ISSN 1648-4142 / eISSN 1648-3480

VILNIUS TECH Vilnius Gediminas Technical University

TRANSPORT

2024
Volume 39
Issue 1
Pages 1–12
https://doi.org/10.3846/transport.2024.20540

Original Article

CURRENT STATE OF ENVIRONMENTAL AWARENESS OF TRANSPORT SERVICE STAKEHOLDERS AND END-CUSTOMERS IN THE INTERMODAL TRANSPORT CHAIN

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Highlights:

- current research fills the gap in stakeholders' understanding of the negative impacts on the environment for the intermodal transport chain;
- the current research results show that 91% of transport logistics companies do not receive or give information about the emission levels of the different parts of the transport chain;
- there is still a significant portion of direct stakeholders who are not very actively involved in any green strategies, meaning that a small part of companies is moving towards green principles and technologies;
- only 21% of asked companies see added value in having information on the level of green transport in the intermodal transport chain;
- the analysis showed that the market is willing to pay more for greener transport (majority of end-customers between 5...10% more, while direct stakeholders between 1...5% more);
- end-customers and direct stakeholders (logistics companies and manufacturers) would appreciate having information on the level of green transport presented a symbolic or numerical value.

Article History:

- submitted 6 May 2021;
- resubmitted 18 March 2022;
- accepted 4 April 2022.

Abstract. Despite all the measures already taken and those still underway, pollution remains a major global problem, as the transport sector is the one where emissions are expected to increase in the coming years. Companies and policy makers are under increasing pressure to reduce the impact of their logistics activities in order to make transportation more environmentally friendly. One of the solutions to reduce emissions from intermodal transport is to choose the "right" mode of transport for each step in the transport chain. Such a measure increases the complexity of the transport chain and places an additional burden on transport companies in planning and organising transport for the entire transport chain. Additional difficulties arise from the fragmentation of information on emissions emitted for a single transport link and the lack of a unified approach to measuring and estimating transport chain emissions. As a result, this work finds that there is a lack of knowledge among users about the environmental impacts of transportation, despite the desire to contribute to greener transportation by paying more for a product or transportation service. The current research fills the gap in stakeholders' understanding of the negative environmental impacts for individual transportation and for the entire transport chain. In addition, the study reveals a need for a systematically regulated and adapted way of informing users of intermodal transport chains due to the lack of transparency and comparison between different intermodal transport chains. To successfully address the challenges, the study proposes a 2-pillar approach. The 1st pillar approach focuses on designing a set of necessary measures (combination of top-down and bottom-up approach) for the transition to a low-carbon transport chain, while the 2nd pillar mainly focuses on mapping the level of green transport for easy comparison of similar products or services. The results of the research study show that the combination of numerical data with symbolic data is best suited to provide information on the level of green transport.

Keywords: green transport, intermodal transport, decarbonisation, green supply chain, minimisation, transport emissions, bottom-up approach, commercial evaluation.

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Notations

CO_2 – carbon dioxide;
DEA – data envelope analysis;
EE – energy efficiency;
EU – European Union;
GHG – greenhouse gases;
GIS – geographic information system;
LNG – liquefied natural gas;
LSP – logistics service provider;
SEM – standard error mean.

1. Introduction

One of the primary functions of logistics is to strategically manage the procurement, movement, and storage of materials, parts, and finished goods. In addition to fulfilling orders cost-effectively to maximize current and future profitability, the environmental aspect of the supply chain is becoming increasingly important. Nowadays, the points of origin of raw materials or semi-finished products are far away from processing plants, production factories and end-customer locations. Such globalization of the manufacturing process underlines the importance of transportation chains and their environmental impact. As a result, the distribution network has grown significantly, mainly at the expense of the distance between nodes. Longer transport distances lead to increased vehicle emissions on transport routes, resulting in an inflated carbon footprint of transport, making it one of the main sources of carbon emissions along with the manufacturing industry. In order to curb global warming, sustainability has become one of the main objectives in the operation of global transportation chains (Muñoz-Torres *et al.* 2021), and thus also in intermodal transportation chains. At the same time, there are also political efforts to reduce emissions at national and global levels, as there have been a number of documents imposing environmental constraints in the form of climate change agreements over the last 2 decades (UNFCCC 1998, 2009, 2012, 2015).

To meet *Paris Agreement* (UNFCCC 2015), the EU has formulated several rounds of energy and emissions targets. To ensure that ambitious 2030 emission reduction targets of at least 55% (compared to 1990) are met, the EU relies on national governments to set more stringent national targets to guide the adoption of clean vehicle and production technologies. To help companies reduce carbon emissions, governments have introduced various environmental policies, such as the carbon tax, cap-and-trade, carbon cap, and cap-and-offset (Sun, Yang 2021; Zhang *et al.* 2021). Compliance with all these regulations can be very difficult for companies operating internationally, especially due to the current state of policy decisions and developments, which can be very uncertain. Moreover, nowadays, end-customers or buyers are more environmentally conscious when purchasing products or services and recognize the importance of controlling carbon emissions in their daily needs. Several studies have confirmed that customers' environmental awareness has increased significantly, leading to an increase in their preferences for low-carbon products and services (Adaman *et al.* 2011; Alberini *et al.* 2018; Bemporad, Baranowski 2007; Hulshof, Mulder 2020). From these studies, there are business opportunities by offering green products and services in the market, and customers' green awareness and willingness to pay for carbon reduction has become one of the drivers that make companies develop their products and services sustainably (Gong *et al.* 2019; Hulshof, Mulder 2020).

Transportation is a remarkably emissions-intensive process, considering the amount of energy consumed, which releases a significant amount of waste such as GHG, solid residues, and noise. Therefore, improving the sustainability of transportation services is crucial for all parties involved in the transportation processes. To date, there are few companies that report to their customers or other stakeholders on the CO_2 emissions generated during the transportation of goods. The results of the work by Liotta *et al.* (2015) show that the availability of data is an important factor in reducing CO_2 emissions. Many logistics transport companies do not coordinate with their transport suppliers on strategies to limit CO_2 emissions by sharing the data needed to calculate and reduce emissions (Baykasoğlu, Subulan 2016; Hrušovský *et al.* 2018). In addition, the transport chain consists of numerous decision-makers that have different planning responsibilities and have been classified by Caris *et al.* (2008) into intermodal operators, terminal operators, drayage operators and network operators. Although some of them disclose the GHG emissions generated by their transport activities within a transport chain, the influence of those who do not provide such information limits the overall transparency of transport sustainability. Consequently, there is a lot of pressure on these operators, as nowadays most modern logistics approaches follow time and cost reduction, resulting in higher GHG emissions (Beškovnik, Golnar 2020). Such long-distance transports are primarily based on intermodal transport optimization (Sun *et al.* 2015). Problems usually arise due to the lack of transparency over the entire transport chain or the lack of information about the EE of the transport and the negative impact of the individual transport on the environment and the GHG footprint.

When comparing the performance of a transport chain, stakeholders typically track 2 components of the service, delivery and the price of the overall service. The component for quality can be evaluated and compared within services and is often used in the search for new alternatives. However, not every stakeholder involved has appropriate knowledge about the environmental impact. In order to successfully deal with such a multi-faceted problem, a common assessment approach with the same emission units, indicators and emission calculation methods should be established to ensure the transparency of the transport chain. On the basis presented, the research objective is to:

- analyse the current provision of information on the carbon footprint of transport services in the transport chain and identify the main gaps that need to be addressed in order to successfully establish sustainable development for all stakeholders, understand stakeholders' perceptions of green transport, their perceptions of transparency in communicating the differences in the sustainable transport chain;
- produce results from a content perspective to provide guidance for more effective future stakeholder information on the comparability of intermodal transport chains.

The study investigates how well-known green transport is among stakeholders and end-customers in the pre-pandemic period who purchase a product with a higher or lower carbon footprint in the value chain, and whether they would choose differently if greener (i.e., more environmentally friendly) but more expensive transport were available. This was explored through an analysis in the region Northern Adriatic between stakeholders from Italy, Slovenia, Croatia and Austria. At the same time, it forms the basis for the development of an integrated approach to stakeholder information for more effective business decision-making in the operation of a complex intermodal transport chain. The study follows the main research hypothesis:

- *H1*: There is a need for a systematically regulated and adapted way of informing users of intermodal transport chains due to their lack of transparency and comparison between different intermodal transport chains.

Following the answer to question *H1*, the article is divided into 5 sections. After the Section 1 – introduction, the Section 2 provides a detailed literature background. The methodology is analysed in Section 3.1. Section 3.2 presents the results of the research. The main discussion of the analysis is presented in the Section 4. Finally, conclusions and further research are discussed in the Section 5. The study contributes new scientific knowledge for modelling new approaches to organize greener intermodal transport chains. Understanding and expectations of stakeholders are the basis for defining effective measures to promote the use of greener technologies in complex transport processes. The results of the research are more widely applicable, both in terms of scientific basis and applicability in the transport and logistics industry.

2. Literature basis and recognitions about green transport in intermodal transport

To date, there is little literature that addresses planning and decision problems in intermodal transportation while at the same time calculates and presents emissions data in such a way that a calculation can be used to provide regular and credible guidance at the operational level. Nevertheless, there are several areas in the literature that attempt to solve the problem of minimizing emissions from the perspective of comparing entire intermodal transport chains and their efficiency, as well as their individual transport legs and transhipment points as intermodal terminals. Vukić *et al.* (2020) proposed a DEA-based model to determine the most efficient route of multiple intermodal transport chains based on the lowest external cost and the shortest route and called it green route. Similarly, Saeedi *et al.* (2019) proposed a network model DEA to identify inefficiencies in intermodal transport chain and give an opportunity for policy makers to prepare a more tailored measures. Regarding sustainability between shippers and LSPs, Bask *et al.* (2018) conducted a study in Finland, which found that large global shippers and carriers are interested in the environmental component of transportation, mainly due to external pressure and partly because they see it as a competitive advantage. In maritime shipping, Lister *et al.* (2015) found in their study that several complex factors such as transnational environmental policies in shipping, the increasing number of multi-stakeholder initiatives, and rating processes with private demands from cargo owners hinder progress on environmental issues when it comes to improving environmental concerns. The deficiencies in maritime shipping are also reflected in the study by Poulsen & Sornn-Friese (2015), in which they find that there are gaps in the provision of information on EE at sea and on land, leading to EE gaps. In addition, Rahim *et al.* (2016) suggest that industry and stakeholders should explore the ways in which global shipping companies systematically disclose the emission reduction performance of ships in a timely manner. In addition, Bask *et al.* (2018) expose in their study that the lack of a consistent way to measure the environmental impacts of intermodal transport chains and a common place for companies to share the costs and benefits of the environmental impacts of intermodal transport chain between stakeholders barriers the environmental improvements. Environmental improvements could also be initiated by buyers, as Jazairy & Von Haartman (2021) found in their study that LSPs generally comply with buyers' green demands. Freight owners' growing interest in greener transport has also been expressed in their requests for proposals (Persdotter Isaksson *et al.* 2019). A similar conclusion is reached by McKinnon (2014), who argues that buyers' demand for greener transport could encourage LSPs to manage their supply chain in more environmentally manner. A potential barrier to buyer demand for green logistics services, according to the study by Bask *et al.* (2018) could also be uneven pressure exerted by buyers throughout the purchasing process, as they sometimes demand green measures in the negotiation phase and sometimes in the execution phase. Although there is strong buyer power, the lack of a direct link between the goods and the end buyer significantly reduces the impact of environmental improvements. As a result, some carriers have improved their services on their own initiative to meet greener practices independently of buyer demands (Jazairy, Von Haartman 2021; Björklund, Forslund 2019), while some cargo owners have begun to base their decisions in the procurement process on the GHG emissions performance of carriers and incorporate it into pricing (Poulsen *et al.* 2016). These findings suggest that multiple management factors, legislation, and strong buyer initiative at all levels are needed to improve the environmental performance of the intermodal transport chain. To some extent, the literature also addresses port/intermodal terminal operations. Yang (2017) investigated new ways to develop a green port strategy and analysed the carbon footprint per container. He finds that with optimal green conditions (labour efficiency, energy cost, CO_2) and the simultaneous use of efficient equipment to manoeuvre containers, not only is the work faster, but also the energy cost and carbon footprint are reduced. Similar results were also obtained by Peng *et al.* (2018) with the evaluation of mitigation measures in ports, where it was shown that measures such as speed reduction in port areas and the choice of LNG instead of diesel lead to significant emission reductions. Using a simulation model, it was also found that most emissions in the port come from ships (81.7%), port cranes (8.0%), container cranes (5.5%) and trucks (4.8%). These results are consistent with the findings of Gibbs *et al.* (2014), who concluded that emissions generated by ships during their journeys between ports are far greater than those generated by port activities. Nevertheless, authors such as Gibbs *et al.* (2014), Johnson & Styhre (2015), Moon & Woo (2014) emphasize the need to look beyond the physical and organizational boundaries of the port, as the efficiency of the port or terminal only partially contributes to the EE and carbon footprint of the entire transport chain. There are analyses and proposals for estimating emissions along the intermodal transport chain, but there is a lack of methodological approaches for effective assessment and comparison between chains.

Consequently, Carvalho *et al.* (2017) developed a model as a decision support tool in selecting the best combination of a green lean supply chain to improve its eco-efficiency. The study notes that in the case of the supply chain, there are several trade-offs between lean and green practices and the choice of the best set is not insignificant. There should be trade-offs in the behaviour of each company to meet the environmental and economic constraints of the supply chain. This was confirmed by the study of Zhang & Yang (2020), in which a multi-criteria model with swarm intelligence algorithm was developed to measure relationships between cost and eco-efficiency. The results showed that the additional environmental efficiency is proportional to the increased cost. In terms of transportation cost and time, Cho *et al.* (2012) proposed a dynamic programming algorithm to study the multimodal transportation route from Busan (South Korea) to Rotterdam (Netherlands). To improve the accuracy of the model, some researchers such as Wan & Wei (2019) introduced combined algorithm techniques with genetic algorithm and ant colony algorithm to successfully improve the intermodal route selection. To affect the cost and emissions, transportation mode was studied as a tactical decision with mixed-integer nonlinear programming by Barzinpour & Taki (2018). Another attempt to reduce operating costs in the distribution network was carried out in the study by Bosona *et al.* (2011) with the optimization of vehicle routes and GIS, while Dutta *et al.* (2022) also combined emissions with the standard problem of vehicle routing. Toro *et al.* (2017) considered the emissions optimization problem from the perspective of minimising fuel consumption combined with the open location routing problem. The proposed model generates a set of trade-off solutions for the relationships between operating costs and environmental impacts. Darvish *et al.* (2019) re-examined previously known logistics problems considering additional environmental constraints. An extended sensitivity analysis provided management insights into the costs of emissions integrated into the transport chain, as well as insights into the costs of being green. The key findings of the study are that an important factor in reducing emissions is reducing empty trips; if emissions are to be minimized, lighter loads are desirable; a balance is needed between vehicle load and distance travelled. Several studies have set transport parameters in a general way, ignoring the fact that the parameters of the same transport route may vary significantly in different transport networks. Based on the fragmentation in the transportation chain, different decision-makers are identified. Caris *et al.* (2008) distinguish between drayage operators, terminal operators, network operators and intermodal operators who are responsible for planning to varying degrees.

According to the literature review, there is a dearth of studies that focus on users' perceptions of green transport chain evaluation. Studies are mostly focused on collecting data on GHG emissions and EE of the transport chain and elaborating data. Consequently, studies on the current state of environmental awareness of transport providers and end-customers should be intensified in order to model a standardized and widely accepted assessment approach for intermodal transport chains.

3. Case study of understanding the level of green transport in complex intermodal chains

3.1. Research methodology

The study is based on the research methodology of a multiphase approach. 1st phase, existing literature on understanding the importance of green transport and previous findings are analysed to identify the gap between published studies and the steps needed to inform and raise awareness among stakeholders about the importance of green transport technologies. The 2nd phase identifies stakeholder groups that are important to understanding and choosing an intermodal transport chain. The 3rd phase involves a data collection method for comprehensive measures. By choosing the survey method, it is necessary to define the structure of the questions and their content. A preliminary survey is necessary to structure the questions according to the defined objectives and *H1* of the research. Based on the data elaboration, the basic objective is to formulate recommendations for simpler and more transparent information services for decision-makers when choosing the mode of transport in complex intermodal chains, defined as the 4th phase (Figure 1). It's deemed that recommendations for decision-makers work best when there is stability in the market, i.e., when there is a balance between supply and demand for transport services. Therefore, the price and reliability of services in the transport chain are constant. As soon as disruptions occur, as we experienced in 2021 with the Suez Canal shipping congestion and in 2020 with the COVID-19 pandemic, the supply chains are disrupted and so is the market equilibrium. In such a case, other criteria such as transportation time, cost and supply become much more important than environmental criteria. Thus, we can conclude that recommendations for more environmentally friendly transportation can only be considered when the market is stable.

Based on the elaborated methodology, 3 main groups of stakeholders were determined: (1) logistics companies, (2) manufacturers and (3) end-customers. Manufacturers and logistics companies are direct decision-makers on the mode of transport and influence the design of intermodal transport chains. End-customers or product buyers form a separate category, as they usually have no influence on the design of the transport process and thus the possibility to choose a more environmentally friendly mode of transport. However, they can buy products whose transport causes the lowest GHG footprint and achieves a higher EE. Consequently, 2 subgroups were formulated, the 1st with manufacturers and logistics companies and the 2nd with end-consumers.

The survey method allows a more comprehensive approach to obtaining a broader data set from both groups. Therefore, the questionnaire was divided into 4 groups of questions: the 1st group collects information about the research topic, the 2nd group deals with market gaps with possible information about green transport, the 3rd group deals with price elasticity of the market in terms of willingness to pay more money for greener intermodal transport services, and the 4th group deals with socio-demographic data. Depending on the role of the respondent within the predefined subsets, some questions were adapted to obtain information as accurately as possible according to the respondent's role in the value chain.

The 1st set of questions was designed to collect information on whether direct stakeholders and end-customers already receive sufficient information about the particular level of green transport at the time of ordering the service, and whether they have sufficient knowledge to understand the issue of conveying the green transport service. In addition, the 1st set included some questions about the positioning of the companies based on their size and whether they have implemented green strategies in their operations. The 2nd set of questions aimed to get an opinion on the value of information on transport sustainability and the further usability of such information as an added value to their business. In addition, there were also questions that tested respondents' perceptions on 4 criteria (time, price, quality, environment) to better understand the decision-making process when purchasing services or products. The 3rd set of questions tested the willingness to pay more for a more environmentally friendly product or service. The goal was to obtain information about how much more they are willing to pay for greener transportation and whether they are open to alternatives that have a longer transportation time but a lower environmental impact. This set of questions concluded with a question about the most appropriate presentation of green transportation data. The 4th set of questions were socio-demographic questions to gain insight into the background information of the respondents. Once the survey was designed, respondents were asked to complete the survey and provide answers about their company's environmental data. One of the most important keys to robust results and meaningful insights is that the data is collected from a large number of people with different socio-demographic characteristics and also different positions.

The survey was conducted between March and May 2019, using the online questionnaire web service "1ka" (*https://www.1ka.si*) for anonymous interviews from Slovenia, Italy, Croatia and Austria. A total of 225 participants from all age groups and all predefined groups were interviewed. The questionnaire was addressed to 2 main groups: the 1st group consists of representatives of manufacturers and LSPs offering transport services through the ports of the Northern Adriatic Sea in combination with transports throughout Europe and were addressed through their company emails; the 2nd group consists of the general

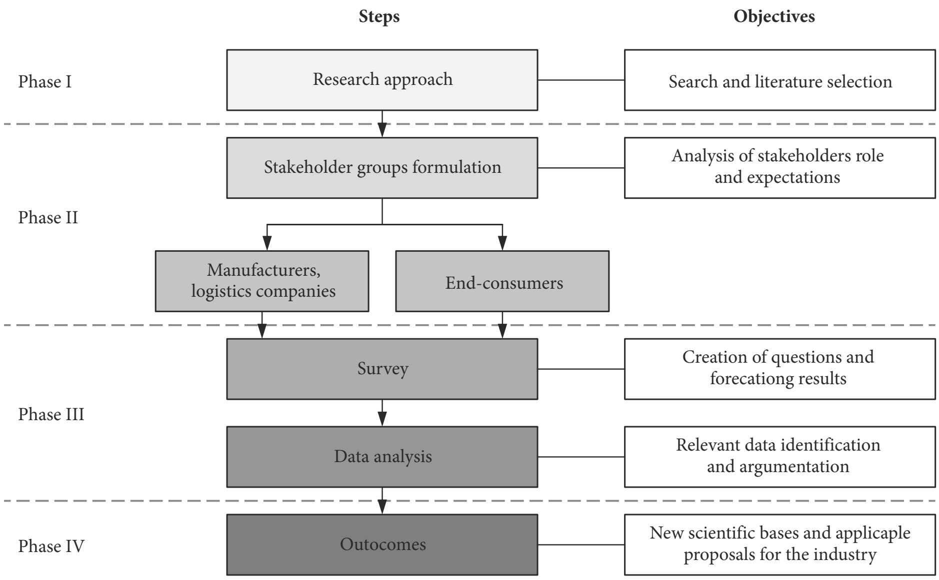

Figure 1. Methodological approach

population addressed through social media with the link to participate in the survey (*Linkedin*, *Facebook*).

The survey was considered complete when all tasks were completed. However, some respondents did not answer the socio-demographic questions. These responses are still considered complete because the theme of uncovering market gaps is the focus of the study. The largest age group of respondents from the manufacturers/logistics companies group was 35...44 years old, with data spread over 9 years. There was not a single respondent in the sample who was older than 65 years or younger than 18 years, which means a strong underrepresentation of young and older people, which is justified by the employment span of people in the companies (working population). On the other hand, the respondents strongly belong to the group of active decision-makers. The respondents were highly educated and had either a master's degree (31%) or a bachelor's degree (63%). Respondents with a doctoral degree ranked 3rd (3%), followed by the 4th ranked group consisting of those who graduated from high school (3%). The reason for this could be mainly due to the organizational structures of the companies where highly qualified individuals work in the operations and research departments.

The largest age group in the end-costumer responses was 25...34 years old, with the same 9 years' bins. There were no respondents over 75 years old and between 55...64 years old in the sample, which means that mainly older people and people in late middle age are not representative. The main reason for this could be that the survey was conducted entirely online through various digital channels. Respondents from the end-customer group, similar to respondents from the manufacturer/logistics group, were highly educated and had either a master's degree (34%) or a bachelor's degree (49%). Respondents with a high school diploma were 3rd (13%), followed by the 4th group representing those whose education was not correctly classified in the questionnaire. There was not a single respondent in the sample with a doctorate or primary education.

3.2. Research results

Analysis of the survey results on the level of green transport services confirms that there are certain gaps in the provision of comprehensive services. The results of the end-customers show that people are positively inclined towards information about the level of green transportation. 60% end users, 5% manufacturers and 35% transport logistics companies participated in the survey. The 1st set of questions shows that both manufacturers and transport logistics companies are present in international markets by using international transport and proving their service quality by acquiring the following standards: ISO 14001:2015, ISO 9001:2015/Amd 1:2024, OHSAS 18001:2007, ISO/IEC 27001:2022/Amd 1:2024, ISO/TS 16949:2009, ISO 22000:2018/Amd 1:2024. Respondents from transport and logistics companies represent all sizes of companies, with 44% working in medium-sized companies, 24% in large companies, 20% in small and 12% in micro companies. Most of them (61%) work in senior management departments and 39% in operations departments. This structure should give us good confidence for the 2nd set of questions, which aimed to obtain data on the value of the information conveyed on the sustainability of transport and the further usability of such information as an added value for their business and strategy.

In response to the question – *How often do you encounter the term "green transport" in your company?* – 58% of direct stakeholders answered "occasionally" and 19% answered "never". Direct stakeholders who encounter the term "green transportation" daily and monthly are only 6%, while 10% of users encounter the term weekly. These responses dovetail nicely with the question of how often companies review the business strategy of other companies they work with on green transportation services. The majority of responses are 41% occasionally, 29% never and 22% monthly. Only 2% review their business strategy at the green transportation services level weekly and 5% daily. From this we can conclude that there is a small part of companies that are moving towards green principles and technologies. Probably, the reason for this is the requirements of the market, which are not yet in the 1st place, although the daily or weekly fulfilment of the green concept does not completely exclude that the company does not apply the green principles in general. Although more than half (54%) of the direct shareholding companies have a green business strategy, only 33% of them have strategically implemented it in integrated transport services. Despite the rather low level of implementation in integrated transport services, only 35% of the companies have energy/eco-efficiency information for specific transport routes in the transport chain. We received a similar percentage (36%) when asked if the company participates in a program or strategy to reduce greenhouse gas emissions in their company, which gives us the impression that a large proportion of companies (64%) are still not very active when it comes to going green.

The 2nd set of questions also focused on how much pollution is caused by transport and whether or not such information is desired. Figure 2 shows that 42% of direct stakeholder responses miss environmental information about transport at least once a month, while 33% miss it between 3...5 times per week and only 3% miss it 1..2 times per week. There were 22% of direct stakeholder responses that did not miss this information, which could be explained by them getting the information they wanted or not looking for it in the 1st place. There are some early adopters who already provide information on the level of green transport of the service (17%), while there is still a large proportion (83%) of companies who have not managed to do so.

Only 9% of businesses receive information about the level of green transport for the entire intermodal chain when they buy a service or product online. When asked how often companies receive information about the level of green transport when they buy a service or product online, 70% of businesses answered "never", 12% answered "weekly", 6% answered "monthly" and 6% answered "quarterly" (Figure 3). This suggests that businesses do not indicate how environmentally friendly the transport is when selling their services, although 76% of those directly affected responded that they would like such information and only 24% do not. When asked if such information would help them make a better decision about the product or service, 76% answered "maybe", 21% answered "yes" and 3% did not see any added value in such information.

The 3rd set of questions tested how much respondents were willing to sacrifice (money, time) for more environmentally friendly transport/service. In general, only 55% of direct stakeholders is willing to pay more for greener transportation, while 45% were unwilling to spend more. Although a fairly large proportion were not willing to pay more for greener transportation, the question with the predefined outcome of 10% greener transportation service and 4 predefined possible ranks (pay more for 1, 5, 10, and 20%) revealed that 45% of direct-shareholders surveyed would be willing to pay 1% more of the actual price for the product/service, and 45% of shareholders would be willing to pay 5% more of the actual price for the product or service (Figure 4).

Only 10% of the shareholders surveyed were willing to pay 10% more of the actual price for greener transport. On the other hand, end-customer respondents were much more determined compared to direct shareholders as 68% of end-customers were willing to pay 5% more for the product/service and 20% of end-customers were willing to pay 10% more for the product/service. The only category where end-customers are less willing to pay more than shareholders is 1% more for the product/service (10 vs. 45%). From another perspective, we tested the willingness of direct stakeholders to wait longer in exchange for a lower price for transportation or that transportation is more environmentally friendly than usual. Responses to both perspectives were similar (10.83, 10.5%), suggesting that direct stakeholder respondents are willing to wait about 10% longer than usual (Figure 5). The comparison of SEM of these 2 shows a lower variance for a lower transport price than for a more environmentally friendly transport, from which it can be concluded that direct stakeholder respondents value the role of price more than the environmental impact of transport.

Complementing these results, the next question about willingness to give a lecture on the operation of green transport and its positive impact on the environment also shows that 69% of direct stakeholder respondents would devote 10 min of their time, 16% would devote up to 30 min of their time, 9% would sacrifice up to 60 min and only 6% would be interested in giving a lecture at all. From this we can conclude that there is an interest in information from direct stakeholders, but they want concise and narrowly focused information as they are mostly willing to devote only 10 min of their time.

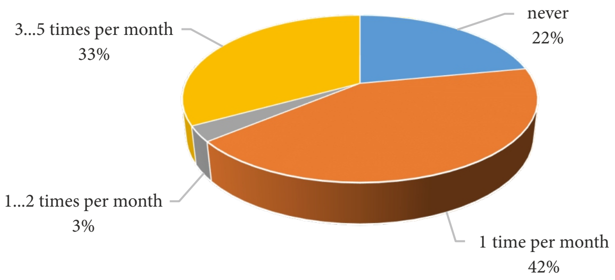

Figure 2. Frequency of missing the information while ordering transport services as direct stakeholder

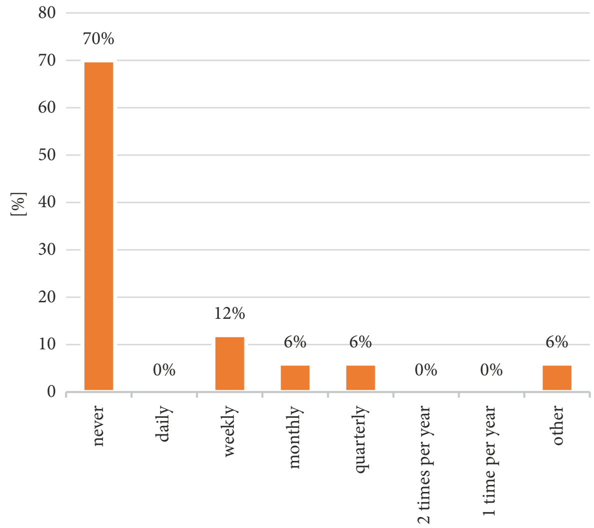

Figure 3. Frequency of getting information as direct stakeholder about the level of green transport while ordering transport services

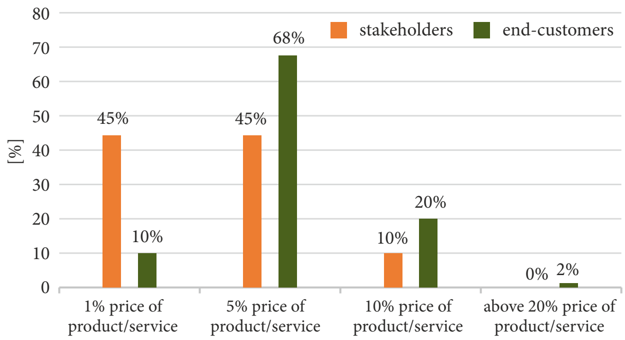

Figure 4. Willingness of stakeholders vs. end-customer to pay more for 10% greener transport service

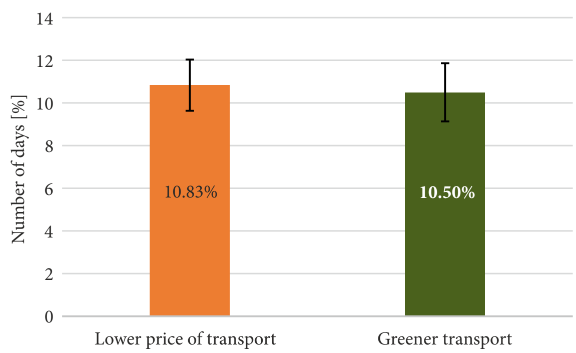

Figure 5. Comparison of waiting time elasticity with lower price vs. greener intermodal transport

Analysis of data from the 2nd group of stakeholders – end-customers – shows that 82% of them would welcome information on the environmental impact of transport for a product or service. In order to better understand how end-customers prioritize when making a purchase decision for a product/service, they were given 4 predefined criteria (price, time, quality, environment) to rank from highest to lowest priority. As can be seen in Figure 6, the most important criterion (1st priority) for the end-customer is the quality of the product (51%), followed by price (31%). Both price and time become less important with decreasing priority. In addition, end-customers consider environmental impact similar to time, as both criteria are ranked 3rd or 4th in terms of percentage. It can be concluded that these are the factors that are considered less important after quality and price. Moreover, it can be concluded that quality and price are important factors that end-customers look at when making a decision whether to buy a product/service or not. The lack of an environment in the 1st priority can be understood as the fact that there is still hardly any environmental information available on the market for a certain product/service.

To confirm the data obtained in the previous question regarding the decision priorities of end-customer, we repeated the question in a slightly different way, but with the same expected results. When asked how important the price, delivery time, quality and environment are, the end-customers had to sort each criterion on 5 ranks, between very important, important, neither important nor irrelevant, irrelevant, very irrelevant. The results in Figure 7 show that price is at least important to very important for 76% of the end-customers. Similar results are shown for quality and environment with 78 and 71% respectively. Summarising this comparison over 2 categories, we can see that price, environment and quality are equally important, while delivery time is less important than the other 3 categories with 56%, but not unimportant. Looking only at the "very important" category, it can be seen that quality, price, environment and delivery time are the most important, which is consistent with the results of the previous question. To simulate the perspective of the transport LSP, we can eliminate the quality of the product, which shows us that environment (20%) and delivery time (17%) are almost equally important, while price is still at the top (32%).

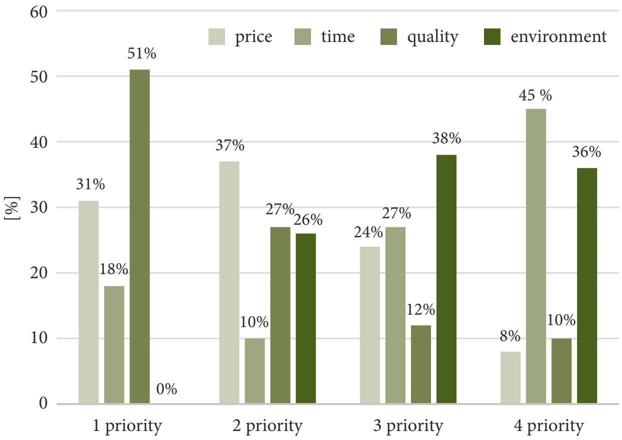

Figure 6. End-customers priorities when buying a service or a product

4. Discussion

The resulting findings of the analysis can be presented and further elaborated using a 2-pillar approach. The 1st pillar focuses on designing a set of necessary measures for the transition to a low-carbon transport chain. Buyers of intermodal transport should be educated and informed about advantages and disadvantages and possible variants of intermodal transport (emissions, price, time). In particular, there is potential in optimizing the choice of transport mode in the multimodal network with appropriate support from transport companies due to the large number of business-to-business operations. The results of the study confirm the assumptions that there is a need for information on the environmental impact of transport and underline the importance of mode choice in intermodal transport as part of the efficient operation of the supply chain. In addition, a legal mechanism should be created to require or encourage logistics companies to provide information on the amount of CO_2 emitted and EE in addition to price and transport duration when making a bid. To enable and implement this niche information service, an top-down approach should be taken in combination

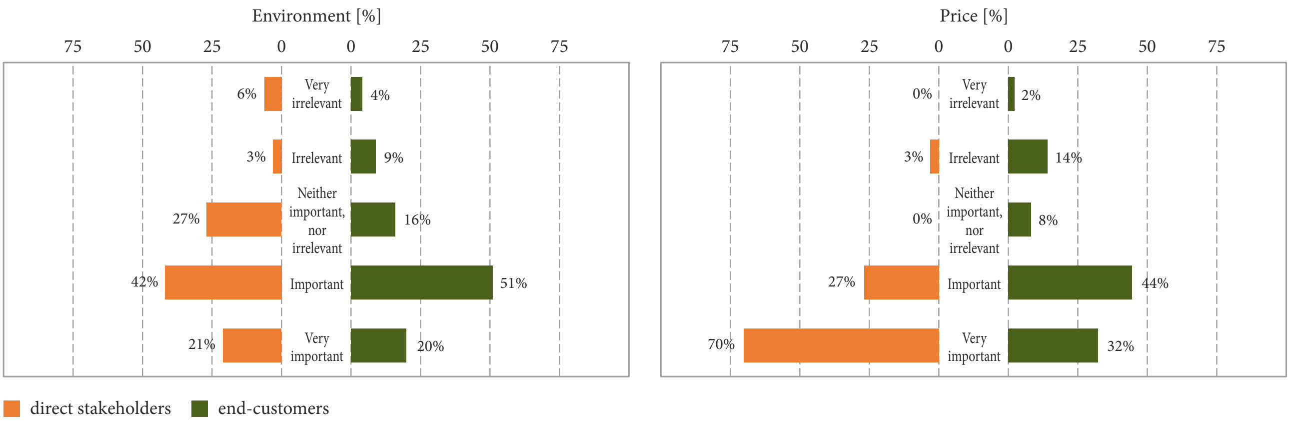

Figure 7. Preferences of end-customers when buying new service/product of selected criteria

with a bottom-up approach. To enable the bottom-up approach, data information and data transparency along the transport chain are needed. The crucial role here is the transparency and comparability of data between different logistics providers, as these are to be standardized in the future. A uniform flow of information could have a positive impact on the implementation of government measures and enable companies to develop new strategies and guidelines for selecting business partners according to their environmental friendliness. Another important step towards greening the transport chain is to inform direct stakeholders about new green technologies and to improve access to information on possible technological differences between intermodal transport chains with information on their EE and greenhouse gas emissions. This sectoral complexity means that there is no single solution to greening the transport chain. Rather, efforts to green the transport chain are likely to vary between sectors (energy, industry, governments) and countries. Furthermore, the promotion of research and studies on this topic, which are currently lacking, would be necessary to better understand the issue.

The 2nd pillar mainly focuses on presenting the level of green transport for easy comparison of similar products or services. The survey proposed and tested different decision options between 4 crucial components of transportation that were compared side by side (service quality, price, environment, time) with the aim of producing results that set guidelines for future more effective information for stakeholders on the comparability of intermodal transportation chains. The current research results show that 91% of transport logistics companies do not receive or give information about the emission levels of the different parts of the transport chain. The analysis showed that the market is willing to pay more for greener transport. In general, the market is willing to receive information (76% would like to have it), but it seems that companies do not see how they can promote and monetise greener transport, as only 21% see added value in having information on the level of green transport in the intermodal transport chain (Figure 8).

There were some discrepancies between direct stakeholders and end-customers in the presentation of environmental transport data (Figure 9). End-customers want information on the level of green transport in the form of trees preserved (33%), numerical data (18%) or as CO_2 savings/fuel savings (14%), while information in the form of descriptive data and rankings does not seem to have any value at 8% and 12% respectively. Direct stakeholders (logistics companies and manufacturers) would like to see

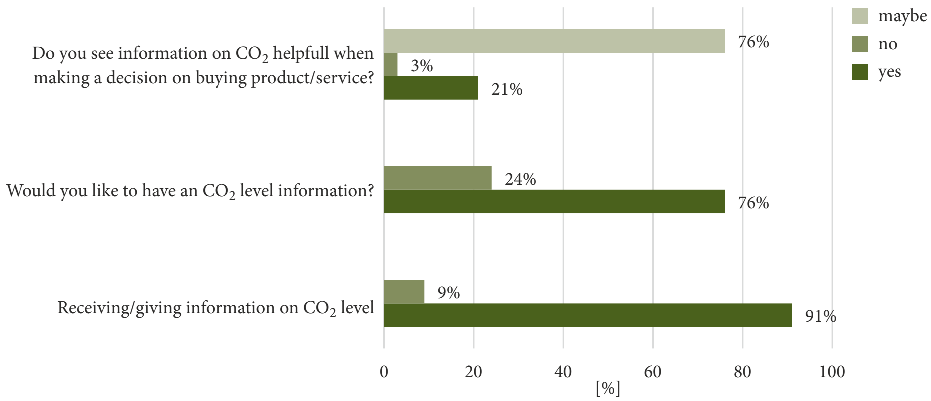

Figure 8. Current state of market from stakeholders' point of view

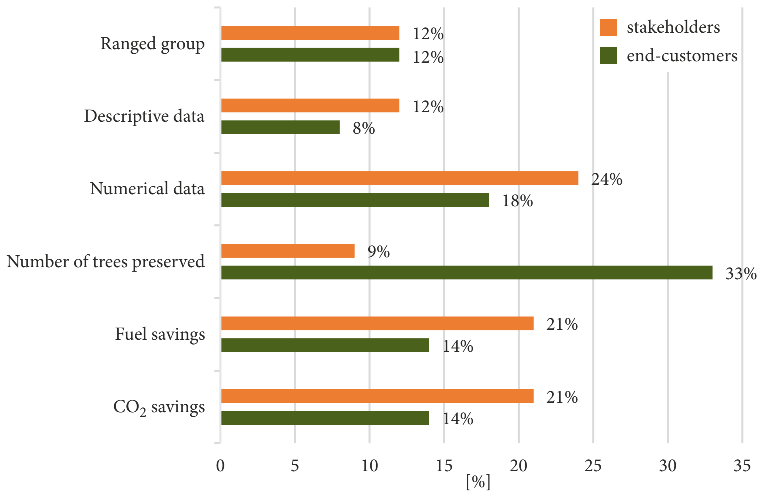

Figure 9. Intermodal transport user's perception on presenting information about the level of green transport

data presented as a numerical value (24%), while CO_2 savings/fuel savings presented 21% each, followed by range group and descriptive data at 12% each. The least popular was presenting the level of green transport as the number of trees preserved, which is in contrast to the end-customer choice. The numerical value to the business is very often an easier form of information provision for other subcontractors and freight owners, as they usually have to decide between different factors in a short period of time in order to pursue lean and agile supply chain operations.

There is no strong lead between the choices presented and it can be seen that the distribution is rather fragmented. To satisfy both parties while appealing to a larger population, a clever design combining numerical data and graphical data presentation should be introduced. The results highlight the need for a simple presentation and assessment of the level of green transport, which at the same time replaces the possible lack of knowledge in the field of green and sustainable intermodal transport.

5. Conclusions

The emissions released during the transport are becoming an increasingly important consideration for end-customers/buyers. This study examines the current state of the market, the current need for information about green transportation, the willingness of direct stakeholders to go green, and the willingness of stakeholders to pay more for a more efficient and greener solution. At the moment, there is fragmentation of information on emissions emitted for a single transport link and the lack of a unified approach to measuring and estimating transport chain emissions.

The results of the study show that still a large proportion of direct stakeholders (64%) are not very actively involved in any green strategies. On the other hand, information on the environmental impacts of transport is desirable at least 3…5 times per week for 33% of direct stakeholders and at least once per month for 42% of direct stakeholders. Direct stakeholders are positive (76%) when it comes to environmental information about transportation, but only 21% of them agreed that it would help them make better decisions about the product or service. Moreover, 69% of direct stakeholders would like to know more about green transportation and there are 90% of direct stakeholders and 78% of end-customers who are willing to pay at least between 1…5% more price for a product for 10% greener transportation services.

Therefore, we can conclude that there is a lack of knowledge among users about the environmental impact of transport and a desire to contribute to greener transport, which is consistent with hypothesis *H1* that there is a need for a systematically regulated and adapted way of informing users of intermodal transport chains, as they lack transparency and the possibility of comparison between different intermodal transport chains. Therefore, the current research fills the gap of stakeholders' understanding of the negative impacts on the environment for the individual transport and for the whole transport chain by proposing a 2-pillar approach. The 1st pillar approach focuses on designing a set of necessary measures (combination of top-down and bottom-up approach) for the transition to a low-carbon transport chain, while the 2nd pillar mainly focuses on mapping the level of green transport for easy comparison of similar products or services.

The results of the research study show that combining numerical data with symbolic data, e.g., preserved trees, is the most appropriate way to provide information on the level of green transport. In the future, such information should include structured data about the level of green transport, which will provide buyers with some additional criteria to decide whether to choose another transport provider or not. This could introduce a decision support tool in manufacturing and trading companies, which could also lead to changed management models in corporations.

The present work is the starting point for further evaluations on the level of green multimodal transport and the basis for an efficient decision-making support tool in intermodal transport for all members of the transport chain.

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