






RESEARCH PAPER

Logistics service provider selection for the road transport of express cargo

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ABSTRACT

Purpose: The objective of this study is to propose and demonstrate a structured method for selecting logistics service providers specialized in express road freight transport, grounded in Multi-Criteria Decision Making and sensitivity analysis. The company specializes in this segment, however, hiring Logistics Service Provider can increase its competitiveness and improve its indicators related to quality and customer satisfaction.

Design/methodology/approach: The case study was carried out in a company specializing in express cargo services, which decided to hire Logistics Service Provider can increase its competitiveness and improve its indicators related to quality and customer satisfaction.

Results: The results demonstrated that information technology, responsiveness, and quality management are the most relevant criteria for the contractor due to the need to preserve the reliability of the company in front of its customers and to remain competitive in the express cargo segment.

Limitations of the investigation: The logistics service provider selection was carried out for the road transport of express cargo, but it cannot be generalized to other types of transport.

Practical implications: Sensitivity analysis to verify the consistency of the weights assigned to the criteria and verified that the proposed model is an alternative that could result in the choice of the company that best meets the needs of the contracting company because the evaluation was based on qualitative and quantitative criteria that express the contractor's needs.

Originality/Value: This study contributes to supply chain managers and express delivery road transport operations because it shows a realistic decision-making process, elucidating the most relevant strategic criteria and subcriteria for the decision, which are important for the contractor to demand from the Logistics Service Provider in the contractual process.

Keywords: Selection; Logistic Service Provider; Express Cargo; Road Transport; Multi-criteria Decision Making; Sensitivity analysis.

1 INTRODUCTION

The outsourcing of activities in Brazil has grown since the 1990s, when large Logistics Service Providers (LSPs) started their activities in Brazil, due to the fact that these companies perceived a great potential for growth in the country (Wanke, 2012; de Oliveira Neto *et al.* 2019).

Since then, companies from different areas have outsourced their logistics operations. This is due to companies dedicating themselves to their activities (Bayazit and Karpak, 2013). E-commerce

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companies have preferred to outsource logistics activities (Souza, 2019), thus outsourcing to carry out logistical activities corroborates to achieve the company's strategic objectives (Singh Bhatti, Kumar, and Kumar, 2010; Hoen *et al.*, 2013; Zhang *et al.* 2019).

The competitiveness of the company increases with third parties carry out the logistics activities (Xiu and Chen, 2012), because there is a sharing of labor and assets, which may reduce costs, increasing the chain profit (Zhong *et al.* 2016).

Outsourcing allows contractor company assets to be reduced and access to state-of-the-art technologies, there is also the possibility of expanding to new markets and increasing service levels. Companies that opt to outsource their logistics activities seek specialists in their area of expertise (Bayazit and Karpak, 2013).

The increase in e-commerce has contributed to the growth of the outsourcing of logistics, mainly due to the need for electronic transactions between companies, and personalized service for a large number of orders, whose volume is small, and demand delivery in the short term (Zhang *et al.*, 2019). This increases the opportunities for LSPs that meet the service levels required by the express cargo services sector. This sector is characterized by strict requirements such as compliance with short deadlines, a large number of orders, small volumes, and fractional loads (Ming, 2017). The quality of the service provided and value-added is an important differential for customer loyalty. As a result, companies in the industry have invested in state-of-the-art technology, especially IT resources to offer customized products that add value to the product (Singh Bhatti, Kumar and Kumar, 2010).

The adequate evaluation of the LSP could avoid contractual terminations. This reinforces the importance of a systematic assessment that assists in the diagnosis of the appropriate candidate company to provide the services at the required levels of it (Chua *et al.* 2008). The contracting of LSPs may cause undesired impacts, such as loss of activities' control and non-compliance with contractual goals (Chua *et al.* 2008). Some important criteria such as delivery area, cost, payment terms, IT resources and lead time can be decisive for assertively choosing an LSP, especially when the contracting party is an e-commerce company, these criteria are a suggestion for be carried out, not only in the selection process, but also in the evaluation of the LSP during the period of service provided. (Naseem, M.H., Yang, J. and Xiang, Z. 2021). This reinforces the need for an accurate analysis of the characteristics desired in the LSP specialized in express cargo road transport (Shen *et al.* 2009). The road transport mode is preferable for door-to-door transportation, especially in the case of deliveries of fragmented products, as for example, computers from an online store to the final customer (Wolff *et al.* 2019).

Fifteen studies were identified that mention road transport of express cargo, with 7 studies that report on strategic aspects for express delivery in the road modal with the aim of: proposing a method to configure the LSP of express cargo (Shen *et al.* 2009); study which resilience strategy international express companies should choose when interruptions occur and affect their delivery activities (Chen *et al.* 2013); explore the express delivery system (Xie *et al.* 2014), develop an economic approach to express package delivery, without degrading the quality of services (Chen *et al.* 2016); provide a formal way to select the best express delivery storage locations (Zhu *et al.* 2016); analyze relationships between electronic commerce and logistics and summarize the main modes of logistics distribution (Ming, 2017); investigate evolving strategies for e-commerce and express delivery companies (Zhang *et al.* 2019). 2 surveys planned physical distribution in order to: study the final distribution system composed of two competing companies and a third responsible for the integration of distribution (Liu and Wei, 2017); develop a model to plan the shared physical distribution of newspapers and e-commerce products using LSP (Souza, 2019). Another study by Chua *et al.* (2008) aimed to develop a qualitative procedure to study the provision of services in an innovative way by an express delivery LSP. Another study by Lee *et al.* (2013) explored the determinants that affect the express delivery company's transportation outsourcing strategy in Taiwan.

The research by Oliveira Neto *et al.* (2019) aimed to identify performance indicators that can be used to assess the adoption of telemetry systems for an LSP for express cargo. The study by Liu *et al.* (2024) aimed to establish a system of key indices to evaluate the quality of express delivery services, with the goal of improving the quality of express delivery services in the context of intelligent logistics development; and only the work of Zhong *et al.* (2016) who mentioned the decision to outsource specialized LSPs on express cargo with a specific focus on profit distribution among partners, as shown in table 1. In this context, there is a scientific gap in the selection of LSPs for road freight transport expressed, driving the following research question: How to select an LSP for an express service company specializing in road freight transport?

It is noteworthy that in this study the criteria were identified through the analysis of decision-makers of contractors of large companies that transport express cargo, as well as, the use of these criteria for the analysis of three LSP in organizational practice. With this, the research contributes to the theory, because it elucidates the selection process of LSP specialized in express cargo

transportation based on strategic criteria, a subject not studied, and also contributes to the organizational practice because the majority of SCM and logistics managers in this sector are unaware of the strategic criteria for the selection of LSP that transports cargo expressed by road. Selecting an LSP is a sensitive and strategic action. According to (Granillo-Macías R and González-Hernán I.J 2020), there are imprecise criteria that can make the decision process hard, due to this, Multi-criteria Decision Making is very relevant. With that, this study can be a guide for SCM and logistics managers for the selection of an appropriate LSP specialist in road transportation of appropriate express cargo, as well as for developing the contract with realistic clauses that allow establishing the monitoring of the operation.

In the selection process, AHP modeling was combined with sensitivity analysis to the evaluation and selection process of the appropriate LSP for a company that transports products that require express delivery that can meet their real needs in terms of criteria relevant to the effectiveness of contractor's operational in the area of operations management, aiming at organizational practice and scientific literature, the use of AHP (Saaty, 1980) is well accepted for decision making because it solves complex problems, which requires multicriteria analysis, which is easy to apply and understand by those involved in the decision-making process. Thus, the evaluation is complex because it requires the consideration of several criteria for decision making, among them: cost reduction, quality, flexibility, punctuality, service delivery, and innovation (Oliveira Neto *et al.*, 2017; Bajec and Tuljak-Suban, 2017). The use of models that consider qualitative and quantitative criteria, corroborates the selection of the LSP adequate to attend to the expected levels of services. This reinforces the importance of using templates instead of using the selection process considering only costs (Ho *et al.*, 2009; Zhong *et al.*, 2016). The analysis of different alternatives to service delivery can show LSPs with different capacities and capabilities, characterizing a complex decision scenario, and having multiple criteria for evaluation (Guo, 2012). In these complex scenarios, which involve criteria, generally conflicting, what is common in corporate decisions, in which there are multiple criteria to evaluate, if it is necessary to use a model and multiple decision method criteria in order to obtain the result expected (Triantaphyllou and Mann, 1995; Salomon, 2010). It was found that multi-criteria decision-making methods were adopted by most researchers, with the Analytic Hierarchy Process being the most robust used for LSP selection (Akhtar, 2023).

The literature presents a study applying the AHP method for the evaluation and selection of LSPs for companies in the sector of: (i) agriculture for the road transport of perishable products, due to the fragility of the products, the criteria identified as most important were satisfaction of the customer, delivery cost, pollutant emission control and transport capacity (Xiu and Chen, 2012; Ying, 2012); (ii) automotive with a focus on minimizing the cost of road transport of parts and pieces with smartness in sea, air freight and license to remain in ports due to the products transported (Vijayvargiya and Dey, 2009, 2010), including service price, IT resources and physical assets, quality of customer service, empathy, cultural similarity and analysis of the transport process's performance (Göl and Atay, 2007; Kuo *et al.* 2010); (iii) electronic that requires security, experience, financial stability, strategic partnership of the LSP because products with high added value are transported (Iañez and Cunha, 2006; Gürçan *et al.* 2016). With this, the LSP needs to have quality distribution know-how to offer personalized services and solve problems quickly, aiming at on-time deliveries, availability of physical equipment for handling and information system (Ho *et al.*, 2009); and Saucedo-Martínez *et al.* (2024) developed a distribution selection process using AHP and Fuzzy AHP for the welding industry in Mexico with fleet shortage and low capacity problems; (iv) international logistics service, requires service level (punctuality, precision, and reliability), cost of services and resources for the global service (Daim *et al.*, 2012; Falsini *et al.* 2012); (v) frozen products requires an LSP located close to customers to ensure timely delivery, operational infrastructure resources (freezing chambers and vehicles with termokings) to preserve the quality of use and consumption of the product (Oliveira Neto *et al.* 2014); (vi) a real-life case study in a confectionery company (Yayla *et al.* 2015); (vii) refrigerated products requires quality management and responsiveness to guarantee the physical integrity of refrigerated products, registered batches and allow traceability (Oliveira Neto *et al.*, 2017). Another important finding is that studies that used AHP to assess and select an LSP for an industry that requires express road transport are not identified. Nian *et al.* (2023) developed an approach to selecting cold chain logistics service providers, making the evaluation and selection process more objective. (viii) manufacturing company. Sibanda *et al.* (2025) evaluated the efficiency and performance comparison of Third-Party Logistics Providers using AHP of diverse products, as companies focus on their core activities, benefiting from the advantages of professional distribution, cost reduction, and increased customer satisfaction provided by LSPs. Wang *et al.* (2024) developed a selection process for Third-Party Logistics Providers in the Industry 4.0 era using Fuzzy AHP and sensitivity analysis, denoting the need for cost optimization. Jia *et al.* (2025) concluded that Fuzzy and AHP show good consistency in LSP evaluation issues, indicating that the level of security management, the level of compensation for cargo damage, support services, response capacity and emergency

management, and the quality of cooperation are the most important factors. Galal *et al.* (2025) presented an integrated framework for evaluating outsourced logistics services using AHP and Fuzzy and sensitivity analysis. The most important factors in selecting an LSP were compatibility, financial performance, reputation, and long-term relationship. However, it is not the application of the AHP that brings the novelty to this research, but the resolution of the industry's problem, specifically in road transportation of express cargo.

Thus, the objective of this study is to propose and demonstrate a structured method for selecting logistics service providers specialized in express road freight transport, grounded in Multi-Criteria Decision Making and sensitivity analysis.

This section presents the introduction, followed by a literature review on road transport of express cargo, research methodology, results, discussion, and conclusion.

2 ROAD TRANSPORT OF EXPRESS CARGO

Nine surveys were identified those mention strategic aspects for express delivery in road transport. Shen *et al.* (2009) developed and applied a synthetic method in China to configure the express cargo service provider based on Analytic Network Process (ANP) and Linear Programming (LP) to help the contractor optimize its service requirements. Xie *et al.* (2014) identified effective strategies to build delivery networks (Air Delivery Network and Ground Delivery Network) and organize express parcel delivery in China using the Barabási-Albert model, mainly considering responsiveness in delivery. Chen *et al.* (2016) developed a non-homogeneous positioning system for express delivery to Chinese e-commerce, aiming to reduce package transportation costs collectively, due to the use of highly efficient delivery routes, without degrading the quality of service. Zhu *et al.* (2016) also focused on express delivery for Chinese e-commerce and adopted a probabilistic verification model to provide a formal way to select the best express delivery storage locations, allowing to guarantee the maximum express delivery search success rate, reduce business costs and increase customer satisfaction. Ming (2017) used Genetic Algorithm (GA), Poisson Distribution, and MATLAB and organized suitable vehicles, optimized the departure time, and organized the vehicle's trajectory to save transportation costs and improved distribution efficiency for Chinese e-commerce. Zhang *et al.* (2019) investigated evolving strategies for Chinese e-commerce companies and express delivery through game theory, allowing to maintain the benefits of e-commerce companies and improve the logistical performance in evolutionary games with the help of operational supervision and punishment. Naseem, M.H *et al.* (2021) studied product delivery as a key success factor for e-commerce companies in Pakistan and consider the importance of selecting the most suitable LSP, having in mind its own business characteristics, for the e-commerce business. The research by Chen *et al.* (2013) studied Taiwan resilience strategies that international express companies should choose when interruptions occur and affect their delivery activities through mixed multi-object non-linear multi-object programming, concluding that it is essential to select alternative routes, exchange shipping modes, renting capacities from other carriers, relocating local trucks and prioritizing the order of shipments due to limited capacities. Granillo-Macias R *et al.* (2020) has performed a search on how the LSP has impacted e-commerce companies since the LSP is essential, but also, a third-party provider and what criteria package can be used to correctly select the most feasible for each market segment.

Six studies mentioned transport planning considering the integration of the LSP. The research by Chua *et al.* (2008) carried out in Singapore, studied through interviews with customers, the provision of services in an innovative way by an express delivery logistics service provider, indicating the need for careful analysis that must be carried out with an LSP. Lee *et al.* (2013) concluded that the determinants for outsourcing express cargo to an LSP in Taiwan through logistic regression, concluding that the main objective of adopting the outsourcing strategy is to reduce operating costs and improve the punctuality of delivery. Liu and Wei (2017) researched the final express cargo distribution system made up of two competing companies and a third one responsible for integrating distribution into the Chinese scenario through game theory, considering the cost of distribution, and quality, under the premise to maximize the interests of all parties. Souza (2019) developed a model based on Integral Linear Programming, Modeling, and Mathematical Processing through MATLAB, to plan the shared physical distribution of newspapers and e-commerce products to be used by the logistics operator in the Brazilian scenario, considering the allocation of cargo and vehicles with the possibility of fines and awards for delivery times, heterogeneous fleets and fixed routes. Oliveira Neto *et al.* (2019) identified indicators to support the evaluation of performance improvements associated with the adoption of telemetry systems in an LSP (Local Service Provider) for express road freight transport in Brazil. The indicators gathered information about: (i) slow-paced engines, (ii) engines not engaged by the driver, (iii) sudden and unintended acceleration, (iv) sudden and unintended stop and (v) high speeds during

rainy and dry weather conditions. Liu *et al.* (2024) established a system of key indices to evaluate the quality of express delivery services, aiming to improve the quality of these services within the context of intelligent logistics development. The findings indicate that, firstly, the level of customer perception is of great importance in evaluating the quality of express delivery services. Secondly, our model can provide valuable feedback for express delivery companies to improve their services. Finally, we proposed corresponding improvement strategies to enhance the service quality of express delivery companies within the context of intelligent logistics development; And only a survey by Zhong *et al.* (2016) that dealt directly with the decision to outsource or not to an express cargo LSP through Stackelberg game theory, concluding a reasonable profit distribution scheme based on the revenue sharing contract to obtain cooperation between the partners in the supply chain of logistical services, in order to achieve a situation where all profits increase.

Therefore, most studies emphasize different strategies for express road freight transport, which are indicated in Table 1 through criteria. It is concluded that most research on this subject is related to cost optimization and the need for quality management, while the least adopted criteria are related to customer empathy and reduction of environmental impacts by means of, for example, the use of biofuel (Marques *et al.* 2024). Also, no studies were identified with structures designed for the selection of express road freight transport, particularly using multi-criteria analysis and sensitivity analysis in the selection decision of LSP.

3 METHODOLOGY

First, a systematic literature review was carried out based on the keywords: ("express cargo" OR "express delivery" OR "express logistics" OR "express roads" OR "express shipping") AND ("selection" OR "logistics service provider" OR "3PL" OR "third-party logistics" OR "outsourcing") to identify the state of the art on LSP selection for road freight transport. The keywords were also searched: ("AHP" OR "analytic hierarchy process") AND ("selection") AND ("logistics service provider" OR "3PL" OR "third-party logistics" OR "outsourcing") to identify the state of the art on the application of AHP for LSP selection. These keywords were searched in the databases: Capes, Ebsco, Emerald, Proquest, Wiley Library, Compendex, Scielo, Science Direct, and Scopus.

In the first systematic literature review on express freight transport, 31 studies were identified. Sixteen studies were excluded: 7 had keywords identified only in references, 4 were in the literature review but without mention of the topic, and 5 were duplicates. Thus, 15 studies were adopted on this subject, and no studies related to LSP selection were identified, indicating a research gap.

In the second part of the systematic literature review on the application of AHP for LSP selection, 67 studies were identified. However, 14 duplicate studies were excluded, 16 did not use AHP in the decision-making process, and in 17 studies, LSP selection using AHP was in the literature review but not in the results. Thus, 20 studies were used in this study, but none applied AHP for LSP selection specialized in express freight transport.

In the research, content analysis was developed, Bardin (1986) mentioned that content analysis is for the inference of knowledge about the study object for the identification of the research gap. It was identified that this exploratory study corroborates the scientific literature because it shows a selection process of LSP specialized in road transport of cargo expressed through AHP and sensitivity analysis, a subject not studied. Yin (2013) mentions that exploratory study is suitable for objects that have not yet been studied or little investigated, making it important to develop a case study. A case study is a detailed analysis of a problem, aimed at understanding its aspects, causes, and possible solution.

This study for the evaluation and selection of LSP occurred in a company specializing in large-scale express cargo services, whose activities are carried out by fleet and own human resources. The fleet of vehicles used is composed of motorcycles, light vehicles, utilities, and heavy vehicles as well as agreements for import and export serving more than 130 countries.

The company is present in all Brazilian states with fixed service stations and collection and delivery services. The units that carry out the activities in the metropolitan region of the state of São Paulo, the area covered by this study, has approximately 19,000 employees.

The company, among the various products and services offered, has as its main service the delivery of express parcels. The services provided are from the transport of products to the integrated logistics, performing them with quality and trust recognized by its customers, demonstrated through quality indicators, and monitoring of customer satisfaction. The company seeks constant innovation of technology, whose purpose is to carry out the tracking of transported objects in all its stages, including making information available to customers and stakeholders in the tracking.

As a differential in the services provided stands out the ability to seek to understand the needs of its customers, proposing services tailored to their needs. However, when it is necessary to

provide express parcel service with short deadlines and small volumes, prices become less competitive due to transportation costs and labor costs.

In this way, this study was carried out to evaluate and select LSPs specialized in express cargo services with the aim of improving the quality indicators, which are related to the costs of logistics services in the personalization of services with reduced deadlines beyond those already offered, when necessary the service at reduced volumes. The main aim is to improve performance indicators related to responsiveness and competitiveness

In addition, the maintenance cost of transportation assets will pass to the contractor, who, besides having a relatively new fleet, compared to the contractor's vehicles, performs strict maintenance control of the vehicles.

The insurance expenses of the assets and products transported by the contractor may reduce, since the contractor, through contractual clauses, can be responsible with the contractor, when the products are under his responsibility, or in the transportation in his vehicles or stored on your premises. One of the advantages of outsourcing is the reduction of operating costs.

The partnership with a company specializing in express cargo services may result in products and services offered more attractively in comparison to competitors, as it increases the coverage of regions served. This also allows the reduction of deadlines and prices due to the sharing of human resources and assets for transport and storage.

3.1. AHP method used in this case study

The Analytic Hierarchy Process provides a flexible and easy way to understand and analyze the risks of the study. It is a methodology of analysis of decisions with several criteria that permit subjective and objective factors to be considered in the process (Mustafa, 1991). Besides that, this is a general theory of evaluation largely accepted (Saaty, 2013). Generally, the process can be divided into three steps, as described in the sequence. Figure 1 shows the applied hierarchical model composed of four levels. The first level was decided by the selection of LSPs; the second and third levels support the LSP selection process, the problem is decomposed into criteria and subcriteria, defining a decision hierarchy and developing the pairwise comparison matrix; and the fourth level is composed of alternatives that are the companies evaluated in this selection process for the provision of logistics services for express cargo.

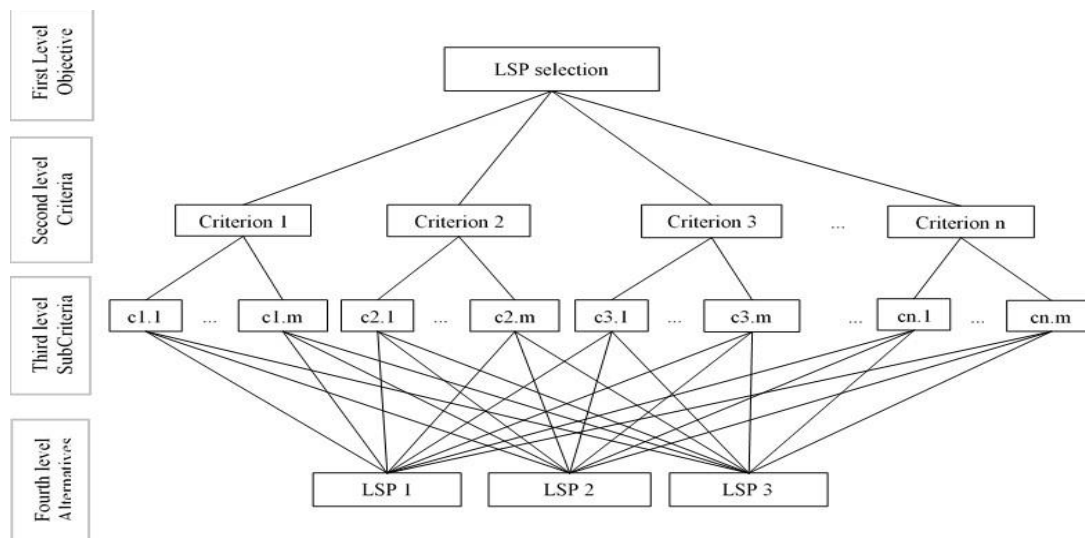


Figure 1: Decision hierarchy model for LSP selection

- 1) **Decompose the problem into a hierarchy structure. In this step, the problem is decomposed into criteria and subcriteria, defining a decision hierarchy.**

1.1. Criteria and sub-criteria definition

The criteria and subcriteria applied in this study were obtained from the literature and are illustrated in Table 1. According to Bajec and Tuljak-Suban (2017), all criteria are important, however, although not all are required, depending on the purpose of the contractor. So, these criteria were refined according to the characteristics of the segment and the strategic objectives of the contractor. In this process, 3 managers participated in the process of outsourcing logistics activities. This resulted in 7 criteria and 28 subcriteria, which are illustrated in Table 1.

Table 1 - Criteria and subcriteria for evaluation and selection of LSP

Criteria	Subcriteria	Concept	Corroborating Researches
Adaptability	LSP in lócus with the contractor; Flexibility in service; Compatibility of cultures of the contracting company and contractor; Common planning; resilience.	It evaluates the rapid adjustment of the LSP on cultural issues, flexibility and communication, which could help in the relationship, reducing flaws.	Ho <i>et al.</i> 2009; Kuo <i>et al.</i> 2010; Vijayvargiya and Dey, 2010; Ying, 2012; Chen <i>et al.</i> 2013; Oliveira Neto <i>et al.</i> 2014; Galal <i>et al.</i> 2025
Cost	Transportation costs; Cost of storage and handling; Cost of delay in delivery; Cost of returns.	Analyzes and compares the costs of transport, storage, handling and LSP returns.	lañez and Cunha, 2006; Göl and Çatay, 2007; Falsini <i>et al.</i> 2012; Xiu and Chen, 2012; Daim <i>et al.</i> 2012; Lee <i>et al.</i> 2013; Oliveira Neto <i>et al.</i> 2014; Yayla <i>et al.</i> , 2015; Chen <i>et al.</i> 2016; Zhong <i>et al.</i> 2016; Zhu <i>et al.</i> 2016; Ming, 2017; Liu and Wei, 2017; Sibanda <i>et al.</i> 2025; Wang <i>et al.</i> 2024
Credibility	Reputation of the company; Logistic partnerships; Number of contracts per year.	Analyzes the reputation of the LSP in the services provided to its customers.	Hadi-Vencheh and Niazi-Motlagh, 2011; Ying, 2012; Oliveira Neto <i>et al.</i> 2014; Oliveira Neto <i>et al.</i> 2017; Yayla <i>et al.</i> , 2015; Jia <i>et al.</i> 2025
Empathy	After-Sell and Commitment.	Analyzes the PSL's ability to place the contractor's place and seek to meet specific needs.	Oliveira Neto <i>et al.</i> 2014; Sibanda <i>et al.</i> 2025
Environmental	ISO 14.000 certification; Cleaner production; Reverse logistic; Training in environmental education.	Evaluates the LSP in relation to its practices to reduce the environmental impacts caused by its processes.	Oliveira Neto <i>et al.</i> 2014
Experience	Service efficiency; Product's amount of experience; Time to market and customer portfolio.	Evaluate LSP experience, competence and ability to meet the demand for contracting services.	lañez and Cunha, 2006; Daim <i>et al.</i> 2012; Oliveira Neto <i>et al.</i> 2014; Nian <i>et al.</i> 2023;
Financial Stability	Investment capacity; Financial soundness; indebtedness.	Evaluates the financial strength, the customer	lañez and Cunha, 2006; Ho <i>et al.</i> 2009; Hadi-Vencheh and

		relationship and the profits of the LSP.	Niazi-Motlagh,2011; Oliveira Neto <i>et al.</i> 2014; Yayla <i>et al.</i> , 2015; Galal <i>et al.</i> 2025
Flexibility	Treatment capacity; Ability to negotiate new customer services, resilience	Examine the LSP's ability to adjust to rapid and seasonal market variations.	Iañez and Cunha, 2006; Kuo <i>et al.</i> 2010; Falsini <i>et al.</i> 2012; Chen <i>et al.</i> 2013; Oliveira Neto <i>et al.</i> 2014; Yayla <i>et al.</i> , 2015.
Human Resources	Employees Qualification; Capacity of Working in Group; Capacitation and practical test, Clothing and neatness of the employees.	Analyzes the qualification of employees, as well as the ability to work in groups, clothing and cleanliness.	Iañez and Cunha, 2006; Xiu and Chen,2012; Ying, 2012; Oliveira Neto <i>et al.</i> 2014.
Information Technology	Easy Communication (Electronic Data Interchange - EDI); (Enterprise Resource Planning - ERP); (Warehousing Management System-WMS); (Transport Management System TMS) and Routing (Global Positioning System - GPS).	Evaluates the technological resources to manage and measure the performance of planning, transportation, storage, tracking, routing and integrated communication.	Iañez and Cunha, 2006; Vijayvargiya and Dey, 2009, 2010; Xiu and Chen, 2012; Ying, 2012; Daim <i>et al.</i> 2012; Chen <i>et al.</i> 2013; Oliveira Neto <i>et al.</i> 2014; Yayla <i>et al.</i> , 2015; de Oliveira Neto <i>et al.</i> 2019.
Operation Infrastructure	Distribution centers location; Facilities adequacy; Work security; Loading; truck conditions; Equipment required for loading; Receipt in JIT without fault in the LSP; Equipment required in receipt; Equipment required for Moving; Handling pallets without fault; Storage and stacking in the warehouse; Equipment required in the warehouse; Separation to dispatch without fault in the LSP; Uniting and own vehicles; Equipment required to transport and dispatch of the order without fault in JIT.	Verify if the outsourcing of logistic activities maintains or improves the quality of the services provided, selecting LSP with the best location, facilities, equipment, information and operating system.	Göl and Çatay, 2007; Ho <i>et al.</i> 2009; Vijayvargiya and Dey, 2009, 2010; Hadi-Vencheh and Niazi-Motlagh,2011; Falsini <i>et al.</i> 2012; Ying, 2012; Daim <i>et al.</i> 2012; Oliveira Neto <i>et al.</i> 2014; Chen <i>et al.</i> 2013; Ming , 2017; Souza, 2019; Jia <i>et al.</i> 2025
Operation Management	Management of: quality, information, people, loading; receipt; storage and transport.	Analyzes whether the LSP adequately manages logistics operations, including people management and communication.	Göl and Çatay, 2007; Hadi-Vencheh and Niazi-Motlagh,2011; Chen <i>et al.</i> 2013; Oliveira Neto <i>et al.</i> 2014; Nian <i>et al.</i> 2023;

<p>Quality Management</p>	<p>Quality Certification; Physical Integrity Compatibility; LSP seeks improvement in the process and traceability.</p>	<p>Analyzes the quality of service, outsourced operational control performance and quality certifications.</p>	<p>lañez and Cunha, 2006; Göl and Çatay, 2007; Kuo <i>et al.</i>2010; Hadi-Vencheh and Niazi-Motlagh,2011; Daim <i>et al.</i> 2012; Falsini <i>et al.</i>2012; Oliveira Neto <i>et al.</i> 2014; Yayla <i>et al.</i> 2015; Zhu <i>et al.</i> 2016; Liu and Wei, 2017; Liu <i>et al.</i> 2024; Jia <i>et al.</i> 2025</p>
<p>Reliability</p>	<p>Complete Order Dispatching; Classified Information Leaking; Security against load stealing and Fines and awards.</p>	<p>Analyzes the LSP's ability to deliver faultless services, ensuring confidentiality, partnership, and problem resolution efficiently.</p>	<p>Ho <i>et al.</i>2009; Falsini <i>et al.</i>2012; Oliveira Neto <i>et al.</i> 2014;Yayla <i>et al.</i>, 2015; Souza, 2019; Zhang <i>et al.</i> 2019; Saucedo-Martínez <i>et al.</i> 2024; Jia <i>et al.</i> 2025; Galal <i>et al.</i> 2025</p>
<p>Responsibility</p>	<p>Operation in JIT and Dispatch in short term.</p>	<p>Evaluates the LSP for its responsiveness to customer service.</p>	<p>Göl and Çatay, 2007; Hadi-Vencheh and Niazi-Motlagh,2011; Lee <i>et al.</i> 2013; Oliveira Neto <i>et al.</i> 2014; Xie <i>et al.</i> 2014; Chen <i>et al.</i> 2016; Ming , 2017; Jia <i>et al.</i> 2025</p>

After selecting the appropriate criteria and subcriteria for the sector of interest, the comparisons between pairs of criteria are performed as described in the sequence.

2) Construct the pairwise comparison matrix

The comparison between two elements utilizing the AHP can be accomplished in several ways. However, the scale of relative importance between two elements proposed by Saaty (Saaty, 2008) is widely used, assigning values from 1 to 9. The scale determines the relative importance of an alternative in relation to another, according to Table 2.

AHP is a multicriteria selection method that is applied to the solution of complex problems that can have multiple objectives that affect decision-making (Neves *et al.*, 2015). It makes it possible to evaluate qualitative and quantitative criteria simultaneously according to the judgments and importance attributed to each criterion and alternative by the decision-makers, resulting in a classification of alternatives. Generally, the process can be divided into three steps.

Table 2 - Scale of the relative importance of Saaty

Valor	Concept	Description
1	Equally preferred	Both criteria also contribute to the objective
3	Weakly preferred	Analysis and experience show that one criterion is slightly more important than the other
5	Strongly preferred	Analysis and experience show that one criterion is significantly more important than the other
7	Very strongly preferred	One criterion is strongly preferred and its importance is demonstrated in practice
9	Extremely preferred	There is evidence that one criterion is extremely important with the highest certainty
2, 4, 6, 8	Intermediate values to alternative;	When compromise is needed
1/3, 1/5, 1/7, 1/9	Reciprocal values	Reciprocal values applied to peer comparison

Source: SAATY (2008)

Generally, odd values are used, once figures 2, 4, 6, and 8 represent intermediate decisions (SAATY, 2008).

1. Construct the pairwise comparison matrix using the Saaty scale importance

The comparison between pairs is carried out by means of specific software or electronic spreadsheet programs. The process is done through decision matrix A, which calculates the partial results of weights of each criterion, as follows:

$$v_i(A_j), j = 1, \dots, n \quad (1)$$

where:

- A_i represents the i -th alternative;
- C_j is the j -th criterion;
- n is the number of criteria;
- $v_i(A_j)$ is the priority (local weight) of alternative A_i relative to criterion C_j .

In order to interpret and give relative weights to each criterion, it is necessary to normalize the previous comparison matrix. To do so, the following expression is used:

$$\sum_{i=1} v_i(A_j) = 1, \text{ for } j = 1, \dots, n \quad (2)$$

where:

- $v_i(A_j)$ is the normalized priority (local weight) of alternative A_i with respect to criterion C_j ;
- n is the number of alternatives.

The judgments made by those involved in the judging process are evaluated by means of a consistency calculation. Firstly, it is necessary to obtain the maximum value of the eigenvector for each matrix, which represents the relative importance between criteria. This is calculated using the following expression:

$$\lambda = \frac{1}{n} \sum_{i=1}^n C_{ik}^{-1} \quad (3)$$

where:

- λ is the maximum eigenvalue of the pairwise comparison matrix;
- C_{ik} represents the element of the comparison matrix corresponding to the relative importance between criteria C_i and C_k ;
- n is the number of criteria.

The index of consistency (CI) is calculated by:

$$CI = \frac{\lambda - n}{n - 1} \quad (4)$$

The consistency ratio (CR) is calculated by the following equation:

$$CR = \frac{CI}{RI(n)} \quad (5)$$

RI(n) is a fixed value based on the number of criteria, as presented in Saaty (2008). If $CR \leq 0.1$, the degree of consistency is satisfactory, but if $CR > 0.1$, serious inconsistencies may exist, and the AHP may not yield meaningful results [12].

Next, the normalized values (partial results) for each alternative under each criterion are calculated using the following expression:

$$v_i(A_j) = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}}, j = 1, \dots, n \quad (6)$$

where:

- a_{ij} is the element of the pairwise comparison matrix representing the performance of alternative A_i with respect to criterion C_j ;
- $v_i(A_j)$ is the normalized value (local priority) of alternative A_i under criterion C_j ;
- n is the number of alternatives.

2. Calculate the priority weights of alternatives according to the pairwise comparison matrix:

For that, the priorities vectors of each alternative i relative to criterion C_k are calculated with the following expression:

$$v_k(A_i) = \frac{\sum_{i=1}^n v_i(A_j)}{n}, \text{ for } j = 1, \dots, n \quad (7)$$

Afterward, the weights of each criterion C_i and their relative importance are calculated from the criteria pairwise comparison matrix $C = [C_{ij}]$ using the following normalization:

$$w_i(C_j) = \frac{C_{ij}}{\sum_{i=1}^m C_{ij}}, j = 1, \dots, m \quad (8)$$

where:

- C_{ij} represents the relative importance of criterion C_i over criterion C_j ;
- m is the number of criteria at the same hierarchical level;
- $w_i(C_j)$ is the normalized weight of criterion C_i with respect to criterion C_j .

The priority vector (global weights of the criteria) is then obtained by averaging the normalized values:

$$w_i = \frac{1}{m} \sum_{j=1}^m w_i(C_j), i = 1, \dots, m \quad (9)$$

where:

- w_i is the final weight of criterion C_i .

Finally, the overall evaluation score of each alternative A_i is calculated as:

$$f(A_i) = \sum_{j=1}^m w_j \cdot v_j(A_i) \tag{10}$$

where:

- $f(A_i)$ is the final score of alternative A_i ;
- w_j is the weight of criterion C_j ;
- $v_j(A_i)$ is the priority of alternative A_i with respect to criterion C_j ;
- m is the number of criteria.

4 CASE STUDY

The objective of this study is to propose and demonstrate a structured method for selecting logistics service providers specialized in express road freight transport, grounded in Multi-Criteria Decision Making and sensitivity analysis. Thus, to select the LSP that meets the requirements of the contractor, 3 managers participated in the process of selection of criteria and subcriteria, which are involved in the process of outsourcing logistics activities. Thus, from Table 1, the most significant criteria were evaluated according to the characteristics of the segment and strategic objectives of the contractor, which resulted in 7 criteria and 28 subcriteria, which are shown in table 5.

The comparison between pairs of criteria and normalization of the comparison matrix, in this step, shows the most significant criteria for this segment and is shown in table 3.

Since it is a company that excels in the traceability and quality of the services provided in the logistics of express orders and loads, it is verified that the information technology criteria (c4) represent the highest priority in the selection of the LSP with a weight of 0.26166 (26,166 %), followed by responsiveness (c5) with weight 0.25300 (25.300%) and quality management (c1) weighing 0.13680 (16.380%). The criteria that represented less influence in the supplier evaluation and selection process were flexibility (c3) with a weight of 0.07135 (7.135%) and human resources (c7) with a weight of 0.02827 (2.827%).

Table 3 - Criteria weights assigned in the decision-making process

	C1	C2	C3	C4	C5	C6	C7	Weight	
C1 - Quality management	1	3	3	1/3	1/3	3	5	0,1638	16,38%
C2 - Operation Infrastructure	1/3	1	3	1/3	1/3	3	5	0,1259	12,59%
C3 - Flexibility	1/3	1/3	1	1/3	1/3	1/3	5	0,0714	7,14%
C4 - Information Technology	3	3	3	1	1	3	7	0,2617	26,17%
C5 - Responsibility	3	3	3	1	1	3	5	0,2530	25,30%
C6 - Reliability	1/3	1/3	3	1/3	1/3	1	5	0,0960	9,60%
C7 - Human Resources	1/5	1/5	1/5	1/7	1/5	1/5	1	0,0283	2,83%
$\Sigma=$	8,200	10,867	16,200	3,476	3,533	13,533	33,00	1,000	100%

The comparison between pairs and normalization of the comparison matrix was performed for the subcriteria and is shown in Table 4. In this way, it was possible to identify how much each criterion impacts the process of evaluation and selection of the LSP. The operation criteria in JIT (c5.1), ease of communication - EDI (c4.1), and routing (c4.5) are the subcriteria that most impact

the LSP evaluation and selection process. On the other hand, the subcriteria that had less impact on the selection process were capacitation and practical tests (c7.3) and Clothing and neatness of the employees (c7.4). The consistency ratio (CR) shown in Table 4, illustrates the consistency in the comparison between pairs since in all cases the $CR < 0.1$.

Table 4 - Consistency of the pairwise comparison

Review Items	Consistencies (CR)
Comparison between criteria - 1st level	0.08884
Comparison between sub criteria - 2nd level	
C1 - Quality management	0.04324
C2 - Operation Infrastructure	0.09288
C3 - Flexibility	0.00000
C4 - Information Technology	0.07799
C5 - Responsibility	0.00000
C6 - Reliability	0.05787
C7 - Human Resources	0.05787

The peer-to-peer comparison between the bidding companies in each of the subcriteria resulted in the classification of the three LSPs in each sub-criterion. Table 5 shows this classification, and it can be seen that LSP 3 presents better scores in most of the comparisons, following the LSP 1 sequence. Thus, with this comparison, we verified the favorable criteria for choosing each one of the LSPs.

LSP 3 is best ranked in twelve of the twenty-eight subcriteria as can be seen in Figure 2, which shows an overview of suppliers' performance against subcriteria. Secondly, there is LSP 1, which stands out in 9 subcriteria in relation to LSP 2. LSP 2 remained in the 3rd place in the evaluations of most of the subcriteria except for the traceability, suitable facilities, ERP, WMS and GPS, operation in JIT, complete order delivery, security against load stealing, clothing and neatness of the employees and employee qualification in which all of the LSPs performed the same performance.

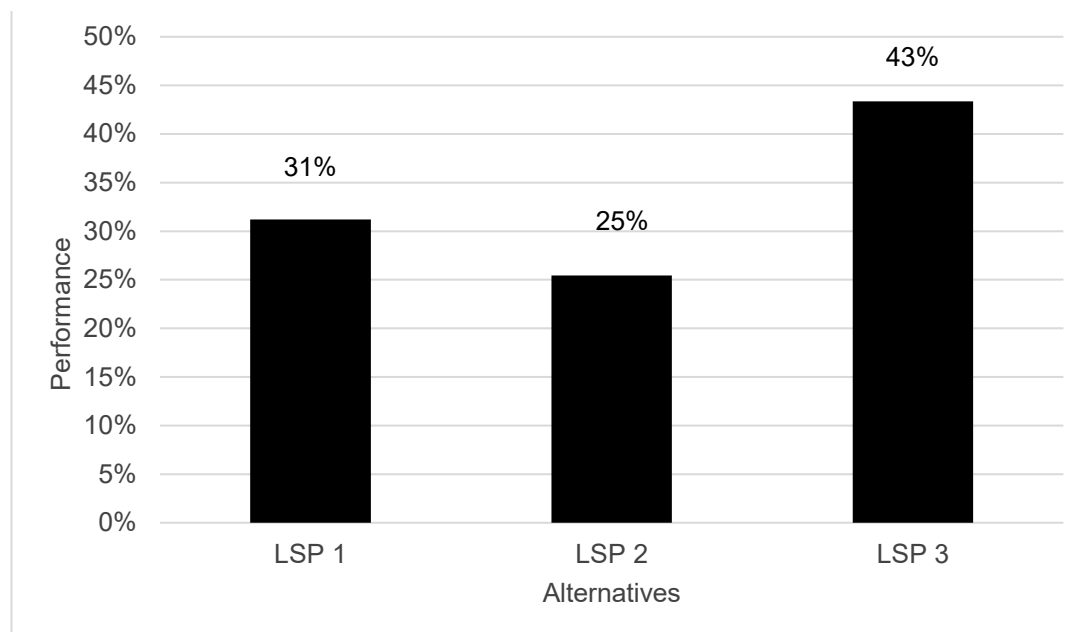


Figure 2 - Decision hierarchy model for LSP selection

3.1.8 Sensitivity analysis

The sensitivity analysis allows decision makers to visualize how much a subjective assessment of the weights of the criteria impacts the classification of the LSP in an application of the AHP

method (Bayazit and Karpak, 2013). This feature allows you to visualize how much it is possible to increase or decrease the weight of the criteria individually without changing the classification of the LSPs. It is also possible to identify the criteria that are most sensitive to variations in opinion. When identified, a more careful evaluation is recommended, since small variations of weights invert the classification of LSPs.

Given this property, the global priorities of alternatives can be expressed as a linear function of w_i using the following formula (Chen, H., Kocaoglu, D. F. A., 2008).

$$P_i = ((P_i'' - P_i' / w_i'' - w_i') (w_i - w_i') + P_i' \tag{11}$$

where P_i'' and P_i' are the priority values for w_i'' and w_i' , respectively.

For illustration purposes, Figure 3 presents the sensitivity analysis performed in the Quality Certification sub-criterion (c1.1), which has a current weight of 1.63%, it is noticed that increasing or decreasing the weight of this subcriterion does not change the classification of LSPs.

However, if this criterion is eliminated, that is, by moving the current value to zero, there will be a tie between LSP1 and LSP2, second and third placed.

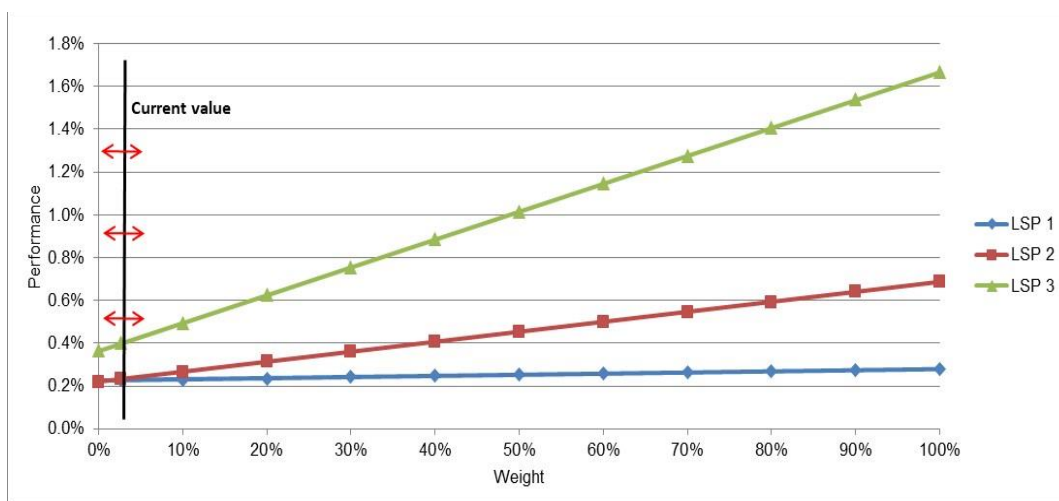


Figure 3 - Sensitivity analysis for the subcriterion C1.1 - Quality Certification

Table 5 illustrates that only subcriteria C1.1, C1.2, and C1.3 are sensitive to variations of opinion on this subcriterion, and they can individually alter the classification of LSP 1 and LSP 2, and this table shows the critical value that causes the change in the classification of the LSP.

Table 5 - Performance of LSPs and Sensitivity analysis

Criteria	Performance			Weight and sensitivity analysis		
	LSP 1	LSP 2	LSP 3	current value	Critical value	Changes classification
C1 - Quality management						
C1.1 - Quality Certification	0.1062	0.2605	0.6334	2.63%	<1,00%	Yes
C1.2 - Physical Integrity Compatibility	0.2000	0.2000	0.6000	5.85%	5.85%	Yes
C1.3 - LSP seeks improvement in the process	0.4286	0.1429	0.4286	1.36%	4.00%	Yes
C1.4 - Traceability	0.3333	0.3333	0.3333	6.53%	100%	No
C2 - Operation Infrastructure						
C2.1 - Distribution Centres Location	0.2000	0.2000	0.6000	4.16%	-	No
C2.2 - Suitable facilities	0.3333	0.3333	0.3333	1.96%	100%	No
C2.3 - Security in distribution centers	0.3206	0.2254	0.4540	1.87%	-	No
C2.4 - Transportation safety	0.2000	0.2000	0.6000	1.71%	-	No
C2.5 - Equipment required for loading into the contractor, storage and transport to the customer	0.4286	0.1429	0.4286	1.05%	100%	No

C2.6 - Vehicle conditions	0.2000	0.2000	0.6000	1.23%	-	No
C2.7 - Own vehicle fleet	0.4546	0.0909	0.4546	0.62%	100%	No
C3 - Flexibility						
C3.1 - Capacity for handling individual requests - customized	0.3333	0.3333	0.3333	5.35%	-	No
C3.2 - Ability to negotiate new customer services	0.2000	0.2000	0.6000	1.78%	-	No
C4 - Information Technology						
C4.1 - Ease of communication (EDI)	0.4286	0.1429	0.4286	0.57%	-	No
C4.2 - ERP	0.3333	0.3333	0.3333	3.86%	100%	No
C4.3 - WMS	0.3333	0.3333	0.3333	5.73%	100%	No
C4.4 - TMS	0.4286	0.1429	0.4286	3.52%	-	No
C4.5 - Routing (GPS)	0.3333	0.3333	0.3333	2.49%	100%	No
C5 - Responsibility						
C5.1 - Operation in Just in Time - (JIT)	0.3333	0.3333	0.3333	18.98%	-	No
C5.2 - Short-term deliver	0.2000	0.2000	0.6000	6.33%	-	No
C6 - Reliability						
C6.1 - Classified Information Leaking	0.3333	0.3333	0.3333	0.93%	100%	No
C6.2 - Fines due to no-treatment	0.2000	0.2000	0.6000	3.69%	-	No
C6.3 - Security against load stealing	0.3333	0.3333	0.3333	2.19%	-	No
C6.4 - Complete order delivery	0.4286	0.1429	0.4286	2.79%	100%	No
C7 - Human Resources						
C7.1 - Capacity of Working in Group	0.3333	0.3333	0.3333	0.37%	100%	No
C7.2 - Employees Qualification	0.2605	0.1062	0.6334	1.10%	-	No
C7.3 - Capacitation and practical test	0.2605	0.1062	0.6334	0.51%	-	No
C7.4 - Clothing and neatness of the employees	0.3333	0.3333	0.3333	0.37%	100%	No

On the other hand, the sensitivity analysis of the subcriterion "LSP seeks improvement in the process (c1.3)", whose importance weight in the decision process is 1.36%, allows to identify of a possible reversal of classification of LSP1 and LSP2 when the current value increases for values above 4%. Criterion C1.3 is the most critical, since a small variation of opinion on the part of the decision-makers, can lead to an inversion of classification between LSP 1 and LSP2. Thus, it is important to provide the sensitivity analysis charts to those involved in the decision process, as they will know the limits of judgments attributed to the criteria and subcriteria that can change the classification of LSPs.

5 DISCUSSION

The selected LSP company must act in partnership, being prepared to adapt to customer needs. Express transportation requires priority delivery and IT resources that enable the customer to check delivery status (Chen *et al.* 2013; de Oliveira Neto *et al.* 2019), constant monitoring of customer satisfaction is necessary (Santos *et al.* 2024). Therefore, it is not possible to select the LSP based only on cost, this process tends to consider an expressive number of attributes that follow the market dynamics where they are performed (Granillo-Macías R and J. González-Hernán J. 2020). The selected partner must meet the infrastructure requirements, including IT resources and quality management that incur costs, but in turn, increase the quality of services provided. The results obtained differ from the majority of the studies based on costs alone (Zhong *et al.* 2016), since for the express cargo segment the levels of services provided, delivery times, and traceability are of paramount importance because they can guarantee the renewal of contracts. At the moment to freight purchase and signing the contract with the LSP, it is essential that solid and transparent criteria for choosing this logistics service have been definitively and previously considered. This will promote effectively the best decision. (Naseem *et al.* 2021; Liu *et al.* 2024).

The availability of information technology by the LSP was the most important criterion (26.17%)

for the contractor, aiming at the selection of an LSP specialized in express cargo road transport. This is due to the contractor's need to provide access to its customers on order positions, product locations, and delivery times. Considering these needs, it is important to integrate information systems between contractors and LSP. The integration of information systems also occurs in the logistics sector to attend E-commerce, because purchases are made through the internet and the LSP receives the information in real-time for the collection, assembly of kits, packaging, and deliveries of products (Chen *et al.* 2016; Zhu *et al.* 2016; Ming, 2017; Zhang *et al.* 2019). Information technology resources for systems integration between companies were also considered relevant in the LSP selection process for the electronics and electronics industries (Iañez and Cunha, 2006) and automotive (Vijayvargiya and Dey, 2010). This finding contributes to organizational practice because it concludes that in order to hire an LSP specialized in express cargo road transport first, it is necessary that it has IT with fast internet to integrate the transport management system with the contractor to have order information in real-time because the main focus of this sector is short-term delivery. It also contributes to the theory, because the surveys carried out in the express service sector do not mention the need to require technological resources from LSP, regardless of the amount charged for the service.

In this context, responsiveness (25.30%) is the second more important criterion for the selection of LSP specialized in land transportation of express cargo, due to the need to deliver on time. Some qualitative evidence on the requirement of responsiveness to the LSP was identified in the literature as a contractual requirement (Lee *et al.* 2013; Xie *et al.* 2014; Chen *et al.* 2016; Ming, 2017), despite not having research that dealt with the selection of LSP for land transportation of express cargo, denoting the contribution to the theory. In addition to the practical contribution, in the field of express charges, the contracted company attends to the orders delivery, which customers are in a hurry to receive the orders, such as in purchases made over the internet, which normally requires placing delivery deadline, tracking the merchandise and possibility of scheduling the delivery, an important aspect according to Ibusuki *et al.* (2023).

As a result, short-term delivery is a competitive differentiator for companies that need express road transport, some surveys that mention e-commerce also show short-term delivery as a relevant aspect (Chen *et al.* 2016; Ming, 2017; de Oliveira Neto *et al.* 2019; Zhang *et al.* 2019). The same happened in the electronics industry, whose commercialization of a product requires the urgent replacement of inventories (Ho *et al.*, 2009). However, short-term delivery is more complex when it comes to express charges, because, in Brazil, Law No. 8,078, of September 11, 1990, article 49 provides that consumers may withdraw from the purchase agreement within seven days of the date of signing when the contracting of products or services occurs outside the commercial establishment (BRASIL, 1990). Such a situation could result in discarding if deadlines are not met, causing costs for the contractor, as well as compromising the company's quality and image indicators in relation to the competitive logistics services market, contributing to the organizational practice.

Also, it was found that it is important to hire an LSP that has quality management (16.38%) with ISO 9000 certification to guarantee the physical integrity of the products in the transport operation for delivery to final customers. This finding corroborates the research by Oliveira Neto *et al.* (2017) who presented performance indicators for monitoring quality in express road transport services. As in the agricultural products sector, the levels of services provided result in the quality perceived by the customers (Xiu and Chen, 2012; Ying, 2012; Liu *et al.* 2024). The demand for quality management in the express road transport operation aims mainly to maintain the physical integrity of the product in the short-term delivery process, that is, delivery of boxes without being crumpled or unwrapped, merchandise in operation, delivery on time, and after-sales service. -sale with warranty. These aspects generally in the express service sector are performance indicators for monitoring the operation.

Nevertheless, for the delivery of the perfect order, it is extremely important that the LSP has operational infrastructure capacity (12.59%), being the fourth most important criterion because the LSP must be located close to the key customers to deliver in JIT, to have transportation security due to the high added value of new products and equipment and vehicles to support the responsibility of the operation. Some research on express road transport has indicated that the operational infrastructure needs to be resilient for selecting alternative routes, changing shipping modes, renting capacities from other carriers, relocating local trucks, and prioritizing the order of remittances due to limited capacities (Chen *et al.* 2013); including the use of suitable vehicles, optimizing the departure time and organizing the trajectory of the vehicle to save transportation costs and improve distribution efficiency (Ming, 2017; Souza, 2019), but no research has conducted research related to the selection of specialist LSPs road transport of express cargo.

A relevant aspect is that the cost analysis in the outsourcing decision was extracted by the contractor's decision makers at the beginning, according to them the profit of the chain is guaranteed, being a consequence of the excellence in terms of IT, responsiveness, quality, and

operational infrastructure. With that, this study advances the scientific literature because only the research by Zhong *et al.* (2016) mentioned the LSP decision and selection of road freight transport with a focus only on the decision with a focus on cost/profit. Ibusuki (2005) mentioned that the adoption of cost management in the stage-gate system is necessary.

The sensitivity analysis showed that LSP 3 is the most appropriate for the transport of express cargo by road because even varying more or less or extracting some sub-criteria (conformity to guarantee the physical integrity of the products in express delivery - C 1.1, LSP with quality certification - C 1.2 and LSP that seeks continuous improvement - C 1.3) the decision to select LSP 3 continues. However, when criteria that require quality certification and physical integrity of products are excluded, there is an impact between LSP 1 and 2, showing that these criteria were fundamental to the decision that LSP 1 is better than LSP 2.

It also noted that the sensitivity analysis performed in this study allowed us to identify that the sub-criterion "LSP seeks improvement in the process (c1.3)" is sensitive to the opinions of the decision-makers, as there is a reversal of classification of LSP1 and LSP2 when the importance weight is increased 1.36% to 4%.

In addition, the sensitivity analysis is very important for decision-making in organizational practice, mainly because if there is a problem in the formalization of the contract with LSP 3, the contractor can select LSP 2, because it is easier to perform improvements in processes, due to the organizational culture of transforming failures into continuous improvements. With this, it may be that LSP 2 has more resilience to adapt the operation than LSP 1, in terms of promoting continuous improvements. This finding corroborates the scientific literature, as no studies were identified that applied sensitivity analysis for the decision to select a specific LSP for express road cargo transportation.

6 CONCLUSION

In this work an LSP specialized in road transport of express cargo for an express service company was selected using the AHP method combined with sensitivity analysis.

The LSP 3 specialized in express road transport was the most suitable to integrate into the supply chain of the express service contractor, because it met the information technology criteria (EDI with broadband and transport management system), responsiveness (short-term deliveries), quality management (ISO 9000 certificate and guarantee of the physical integrity of the product in transport) and operational infrastructure (close location to key clients, equipment and new vehicles that ensure responsiveness in delivery) required by the contractor, thus contribute to improving the levels of services provided, preserving the company's image and customer loyalty.

In the sensitivity analysis, the LSP 3 selection decision was confirmed, because even moving some more important sub-criteria, which aims at quality management to promote continuous improvements with a focus on guaranteeing the physical integrity of products in transport until delivery, the decision remains the same. In case of problems in contracting LSP 3, the best option was reversed for LSP 2, because the contractor prefers an LSP that has the ability to promote continuous improvements over time.

Moreover, from the best of your knowledge, it is the first work that identifies the strategic criteria for the selection of LSP specialized in road transportation of express cargo through analysis of specialists of the contractor; and then uses these strategic criteria for evaluating three LSPs to identify which one is the most suitable to integrate an express service company's supply chain transportation operation. In addition, it was concluded that this result contributes to the literature because the only scientific research on the selection of LSP specialized in the transport of express cargo aims only at cost analysis in terms of profit sharing among partners. This finding also corroborates with the scientific literature because no research has been identified that applied sensitivity analysis to the decision to select an LSP in express cargo road transport.

Moreover, this study contributes to supply chain managers and express delivery road transport operations because it shows a realistic decision-making process, elucidating the most relevant strategic criteria and subcriteria for the decision, which are important for the contractor to demand from the LSP in the contractual process.

It also reinforces to industrial managers that the outsourcing decision must be established based on an in-depth study, not only focused on cost reduction, mainly because in the express service sector, the operation is usually costly due to operational responsiveness and the required quality.

It is also concluded that the findings achieved are relevant and indirectly impact society, whether through a better understanding of the criteria for selecting service providers (personalization/satisfaction), or through an appreciation of companies and employees who consider these points (recognition/appreciation), allowing decisions not to be made solely based

on the lowest cost.

As further investigations, the approach presented could be extended to be applied to other sectors, in which there is important to select LSP. It is noteworthy that a proposed approach may be applicable to other contexts, such as different countries, regulatory environments, or express transport operators, thereby strengthening the analytical generalization and external applicability of the method for selecting logistics service providers specialized in express road freight transport, grounded in multi-criteria decision making and sensitivity analysis.

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