of new zero-emission vehicles: currently, taking into account the subsidies available in some countries, their prices are on average three times higher than the prices of vehicles powered by fossil fuels. This results in the carriers' expectation of support for this activity by the state, which is not provided in Poland, as it applies only to cars and vans. The second barrier is related to infrastructure: Poland has one charging station per 100 kilometres of roads, and even if one considers that it is possible to obtain support for their construction, range limitations and charging times effectively limit, for now, the use of electric lorries for medium- and long-distance trips. Therefore, since the goal – a zero-carbon economy in 2050 – has been defined, the following question arises: How can the problem with the 'path to get there' be solved? Should carriers be left without support and should we wait another 10 to 15 years until vehicles powered by fossil fuels are naturally eliminated? Or should carriers be supported and should that time be shortened so that, for example, zero-emission road freight transport becomes a reality by 2050?

References

1. Brach, J. (2022). *Zastosowanie paliw alternatywnych i alternatywnych zespołów napędowych w samochodach ciężarowych klas tonażowych średniej i ciężkiej w warunkach zachodnioeuropejskich. Wyzwania i ograniczenia – aspekty praktyczne.* Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.
2. Broadbent, G., Allen, C., Wiedmann, T., Metternicht, G. (2022) The role of electric vehicles in decarbonising Australia's road transport sector: modelling ambitious scenarios. *Energy Policy, no. 168.*
3. Caban, J. (2021). A Study of Eco-Driving Possibilities in Passenger Cars Used in Urban Traffic. *The Archives of Automotive Engineering – Archiwum Motoryzacji, Vol. 91, No. 1,* pp. 37-48
4. Ciepiela, D. (2023). *Polska w ogonie Europy. Liczba ładowarek do elektryków musi wzrosnąć*. Retrieved from: https://www.wnp.pl/energetyka/polska-w-ogonie-europy-liczba-ladowarek-do-elektrykow-musi-wzrosnac,697222.html, 31.08.2023.
5. Comin, L.C., Aguiar, C.C., Sehnem, S., Yusliza, M.-Y., Cazella, C.F., Julkovski, D.J. (2020). Sustainable business models: a literature review. *Benchmarking: An International Journal, Vol. 27, No. 7*, pp. 2028-2047. https://doi.org/10.1108/BIJ-12-2018-0384
6. *Czy wiesz ile oleju napędowego zużywa ciężarówka na km?* Retrieved from: https://www.webfleet.com/pl_pl/webfleet/blog/czy-wiesz-ile-oleju-napedowego-zuzywa-ciezarowka-na-km/, 29.08.2023.
7. Dam, L., Lundgren, T., Scholtens, B. (2019). Environmental Responsibility: Theoretical Perspective. In: A. McWilliams, D.E. Rupp, D.S. Siegel, G.K. Stahl, D.A. Waldman (Eds.), *The Oxford handbook of corporate social responsibility: Psychological and organizational perspectives* (pp. 240-260). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198802280.013.10
8. de Almeida, L., van Zeben, J. (2023). *The EU's circular energy system and the Green Deal*, in *Law in the EU's Circular Energy System Biofuel, Biowaste and Biogas New Horizons in Environmental and Energy Law series.* L. de Almeida, J. van Zeben (eds.). Elgaronline. Retrieved from: https://doi.org/10.4337/9781802205879
9. *EURO 7 – nowa norma emisji spalin budzi przerażenie. Ale czy jest się czego obawiać?* Retrieved from: https://www.autodna.pl/blog/norma-euro-7-jakie-zmiany-wprowadzi/, 30.08.2023.
10. Fryca-Knop, J., Letkiewicz, A., Majecka, B. (2017). Functional Efficiency and Stability of Road Transport Enterprises. In: A. Letkiewicz, M Suchanek (Eds.), Determinants of Functional Effectiveness and Durability of Road Transport Enterprises. *Research Journal of the University of Gdansk, Transport Economics and Logistics, Vol. 73,* pp. 7-16, DOI:10.5604/01.3001.0010.8296

11. González Palencia, J.C., Nguyen, V.T., Araki, M., Shiga, S. (2020) The Role of Powertrain Electrification in Achieving Deep Decarbonization in Road Freight Transport. *Energies, 13*, 2459; DOI:10.3390/en13102459
12. *Ile kosztuje elektryczna ciężarówka? Średnia z 2022 roku to 296 tys. euro za sztukę*. Retrieved from: https://40ton.net/ile-kosztuje-elektryczna-ciezarowka-srednia-z-2022-roku-to-296-tys-euro-za-sztuke/, 31.08.2023.
13. *Infrastruktura ładowania - o programie*. Retrieved from: https://www.gov.pl/web/elektromobilnosc/o—programie, 31.08.2023.
14. Janulek, P. (2022). *Projektowanie modeli biznesu usług profesjonalnych w mediach społecznościowych.* Sopot: Centrum Myśli Strategicznych.
15. Kurznack, L., Schoenmaker, D., Schramade, W. (2021). A Model of Long-Term Value Creation Forthcoming. *Journal of Sustainable Finance & Investment*. Retrieved from: SSRN: https://ssrn.com/abstract=3829778, http://dx.doi.org/10.2139/ssrn.3829778
16. Leszczyńska, A. (2017). Modele biznesu oparte na innowacjach ekologicznych. *Annales Universitatis Mariae Curie-Skłodowska, Vol. LI, 1, Sectio H,* pp. 39-50, DOI:10.17951/h.2017.51.1.39
17. *Liczba stacji paliw w Polsce. Ile wyniosła na koniec I kw. 2023 r.?* Retrieved from: https://forsal.pl/biznes/energetyka/artykuly/8702737,liczba-stacji-paliw-w-polsce-ile-wyniosla-na-koniec-i-kw-2023-r.html, 31.08.2023.
18. Miniszewski, M., Maj, M., Wiśniewski, J., Ziółkowski, P. (2023). *Elektryfikacja sektora drogowego transportu ciężkiego*. Warszawa: Polski Instytut Ekonomiczny.
19. *Nabór dla przedsiębiorców i podmiotów innych niż osoby fizyczne*. Retrieved from: https://www.gov.pl/web/elektromobilnosc/nabor-dla-przedsiebiorcow-i-podmiotow-innych-niz-osoby-fizyczne, 31.08.2023.
20. *New trucks in the EU by fuel type.* Retrieved from: https://www.acea.auto/figure/trucks-eu-fuel-type/, 30.08.2023.
21. *Planowanie, wyznaczanie i optymalizacja tras Twoich pojazdów*. Retrieved from: https://routimo.com/, 29.08.2023.
22. Przybylski, R. (2023). *Producenci ciężarówek oczekują doskonałych dwóch lat.* Retrieved from: https://logistyka.rp.pl/drogowy/art37783611-producenci-ciezarowek-oczekuja-doskonalych-dwoch-lat, 23.08.2023.
23. *Raport Zintegrowany Grupy Orlen za rok 2020*. Retrieved from: https://raportzintegrowany2020.orlen.pl/grupa-orlen-i-otoczenie/grupa-orlen/segmenty-operacyjne/segment-detal/, 1.09.2023.
24. *Raport Zintegrowany Grupy Orlen za rok 2021*. Retrieved from: https://raportzintegrowany2021.orlen.pl/grupa-orlen-i-otoczenie/grupa-orlen/segmenty-operacyjne/segment-detal/, 1.09.2023.

25. *Raport Zintegrowany Grupy Orlen za rok 2022*. Retrieved from: https://raportzintegrowany2022.orlen.pl/grupa-orlen/dzialalnosc-operacyjna-w-2022-roku/segment-detal, 1.09.2023.
26. *Road transport in Poland in the years 2020 and 2021* (2023). Statistics Poland. Warszawa/Szczecin: Statistical Office in Szczecin.
27. *Szczegóły normy Euro 7. Od kiedy zacznie obowiązywać?* Retrieved from: https://truckfocus.pl/nowosci/67730/szczegoly-normy-euro-7-od-kiedy-zacznie-obowiazywac, 23.08.2023.
28. Szumniak-Samolej, J. (2022). Zrównoważone modele biznesowe – charakterystyka, kryteria, innowacje. *e-mentor, 1(93),* pp. 37-45. Retrieved from: https://doi.org/10.15219/em93.1550, 29.06.2023.
29. *Transport 4.0 Rozwój elektromobilności i wodoromobilności na świecie i w Polsce. Część I. Regulacje, rynek, praktyka* (2021). Warszawa: Agencja Rozwoju Przemysłu S.A. Retrieved from: https://arp.pl/documents/95/Raport_eMobility_I_FINAL_PART_1.pdf 30.08.2023
30. *Wszystko, co musisz wiedzieć o AdBlue - co to jest, do czego służy i jak działa?* Retrieved from: https://devil-cars.pl/blog/adblue-wszystko-co-musisz-o-nim-wiedziec, 29.08.2023.