THE IMPLEMENTATION OF GREEN LOGISTICS IN ROAD TRANSPORTATION

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Abstract. The article presents an analysis of academic literature in an attempt to identify the importance of the implementation of green logistics in road transportation. Areas of concern as well as solution and implementation opportunities are presented. A research of transportation companies was conducted in an attempt to understand the real situation regarding the implementation of green logistics measures. The research results are presented in the article. Solutions are provided in the form of a conceptual model for the implementation of green logistics measures in transportation organisations. Nowadays the interest in ecology, minimization of fossil fuel usage, and mitigation of harmful road transportation consequences is rapidly increasing. Eco-friendly vehicles, effective transportation system, application of advanced technologies and innovations should become the main factors in promoting the implementation of green logistics in the transportation sector to mitigate negative effects on the environment. In order to maintain their competitive advantage and customer satisfaction, transportation organisations should begin implementing the concept of green logistics in their businesses. The significance of the concept of green logistics can be observed on global, regional, and national levels. Business is still seen as the leader, responsible for initiation and implementation of ecological logistics principles. The implementation of green logistics is critically important; however, lack of funding and collaboration between the public and the private sectors prevent companies from adopting green logistics measures. Economic driving classes, employee education, electric

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and hybrid cargo-handling vehicles are some of the possible green logistics measures.

Keywords: concept, implementation of green logistics, implementation of measures, road transportation, research.

Introduction

Logistics enables effective planning, implementation, and control of the processes (Guo-chuan, 2010; Sprogytė & Zinkevičiūtė, 2014). Spiriajevas (2014) claims that logistics is about distribution in a particular territory; therefore, theoretically it is related to transport geography. Moreover, logistics is strategic purchasing management. It is storage as well as transfer of materials, parts, and finished products together with relevant information within an organisation, also through marketing channels, while fulfilling orders in a cost-effective manner and at the same time maintaining current as well as generating future profitability. Gargasas & Mūgienė (2018) point out highly customer-centric nature of the logistic services. Nowadays service providers develop services that are in the highest demand and their main goals are to increase value and maintain positive client relationships (Lodienė, 2012).

Green logistics has evolved into a variety of green actions to reduce overall environmental impact and ensure environmental protection and sustainable production (Karaman et al., 2020; Rizvi et al., 2020; Long et al., 2022).

Green logistics tries to combine efficient transportation with environmentally friendly urban logistics system (Wang & Hu, 2021).

Green logistics is perceived as a contribution of organisations to sustainable development in order to meet the needs of future generations with low greenhouse gas emissions (Kurbatova et al., 2020).

An increasing interest in green logistics as a solution has been observed. Nonetheless, it is not yet clear what the term means and encompasses (Sprogytė & Zinkevičiūtė, 2014). According to McKinnon et al. (2015), green logistics is a new scientific field that is missing scientific research.

The implementation of green logistics in the organisation highlights a number of advantages. This practice reveals an increase in the volume of goods delivered on time, a better use of capacity, promotes the quality of products or services, increases product variety and reduces waste. In addition, the implementation of green logistics benefits organisations by reducing material purchase costs, energy costs, waste treatment and disposal fees in an effort to eliminate environmental damage (Sidek

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et al., 2021). According to Dzwigol et al. (2021) the main principles of green logistics should be: application of an integrated approach in managing logistics flows; rational use of resources; minimum raw materials and packaging, the use of non-recyclables; maximum use of production waste, containers and packaging as secondary raw materials or their environmentally friendly disposal; environmental education and personnel responsibilities increase; implementation of innovative technologies in order to reduce the burden on the environment.

Also this term is not well known and clearly defined (Čepinskis & Masteika, 2011; Chin et al., 2015). The first environmental protection document published in one of transportation and logistics journals sparked the interest in the topic and scientific research was set in motion (Browne et al., 2012). As a scientific field, green logistics is not clearly defined and the term itself is not well known. (Long et al., 2022). Cosimato & Troisi (2015) describe the term concept of green logistics as transporting goods to their destination with transport that uses alternative or less harmful fuels. Green logistics is closely associated with sustainable development policy in transportation sector (Čepinskis & Masteika, 2011; McKinnon et al., 2010). The primary goal of green logistics is to reduce negative external environmental impact, which is mostly related to greenhouse gases, noise, and accidents (Dekker et al., 2011; Mensing et al., 2011; Palšaitis, 2010). The concept of green logistics can be described as a system of measures which is designed according to human needs and interests, and it highlights the strategic direction of the implementation of sustainable development while taking into account ecological, economic, social, and humanitarian aspects (Gnann et al., 2018; Jedlinski, 2014; Kutkaitis & Župerkienė, 2011; Šostko & Jakubavičius, 2018).

By increasing effectiveness of logistic activity and providing logistic services that are less harmful to the environment, proper infrastructure development can partially contribute to resolving the aforementioned issues (Liimatainen et al., 2014).

Barysienė et al. (2015) draw the attention to the fact that the Lithuanian society does not yet grasp the importance of ecological logistics, and logistic firms lack appropriate operation models. There are no concrete measures for realizing the concept of ecological logistics. The significance of the concept of green logistics can be observed on global, regional, and national levels (Čepinskis & Masteika, 2011; Europos Komisija, 2011a; Europos Komisija, 2011b). Business is still seen as the leader, responsible for initiation and implementation of ecological logistics principles (Meidutė & Paliulis, 2011). Intelligent transportation system (ITS) ensures a safer, better coordinated and more effective utilization of transportation network to different users (Pečiukėnas

et al., 2017; Poullikkas, 2015). Economic, social, and ecological aspects must be considered when implementing the goals of the concept of green logistics (see Figure 1).

Companies that are working towards implementation of ecological logistics must take concrete actions (Srivastava, 2007). Route and load optimization as well as logistic IT processes optimization are some of the measures that can be adopted in order to make the whole transportation system greener and eco-friendlier (Barysienė et al., 2015). Dües et al. (2013) argue that going green goes hand in hand with LEAN system implementation.

Figure 2 presents the main problem areas for implementing green logistics based on the literature analysis.
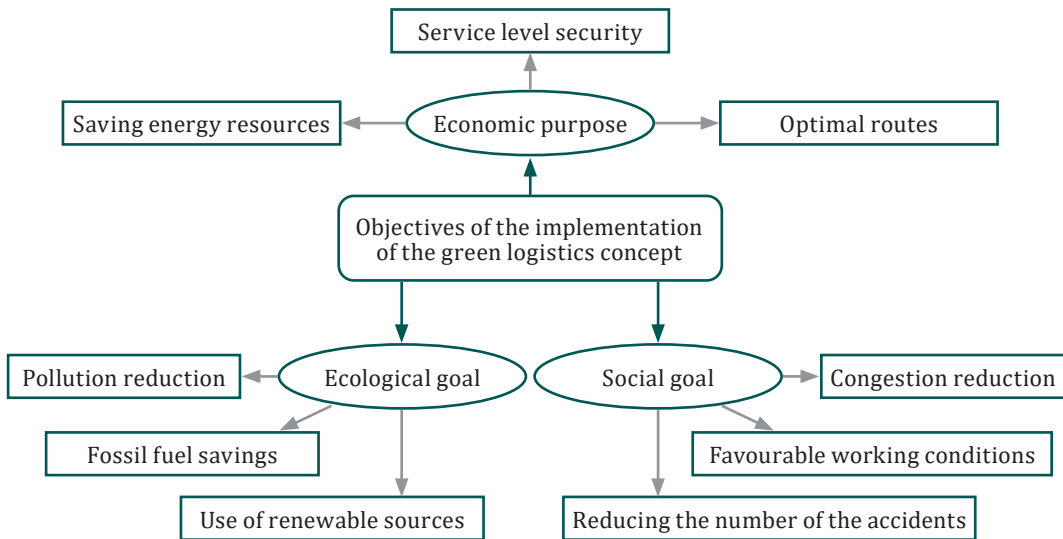

Figure 1. The main goals of the implementation of the concept of *green logistics* (Russo & Comi, 2012)
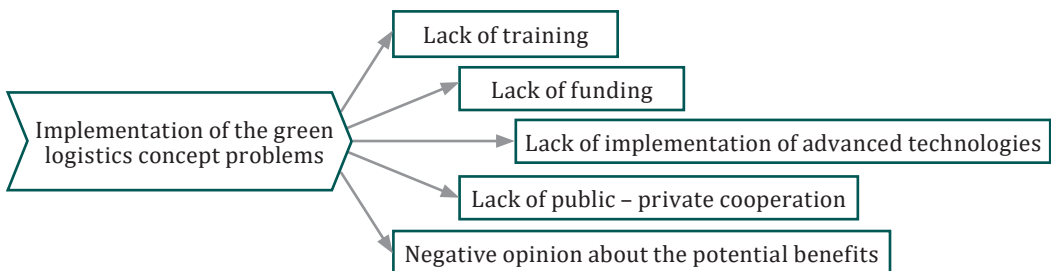

Figure 2. The main problem areas for implementing the concept of green logistics (created by the authors)

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The public and the private sector organisations as well as users lack knowledge regarding green logistics. The policy and regulations of green logistics are inadequate, and effective monitoring and control mechanisms of green logistics activities are insufficient. The authors also highlight the unsuitable infrastructure, deficiency of qualified green logistics specialists, and inadequate level of information and technology. Radavičiūtė (2019) found even more green logistics challenges that can be categorized into internal and external (see Table 1).

Based on the analysis of the scientific literature presented in the article it can be noted that the term *green logistics* is new and not clearly understood. Often green logistics is also called balanced logistics or sustainable logistics. The implementation of green logistics is complex and multifaceted. The implementation of green logistics must be done from an economic, social and ecological perspective. It has been clarified that the companies do not understand and have not properly evaluated the possible benefits and do not have the competence and knowledge on how to implement green logistics measures in their business. The tools presented in the reviewed literature are of a recommendatory nature and abstract. The performed theoretical analysis showed that road transport is inevitable and important in the logistics system. However, it should be emphasized that the goal is to transport goods by road only over medium distances, that is, less than 300 km. Also this mode of transportation has the most negative impact on the environment. Therefore, the implementation of green logistics measures in transport companies is very important in order to reduce the negative impact of freight transport on the environment. After implementing the concept of green logistics in their business, transport companies gain a competitive advantage, improve financial indicators, increase customer satisfaction

Table 1. Internal and external challenges of implementing *green logistics* solutions according to Radavičiūtė (2019)

Internal challenges of implementing green logistics solutions	External challenges of implementing green logistics solutions
Lack of financial resources	Lack of interest from users
Lack of information technologies	Lack of interest from business
Lack of knowledge and skills	partners and vendors
Lack of initiative from top management	Lack of economic incentive
Lack of motivation	Lack of national support policies
Lack of activities needed for raising qualification level	Lack of clear juridical regulation
A need for large-scale investment	

and the quality of services provided. In order to be greener, every road transport company must start applying such measures as intelligent transport systems, creating a new strategy focused on greenness, purchasing vehicles that run on harmless fuels and thus contribute to reducing the negative impact on the environment. Political and legal, social, ecological and technological factors are equally important factors determining the implementation of green logistics measures. The essence of the research problem is the fact that the application of green logistics measures in transport companies is possible and important, but the benefits of applying green logistics measures are not perceived and they are not rapidly applied in transport companies. It is necessary to find out the reasons why transport companies decide to apply or not apply green logistics measures in their business. Therefore, the scientific problem should be formulated as a question: what are conditions of the application of green logistics measures in transport companies? The results of such a study should be relevant for planning transport strategies and action plans aimed at strengthening the common transport space.

Theoretical aspects of last mile and green logistics. Lingaitis & Bazaras (2007) were among the first to examine the concept of Green Logistics in Lithuania. Analysing Green Logistics, the authors draw attention to the fundamental differences between Green Logistics and another system close to it, Reverse Logistics. The operation of Reverse Logistics is concluded to be more focused on the Last Mile system and the management of end-of-life waste and products. Meanwhile, the operation of Green Logistics is focused on the organisation of the entire logistics supply chain, in order to achieve environmentally friendly solutions, using suitable materials (packaging, fuel, energy resources) and organising activities, avoiding empty mileage, fully charging the vehicle, etc. This comparative analysis is meaningful in order to avoid confusion of concepts and to name more precisely the aspects of operation of similar systems. Most authors emphasise that it makes sense to create universal concepts that include several goals and areas of activity, such as social, economic, and environmental, and combine all of this into the concept of sustainable development. It can even be assumed that this concept occupies a significant place in the perspective of modern business development and emphasises social and ecological issues instead of commercial profit (Bajdor et al., 2021). These sources emphasise that Green Logistics, as a concept of sustainable development, is important in solving environmental, economic and social problems as a whole. The economic aspect of problem solutions includes activities such as proper routing, use of multimodal transport, proper pricing of services, ensuring quality, and competitiveness. The aspect of

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solving environmental problems is focused on the use of renewable energy sources, saving fossil fuel energy, minimising emissions, and other measures related to the concept of environmental friendliness. The social aspect of problem solving is focused on the formation of a "conscious" user and organisation, which includes social responsibility and employee competence (Vienažindiene et al., 2021). Very often, authors present the understanding of Green Logistics as directly focused on the minimization of dangerous emissions, including CO_2, and by what means - from technical to managerial - this minimization is an achievement (Centobelli et al., 2020).

The objectives of green logistics go beyond the economic contribution to logistics policy in companies. They are wider and more social and environmental objectives, such as the rise in air pollution levels and global warming. One of the causes of these problems is road transport, i.e., its function of transporting the last mile. This leads to the measurement of environmental impacts in sustainable logistics activities, using different allocation strategies to reduce the use of certain environmentally damaging energies in the last mile logistics service (Vinickas, 2021). High population density in cities leads to a combination of overcrowded transport infrastructure, lack of parking spaces and the associated problems of compliance with delivery obligations and vehicle pollution. In addition, last-mile recipients find it more difficult to successfully deliver a parcel on the first try, recipients are less sedentary, and the courier or administrative staff have to coordinate by phone other possible meeting points, times or dates, which takes time and requires additional resources (Hopkins & McCarthy, 2016). Macharis & Kin (2017) point out that increasing congestion in cities has a negative impact on the performance of transport companies. It leads to additional fuel costs for last-mile operators due to uneven driving speeds, and reduced efficiency in the use of human and material resources. In addition, it is difficult to plan punctuality of deliveries, and couriers have to break the rules of the road in order to keep their promises to last mile customers or recipients. This reduces road safety, causes frustration among other road users and increases environmental damage. Freight vehicles are more polluting due to their heavier weight, so reducing pollution from goods distribution is critical to achieving a significant breakthrough in reducing transport pollution. With the increasing influence of environmental (air and noise pollution) legislation and the problems of smooth urban traffic flows, technological innovations and managerial solutions at all levels are being used to increase the efficiency and green credentials of companies involved in the last mile of international freight. Macharis & Kin (2017) identify three areas of last mile sustainable freight delivery:

restriction, promotion and taxation. Restrictions include traffic bans at certain times of the day, vehicle characteristics (weight, size and pollution), low emission zones and parking zones. These restrictions allow congestion pollution to be reduced during last-mile deliveries to consignees, and consignees would be given a specific time slot to collect their goods. However, quality of life is widely understood, so while increasing environmental regulation improves social and environmental sustainability, it has a negative impact on economic sustainability.

Macharis & Kin (2017) argue that transport costs account for 10 to 15% of the price, but last-mile delivery accounts for up to 75% of the total logistics costs. Reducing the negative environmental impact of transport activities, according to Macharis & Kin (2017), is simply a matter of shortening the distance of freight transport. The other side of reducing the need for transport services is returning production and final product assembly closer to the point of consumption. Hopkins & Mcarthy (2016) argue that this nevertheless results more in global supply chains between producing countries and consuming countries than in last-mile delivery of shipments in an urban area. Macharis & Kin (2017) observe that, especially in the urban area, the average vehicle load is decreasing. Although options for increasing freight consolidation have been widely explored (terminals serving the city centre, 'freight towns', freight post offices, drones), they are generally not economically viable because of the cost-intensive need for additional transhipment and administration, and the reluctance of transport customers to accept price rises. The situation is therefore changing due to the increasingly stringent environmental regulatory environment. Another direction to reduce the negative environmental impacts of last mile transport activities, according to Macharis & Kin (2017), is modal shift between modes (drones, human-powered vehicles, electric vehicles) and shifting to off-peak times. In urban logistics, there is a demand for electric modes, drones, trains, trams, trolleybuses, cargo bikes. These vehicles allow deliveries to post offices or urban terminals, where recipients can collect their goods themselves, and some modal shift groups can also deliver directly to recipients, thus shortening the last mile of delivery and reducing the environmental impact of the transport of the delivery leg. Macharis and Kin also encourages the distribution of freight to be shifted to the night, early morning or late evening to avoid traffic congestion. However, this encouragement may lead to legal regulations on noise levels, which would require investment in quiet vehicles and equipment to avoid this. Green logistics and the last mile are very closely linked and correlated, as the description of the last mile above shows that the last mile is mostly transported by road transport, which is the most polluting mode of transport of all in terms of the ratio of freight.

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Road transport carries the largest share of freight, as it is the only mode that can fulfil the last mile function of delivering the goods 'to the door', and is therefore the most unsafe and energy-intensive mode of transport.

1. Research methodology

The analysis of implementation of green logistics measures in road transportation. Research is a complex process consisting of four key stages: preparing for the research, organising the research process, collecting and processing the research data, and publishing the research findings (Grigorjeva & Andriušytė, 2015). The stages of a research study are presented below.

- *Preparation for the research* – topic, literature, subject, problem, aim, objectives.
- *Organisation of the research* – research method, tools.
- *Research* – data collection, processing, practical application of results.
- *Publication of results* – reports, articles, studies.

In order to determine the ways *green logistics* measures are implemented in transport firms, a questionnaire was selected as the tool for gathering data. A questionnaire is a quantitative research method (Butkevičienė, 2011). There are several types of surveys, namely questionnaire, interview, postal questionnaire survey, telephone survey, mass communication media survey, etc. (Grigorjeva & Andriušytė, 2015; Kardelis, 2016; Prakapas & Butvilas, 2011). The other type of survey instruments is an interview which is usually defined as systemic data collection over a direct or indirect conversation between the researcher and the interviewee (Bitinas et al., 2008).

When conducting the research, the object, the aims, and the most suitable methods are determined. Questionnaire survey and unstructured telephone interview are used. The aforementioned methods would assist in achieving set goals (Radavičiūtė & Jarašūnienė, 2019).

The analysis of the results of the research into implementation of green logistics measures in transportation organizations

The object of the study is the application of green logistics measures in Lithuanian transport companies.

Objectives of the study:

- To determine whether the concept of green logistics is correctly understood and interpreted in transport companies;
- To identify the percentage of transport companies that apply green logistics measures in their business and whether the

implementation of this concept is foreseen in the company's strategy;
– To identify which green logistics measures are most commonly used in transport companies;
– To identify the main risks and challenges of applying green logistics measures in transport companies.

Research methods. The research was carried out by means of a questionnaire survey and an unstructured telephone interview. These research methods will help achieve the objectives of the study. The questionnaire comprised 15 questions designed to identify the following aspects of green logistics. The questions 1–3 were therefore of a general character, which allowed identifying the size of the company, the character of its activities and its experience in the transport sector. Question 4 was designed to determine whether the concept of green logistics was correctly understood and interpreted in transport companies. Questions 5–6 were also addressed to identify the percentage of transport companies applying green logistics measures in their business and whether there was sufficient information on the feasibility of green logistics measures. Questions 10–15 aimed at identifying the most common use of green logistics measures in transport companies and identifying risks, problems, reasons for non-use and drivers for use.

130 respondents voiced their opinions in the survey. Only Lithuanian road transport firms were selected for the research. Study population – all Lithuanian transportation organisations, population size – 7620 economic agents. The questionnaires were sent to companies in January 2022 and processed for one month. In order to measure the confidence interval, the following Equation (1) was applied:

$$n = \frac{1}{\Delta^2 + \dfrac{1}{N}}, \tag{1}$$

n – sample selection size; N – statistical population; Δ – margin of error (confidence interval).

$$132 = \frac{1}{\Delta^2 + \dfrac{1}{7620}},$$

$$132\Delta^2 = 1 - \frac{132}{7620},$$

$$\Delta^2 = \frac{3744}{502920}; \Delta \approx 0.086 \ 9\%.$$

The survey's confidence interval (Δ) at a 95% confidence level is 9%. The distribution of respondents based on the size of the firm is as follows: 42 respondents work at an organisation with less than 10

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people, which makes up 32% of all respondents; 36 respondents work at a company with 10 to 49 employees, which accounts for 27% of all respondents; 42 respondents work at an organisation with 50 to 149 employees, and that is 32% of all respondents; 6 respondents of the survey work at transportation firms with 150 to 249 employees and there are also 6 respondents who work at an organisation with more than 250 employees, which makes up 4.5% of all participants of the survey.

The participating road transportation organisations were also categorised in terms of the main business activities they perform. 66 firms, or 50% of all participants, indicated international cargo transportation as their main area of business, which made it by far the most common service provided by the participating transportation firms. 12 transportation firms, or 9%, specialise in local cargo transportation. 18 firms, or 14% of all participants, indicated freight forwarding as their area of specialisation, and 36 transportation firms, or 27% of all respondents, provided combined services.

Experience in transportation sector is another highly important criterion. The research revealed that 120 respondents correctly described the concept of *green logistics*, which made up 91% of all participants; whereas 12 respondents, or 9% of all participants, claimed that *green logistics* was cargo transportation form its origin to its destination. Thus, a conclusion can be made that a vast majority of transportation organisations understand the concept of *green logistics*.

The analysis showed that 59% of transportation firms that participated in the survey implemented green logistics measures, whereas 41% did not. Due to the fact that the proportion of organisations that adopt green logistics measures is significantly smaller (59%) than the proportion of respondents who know and understand the concept of green logistics (91%), it can be stated that the adoption of green logistics is not widespread.

In order to obtain more accurate data, it is necessary to determine whether stochastic (accidental) dependence between analysed factors exists. In this study, a correlation regression analysis was performed, which allowed determining whether there was a stochastic dependence between the variable Y (implementation of *green logistics* measures; implement – 6, do not implement – 7) and the variable X (organisation size; less than 10 employees – 1, 10 to 49 employees – 2, 50 to 149 employees – 3, 150 to 249 employees – 4, 250 or more employees – 5). In order to determine whether there is a stochastic dependence between the implementation of *green logistics* measures (Y) and the size of the transportation organisation (X), CORREL function was used to calculate the correlation coefficient. To identify whether the relationship between

Y and X exists, the correlation coefficient was calculated using the following formula:

$$r = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - \left(\sum x_i\right)^2} \times \sqrt{n\sum y_i^2 - \left(\sum y_i\right)^2}}$$

or CORREL function.

The correlation coefficient $r = -0.77$ was calculated, and it can be concluded that the relationships between the implementation of *green logistics* measures and the size of the organization is strong. Thus, the implementation of *green logistics* measures depends on the size of the organization – the larger the company, the higher the likelihood that the company adopts *green logistics* measures.

The results of the study also revealed that 73% of transportation firms that participated in the survey agreed with the statement provided by the scientists pointing out that implementation of *green logistics* measures could be significantly faster and more effective with collaboration between the public and the private sector.

The results also indicated that 55% of participating organisations included the concept of *green logistics* implementation into the strategy and vision of the company. Also 24 firms, or 18% of all participating organisations, allocated budget for *green logistics* implementation, whereas a significantly higher proportion of participating organisations, 108 firms or 82%, did not invest a specific sum for the purposes of implementing *green logistics*. The results showed that organisations did not prioritize implementation of *green logistics* measures because resources for them are not budgeted. Despite the fact that more than half of the companies adopt *green logistics* measures and include the implementation of such measures in their strategies, the results suggest that the *green logistics* measures are implemented on a theoretical level rather than practically.

The study also revealed the measures of *green logistics* that are implemented in transportation firms (Table 2).

It was discovered that the most widely implemented *green logistics* measures were the following: route and load optimization, optimization of logistic processes by utilization of informational technologies, vehicles with lower impact on the environment, and employee training / competence development.

Organisations that implement green logistics measures highlighted several anticipated benefits. *Green logistics* measures increase effectiveness, build up company reputation, and improve the quality of services provided. Amongst the least mentioned benefits was the opportunity to come into new markets.

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Another aim of the study was to identify the risks of adopting green logistics measures and the reasons behind avoiding them. Finance, time, failure, and psychological factors were identified as the main risks of implementing green logistics measures. The research revealed that 66 respondents often think about the financial risks, while 36 respondents frequently think about risks related to time resources, and 24 respondents think about risks of failure the most. Only 6 respondents indicated that they thought about psychological risks the most. 12 participants of the survey claimed that they did not see any imposing risks of implementing *green logistics* measures in their businesses.

Another objective of the research was to assess high and low risks for transportation organisations by grading them from 1 (low risk) to 5 (high risk). The implementation of *green logistics* measures requires large investments, which in turn raises concerns about generating profit and achieving desired results as well as avoiding losses; therefore, a possible financial loss due to *green logistics* was one of the assessed risks. Another important factor was technical issues and various faults. The implementation of *green logistics* is closely linked with innovation and information technologies; thus, the risks of technical faults increase.

The study also examined the reasons for avoiding the implementation of *green logistics* measures in transportation organisations. The results showed that the lack of financial resources was the primary reason for staying away from *green logistics*. Other prominent reasons

Table 2. *Green logistics* measures implemented in transportation firms
(created by the authors)

Green logistics measures	Number of respondents	Percentage, %
Route and load optimization	108	26
Promotion of intermodal transportation, interplay between different modes of transport	36	9
Optimization of logistic processes by utilization of informational technologies	90	22
Vehicles with lower impact on the environment	66	16
Employee training / competence development	48	11
Promotion of social responsibility	24	6
Open access reports, which provide information about efforts and achievements in tackling environment protection issues	6	1
Rearrangement of the logistic system elements in regards to environment and social factors	36	9

include insufficient application of advanced technologies and a lack of collaboration between the public and the private sector. Pessimistic views on potential benefits as well as competence gap and lack of training are amongst less important factors.

The results revealed that government support and concessions were the most significant incentives for implementing the measures of *green logistics*. Technological advancement, more accessible information (workshops etc.), and a universal concept of the implementation of *green* logistics are also amongst the most important factors in promoting *green logistics*.

The survey results showed that a lack of funding and collaboration between the public and the private sectors were preventing the implementation of *green logistics* measures. In order to obtain more accurate results regarding the situation of implementation of *green logistics* measures, unstructured telephone interviews with foreign transportation companies were conducted. The aim of the interviews was to gain insight into *green logistics*, theoretical and practical implementation, and views towards its benefits as well as difficulties with its application. Five transportation firms from different countries were examined. Aggregated results revealed that there was a gap in knowledge about *green logistics.* Only two out of five companies indicated that the concept of *green logistics* was clear and understandable to them; however, just one company emphasised the importance of ecology in its strategy and work. Client needs and requests are at the centre of these companies. The reason behind installing transportation information systems is effective performance rather than ecology. The key elements that are instrumental in opening up implementation of *green logistics* opportunities for transportation companies are legislation, government support and funding, and technological advancement.

Taking all things into account, *green logistics* measures are implemented in transportation firms. In many cases, the companies do not know that certain practices they use are *green logistics* measures. A majority of *green logistics* measures are adopted to increase organisational effectiveness and service quality rather than to contribute to environmental causes or to the development of sustainable transportation system.

The results of the survey of Lithuanian transportation firms and the interviews with foreign transportation companies revealed that funding, a lack of government support, and low levels of applicability of technologies are the main factors preventing transportation companies from implementing *green logistics* measures. *Green logistics* measures are becoming more accessible to larger transportation companies. These

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companies have the advantage in investing in eco-friendly vehicles, advanced technologies, and employee training.

Transportation companies work according to international laws and regulations. Government support, funding, or favourable legal basis could be particularly beneficial in helping transportation companies to invest in eco-friendly vehicles, advanced information systems, and employee training.

2. Results. The model for the implementation of green logistics measures in transportation organisations

The premise for conceptual model. The results showed that government support and funding would create more opportunities for all transportation firms to purchase environmentally-friendly vehicles, implement advanced technologies, and invest in employee competence development and training despite the size of the company. The conceptual model was based on the results of the questionnaire with foreign transportation companies (Figure 3). It was discovered that current political and legal circumstances are not effective in promoting the implementation of *green logistics* in transportation companies and contributing to creating a green logistical chain.

The model has four fundamental factors: political and legal environment, technological advancement, transportation organisation, and user / client. These four elements are closely interconnected, and it
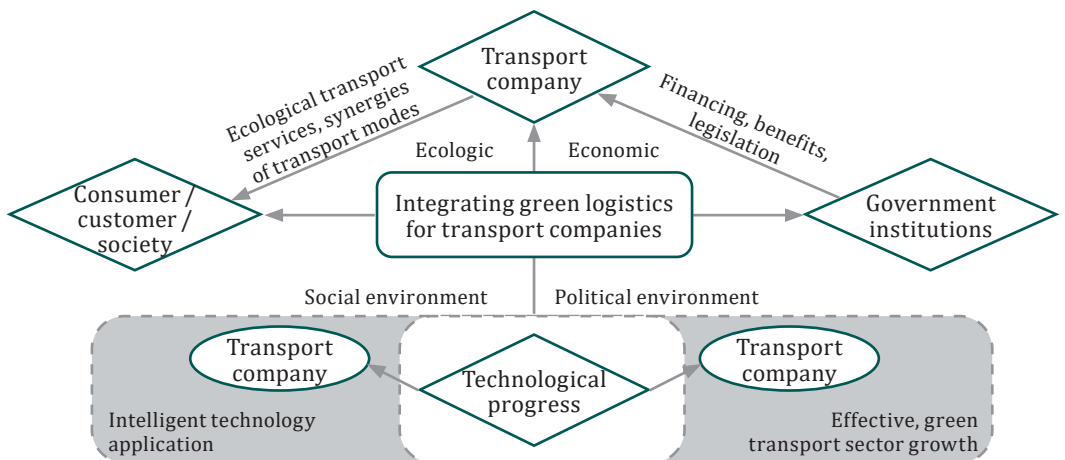

Figure 3. The model for the implementation of *green logistics* measures in transportation organisations

means that the implementation of *green logistics* measures depends on external factors, namely, technological advancement, political and legal environment, and society. Technological advancement encompasses modern transport infrastructure and the achievement level of information systems as well as their applicability in transportation firms. Road infrastructure must be adapted to accommodate cargo transportation using electric trucks, which includes sufficient network of charging stations and development of technical support services for electric trucks etc. Technological advancement and its applicability facilitate the implementation of the concept of *green logistics* and in turn improve quality of service, financial results, and the reputation of the company and help businesses come to new markets. Another important element is political and legal environment, which entails government support, subsidies, international relations, and legislation related to impact to the environment and the health of the people. The study revealed that a lack of finances was preventing most of the companies that participated in the survey from implementing *green logistics* measures. Thus, political and legal environment play a major role in enabling transportation companies to implement *green logistics* measures faster. Moreover, user/client/society are also one of the factors determining whether transportation companies implement measures of *green logistics*. This factor can also be identified as the social factor. It depends on lifestyle, education, and the level of awareness as well as the requirements for work conditions. In the model, transportation organisations interact with aforementioned external factors.

Expert evaluation methodology. In order to evaluate the model for the implementation of *green logistics* measures in transportation organisations, in-depth structured interviews with experts from transportation organisations were conducted. Assessment by the experts is highly significant; therefore, it is important for respondents to have adequate experience and knowledge of the field. Necessary understanding level includes:

– *Green logistics*, implementation opportunities, areas of concern;
– Potential measures of *green logistics* for transportation organisations;
– Company policies, strategy, and vision.

Due to the aforementioned factors, requirements for respondents included the following: degree at Master's level or above, managerial role, at least eight years of experience in the field. In addition, academic work and experience were also considered. The interviews were conducted with seven respondents, each of whom was contacted personally and familiarized with the goals and the course of the study. The questionnaire was provided via email or during a meeting. The

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questionnaire consisted of five questions, two of which were close ended yes / no questions, while the remaining questions were open ended. Open-ended questions were designed to get expert opinions, comments, and insights. The results from the experts' survey are provided below.

Results of the expert survey. All respondents gave a positive assessment of the Green Logistics for Transport model. They stress that green logistics measures increase a company's competitive advantage, productivity, profits and allow it to offer lower transport rates to customers due to cost savings. Experts agree that the political and legal environment is important to encourage companies to use green logistics measures. Another important point highlighted is technological progress. Respondents identified that without technological progress the implementation of green logistics measures in transport companies would become impossible. However, not all companies use technological progress and legislation should regulate its use and application. Experts identified that a transport company cannot implement green logistics without human resources. Drivers, managers and other responsible staff must be responsible, educated and understand the importance of going green. Staff education and competence development are important factors for a company to become greener. For this reason, it is proposed to introduce an economic driving course. It is argued that a driver without competence and knowledge, even when driving an environmentally friendly vehicle, will have high emissions due to high fuel consumption. Fuel consumption depends on the driver and their ability to operate the vehicle. Eco-driving courses should be made compulsory for every driver.

The results of the study also showed that large companies could more easily adopt green logistics measures due to their greater financial capacity. Large transport companies realise the benefits of economic driving and set up a separate economic driving unit to train and test drivers. Interviews with experts revealed that the implementation of green logistics measures depends not only on technological progress, the political and legal environment and society, but also on the company's own internal strategy and the available human and financial resources. According to the experts, economic driving courses and employee education are among the key elements to promote the application of green logistics in road transport companies. According to the experts, the model developed is appropriate.

Conclusions

1. The implementation of *green logistics* is a new concept and numerous companies seek to adopt these ideas into their businesses in order to gain competitive advantage. Nonetheless, there is a gap in knowledge and education about how to apply *green logistics* measures to business, and it is not clear what specific actions must be taken by any transportation firm to implement *green logistics*.

2. The majority of academics claim that *green logistics* entails ecology, which is about mitigating the negative consequences of logistics to the environment, using less harmful fuels, and promoting renewable resources.

3. The concept of *green logistics* implementation is not clearly defined and universal. Nonetheless, collaboration between the public and the private sector would help in implementing *green logistics* measures. An organisation must rethink its vision and strategy as well as re-evaluate their activities. Employee training, implementation of new technologies, and a plan for specific actions could help the companies adopt *green logistics.*

4. A lack of funding, collaboration between the public and the private sector, pessimistic views on potential benefits, insufficient application of advanced technologies as well as competence gap and a lack of training are the main issues that prevent companies from implementing *green logistics.*

5. Common *green logistics* measures have been identified: intermodal transportation promotion, route optimization, freight bicycles, logistic process optimization, employee education, social responsibility promotion, public reports, ecological carriers, and more active involvement of the public sector.

6. The study on the implementation of *green logistics* in transportation companies revealed that Lithuanian transportation companies did not implement *green logistics* measures due to a lack of funding and cooperation with the public sector. The majority of respondents pointed out that information resources about possibilities for implementation of *green logistics* were insufficient.

7. The research showed that universal implementation model designed specifically for transportation companies would not accelerate the implementation of *green logistics* measures, whereas funding, government support, and wider application of advanced technologies would push *green logistics.*

8. The proposed model for the implementation of *green logistics* measures in transportation organisations is based on external and internal transportation environment. External factors, such

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as political and legal environment, technological advancement, and social aspects highly influence transportation companies while seeking to implement *green logistics* measures. The expert survey revealed that in order to adopt *green logistics* measures, transportation companies must build the company's strategy around the idea of *green logistics*, provide economic driving classes, and invest in employee education.

REFERENCES

Abramovic B., Brnjac N., & Skrinjar P. J. (2014). Railway industrial track as the last mile in supply chain management. *International Conference on Traffic and Transport Engineering (ICTTE), 2,* Belgrade, 890–897. https://www.researchgate.net/publication/284617638_RAILWAY_INDUSTRIAL_TRACK_AS_THE_LAST_MILE_IN_SUPPLY_CHAIN_MANAGEMENT

Bajdor, P., Pawełoszek, I., & Fidlerova, H. (2021). Analysis and assessment of sustainable entrepreneurship practices in Polish small and medium enterprises. *Sustainability, 13*(7), Article 3595.
https://doi.org/10.3390/su13073595

Barysienė, J., Batarlienė, N., Bazaras, D., Čižiūnienė, K., Griškevičienė, D., Griškevičius, A.J., Lazauskas, J., Mačiulis, A., Palšaitis, R., Vasilis-Vasiliauskas, A., & Vasilienė-Vasiliauskienė, V. (2015). Analysis of the current logistics and transport challenges in the context of the changing environment. *Transport, 30*(2), 233–241. https://doi.org/10.3846/16484142.2015.1046403

Bitinas, B., Rupšienė, L., & Žydžiūnaitė, V. (2008). *Kokybinių tyrimų metodologija [Qualitative research methodology].* Klaipėda: S. Jokužio leidykla-spaustuvė. In Lithuanian.

Browne, M., Allen, J., Nemoto, T., Patier, D., & Visser, J. (2012). Reducing social and environmental impacts of urban freight transport: A review of some major cities. *Procedia – Social and Behavioral Sciences, 39*, 19–33.
https://doi.org/10.1016/j.sbspro.2012.03.088

Butkevičienė, E. (2011). *Apklausų duomenų analizė [Survey data analysis].* Kaunas: Seminaro medžiaga [Seminar material]. In Lithuanian.

Centobelli, P., Cerchione, R., & Esposito, E. S. (2020). Evaluating environmental sustainability strategies in freight transport and logistics industry. *Business Strategy and the Environment, 29*(3), 1563–1574.
https://doi.org/10.1002/bse.2453

Chin, T.A., Tat, H.H., & Sulaiman, Z. (2015). Green supply chain management, environmental collaboration and sustainability performance. *Procedia CIRP*, 26, 695–699. https://doi.org/10.1016/j.procir.2014.07.035

Cosimato, S., & Troisi, O. (2015). Green supply chain management. Practices and tools for logistics competitiveness and sustainability. The DHL case study. *The TQM Journal, 27*(2), 256–276.
https://doi.org/10.1108/TQM-01-2015-0007

Čepinskis, J., & Masteika, I. (2011). Impacts of globalization on Green Logistics Centre's in Lithuania. *Environmental Research, Engineering and Management, 1*(55), 34–42. In Lithuanian.
https://erem.ktu.lt/index.php/erem/article/view/116

Dekker, R., Bloemhof, J., & Mallidis, I. (2011). Operations research for green logistics – An overview of aspects, issues, contributions and challenges. *European Journal of Operational Research, 219*(3), 671–679.
https://doi.org/10.1016/j.ejor.2011.11.010

Dües, C.M., Tan, K.H., & Lim, M. (2013). Green as the new Lean: how to use Lean practices as a catalyst to greening your supply chain. *Journal of Cleaner Production, 40*, 93–100. https://doi.org/10.1016/j.jclepro.2011.12.023

Dzwigol, H., Trushkina, N., & Kwilinski, A. (2021). Green logistics as a sustainable development concept of logistics systems in a circular economy. *37th International Business Information Management Association (IBIMA)*, Cordoba, Spain, 10862–10874. https://www.researchgate.net/profile/Aleksy-Kwilinski/publication/353413345_Green_Logistics_as_a_Sustainable_Development_Concept_of_Logistics_Systems_in_a_Circular_Economy/links/60fae5112bf3553b29094cd4/Green-Logistics-as-a-Sustainable-Development-Concept-of-Logistics-Systems-in-a-Circular-Economy.pdf

Europos Komisija. (2011a). Baltoji knyga. Bendros Europos transporto erdvės kūrimo planas. Konkurencingos efektyvių išteklių naudojimu grindžiamos transporto sistemos kūrimas [European Commission. White Paper. Plan for the creation of a common European transport area. Development of a competitive transport system based on the use of efficient resources]. In Lithuanian. Europos Komisija. Retrieved: October 18, 2017.
http://eur-lex.europa.eu/legal-content/LT/TXT/?uri=celex%3A52011DC0144

Europos Komisija. (2011b). Konkurencingos mažo anglies dioksido kiekio technologijų ekonomikos sukūrimo iki 2050 m. planas. Retrieved: October 18, 2017.
http://eur-lex.europa.eu/legal-content/LT/ALL/?uri=celex:52011DC0112

Gargasas, A., & Mūgienė, I. (2018). Creation and evaluation of logistic services value. *Management Theory and Studies for Rural Business and Infrastructure Development, 2*(40), 187–197. https://doi.org/10.15544/mts.2018.18

Gnann, T., Funke, S., Jakobsson, N., Ploetz, P., Sprei, F., & Bennehag, A. (2018). Fast charging infrastructure for electric vehicles: Today's situation and future needs. *Transportation Research Part D: Transport and Environment, 62*, 314–329. https://doi.org/10.1016/j.trd.2018.03.004

Grigorjeva, T., & Andriušytė, A. (2015). *Mokslinių tyrimų pagrindai [Fundamentals of scientific research].* Vilnius: VGTU leidykla Technika.
https://doi.org/10.3846/1535-S

Guo-chuan, Y. (2010). Constraints and counter measures of China's green logistics development. *Journal of International Economics and Trade Research Editorial Department*, 5–11.
http://en.cnki.com.cn/Article_en/CJFDTotal-SYJG201002005.htm

Hopkins D., & McCarthy, A. (2016). Change trends in urban freight delivery: A qualitative inquiry. *Geoforum, 74*, 158–170.
https://doi.org/10.1016/j.geoforum.2016.06.006

Aldona Jarašūnienė,
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The Implementation
of Green
Logistics in Road
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Jedliński, M. (2014). The position of green logistics in sustainable development of a smart green city. *Procedia – Social and Behavioral Sciences, 151*, 102–111. https://doi.org/10.1016/j.sbspro.2014.10.011

Karaman, A. S., Kilic, M., & Uyar, A. (2020). Green logistics performance and sustainability reporting practices of the logistics sector: The moderating effect of corporate governance. *Journal of Cleaner Production, 258*, Article 120718. https://doi.org/10.1016/j.jclepro.2020.120718

Kardelis, K. (2016). *Research methodology and methods [Mokslinių tyrimų metodologija ir metodai].* Vilnius: Science and Encyclopedia Publishing Center.

Kurbatova, S. M., Aisner, L. Y., & Mazurov, V. Yu. (2020). Green logistics as an element of sustainable development. *IOP Conference Series: Earth and Environmental Science, 548,* 052067.
http://doi.org/10.1088/1755-1315/548/5/052067

Kutkaitis, A., & Župerkienė, E. (2011). Darnaus vystymosi koncepcijos raiška uosto logistinėse organizacijose [Expression of the sustainable development concept in Klaipėda seaport logistics organizations]. *Vadybos mokslas ir studijos - kaimo verslų ir jų infrastruktūros plėtrai [Management theory and studies for rural business and infrastructure development], 2*(26), 130–137.

Lietuvos Respublikos susisiekimo ministerija. (2019). Nacionalinė susisiekimo plėtros 2014-2022 metų programa [Ministry of Transport of the Republic of Lithuania. National transportation development program 2014-2022]. In Lithuanian. sumin.lrv.lt: https://sumin.lrv.lt/lt/veiklos-sritys/nacionaline-susisiekimo-pletros-2014-2022-metu-programa-1

Lietuvos Respublikos vyriausybė. (2005). Nutarimas dėl ilgalaikės (iki 2025 metų) Lietuvos transporto sistemos plėtros strategijos patvirtinimo [Government of the Republic of Lithuania. Resolution on the approval of the long-term (until 2025) development strategy of the Lithuanian transport system]. In Lithuanian.
https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.258496

Liimatainen, H., Arvidsson, N., Hovi, I. B., Jensen, T. C., & Nykänen, L. (2014). Road freight energy efficiency and CO2 emissions in the Nordic countries. *Research in Transportation Business & Management, 12*, 11–19.
https://doi.org/10.1016/j.rtbm.2014.08.001

Lingaitis, L.P., & Bazaras, D. (2007). An analysis of reverse and green logistics: theoretical aspects. *Transport: Prace Naukowe, 60*, 5–12.

Lodienė, D. (2012). Globalios tiekimo grandinės įtaka verslo organizacijai [Influence of global supply chain for business]. *Management Theory and Studies for Rural Business and Infrastructure Development, 3*(32), 98–105.

Long, J., Zhong, C., Bilal, A., Muhammad, I., & Rabia, N. (2022). How do green financing and green logistics affect the circular economy in the pandemic situation: key mediating role of sustainable production. *Economic Research-Ekonomska Istraživanja, 35*(1), 3836–3856.
https://doi.org/10.1080/1331677X.2021.2004437

Macharis, C., & Kin, B. (2017). The 4 A's of sustainable city distribution: Innovative solutions and challenges ahead. *International Journal of Sustainable Transportation, 11*(2), 59–71.
https://doi.org/10.1080/15568318.2016.1196404

McKinnon, A., Browne, M., Whiteing, A., & Piecyk, M. (2015). *Green logistics: Improving the environmental sustainability of logistics.* London: Kogan Page.

McKinnon, A., Cullinane, S., Whiteing, A., & Browne, M. (2010). *Green Logistics: Improving the Environemental Sustainability of Logistics.* London: Kogan Page.

Meidutė, I., & Paliulis, N. K. (2011). Feasibility study of public-private partnership. *International Journal of Strategic Property Management, 15*(3), 257–274. https://doi.org/10.3846/1648715X.2011.617860

Mensing, F., Trigui, R., & Bideaux, E. (2011). Vehicle trajectory optimization for application in eco-driving. *IEEE Vehicle Power and Propulsion Conference,* Chicago, IL, USA, 1–6. https://doi.org/10.1109/VPPC.2011.6042993

Palšaitis, R. (2010). *Šiuolaikinė logistika. Vadovėlis*. [Modern logistics. Textbook]. In Lithuanian. Vilnius: Technika.

Pečiukėnas, A., Pečeliūnas, R., & Nagurnas, S. (2017). Intelektinių transporto sistemų įtaka kelių transporto priemonių srautų reguliavimui. *Inžinerinės ir edukacinės technologijos [Engineering and Educational Technologies], 1*, 33–38. http://dspace.vgtu.lt/handle/1/3589

Poullikkas, A. (2015). Sustainable options for electric vehicle technologies. *Renewable and Sustainable Energy Reviews, 41*, 1277–1287.
https://doi.org/10.1016/j.rser.2014.09.016

Prakapas, T., & Butvilas, T. (2011). *Mokslinio tiriamojo darbo logografika studijoms [Research logographics for studies].* Vilnius: Mykolo Romerio universitetas. https://repository.mruni.eu/handle/007/16931

Radavičiūtė, G., & Jarašūnienė, A. (2019). Žaliosios logistikos taikymo reikšmė kelių transporte [Study of possibilities of application of green logistics measures in transport companies]. *Transporto inžinerija ir vadyba. XXII jaunųjų mokslininkų konferencija.* Vilnius: Vilniaus Gedimino technikos universitetas. http://jmk.transportas.vgtu.lt/index.php/tran2017/tran2019/paper/viewFile/210/234

Rizvi, S. K. A., Mirza, N., Naqvi, B., & Rahat, B. (2020). Covid-19 and asset management in EU: a preliminary assessment of performance and investment styles. *Journal of Asset Management, 21*(4), 281–291.
https://doi.org/10.1057/s41260-020-00172-3

Russo, F., & Comi, A. (2012). City characteristics and urban goods movements: A way to environmental transportation system in a sustainable city. *Procedia – Social and Behavioral Sciences, 39*, 61–73.
https://doi.org/10.1016/j.sbspro.2012.03.091

Sidek, S., Khadri, N. A. M., Hasbolah, H., Yaziz, M. F. A., Rosli, M. M., & Husain, N. M. (2021). Society 5.0: Green logistics consciousness in enlightening environmental and social sustainability. *IOP Conf. Series: Earth and Environmental Science, 842, 3rd International Conference on Tropical Resources Sustainable Sciences,* Article 012053.
https://doi.org/10.1088/1755-1315/842/1/012053

Aldona Jarašūnienė,
Darius Bazaras

The Implementation
of Green
Logistics in Road
Transportation

Spiriajevas, E. (2014). Transporto ir tarptautinės prekybos tarp Baltijos šalių ir Turkijos geografija [Geography of transport and international trade between the Baltic countries and Turkey]. In Lithuanian. *Regional Formation and Development Studies, 1*(11), 207–220.
https://doi.org/10.15181/rfds.v12i1.697

Sprogytė, I., & Zinkevičiūtė, V. (2014). Development of quality management system in a transport company by evaluating consumers needs. In Lithuanian. *Mokslas – Lietuvos ateitis [Science – Future of Lithuania]. 1*, Vilnius, Lithuania, 1–8.
http://dx.doi.org/10.3846/mla.2014.01

Srivastava, S. K. (2007). Green supply-chain management: a state-of-the-art literature review. *International Journal of Management Reviews, 9*(1), 53–80.
https://doi.org/10.1111/j.1468-2370.2007.00202.x

Šostko, A., & Jakubavičius, A. (2018). Gamybos logistikos tobulinimas bioekonomikos iššūkių kontekste [Improvement of production logistics in the context of bioeconomic challenges]. *Mokslas – Lietuvos ateitis. Ekonomika ir vadyba [Science – Future of Lithuania], 10*, Vilnius, Lithuania, 1–7.
https://doi.org/10.3846/mla.2018.2864

Vienažindienė, M., Tamulienė, V., & Zaleckienė, J. (2021). Green logistics practices seeking development of sustainability: Evidence from Lithuanian transportation and logistics companies. *Energies, 14*(22), Article 7500.
https://doi.org/10.3390/en14227500

Vinickas, A. (2021). *The last mile sustainability problems in international freight logistics organization* [Master thesis, Paskutinės mylios darnumo problematika organizuojant tarptautinių krovinių logistiką]. In Lithuanian. Vilnius: VGTU.

Wang, S., & Hu, Z-H. (2021). Green logistics service supply chain games considering risk preference in fuzzy environments. *Sustainability, 13*(14), Article 8024. https://doi.org/10.3390/su13148024