

Investigating the environmental awareness of Logistics Service Providers. The case of Italy

Original

Investigating the environmental awareness of Logistics Service Providers. The case of Italy / Rosano, Mariangela; Cagliano, Anna Corinna; Mangano, Giulio. - In: CLEANER LOGISTICS AND SUPPLY CHAIN. - ISSN 2772-3909. - STAMPA. - 5:(2022), p. 100083. [10.1016/j.clscn.2022.100083]

Availability:

This version is available at: 11583/2975391 since: 2023-01-30T17:54:15Z

Publisher:

Elsevier

Published

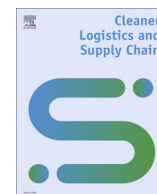
DOI:10.1016/j.clscn.2022.100083

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)



Investigating the environmental awareness of Logistics Service Providers. The case of Italy

Mariangela Rosano^a, Anna Corinna Cagliano^b, Giulio Mangano^{*,b}

^a ICT for City Logistics and Enterprises ICELA@Polito – Politecnico di Torino, Corso Duca degli Abruzzi 24, I-10129, Italy

^b Dept. of Management and Production Engineering – Politecnico di Torino, Corso Duca degli Abruzzi 24, I-10129 Turin, Italy

ARTICLE INFO

Keywords:

Logistics
Logistics Service Providers
Sustainable practices
Kruskal-Wallis test
Italian market

ABSTRACT

Environmental sustainability in transportation operations is acquiring an increasing importance in recent years and a lot of Logistics Service Providers (LSPs) are including green practices in their business. However, the interests of logistics operators and the related level of awareness about the adoption of environmental friendly practices are still not deeply analyzed in literature. Therefore, the proposed paper is intended to investigate the perception of LSPs about the environmental issues and their willingness of pursuing future green strategies. To this end, based on a literature analysis aimed at identifying a comprehensive list of green practices, a questionnaire survey is administered to LSPs operating in the Italian market. The data gathered are then analyzed via the Kruskal-Wallis test and the questionnaire outcomes discussed with the LSPs participating to the survey through face to face interviews. Results show that the environment is highly considered by the freight carriers of the sample, both small and large ones. In addition, personnel involved in different company roles appear to pay diverse levels of attention to the sustainability issue. In particular, the reduction of pollutant is considered more crucial for employees in charge of dealing with operations (median equal to 5) and reverse logistics is perceived less important by managers (median equal to 3). The outcomes of the study might support companies to achieve sustainability and promote the green awareness issue. At the same time, policy makers might be facilitated by this study in designing environmental friendly programs in the logistics field.

1. Introduction

The issue of environmental sustainability of transportation activities is gaining more and more attention in the last few years, given also the European and international pressure on this topic (European Commission, 2019).

Transportation accounts for a large portion of the European total greenhouse gas emissions (Gustafsson et al., 2021). Thus, given its huge impact on the environment, green transportation is mainstreamed by governments in their sustainability agenda. For example, with the Green Deal the European Commission has set the goal of achieving the climate neutrality objectives by 2050, fostering initiatives to make transportation and parcel delivery more sustainable.

The problem challenges both practitioners and academicians. In fact, scientific literature on logistics has widely investigated the topic of environmental sustainability and the associated measurement of the carbon footprint of delivery trips. In fact, works mainly focus on quantitatively assessing the environmental impact of freight transportation

logistics by proposing specific Key Performance Indicators (KPIs), such as emissions per km, measurement of noise, and congestion level, as well as mathematical models (Mariano et al., 2017; Björklund and Forslund, 2013). Additionally, they investigate green logistics initiatives, such as the use of low impact vans, alternative fuels, commercial vehicle sharing, and transit networks for last-mile delivery (Centobelli et al., 2017a; Colicchia et al., 2013; Xu et al., 2022; Qu et al., 2022). Another huge stream of research is associated with proposing and assessing guidelines about how to choose logistics service providers (LSPs) in order to ensure an appropriate service level while being compliant with carbon reduction policies (Chen and Wang, 2016; Davis-Sramek et al., 2020; Kudla and Klaas-Wissing, 2012). In this context, relevant literature can be found about the development of partnerships among LSPs, LSPs and shippers, as well as among public administrations, suppliers, and customers of freight transportation services in order to implement sustainable practices (Doherty and Hoyle, 2009; Evangelista, 2014). Just a few papers investigate the point of view of LSPs only and in particular address their awareness towards the environmental sustainability issue

* Corresponding author.

E-mail addresses: mariangela.rosano@polito.it (M. Rosano), anna.cagliano@polito.it (A.C. Cagliano), giulio.mangano@polito.it (G. Mangano).

<https://doi.org/10.1016/j.clscn.2022.100083>

Received 17 January 2022; Received in revised form 11 September 2022; Accepted 29 September 2022

Available online 30 September 2022

2772-3909/© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

by taking into account different companies sizes and professional roles (Jazairy and von Haartman, 2020; Sallnas and Hüge-Brodin, 2018). Also, scarce literature can be found on Continental European countries heavily facing congestion and pollution problems.

With the aim of deeply analyzing the awareness of LSPs towards the environmental sustainability of their logistics services, the purpose of the present research is understanding their own perception.

To this end, a survey is conducted among LSPs operating in the Italian market. The aspects the survey focuses on include the importance and the evaluation of KPIs to assess the environmental sustainability, the possibility of establishing green partnerships among the main stakeholders, and the cost-benefit balance of performing environmentally sustainable deliveries. The survey responses are analyzed through the Kruskal-Wallis statistics tests and the outcomes discussed and interpreted.

The remainder of the paper is structured as follows. Section 2 reviews the literature on the environmental sustainability of LSPs. Section 3 describes the methodology adopted, which is based on a survey questionnaire administered to a sample of professionals in the logistics service field. Key results are then discussed in Section 4. Finally, Section 5 concludes the paper.

2. LSP environmental sustainability: A literature state of the art

This section reviews the literature relevant to frame the topic of the research and make the associated research gap emerge. After an overview on the main debated themes, the focus is moved to the LSP awareness about environmental sustainability. The discussion is then completed by addressing the drivers and barriers to the adoption of green initiatives by LSPs and comparing environmental sustainability to the other features characterizing the LSP business. Both these last issues constitute the foundation of the survey carried out in the present study.

2.1. Overview on LSP environmental sustainability

Although the academic research about the environmental sustainability of supply chains has largely focused on the manufacturing sector (Evangelista et al., 2018), there is an already significant number of studies addressing LSPs. Table 1 summarizes the main topics.

Some authors discuss and classify the most diffused green practices adopted by LSPs (Centobelli et al., 2017a; Massaroni et al., 2016). On the one hand, operational practices include optimization of routes and

transportation loads, adoption of low impact commercial vehicles, also supported by both public and private economic incentives (Cagliano et al., 2017; Pilati et al., 2020), energy efficient warehousing and building, eco-packaging for logistics activities (Sarjono et al., 2021; Tran et al., 2019), and periodic reports about the CO2 footprint of customer orders. On the other hand, managerial initiatives encompass earning international certifications, promoting environmental awareness both within an organization and among its suppliers and customers, and setting up environmental performance measurement systems (Isaksson and Hüge-Brodin, 2013). The diffusion of green initiatives among LSPs is ruled by a combination of drivers and barriers (Abdullah et al., 2016) that will be discussed in Section 2.3. This situation makes LSPs be at the early stages of maturity towards the environmental sustainability issues, as recognized by Wehner et al. (2022) in their work addressing energy efficiency in LSP operations.

Accurately measuring the performance of green strategies (Goswami et al., 2020; Lam and Dai, 2015), together with including environmental performance in transportation contracts (Björklund and Forslund, 2013), are possible ways for increasing the environmental commitment and maturity of LSPs.

In addition, collaboration among LSPs and their stakeholders might facilitate an increased attention to green issues. This can take the form of coordinated logistics programs and certification strategies among LSPs, their customer companies, and public administrations, operational collaboration among logistics providers, as well as information sharing about carbon footprint and greenhouse gas goals (Doherty and Hoyle, 2009; Evangelista, 2014). However, according to Bask et al. (2018), the lack of standardized methods to measure the environmental impacts of freight transportation activities makes companies not able to share the costs and benefits of adopting green initiatives, which is an evident obstacle to partnerships. For this reason, literature is still split on the degree to which collaborations are currently able to promote green logistics practices, and in particular those involving shippers, who still select their transportation partners based on cost, quality, and time (Jazairy et al., 2021).

2.2. LSP awareness of environmental sustainability

Recognizing environment as an important aspect affected by LSP operations is fundamental to establish successful green initiatives (Evangelista and Durst 2015). Thus, LSPs are paying a growing attention to how to stimulate organizational awareness about environmental issues, with the ultimate goal of including green practices in their activities (Isaksson et al., 2017). Based on that, an already quite relevant number of literature contributions focus on this topic by either trying to understand the level of LSP environmental maturity or identifying the levers that are able to increase the green awareness.

The available works are mainly empirical in nature and rely on multiple case studies addressing selected companies (Abbasi and Nilsson, 2016; Hüge-Brodin et al., 2020; Jazairy, 2020) as well as surveys (Jazairy and von Haartman, 2020; Ashfaq and Ismail, 2019). In most of the cases, the points of view of both LSPs and shippers are studied to find out any mismatches in the supply and demand of green logistics services (Hüge-Brodin et al., 2020; Jazairy and von Haartman, 2020; Jazairy, 2020; Sallnas and Hüge-Brodin, 2018). Within such a research stream, the alignment of environmental practices during the procurement process appears to be of particular interest, since it influences the choice of the LSP company. Conversely, a relatively limited number of works focus on LSPs only and the environmental sustainability challenges they face, although this is crucial to foster the inclusion of green aspects in the value proposition of logistics providers (Abbasi and Nilsson, 2016; Isaksson et al., 2017).

According to their size, LSPs can be more or less keen to embrace the environmental sustainability issue and have different financial availability to support the actual implementation of actions. This is recognized by all the authors that have approached the awareness topic in the

Table 1
Main literature topics on LSP environmental sustainability.

Literature topic	References
Environmental sustainable practices	Cagliano et al., 2017; Centobelli et al., 2017a; Isaksson and Hüge-Brodin, 2013; Massaroni et al., 2016; Pilati et al., 2020; Sarjono et al., 2021; Tran et al., 2019
Drivers and barriers to the adoption of environmental sustainable initiatives	Celik et al., 2016; Centobelli et al., 2017b; Colicchia et al., 2013; Evangelista, 2014; Froio and Bezerra, 2021; Ho and Lin, 2012; Jazairy and von Haartman, 2020; Jumadi and Zailani, 2010; Laari et al., 2018; Lieb and Lieb, 2010; Nilsson et al., 2017; Sarjono et al., 2021; Tacke et al., 2014; Wong and Fryxell, 2004; Zailani et al., 2011
Environmental awareness	Abbasi and Nilsson, 2016; Ashfaq and Ismail, 2019; Hüge-Brodin et al., 2020; Isaksson et al., 2017; Jazairy, 2020; Jazairy and von Haartman, 2020; Sallnas and Hüge-Brodin, 2018; Vieira et al., 2016
Green initiatives performance measurement and management	Björklund and Forslund, 2013; Goswami et al., 2020; Lam and Dai, 2015
Collaboration on environmental sustainability issues	Bask et al., 2018; Doherty and Hoyle, 2009; Jazairy et al., 2021

last ten years. In fact, all the studies pay attention to include companies representing a wide range in terms of size, although not all of them consider it as a key perspective to interpret the obtained results.

Besides the company size, it might be interesting to analyze the point of view of different professional roles (e.g., managers, warehouse personnel, drivers, etc.) about environmental sustainability in LSP activities. This would enable to detect any resistance to change or to identify those employees who can lead the diffusion of the green awareness throughout an entire organization. However, very few of the existing studies explicitly take into account company roles in investigating LSP green maturity (Zailani et al., 2011).

Finally, environmental sustainability cannot ignore the reference geographical area because related aspects, such as the land morphological characteristics, the urbanization degree, the population levels as well as the pollution concentration, make the green problem more or less urgent with a consequent impact on the LSP awareness. Most of the existing works look at Scandinavian countries, such as Sweden and Finland, which are traditionally keener than other countries to address pollution problems (Abbasi and Nilsson, 2016; Isaksson and Hüge-Brodin, 2013; Jazairy and von Haartman, 2020; Sallnas and Hüge-Brodin, 2018). Very few contributions address countries with large and polluted cities like Brazil or Malaysia (Ashfaq and Ismail, 2019; Vieira et al., 2016) and a limited number of works focus on Continental European countries, such as Germany or Italy (Hüge-Brodin et al., 2020; Jazairy, 2020). Nevertheless, Continental Europe suffers a lot from traffic congestion and the associated pollution issues, also due to city centers characterized by narrow streets and outdated infrastructures not able to keep up with the increased urbanization and the consequent growing people and material flows (Battista et al., 2016). Additionally, in recent years, in countries such as for instance Italy, the interest in sustainable logistics is increasing. Indeed, several associations are attempting to promote the culture of sustainability, gather and disseminate best practices for green logistics and environmental sustainability. For example, different programs and methodologies, e.g., *Lean and Green* (Freight Leader Council, 2021) and *SOS Log Trademark* (Assolistica, 2021), were launched in Italy to support logistics companies in implementing green initiatives and certificating the obtained results.

2.3. Drivers and barriers to the adoption of environmental sustainable initiatives by LSPs

As Centobelli et al. (2017a) point out, the adoption of green initiatives by LSPs is becoming strategic to support companies and customers pursuing environmental sustainability strategies. In fact, the selection of the most appropriate LSP to establish sustainable alliances is key to achieve a superior business value (Roy et al., 2020). Thus, given the crucial role of these initiatives, some relevant aspects have to be carefully considered (Sureeyatanapas et al., 2018). In particular, it is commonly recognized that, when deploying environmental sustainability strategies, LSPs are focused on the enhancement of the environmental performance, and thus the reduction of emissions, negative externalities, and waste, while achieving cost savings. The latter, in particular, stimulates LSPs to adopt green initiatives and practices, e.g., alternative fuel or vehicles, intermodal transportation, and routing systems, to enable cost-savings related to fuel and resource consumption (Froio and Bezerra, 2021; Tackén et al., 2014). Indeed, Tackén et al. (2014) argue that the deployment of green initiatives that are both ecological and cost-effective promotes environmental sustainability strategies in the freight transportation sector.

In their systematic literature review, Centobelli et al. (2017b) identify a large quantity of drivers affecting the adoption of green initiatives by LSPs. For example, the authors consider the impact on the company image as well as the increase in profitability and the improvement of competitiveness (Maas et al., 2014) due to the reputation for pro-environment corporate behavior. In this direction, several papers in

literature argue that the pressure by the different stakeholders influences the adoption of measures for the environmental sustainability (Evangelista, 2014; Wong and Fryxell, 2004; Lieb and Lieb, 2010; Jumadi and Zailani, 2010). In particular, market pressure is linked with the firm size: large LSP companies tend to receive more intensive pressure than small and medium ones (Sarjono et al., 2021).

According to a survey conducted by Evangelista (2014), green government support is one of the most influential drivers for facilitating environmental sustainability of LSPs. The conducted study involves 54 companies operating in the logistics sector that have implemented different kinds of innovative initiatives related to a more effective use of vehicles, carrying out energy efficiency and recycling strategies, and fostering environmental supply chain collaboration. Most of the companies claim that the engagement of public authorities might effectively support the development of environmentally friendly projects. This outcome is also confirmed by a later study by Celik et al. (2016). By adopting an approach based on the AHP methodology, their study highlights the crucial role of governments, that through specific regulations and dedicated agencies can work to promote sustainable programs.

Aspects related to innovation and technology also play a key role in the LSPs' attitude toward sustainable logistics practices. Ehmke (2012) defines the dilemma of urban freight transportation, consisting of being innovative and competitive while limiting the environmental impact. This is also confirmed by the study conducted by Zailani et al. (2011) in Malaysia. The authors stated that one of the big challenges faced by the logistics industry is creating a long-term sustainable society with the least possible negative environmental impact. To achieve this goal, integrating green innovation into logistics services becomes of paramount importance.

Ho and Lin (2012) point out that technological characteristics should be considered when analyzing environmental issues. The authors recognize compatibility, complexity, and the advantages of clean technologies as factors influencing their adoption within a sustainable strategy. Again, government financial support and incentives can be crucial to foster technological innovation, particularly for small and medium sized LSPs.

Finally, again Ho and Lin (2012) demonstrate that organizational capabilities and knowledge are important aspects to implement an environmental sustainability strategy that is consistent with the existing system where LSPs operate. In particular, the operational excellence, together with a strong top management commitment, are relevant drivers of environmental friendly logistics activities (Jazairy and von Haartman, 2020; Laari et al., 2018).

Environmental sustainability is potentially able to make LSPs shift from offering a commodity to providing a strategic service but customers still do not consider ecology as a value added feature and are not willing to pay more for it. Therefore, reliability, flexibility, and customer service remain the strategic competitive levers. This is one of the most noteworthy barriers to the adoption of environmental sustainable initiatives, followed by logistics industry fragmentation and regulation heterogeneity. LSPs usually do not own transportation resources but outsource the associated activities to very small organizations, thus it is hard for them to establish and monitor green development programs with such suppliers. Furthermore, environmental regulations are often heterogeneous, not only among countries but also in different regions of the same country. Additionally, they are changing rapidly so that LSPs feel uncertain about their future requirements (Colicchia et al., 2013; Nilsson et al., 2017).

2.4. Features of LSP business

There are many aspects that need to be considered when assessing the features of LSP business. Some of them are more associated with operational issues, others are more economics based, and other ones more oriented to the environment. Among them, quality plays a crucial

role. It is often intangible and difficult to measure (Wong et al., 2009), because it is a lever for customer satisfaction and loyalty thanks to an increase in company reputation (Phuong Vu et al., 2020), as well as it allows to achieve higher shares of business (Liu et al., 2017). As already mentioned before, aspects related to cost are also crucial. The delivery cost traditionally has high priority in the selection of a LSP (Bask et al., 2018). Similarly, LSPs pay attention to reduce transportation costs and more in general the cost of pick-up and delivery services (Jazairy, 2020). In addition, LSP deal with traffic jam and availability of parking lots issues in their daily business, which are obstacles to prompt delivery time and, in turn, to provide a satisfactory service to customers (Tsai and Tiwasing, 2021). In fact, Lou et al. (2020) demonstrate that the shorter the delivery time, the higher the demand for logistics services. Another lever for increasing the competitive advantage is to pay attention to service flexibility, especially when customers ask for changes between the order placement and the order delivery (Giannikas and McFarlane, 2021).

The increased demand for goods mobility and the need for more tailored deliveries in terms of execution time heavily affect the environment through the consumption of fossil and natural resources, greenhouse emissions, and congestion (Aschauer et al., 2015). However, in recent years LSPs can transform environmental problems in business opportunities by including sustainability issues in operations programs as a lever for enhancing the competitiveness (Froio and Bezerra, 2021). In this context, the literature points out several elements that should be taken into account in order to facilitate sustainability in LSPs processes. A starting point might be the implementation of sustainable practices by the company management. In fact, environmental sustainability strategies, exploiting recent enabling technologies and green practices (Centobelli et al., 2020), can even affect the entire supply chain (Mehmann and Teuteberg, 2016). In addition, LSPs are more and more becoming compliant to national and international policies that public authorities worldwide are gradually introducing to promote more sustainable logistics practices (Zhang et al., 2020). The latter might be supported by warehouse energy efficiency initiatives, that constitute a recent aspect considered in depot design. In fact, over the years, the main issues taken into account are the layout, the safety, and the space efficiency (Yong Park et al., 2018). Energy initiatives can be associated with different aspects: for instance, low impact lighting systems (Shanmugam et al., 2021), more efficient heating ventilation and air conditioning facilities (Seifhashemi et al., 2018), and systems for saving energy in loading, storing, and retrieving goods (Yong Park et al., 2018). In this context, promoting the reduction of the emissions related to warehouse processes is crucial (Benjaafar et al., 2013). Such an objective might be achieved by more efficient building facilities and via inventory management strategies focused on emission reduction (Li and Hai, 2019). Perotti et al. (2012) consider reverse logistics as a green practice for LSPs. It is based on taking back products or packaging materials from customers for reuse or recycling (Jazairy, 2020). LSPs are still not always fully aware of the benefits of carrying out reverse logistics and they are often pushed by customers to implement reverse strategies (Sureeyatanapas et al., 2018). Reverse logistics is closely connected with green packaging. It is the adoption of recyclable or reusable packaging, containers and of environmental friendly materials instead of harmful ones (Jazairy, 2020). A packaging might be also considered green in case of a reduction of the material required for its production (Froio and Bezerra, 2021). Therefore, the packaging can be seen as a pillar for enhancing green logistics goals (Ashfaq and Ismail, 2019) and for improving environmental performance (Kumar and Anbanandam, 2020).

The LSP business features resulting from the performed literature review are summarized in Table 2 with a short description and the related references.

The discussed literature reveals that LSP environmental sustainability has been already widely debated under multiple dimensions. Moreover, how shipper and carrier levels of green awareness match has been extensively discussed in the last decade. However, most of the

Table 2

Description of LSP business features.

Feature	Description	Reference
Quality	Lever for customer satisfaction, related to the reputation	Wong et al., 2009; Phuong et al., 2020
Cost	Cost of transportation, pick-up and delivery	Bask et al., 2018
Quickness of Delivery	Time required to fulfill a delivery	Lou et al., 2020
Environmental Sustainability	Inclusion of sustainability in operations issues	Froio and Bezerra, 2021
Flexibility	Change in order placement and order delivery	Giannikas and McFarlane, 2021
Implementation of Strategies	Exploitation of innovative technologies	Centobelli et al., 2020
Alignment with Public Policies	Compliance with local, national, and international sustainable standards	Zhang et al., 2020
Energy Efficient Warehouses	Practices for reducing the energy consumption	Shanmugam et al., 2021; Seifhashemi et al., 2018
Reduction of Pollutants	Actions for reducing emissions	Li and Hai, 2019
Reverse Logistics	Taking back products from customers for reuse	Jazairy, 2020; Sureeyatanapas et al., 2018
Ecofriendly Packaging	Reusable and recyclable packaging	Jazairy, 2020

scholars take a double perspective and compare the green awareness of LSPs with the one of their customers, in order to understand how much both the parties value environmental sustainability in logistics services. Few contributions provide an in-depth investigation of the point of view of LSPs only and study the environmental awareness of the different company professional roles to give insights on how crucial they are in promoting environmental sustainable logistics. In addition, case studies about Continental European countries are still very scarce.

The present work contributes to advance such a research stream by carrying out an empirical study aimed at understanding the perception about environmental sustainability of LSPs operating in Italy. The authors analyze the perspectives of the main company roles, together with their availability to implement environmental friendly practices as an integral part of the logistics services offered. The environmental awareness is also investigated according to the company size.

3. Methodology

This research is conducted through the following steps.

Questionnaire construction: based on the literature review outcomes, a survey questionnaire is developed in order to gather information and the opinion of professionals in the field with regard to the different dimensions that represent the awareness of LSPs about sustainability issues. A questionnaire pre-test, before its administration, is performed in order to identify criticalities, such as those related to vocabulary, consistency and ambiguity of questions, redundant questions, and any relevant questions missing. Among the several methods to conduct a pre-test, expert judgement is one of the most effective (Presser et al., 2004). Therefore, the questionnaire is submitted to some professionals in the fields of logistics and transportation service providers and then reviewed and changed according to their comments.

Sample identification: the survey sample is constituted by 420 logistics service providers operating in Italy. The decision to focus on the Italian market is due to its peculiarity for logistics. In fact, urban streets are often very narrow, especially in city centers, with consequent relevant impacts on congestion, pollution, and public space occupancy (Arbolino et al., 2017). The companies in the sample were selected from the AIDA database (AIDA, 2021) that contains comprehensive information on companies operating in Italy, by using the specific industry type code (i.e., ATECO code), and from an Italian association of freight and logistics leading companies.

Questionnaire administration: the questionnaire was implemented by means of Google Forms and subsequently administered by e-mail to the sample companies. In particular, respondents received the link to the questionnaire and entered their answers directly in the Google Forms system, which automatically saved them. Responses were then downloaded from Google Forms and organized in an Excel spreadsheet in order to create a manageable dataset for the analysis. The administration period extended over two months based on two separated waves, namely the invitation to take part to the survey and the reminder. The respondents were also asked to take part to a remote face to face interview aimed at discussing and explaining the outcomes of the on line survey. Three respondents accepted to be involved in this further part of the study. Two of them were managers and the other one was an employee in charge of dealing with the picking and the packaging operations. These respondents work in small, medium, and large enterprises respectively. The interviews were one to one so that each respondent could talk without any influences of the other ones. They lasted about one hour and after a general overview of the results of the whole survey, they were asked if they agreed with the outcomes and then focusing on their specific answers why they gave that mark in order to better understand the reasons behind the opinions.

Questionnaire results analysis and interpretation: this step is discussed in Section 4 and Section 5.

3.1. Questionnaire structure

The questionnaire, as reported in the Appendix, is structured into four sections that seek to investigate how crucial the sustainability topic is for the LSP business and the relationship with customers and other partners.

The questionnaire asked for:

- **Details about the respondents and their organization.** In the first section, some identifying information was collected (e.g., name and job title of the respondent) to characterize each respondent.
- **LSP sustainability evaluation criteria.** After the demographic aspects, respondents have been asked to rate the importance of different evaluation criteria, including the environmental impact, together with other more operation-oriented features that can be used to assess the delivery service. For all the criteria, a Likert scale scoring system is used, where 1 = Not Important, 2 = Moderately Important, 3 = Important, 4 = Very Important, 5 = Extremely Important. This scale is commonly adopted in survey research in order to assess questionnaire answers (Mangano et al., 2021).

By focusing on sustainability, a set of questions has been designed to investigate the importance levels of different features to assess and reduce the environmental impact. Again, by means of a Likert scale, the respondents provide their level of agreement or disagreement to a list of parameters developed by the authors based on the literature review discussed in Section 2. The investigated features are:

- Quality.
- Cost.
- Quickness of Delivery.
- Flexibility.
- Definition and implementation of strategies by the top management.
- Compliance with national and international regulations on environmental sustainability.
- Energy efficiency of warehouses.
- Reduction of pollutants.
- Reverse logistics.
- Use of eco-friendly packaging.

In addition, two sections were aimed at investigating the level of interest of respondents' customers about the sustainability issue and at

understanding the most important aspects of LSPs business and finally respondents were asked their availability in sharing data and information about their business operations impact on the environment.

Finally, as soon as respondents complete the questionnaire, the results are collected and sent to the authors of this paper for statistical analysis. The survey results are analyzed using the *Kruskal-Wallis test* (Kruskal and Wallis, 1952). This non-parametric procedure has been selected to support the statistical analysis for three main reasons: (i) data is not normally distributed (Mahoney and Magel, 1996); (ii) data size is small (Kitchen, 2009); (iii) the Likert scale used to collect some answers is ordinal, it means that it is not possible to guarantee the same distance between scores (Panchal et al., 2020). Other statistical approaches such as the Analysis of Variance (ANOVA) cannot be applied here because they require normally distributed data (Tabachnick and Fidell, 2019).

A brief overview of the Kruskal-Wallis test is provided in the remainder of this section. The test evaluates whether two or more samples are from the same distribution.

Let k be the number of samples under investigation, each of them contains a set of values such that N is the total number of values in all the samples. Let n_i and r_i be the number of values and the rank among all the observations in the i -th sample respectively. \bar{r}_i is the median value of each sample i and \bar{r} the median of all the samples.

The value of the test H is expressed as follows:

$$H = (N - 1) \frac{\sum_{i=1}^k n_i (\bar{r}_i - \bar{r})^2}{\sum_{i=1}^k \sum_{j=1}^{n_i} (r_{ij} - \bar{r})^2} \quad (1)$$

The null hypothesis H_0 is that all the k samples come from the same distribution, and thus, the population medians are all equal. If the test returns a p -value lower than 5 %, it indicates a strong evidence against the null hypothesis. This means that the null hypothesis is rejected in favor of the alternative hypothesis H_1 , i.e., there is a significant difference among the samples under study, that will be accepted instead.

4. Analysis of results

The survey achieved 94 responses. According to the classification provided by the European Commission based on staff headcount and the total turnover of balance sheet (European Commission, 2003), about 60 % of the respondents are from small and medium enterprises, while the remaining part is composed of large companies.

The respondents represent the following stakeholder groups:

- Corporate executives in charge of creating long-term strategies for the company/department.
- Managers and supervisors responsible for making significant decisions and commitments to achieve the strategies established by the executives.
- Operators in charge of executing logistics activities.

This classification allows to understand the different perception about sustainability within the same logistics company.

About 38 % of respondents are in charge of operations, 19 % are executives, while the most of them (57 %) are managers.

Respondents are asked for their level of implementation of such measures, both in terms of time and solutions.

- **Customer relationships.** This section includes a number of questions to assess the level of interest of customers about green services and solutions. Thus, the respondents are asked to rate the percentage of their customers that demand sustainable solutions and how frequently they request information on the environmental impact. Most of the respondents claim that less than 20 % of their customers require sustainable practices in LSP operations. In addition, nearly 70 % of the respondents declare that some of their customers are interested in the development of green initiatives. This result is quite

relevant, as it demonstrates that there is still a scarce awareness on the environmental impacts of logistics operations. At the same time, the present outcome indicates that there are a lot of opportunities for enhancing sustainability in the logistics arena. However, sustainability comes at a cost. Thus, the respondents are asked to estimate the extra price they charge for providing a sustainable service, as well as the willingness of their customers to pay for obtaining deliveries with a low environmental impact.

- **Partnership.** Given the emerging need for collaboration between LSPs and integrated logistics platforms, the respondents are asked to provide the three most important service characteristics that are crucial in their partnerships, selecting them among the following ones: i) service quality; ii) environmental sustainability; iii) quickness of delivery; iv) flexibility; v) cost. Most of the LSPs (37 %) claim that they might be selected by potential partners for the quality of their services. Then, 20 % of the respondents state that their attention to environmental and sustainability issues would be the main reason why partners should rely on them. Only 5 % of the surveyed LSPs emphasize the role of low service prices in establishing partnerships.

Additionally, LSPs were asked about their availability to share data and information on the provided services and the associated sustainability. It is worth noting that an important result that might support future collaborations in order to achieve sustainability is the strong willingness of LSPs (66 % of the respondents) to share this kind of information (e.g., type of fleet vehicles, speed, fuel consumption, load). The remaining part, about 38 % of the respondents are not available to share their data. This outcome can be justified by the generally low willingness of logistics operators to share data with external organizations, although all the companies are aware about the importance of data security, as emerged in the survey conducted by 5G-LOGINNOV, 2021 (5G-LOGINNOV, 2021).

4.1. LSP customers' environmental awareness

As previously mentioned, the respondents are asked to evaluate the attention that their customers give to the environmental sustainability issue. In particular, it is investigated if the respondents' customers require sustainable operations practices. The results dramatically reveal that more than 60 % of the surveyed companies have customers not interested at all in sustainability. Less than 30 % have between 25 % and 50 % of customers more aware about the relevance of sustainability. Only 11 % of the respondents declare that most of their customers are concerned with the environmental programs developed by LSPs. Similarly, 50 % of the respondents state that 50 % of their customers have never asked information about the environmental impacts of LSPs' activities. 36 % of the companies in the sample receive requests for environmental information sometimes or rarely and only 12 % often have to provide their customers with information about sustainability.

Such an outcome is corroborated by the fact that most of the green actions that have been implemented by the surveyed LSPs for more than one year are related to the compliance with national and international environmental regulations. Therefore, companies seem still mostly pushed by policy makers in the development of green programs. Environmental sustainability is scarcely addressed by LSPs because it is still not enough considered as important by customers. This means that it is not often taken into account as a criterion in the selection for the provider of logistics services (Abbasi and Nilsson, 2016). Thus, LSPs are less willing to include sustainability in their portfolio strategy as it is not seen as a lever for competitive advantage for their customers, that are still more focused on service level and costs. In other words, since implementing environmental sustainability policies is not considered as an added value by customers (Nilsson et al., 2017), LSPs do not perceive green strategies as crucial to excel over their competitors and increase their market share. For such a reason, they prefer to put their efforts in

maximizing the service level while containing costs, rather than in minimizing the associated environmental impact. As a consequence, the environmental compliance is more considered as a "duty" by LSPs, in order to observe the requirements by national and international regulations, since the beneficial effects of sustainability strategies on business performance appear limited (Bask et al., 2018; Evangelista et al., 2017). In the next future, partnerships between customers and LSPs might facilitate a wider implementation of green initiatives (Huge-Brodin et al., 2020).

In the following sections, the results obtained by carrying out the Kruskal-Wallis test according to the size of the company and the role of respondents are presented.

4.2. LSP environmental awareness and company size

Table 3 shows the results obtained by carrying out the Kruskal-Wallis test according to the size of the company. For every aspect taken into account, the median of every group is reported, together with the p-value associated with the single completed test. The results highlight a significant difference related to the adoption of energy efficient warehouses, reverse logistics practices, and ecofriendly packaging. For the three investigated aspects, the medium sized companies report a lower median compared with the small and the large ones. The reason might be the fact that medium companies still consider sustainability as a formal commitment and not as an opportunity. According to the outcomes of the performed interviews, medium sized LSPs are not so interested in improving their market position through the proactive adoption of environmental sustainable practices regarding warehouse buildings or reverse logistics because it might be quite expensive and, also, they deem not to be in an extreme need to enlarge their business size. On the contrary, results of small organizations prove their high interest in sustainability. This might reflect a higher awareness about the challenges that they will have to face in the next future, together with the willingness to increase their reputation and to acquire new customers that are more and more requiring green certifications for the logistics services. As a matter of fact, large LSPs often outsource transportation operations to small providers that are called to demonstrate to pursue sustainable practices in their business (Lou et al., 2020). The representative of small LSP companies participating to the interviews explained such a result by pointing out how relevant environmental sustainability is nowadays for their business growth, given the significant environmental impact of logistics and transportation activities and the increasing attention to optimizing the use of the natural resources available at a global level. Furthermore, large LSPs are highly aware of the relevance of environmental sustainability. As emerged from the interviews, this is due to the fact that large LSP companies can rely on more human and financial resources than small and medium logistics providers, which gives them the opportunity to put more efforts and money not only in optimizing the operational and economic aspects of their service but also in addressing other related issues, including the environmental one. Dealing with the side aspects of the logistics service

Table 3
Kruskal-Wallis test for Company Size.

Company Size	Small	Medium	Large	Kruskal
Investigated Feature				
Quality	4	4	4	0,425
Cost	4	3	4	0,385
Quickness of Delivery	4	5	4	0,358
Environmental Sustainability	3,5	4	4	0,229
Flexibility	4	4	4	0,682
Implementation of Strategies	4	3	4	0,205
Alignment with Public Policies	4	4	4	0,115
Energy Efficient Warehouses	4	3	4	0,001
Reduction of Pollutants	5	5	4	0,419
Reverse Logistics	4	3	3,5	0
Ecofriendly Packaging	4	3	4,5	0,001

is also allowed by the fact that a larger number of human resources brings heterogeneous skills to the company. This in turn leads to a more comprehensive knowledge and a higher sensitivity towards the different impacts of freight transportation, as well as to the availability of the right approaches to tackle such impacts. Also, large LSPs are usually compliant with the requirements of international certifications, which force them to take into account the environmental sustainability of their activities. As a matter of fact, out of the companies taking part to the questionnaire follow-up, just large ones are already implementing photovoltaic modules in their warehouses and ecofriendly packaging, which require significant investments, although the economic public incentives that many country may correspond, and not all the customers are willing to pay for them. Finally, the different median values reported for energy efficient warehouses, reverse logistics, and ecofriendly packaging might be due to the fact that these aspects have recently come to the fore as key issues for establishing environmental friendly logistics operations (Kumar and Anbanandam, 2020). The performed interviews revealed that not all the LSPs have already developed a deep knowledge and consideration of them because they are still more focused on the environmental effects of the transportation activities they perform, e.g. CO₂ emissions, rather than the impacts of other tasks associated to the logistics service. The interviewed companies declared to pay close attention to the compliance with national and international environmental regulations to reduce pollutants, especially related to transportation activities, supporting the evidence about the still prominent role of regulations to foster green initiatives by logistics operators.

4.3. LSP environmental awareness and company role

The results of the Kruskal-Wallis test carried out according to the company role are presented in Table 4.

In general terms, the three investigated roles show a relevant attention to the environmental aspects of the business. Quality is an important aspect to be taken into account for all of them. The follow-up interviews explained such an evidence with the willingness to provide customers with the best possible service level, regardless the company size and the role of the personnel taking part to this survey. Respondents more in charge of dealing with the operations processes view the quickness of delivery as a key feature. This might be due to the fact that they are more involved in daily processes carried out for filling the orders respecting the expected lead time. As explained by the interviewed representatives, on time delivery is one of the parameters often adopted by LSPs to assess the performance of operations professionals. On the contrary, from a strategic point of view, the quickness of delivery is not recognized by managers and executives so important because, again according to the representatives participating to the follow-up, top quality is able to secure LSPs higher returns than the delivery speed. Due to the already mentioned high attention to the environmental impacts of transportation activities, operations personnel consider the reduction of

pollutants crucial for increasing sustainability. Similarly, the adoption of ecofriendly packaging is viewed as an important element for the enhancement of sustainability. Moreover, according to managers, reverse logistics is seen not so relevant to improve sustainability compared with the other two professional categories included in the study. This because managers tend to give more importance to the strategic levers they can rely on to improve the service, such as quality or implementation of green policies. In such a context, managers can be seen as crucial for enforcing green initiatives in an organization (Isaksson and Høge-Brodin, 2013), in the sense that they might promote networking among companies, academia, and other stakeholders. In addition, if managers are not interested in environmental management, they are not likely to encourage employees to undertake and follow green initiatives (Seroka-Stolka, 2016).

These results demonstrate that there can be different perceptions between professionals more directly in charge of operations processes and the other ones. In particular, the professionals involved in daily operations have a direct experience of the effects of both the aspects related to strategy, like for instance quality, cost, and flexibility, and the environmental issues associated with the execution of logistics tasks, as the adoption of ecofriendly packaging or the level of polluting emissions produced by transportation activities. As the authors could conclude from the interviews, this is because the operational staff is the one more in contact with customers benefitting from the logistics service and can more directly observe, also through the received complaints, how the delivery of damaged goods or a poor ability to meet the requested service time windows negatively affect them. Similarly, operations professionals, who are involved in managing the vehicle fleet and the on-field activities day by day, can clearly perceive how a high level of CO₂ emissions worsens the environment where they work. For example, they are directly aware of the age of the used vans and of the associated CO₂ emission levels or of the air quality in the urban areas served. For such reasons, operations professionals grade as highly important all the business features addressed in the present study. Conversely, executives and managers view as prevalent only the aspects they are traditionally more strategic in nature, considering the investigated operational features playing a less key role, although not negligible. This difference in the perceptions of executive and managers on the one hand and of operations professionals on the other hand is witnessed by the statistically different median values related to reduction of pollutants and reverse logistics, which are regarded as important by the former two groups but as crucial by the latter category.

5. Discussion and conclusions

The present research proposes the results of a questionnaire survey carried out among LSPs operating in the Italian market. The objective of the study is to evaluate the perception and the level of awareness of the professionals about sustainability practices that can be implemented. In fact, only few LSPs have included structured sustainable programs in their mission (Abbasi and Nilsson, 2016). At the same time, the already quite developed academic research on LSP environmental sustainability lacks studies specifically focused on how the LSP structure and organization affect their awareness. In particular, few contributions address the heterogeneous degrees of environmental awareness by different professional roles in small, medium, and large LSP companies. Also, the geographical outlook of the existing literature works is fragmented since a very limited number of contributions investigate the green awareness of LSPs operating in Continental Europe (Jazairy, 2020), an area more and more affected by traffic congestion and pollution problems.

The outcomes of the present study reveal that there is a general high consideration of the environmental issues among the freight carriers of the sample. However, several significant relationships come up through the Kruskal-Wallis test. The attention of medium organizations is lower compared with small and large ones, highlighting that there are still margins for promoting environmental processes, especially for the

Table 4
Kruskal-Wallis test for Company Role.

Company Role	Executive	Manager	Operations	Kruskal
Investigated Feature				
Quality	4	4	4	0,677
Cost	4	4	4	0,814
Quickness of Delivery	4	3,5	4,5	0,008
Environmental Sustainability	3	5	4	0,435
Flexibility	4	3	4	0,104
Implementation of Strategies	4	4	4	0,604
Alignment with Public Policies	4	4	4	0,136
Energy Efficient Warehouses	3,5	4	4	0,224
Reduction of Pollutants	4,5	4	5	0,011
Reverse Logistics	4	3	4	0,045
Ecofriendly Packaging	4	4	4	0,507

adoption of more sustainable warehouses and reverse logistics practices. This latter aspect is quite relevant in the nowadays e-commerce society wherein a lot of on-line purchases are returned. The phenomenon is so frequent that processing returned products requires a great deal of extra reverse logistics costs (Ren et al., 2021). On the contrary, the service quality provided to customers is always considered as fundamental. This might depend on the higher service level that customers are requiring for logistics services (Jap et al., 2021). Another interesting result is the different perception of the key aspects of LSP environmental sustainability by managers, executives, and operations professionals. While all of them give a medium to high importance to green logistics, the operations professionals tend not to neglect any facet of the environmental sustainability, both strategic and operational ones. In fact, they are involved in day by day executing activities and can appreciate the effects of both high-level strategies and on the field practices to improve sustainability. For the same reasons they claim to be more focused on completing deliveries in a short time so that to be aligned with the expected order lead times (Hsieh and Zhang, 2022). On the contrary, managers and executives pay more attention to those business features that can drive future general strategies for both the industry and each single company.

This work originates several theoretical and practical implications. From a theoretical point of view, the present study enlarges the body of knowledge in the field of the evaluation of sustainability in logistics processes. In fact, this research is aimed at developing a systematic picture of the level of awareness and the degree of importance LSPs give to the logistics environmental sustainability topic by taking into account the most relevant LSP business features. In such a way, the present work might inspire studies on the levers to increase the LSP environmental awareness according to the perceptions of different company staff roles about the green deal as well as the organizational size. Such studies might be also beneficial to pave the way for future research streams about the interconnection between environmental sustainability and the recent technological advances in the logistics field. Furthermore, the reference geographical area of this contribution sheds lights on the need for assessing the current level of LSP environmental awareness and proposing approaches to increase it in Continental European countries. Finally, this work, by presenting a structured questionnaire survey as an empirical methodology, proposes a quite well established approach for assessing the environmental awareness of logistics operators. Indeed, a relevant number of literature contributions deal with this issue by exploiting the multiple case study approach (Abbasi and Nilsson, 2016; Jazairy, 2020).

From a practical point of view, the proposed study might support LSPs in identifying the most appropriate strategies for a more effective achievement of sustainability. In fact, it provides a comprehensive list of green practices that might be adopted by LSPs and, through a well-established empirical method, these practices are assessed by professionals. In addition, the results of the empirical analysis can suggest companies the levers to be focused on to promote and advance the green awareness in their organizations. In fact, they provide a ranking of business features according to their importance for each company size. Thus, LSPs can know what kind of green interventions are likely to be most successful in their firms and how they compare with traditional cost, quality, and time strategies. A similar classification is provided according to the company role: here LSPs can get an idea about the commitment of which professionals should be secured in order to establish environmental sustainable actions. In this way, the green awareness is expected to be more diffused in LSP business. Such an aspect has been acquiring particular relevance considering the importance of logistics processes with the recent dramatic increase of e-commerce purchases and demand for last mile processes. At the same time, public policy makers might exploit this study for a more precise design of strategies to promote environmental friendly programs. In particular, by observing the importance of the different business features resulting from the present work, public decision-makers could more

easily identify the operational areas towards orienting the development of new policies, according to the size of their target companies and the relevance these are expected to give to the green practices public decision-makers are planning to stimulate. Also, the results of this analysis might help public policy makers to understand the professional roles they should rely on to promote environmental responsibility by LSPs through specific practices.

Future research might be addressed to include a larger sample of companies in the survey, with the aim of consolidating the achievements of this preliminary contribution. In addition, the outcomes of the study related to the Italian market might be compared with the level of LSP green awareness in other both European and international countries.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.clscn.2022.100083>.

References

- Abbasi, M., Nilsson, F., 2016. Developing environmentally sustainable logistics: Exploring themes and challenges from a logistics service providers' perspective. *Transport. Res. Part D: Transp. Environ.* 46, 273–283. <https://doi.org/10.1016/j.trd.2016.04.004>.
- Abdullah, R., Daud, M.S., Ahmad, F., Shukli, A., Shah, M., 2016. Green logistics adoption among 3PL companies. *Int. J. Supply Chain Manage.* 5, 82–85.
- AIDA, 2021. AIDA Bureau Van Dijk Website. URL: <https://www.bvdinfo.com/en-gb/our-products/data/national/aida>. Last accessed: 07/07/2021.
- Arbolino, R., Carlucci, F., Cirà, A., Ioppolo, G., Yigitcanlar, T., 2017. Efficiency of the EU regulation on greenhouse gas emissions in Italy: The hierarchical cluster analysis approach. *Ecol. Ind.* 81, 115–123. <https://doi.org/10.1016/j.ecolind.2017.05.053>.
- Aschauer, G., Gronalt, M., Mandl, C., 2015. Modelling interrelationships between logistics and transportation operations - a system dynamics approach. *Manage. Res. Rev.* 38, 505–539.
- Ashfaq, M., Ismail, F., 2019. Awareness on green logistics among transportation companies in Johor towards business performance. *Int. J. Recent Technol. Eng.* 8.
- Assologica, 2021. SOS LOG Trademark. URL: <https://www.sos-logistica.org/en/protocollo-sos-log/>. Last accessed: 15/10/2021.
- Bask, A., Rajahonka, M., Laari, S., Solakivi, T., Töyli, J., Ojala, L., 2018. Environmental sustainability in shipper-LSP relationships. *J. Cleaner Prod.* 172, 2986–2998. <https://doi.org/10.1016/j.jclepro.2017.11.112>.
- Battista, G., Pagliaroli, T., Mauri, L., Basilicata, C., De Lieto Vollaro, R., 2016. Assessment of the air pollution level in the City of Rome (Italy). *Sustainability*. <https://doi.org/10.3390/su8090838>.
- Benjaafar, S., Li, Y., Daskin, M., 2013. Carbon footprint and the management of supply chains: Insights from simple models. *IEEE Trans. Autom. Sci. Eng.* 10, 99–116. <https://doi.org/10.1109/TASE.2012.14777831311303092>.
- Björklund, M., Forslund, H., 2013. The inclusion of environmental performance in transport contracts. *Manage. Environ. Quality: Int. J.* 24 <https://doi.org/10.1108/14777831311303092>.
- Cagliano, A.C., Carlin, A., Mangano, G., Rafele, C., 2017. Analysing the diffusion of eco-friendly vans for urban freight distribution. *Int. J. Logistics Manage.* 28 <https://doi.org/10.1108/IJLM-05-2016-0123>.
- Celik, E., Erdogan, M., Gumus, A., 2016. An extended fuzzy TOPSIS-GRA method based on different separation measures for green logistics service provider selection. *Int. J. Environ. Sci. Technol.* 13 <https://doi.org/10.1007/s13762-016-0977-4>.
- Centobelli, P., Cerchione, R., Esposito, E., 2017a. Developing the WH2 framework for environmental sustainability in logistics service providers: A taxonomy of green initiatives. *J. Cleaner Prod.* 165, 1063–1077. <https://doi.org/10.1016/j.jclepro.2017.07.150>.
- Centobelli, P., Cerchione, R., Esposito, E., 2017b. Environmental sustainability in the service industry of transportation and logistics service providers: Systematic literature review and research directions. *Transport. Res. Part D: Transport Environ.* 53, 454–470. <https://doi.org/10.1016/j.trd.2017.04.032>.
- Centobelli, P., Cerchione, R., Esposito, E., 2020. Pursuing supply chain sustainable development goals through the adoption of green practices and enabling

- technologies: A cross-country analysis of LSPs. *Technol. Forecast. Soc. Chang.* 153, 119920 <https://doi.org/10.1016/j.techfore.2020.119920>.
- Chen, X., Wang, X., 2016. Effects of carbon emission reduction policies on transportation mode selections with stochastic demand. *Transport. Res. Part E: Logistics Transport. Rev.* 90, 196–205. <https://doi.org/10.1016/j.tre.2015.11.008>.
- Colicchia, C., Marchet, G., Melacini, M., Perotti, S., 2013. Building environmental sustainability: empirical evidence from logistics service providers. *J. Cleaner Prod.* 59, 197–209. <https://doi.org/10.1016/j.jclepro.2013.06.057>.
- Davis-Sramek, B., Robinson, J.L., Darby, J.L., Thomas, R.W., 2020. Exploring the differential roles of environmental and social sustainability in carrier selection decisions. *Int. J. Prod. Econ.* 227 <https://doi.org/10.1016/j.ijpe.2020.10766>.
- Doherty, S., Hoyle, S., 2009. Supply chain decarbonization: The role of Logistics and Transport in Reducing Supply Chain Carbon Emissions. World Economic Forum, Geneva.
- Ehmke, J., 2012. Integration of Information and Optimization Module for Routing in City Logistics. Springer.
- European Commission, 2003. Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. *Official Journal L 124 C* (2003) 1422, 36–41.
- European Commission, 2019. The European Green Deal. COM 640.
- Evangelista, P., 2014. Environmental sustainability practices in the transport and logistics service industry: an exploratory case study investigation. *Res. Transport. Bus. Manage.* 12, 63–72. <https://doi.org/10.1016/j.rtbm.2014.10.002>.
- Evangelista, P., Colicchia, C., Creazza, A., 2017. Is environmental sustainability a strategic priority for logistics service providers? *J. Environ. Manage.* 198 (Pt1), 353–362. <https://doi.org/10.1016/j.jenvman.2017.04.096>.
- Evangelista, P., Durst, S., 2015. Knowledge management in environmental sustainability practices of third-party logistics service providers. *Vine* 45, 509–529. <https://doi.org/10.1108/VINE-02-2015-0012>.
- Evangelista, P., Santoro, L., Thomas, A., 2018. Environmental sustainability in third-party logistics service providers: A systematic literature review from 2000–2016. *Sustainability* 10, 1627. <https://doi.org/10.3390/su10051627>.
- Freight Leader Council, 2021. Lean & Green. URL: <https://www.freightleaders.org/lean-and-green/>. Last accessed: 15/10/2021.
- Froio, P.J., Bezerra, B.S., 2021. Environmental sustainability initiatives adopted by logistics service providers in a developing country – an overview in the Brazilian context. *J. Cleaner Prod.* 304, 126989 <https://doi.org/10.1016/j.jclepro.2021.126989>.
- Giannikas, V., McFarlane, D., 2021. Examining the value of flexible logistics offerings. *Eur. J. Oper. Res.* 290, 968–981. <https://doi.org/10.1016/j.ejor.2020.08.056>.
- Goswami, M., De, A., Habibi, M.K.K., Daultani, Y., 2020. Examining freight performance of third-party logistics providers within the automotive industry in India: an environmental sustainability perspective. *Int. J. Prod. Res.* 58, 7565–7592. <https://doi.org/10.1080/00207543.2020.1756504>.
- Gustafsson, M., Svensson, N., Eklund, M., Dahl Öberg, J., Vehabovic, A., 2021. Well-to-wheel greenhouse gas emissions of heavy-duty transports: Influence of electricity carbon intensity. *Transport. Res. Part D: Transport Environ.* 93, 102757 <https://doi.org/10.1016/j.trd.2021.102757>.
- Ho, Y.H., Lin, C.Y., 2012. An empirical study on Taiwanese logistics companies attitudes toward environmental management practices. *Adv. Manage. Appl. Econ.* 2, 1–14.
- Hsieh, C.H., Zhang, M., 2022. Critical factors affecting performance of logistics operation planning considering interdependency: A case study in automotive aftermarket. *Asian Transport Stud.* 8, 100055 <https://doi.org/10.1016/j.eastsj.2022.100055>.
- Huge-Brodin, M., Sweeney, E., Evangelista, P., 2020. Environmental alignment between logistics service providers and shippers - a supply chain perspective. *Int. J. Logistics Manage.* <https://doi.org/10.1108/IJLM-04-2019-0101>.
- Isaksson, K., Evangelista, P., Huge-Brodin, M., Lämätäinen, H., Sweeney, E., 2017. The adoption of green initiatives in logistics service providers – a strategic perspective. *Int. J. Bus. Syst. Res.* 11, 349–364. <https://doi.org/10.1504/IJBSR.2017.087096>.
- Isaksson, K., Huge-Brodin, M., 2013. Understanding efficiencies behind logistics service providers' green offerings. *Manage. Res. Rev.* 36, 216–238. <https://doi.org/10.1108/01409171311306382>.
- Jap, S.D., Gibson, W., Zmuda, D., 2021. Winning the new channel war on Amazon and third-party platforms. *Bus. Horiz.* <https://doi.org/10.1016/j.bushor.2021.04.003>.
- Jazairy, A., 2020. Aligning the purchase of green logistics practices between shippers and logistics service providers. *Transport. Res. Part D: Transp. Environ.* 82, 102305 <https://doi.org/10.1016/j.trd.2020.102305>.
- Jazairy, A., von Haartman, R., 2020. Measuring the gaps between shippers and logistics service providers on green logistics throughout the logistics purchasing process. *Int. J. Phys. Distrib. Logistics Manage.* <https://doi.org/10.1108/IJPDLM-08-2019-0237>.
- Jazairy, A., von Haartman, R., Björklund, M., 2021. Unravelling collaboration mechanisms for green logistics: the perspectives of shippers and logistics service providers. *Int. J. Phys. Distrib. Logist. Manage.* 51, 423–448. <https://doi.org/10.1108/IJPDLM-09-2019-0274>.
- Jumadi, H., Zailani, S., 2010. Integrating green innovations in logistics services towards logistics services sustainability: A conceptual paper. *Environ. Res. J.* 4, 261–271.
- Kitchen, C.M., 2009. Nonparametric vs parametric tests of location in biomedical research. *Am. J. Ophthalmol.* 147 (571–572), 820. <https://doi.org/10.1016/j.ajo.2008.06.031>.
- Kruskal, W.H., Wallis, W.A., 1952. Use of ranks in one-criterion variance analysis. *J. Am. Stat. Assoc.* 47, 583–621.
- Kudla, N.L., Klaas-Wissing, T., 2012. Sustainability in shipper-logistics service provider relationships: A tentative taxonomy based on agency theory and stimulus-response analysis. *J. Purch. Supply Manage.* 18, 218–231. <https://doi.org/10.1016/j.pursup.2012.04.001>.
- Kumar, A., Anbanandam, R., 2020. Assessment of environmental and social sustainability performance of the freight transportation industry: An index-based approach. *Transp. Policy*. <https://doi.org/10.1016/j.tranpol.2020.01.006>.
- Laari, S., Töyli, J., Ojala, L., 2018. The effect of a competitive strategy and green supply chain management on the financial and environmental performance of logistics service providers. *Bus. Strategy Environ.* 27, 872–883. <https://doi.org/10.1002/bse.2038>.
- Lam, J.S.L., Dai, J., 2015. Environmental sustainability of logistics service provider: an ANP-QFD approach. *Int. J. Logistics Manage.* 26, 313–333. <https://doi.org/10.1108/IJLM-08-2013-0088>.
- Li, Z., Hai, J., 2019. Inventory management for one warehouse multi-retailer systems with carbon emission costs. *Comput. Ind. Eng.* 130, 565–574. <https://doi.org/10.1016/j.cie.2019.03.015>.
- Lieb, R.C., Lieb, K.J., 2010. The North American third-party logistics industry in 2008: The provider CEO perspective. *Transport. J.* 49, 53–65.
- Liu, W., Shen, X., Xie, D., 2017. Decision method for the optimal number of logistics service providers with service quality guarantee and revenue fairness. *Appl. Math. Model.* 48, 53–69. <https://doi.org/10.1016/j.apm.2017.03.058>.
- Lou, Y., Feng, L., He, S., He, Z., Zhao, X., 2020. Logistics service outsourcing choices in a retailer-led supply chain. *Transport. Res. Part E: Logistics Transport. Rev.* 141, 101944 <https://doi.org/10.1016/j.tre.2020.101944>.
- Maas, S., Schuster, T., Hartmann, E., 2014. Pollution prevention and service stewardship strategies in the third-party logistics industry: Effects on firm differentiation and the moderating role of environmental communication. *Bus. Strategy Environ.* 23, 38–55. <https://doi.org/10.1002/bse.1759>.
- Mahoney, M., Magel, R., 1996. Estimation of the power of the Kruskal-Wallis test. *Biometrical J.* 38, 613–630. <https://doi.org/10.1002/bimj.4710380510>.
- Mangano, G., Zenezini, G., Cagliano, A.C., 2021. Value proposition for sustainable last-mile delivery. A retailer perspective. *Sustainability*. doi: 10.3390/su13073774.
- Mariano, E.B., Gobbo, J.A., de Castro Camiato, F., do Nascimento Rebelatto, D.A., 2017. CO2 emissions and logistics performance: a composite index proposal. *J. Cleaner Prod.* 163, 166–178. <https://doi.org/10.1016/j.jclepro.2016.05.084>.
- Massaroni, E., Cozzolino, A., Wankowicz, E., 2016. Sustainability reporting of logistics service providers in Europe. *Int. J. Environ. Health* 8, 38–58. <https://doi.org/10.1504/IJENVH.2016.077662>.
- Mehmann, J., Teuteberg, F., 2016. The fourth-party logistics service provider approach to support sustainable development goals in transportation - a case study of the German agricultural bulk logistics sector. *J. Cleaner Prod.* 126, 382–393. <https://doi.org/10.1016/j.jclepro.2016.03.095>.
- Nilsson, F.R., Sternberg, H., Klaas-Wissing, T., 2017. Who controls transport emissions and who cares? Investigating the monitoring of environmental sustainability from a logistics service provider's perspective. *Int. J. Logist. Manage.* 28, 798–820. <https://doi.org/10.1108/IJLM-11-2015-0197>.
- Panchal, J., Majumdar, B.B., Ram, V., Basu, D., 2020. Analysis of user perception towards a key set of attributes related to bicycle-metro integration: A case study of Hyderabad, India. *Transportation Research Procedia* 48, 3532–3544. doi: 10.1016/j.trpro.2020.08.098. Recent Advances and Emerging Issues in Transport Research - An Editorial Note for the Selected Proceedings of WCTR 2019 Mumbai.
- Park, S.-y., Cho, S., Ahn, J., 2018. Improving the quality of building spaces that are planned mainly on loads rather than residents: Human comfort and energy savings for warehouses. *Energy Build.* 178, 38–48. <https://doi.org/10.1016/j.enbuild.2018.08.007>.
- Perotti, S., Zorzini, M., Cagno, E., Micheli, G.J., 2012. Green supply chain practices and company performance: the case of 3PLs in Italy. *Int. J. Phys. Distrib. Logistics Manage.* 42, 640–672. <https://doi.org/10.1108/09600031211258138>.
- Phuong Vu, T., Grant, D.B., Menachof, D.A., 2020. Exploring logistics service quality in Hai Phong, Vietnam. *Asian J. Shipp. Logistics* 36, 54–64. <https://doi.org/10.1016/j.ajsl.2019.12.001>.
- Pilati, F., Zennaro, I., Battini, D., Persona, A., 2020. The sustainable parcel delivery (SPD) problem: Economic and environmental considerations for 3PLs. *IEEE Access* 71880–71892. <https://doi.org/10.1109/ACCESS.2020.2987380>.
- Presser, S., Couper, M.P., Lessler, J.T., Martin, E., Martin, J., Rothgeb, J.M., Singer, E., 2004. Methods for testing and evaluating survey questions. *Public Opinion Q.* 68, 109–130. <https://doi.org/10.1093/poq/nfh008>.
- Qu, X., Wang, S. and Niemeier, D. 2022. On the urban-rural bus transit system with passenger-freight mixed flow. *Commun. Transport. Res.*, 2, 100054. <https://doi.org/10.1016/j.commtr.2022.100054>.
- Ren, M., Liu, J., Feng, S., Yang, A., 2021. Pricing and return strategy of online retailers based on return insurance. *J. Retail. Consumer Services* 59. <https://doi.org/10.1016/j.jretconser.2020.102350>.
- Roy, J., Pamu Car, D., Kar, S., 2020. Evaluation and selection of third party logistics provider under sustainability perspectives: an interval valued fuzzy-rough approach. *Ann. Oper. Res.* 293, 669–714. <https://doi.org/10.1007/s10479-019-03501-x>.
- Sallnas, U., Huge-Brodin, M., 2018. De-greening of logistics? – Why environmental practices flourish and fade in provider-shipper relationships and networks. *Ind. Mark. Manage.* 74, 276–287. <https://doi.org/10.1016/j.indmarman.2018.07.001>.
- Sarjono, H., Saputra, O., Handoko, B. L., 2021. Analysis of Environmental Sustainability in the Transportation Industry of Logistic Service Providers: Systematic Literature Review. The 3rd International Conference on E-Business and E-commerce Engineering, 17–19 December 2021, Sanya, China, 259–267. doi: 10.1145/3510249.3510295.
- Seifhashemi, M., Capra, B., Miller, W., Bell, J., 2018. The potential for cool roofs to improve the energy efficiency of single storey warehouse-type retail buildings in Australia: A simulation case study. *Energy Build.* 158, 1393–1403. <https://doi.org/10.1016/j.enbuild.2017.11.034>.
- Seroka-Stolka, O., 2016. Green initiatives in environmental management of logistics companies. *Transp. Res. Procedia* 16 (483–915), 489. <https://doi.org/10.1016/j.trp.2016.03.001>.

- trpro.2016.11.045. The 2nd International Conference Green Cities - Green Logistics for Greener Cities, 2-3 March 2016, Szczecin, Poland.
- Shanmugam, M., Aravind, S., Yuvashree, K., JaiVignesh, M., Jagan Shrinivasan, R., Santhanam, V., 2021. Energy efficient intelligent light control with security system for materials handling warehouse. *Mater. Today: Proc.* 37, 1884–1886. <https://doi.org/10.1016/j.matpr.2020.07.461>.
- Sureeyatanapas, P., Poophiukhok, P., Pathumnakul, S., 2018. Green initiatives for logistics service providers: An investigation of antecedent factors and the contributions to corporate goals. *J. Cleaner Prod.* 191, 1–14. <https://doi.org/10.1016/j.jclepro.2018.04.206>.
- Tabachnick, B. G., Fidell, L. S., 2019. Using multivariate statistics (Seventh Edition). Pearson.
- Tacken, J., Rodrigues, V.S., Mason, R., 2014. Examining CO₂e reduction within the German logistics sector. *The International Journal of Logistics Management* 25, 54–84. doi: 10.1108/IJLM-09-2011-0073.
- Tran, D.T., Wong, W.K., Moslehpour, M., Xuan, Q.L.H., 2019. Speculating environmental sustainability strategy for logistics service providers based on DHL experiences. *Journal of Management Information & Decision Sciences* 22, 415–443.
- Tsai, Y.T., Tiwasing, P., 2021. Customers' intention to adopt smart lockers in last-mile delivery service: A multi-theory perspective. *J. Retail. Consumer Services* 61, 102514. <https://doi.org/10.1016/j.jretconser.2021.102514>.
- Vieira, J.G.V., Mendes, J.V., Suyama, S.S., 2016. Shippers and freight operators perceptions of sustainable initiatives. *Eval. Program Plann.* 54, 173–181. <https://doi.org/10.1016/j.evalprogplan.2015.07.011>.
- Wehner, J., Deilami, N.T.N., Vural, C.A., Halldórsson, Á., 2022. Logistics service providers' energy efficiency initiatives for environmental sustainability. *Int. J. Logistics Manage.* 33, 1–26. <https://doi.org/10.1108/IJLM-10-2019-0270>.
- Wong, L.T., Fryxell, G.E., 2004. Stakeholder influences on environmental management practices: a study of fleet operations in Hong Kong (SAR), China. *Transport. J.* 43, 22–35.
- Wong, J.Y., Tsaui, S.H., Wang, C.H., 2009. Should a lower-price service offer a full-satisfaction guarantee? *Serv. Ind. J.* 29, 1261–1272. <https://doi.org/10.1080/02642060801911102>.
- Xu, Q., Li, K., Wang, J., Yuan, Q., Yang, Y., Chu, W., 2022. The status, challenges, and trends: an interpretation of technology roadmap of intelligent and connected vehicles in China (2020). *J. Intelligent Connected Vehicles*. <https://doi.org/10.1108/JICV-07-2021-0010>.
- Zailani, S., Amran, A., Jumadi, H., 2011. Green innovation adoption among logistics service providers in Malaysia: An exploratory study on the managers' perceptions. *Int. Bus. Manage.* 5, 104–113. <https://doi.org/10.3923/ibm.2011.104.113>.
- Zhang, W., Zhang, M., Zhang, W., Zhou, Q., Zhang, X., 2020. What influences the effectiveness of green logistics policies? a grounded theory analysis. *Sci. Total Environ.* 714, 136731 <https://doi.org/10.1016/j.scitotenv.2020.136731>.