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Research Article

Analytic hierarchy process applied in the prioritization of third-party logistics providers in banking services

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Abstract

Paper aims: This paper describes research that aimed to develop a procedure for prioritizing the performance management of Third-party logistics (3PL) who work in a banking services company.

Originality: This article's main contribution is the development of a procedure for evaluation and prioritization of the main 3PL performance indicators based on the SCOR model's metrics.

Research method: This paper applied Analytic Hierarchy Process (AHP), a method for multi-criteria analysis, using the metrics of Supply Chain Operations Reference Model (SCOR).

Main findings: The approach proposed evaluates performance indicators of 3PL and prioritizes the development of new performance indicators using the metrics agility, responsiveness, and reliability of SCOR.

Implications for theory and practice: This research contributes to the literature by demonstrating the applicability of multicriteria approach to find the prioritization of 3PL in a banking services company.

Keywords

Analytic hierarchy process. Banking services. Performance management. Third-party logistics providers

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1. Introduction

The study of the relationship between firms and third-party logistics (3PL) has become increasingly relevant in academia, as logistics services encompass a wide range of activities, including product processing and receiving, distribution, asset recovery, and customer interface (Akhtar, 2023; Taha & Reynolds, 2023; Daugherty et al., 2019).

Furthermore, aligned with the performance management approaches adopted by Hwang et al. (2016) and Kumar & Prashar (2024), who consider logistics capabilities alongside human and technological resources, the literature highlights the significance of relationships in 3PL. Strong partnerships, as emphasized by Hsu et al. (2013) and Liao & Kao (2014), are vital for facilitating tailored solutions, improving communication, and fostering innovation. Addressing this gap is crucial for mutual growth and competitiveness in the 3PL sector.

Moreover, the success or failure of initiatives involving 3PL depends on interpersonal relationships performance management, and the context in which the relationship is established (Pellathy et al., 2018; Sanchís-Pedregosa et al., 2018). The provision of 3PL services and their performance can directly affect clients, necessitating constant management, especially when connecting the company to the client (Sengupta et al., 2018).

More than forty years ago, Heskett (1977) asserted that "Logistics can spell the difference between success and failure in business," a statement that remains pertinent today. Despite this, there is a noted gap between the expectation of utilizing client data in 3PL performance management and its practical implementation

(Daugherty et al., 2019). Relationship management between companies and 3PL extends beyond financial capabilities, encompassing reliability and other essential attributes (Abidi et al., 2019; Sengupta et al., 2018).

Performance management in 3PL must align with strategic, operational, and financial requisites. However, there exists no consensus on a specific approach to managing performance, with considerations extending to human and financial resources and the level of collaboration between firms and 3PL providers (Sanchís-Pedregosa et al., 2018; Santos & Lima, 2018; Fernandes et al., 2018).

According to a special edition of Logistics Management magazine titled "The E-commerce Logistics Revolution," relationships and clarity in process definition, in addition to software and technology, are instrumental in assisting retail and manufacturing companies, along with their respective 3PL partners, in meeting the growing demands of clients—both in B2B (Business to Business) and direct-to-customer scenarios (Levans, 2018).

Throughout this research, the Analytic Hierarchy Process (AHP) method was utilized. This method was chosen due to its flexibility in decision-making processes and its ability to handle multiple criteria when addressing complex problems. AHP facilitates decision-making by conducting pairwise comparisons and assigning weights to criteria and sub-criteria (Ortiz-Barrios et al., 2020).

The literature about the banking system service domain addresses various aspects related to 3PL, including capital-constrained environments, pricing strategies (Sun et al., 2023), logistics finance risks (Li & Liu, 2013), and risk prevention and guarantee finance (Zhang et al., 2024). This research introduces innovation by focusing on the performance of 3PL logistics services within the context of a banking services company. Therefore, the primary objective of this article is to devise a procedure for analyzing the performance management of 3PL providers in collaboration with a banking services company. Specific objectives include utilizing a multi-criteria approach to evaluate the performance management of 3PL partners and prioritize the proposal of new performance indicators, leveraging the metrics outlined in the Supply Chain Operations Reference Model (SCOR).

This article is organized as follows: Section 2 introduces the background literature, focusing on logistics services, key performance indicators, SCOR, and performance and relationship management. The methodology is described in Section 3, while Section 4 presents the procedure for executing performance management analysis of 3PL. Finally, the article concludes with a Discussion, Conclusions, and References section.

2. Literature review

2.1. Bibliometric analysis

Bibliometric analysis helps to logically analyze data and reveal patterns and conclusions that may not be immediately obvious. This review includes an overview of publications closely related to the study presented in this article. There are several different approaches to literature reviews (Grant & Booth, 2009). To meet and support the objective outlined in Section 1, a bibliometric analysis of the literature was conducted. The results of this analysis provide comprehensive insights and necessary support for the development of the research (Ruiz Bargueno et al., 2021). The bibliometric analysis was made through Scopus (https://www.scopus.com) and Web of Science (https://www.webofscience.com) databases. The search was carried out considering the combination of keywords such as "Third-party logistics", "Analytic Hierarchy Process" and "Performance management", based on "Article title, abstract, keywords" to Scopus and on "Topic" to Web of Science. Likewise, only articles, conference papers and reviews until August 3, 2023 were considered.

The combination of keywords searched is presented in Table 1. It contains information about the number of documents found in Scopus and Web of Science, and the number of unique papers excluding repeated records in the database merge.

Table 1. Scopus and Web of Science publications.

Keywords	Scopus	Web of Science
"Analytic Hierarchy Process"	31,394	22,709
"Performance management"	10,489	6,847
"Analytic Hierarchy Process" AND "Third-party logistics"	85	65
"Performance management" AND "Third-party logistics"	12	6
("Analytic Hierarchy Process" OR "Performance management") AND "Third-party logistics"	97	71

Table 1 illustrates that the number of publications considering the keywords "Analytic Hierarchy Process" or "Performance management" is considerable. Also, it is possible to observe that through the combination of

keywords ("Analytic Hierarchy Process" OR "Performance management") AND "Third-party logistics" the number of articles was only 97 documents in Scopus and 71 documents in Web of Science. Some duplicate documents were found from these articles in the two databases, which were subsequently debugged.

Publications were distributed from 2004 to 2023 among a total of 102 sources and with a total of 1606 citations. Also, according to the authors' collaboration was obtained about three co-authors per document and an international co-authorships index of 10.92%.

Figure 1 shows the number of publications per year, where it is notable that there were more publications in the years 2009 (14) and 2019 (12). It was also observed that the mean number of citations per year in this period oscillated between 0 and 3 citations approximately.

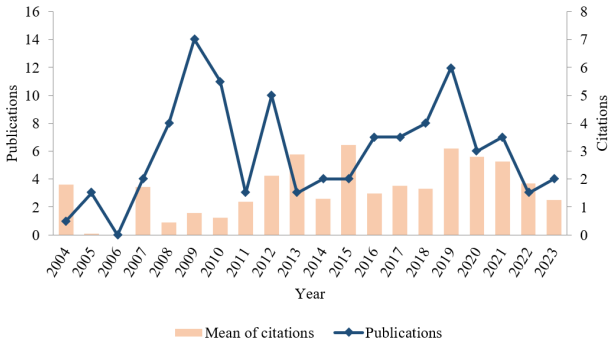

Figure 1. Number of publications and mean of citations per year.

In the same way, the number of publications per country of the corresponding author was analyzed because through this analysis is possible to identify the interest of the study at the global level. Figure 2 shows that the documents were published by 21 countries, identifying that China (56) and India (18) were in the first and second position being the countries with the highest number of publications. In addition, it was found that Brazil only obtained one document published in 2022.

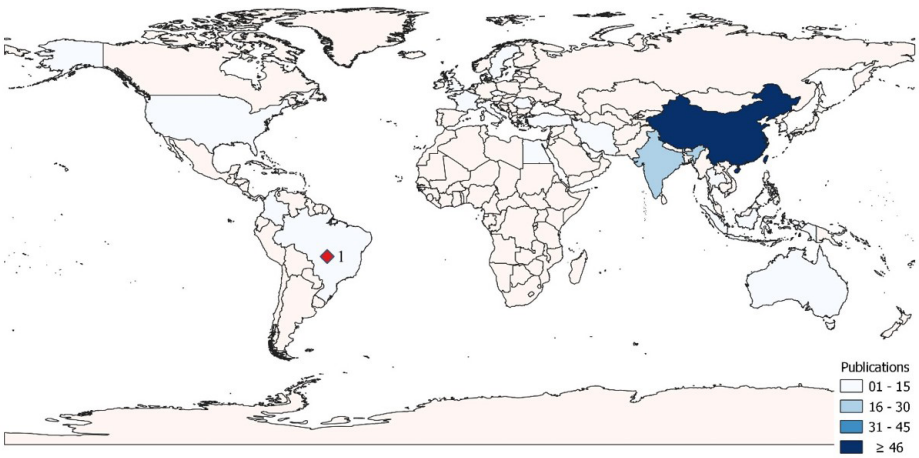

Figure 2. Number of publications by country of the corresponding author.

Effects of organizational culture and the size of companies in collaboration and in management of logistics performance can be based on values and beliefs influence on the construction of a collaborative relationship. Besides that, it can be evaluated it performance and relationship management are seen in different ways according to the company size (Aharonovitz et al., 2018).

The challenges of performance management under 3PL optics involve the opportunities they see in the partnership, in conflict reduction and in how to achieve their potential to contribute to the company (Sanchís-Pedregosa et al., 2018). Customers have a very sensible perception about 3PL performance (Pellathy et al., 2018). Regulatory organizations monitor functioning, create laws and are change agents of companies' relationship with their 3PL (Sengupta et al., 2018).

Impacts of integrating Information Technology (IT) systems of companies and 3PL in performance management is one of the biggest problems at the beginning of a partnership. Data usage and information confidentiality, as well as the use of different IT platforms have influence on the partnership (Song et al., 2019). Table 2 shows the topics describe the literature research gap.

Table 2. Literature research gap summary.

References	Topics
Aharonovitz et al. (2018)	Effects of organizational culture and company size on performance management.
Pellathy et al. (2018)	Influence at performance management on the final client perception of the company.
Sanchís-Pedregosa et al. (2018)	Challenges of performance and relationship management through 3PL optics.
Sengupta et al. (2018)	Legislation and Regulation Organization effects on performance management.
Song et al. (2019)	Influence of logistics systems integration on performance management.

The bibliometric analysis of 3PL contributes to the literature by examining various approaches to performance management, as identified by (Aharonovitz et al., 2018; Pellathy et al., 2018, Sanchís-Pedregosa et al., 2018; Sengupta et al., 2018; Song et al., 2019). Considering the limited number of publications in this area in Brazil (Figure 2), this study aims to expand the body of research in Brazil by presenting a procedure for conducting performance management analysis of 3PL using the AHP framework. The analysis presented in this section indicates that the topic of 3PL is still emerging in the Brazilian context, offering ample opportunities for further exploration.

2.2. Logistics services

Logistics is one of the most important functions in economy and begins in the raw input acquisition for a given product until the delivery to the final user and Reverse Logistics (RL) are the reverse flows in relation to the traditional direct flows of supply networks. Over time, logistics from simple operational support to a net, which covers all added value phases of the chain. The main services in logistics are order processing, warehousing, and transportation (Gleissner & Femerling, 2013).

Logistics services present a wide range of components, such as information services, orders processing, warehousing, and transportation (Isermann, 1994). They have the main objective of integrating material, financial and information flows, connecting companies end to end through processes and controls to build a single system, maximizing value creation and profit during the whole life cycle of an item. (Mangla et al., 2018).

Logistics services performed by 3PL are expressed in the form of a contract, which, in most of the cases, is customized to address a client's requisites, demanding equipment, facilities, personnel and training investments to meet the needs of companies in gain of scale, scope enlargement, technology knowledge and human resources (Mendes, 2019).

During most logistics services execution there is value assertion from 3PL. In Brazil it is considered that there is much more space for 3PL to expand their portfolio of services provided to firms, thereby developing contracts of continuous and unique services which highlight their competencies integrated to client companies' business medium and long term (Almeida et al., 2020).

Conflict between logistics services and costs represent a challenge to companies. Logistics services comprising delivery time and quality, readiness and availability can be compared with logistics costs like warehousing, handling, transportation, and logistics system (Schulte, 2009). Logistics services are of great relevance to bring strategic and sustainable advantages to companies (Cohen & Roussel, 2013).

2.3. Management through performance indicators

Key Performance Indicators (KPI) are indexes that help companies in following operations evolution, avoiding build-up and use of irrelevant information. Through this tool companies remain focused and communicate their vision and mission to employees in lower hierarchy levels. After all, establishing and sharing what will be measured makes

clear to the whole team what is in fact relevant (Santos & Santos, 2018). The worry about indicators employment is shown by several sectors such as: government, private organizations, Non-Government Organizations (NGOs), universities and research institutes, and there is extensive material about the subject (Lellis, 2020).

The degree of excellence of a performance indicator can be defined by its capacity to measure what it aims to, data collection readiness, results reliability, relevance, cost an effort to produce it, as well as real effectiveness of its utilization. The process of elaborating performance indicators must be lined with those requisites (Pereira, 2018).

A comparison between the found result and the set goal is made, with the purpose to verify if there were deviations; in positive case, the causes should be examined, solutions found and actions taken to repeat the process until it is performing properly (Tavares, 2018).

The companies should be careful so that they communicate important and reliable information, relevant to solve process flaws and support decision-making. Implementation of performance indicators involves costs related to adoption and accommodation to technological resources, internal controls, and routines, then the company should act with a collaborative spirit and targeted objectives should be clear to all personnel involved (Ramos et al., 2020).

There is a wide range of performance indicators categories that provide a series of fundamental information to the adequate development of an organization, some of them it`s could cite the productivity, capacity quality, strategic, among others (Santos & Lima, 2018). To support indicators identification, meetings with professionals involved in the process are used, documentary consults and data mining techniques to correlate data (Peral et al., 2017).

Performance indicators can be customized to address specific needs of an organization. However, some performance indicators are used uniformly in logistics sector such as On Time in Full (OTIF), Service Level Agreement (SLA) and First Time Through (FTT). OTIF is commonly used to measure the level of logistics service. It evaluates the number of orders received in accordance by the client, according to established standards like date and time for example. Its calculation is usually performed as a ratio between deliveries executed successfully and total of deliveries executed by a company (Cardoso & Santos, 2019).

FTT is an indicator wanted for almost all organizations, once it measures the number of products and/or services successfully achieved, without any sort of imperfection or rework need. Its calculation is obtained by a ratio of products and/or services concluded with some type of deviation and the total number of products and/or services concluded (Borges, 2019).

Management through performance indicators has become a necessary tool to measure and analyze the results of logistics operations, regardless of their segment or size. Performance indicators can be classified in strategic, which are linked to long term objectives of organizations; tactical, that monitor changes in operational performance; and operational, that connect routine measurements (Silva et al., 2018).

2.4. Supply chain operations reference model (SCOR)

SCOR was stablished by the Supply Chain Council in 1996. Its measurement is made through key-indicators identification within the company's logistics chain, to evaluate and implement actions to improve performance (Prasetyaningsih et al., 2020). It is useful to strategic enhancement, structures definition (including human capital), processes management and performance measurement. Besides, it allows to identify and eliminate redundant practices in logistics chain (Huang et al., 2020).

SCOR allows companies to conduct a complete analysis based on facts of all supply chain aspects, providing a complete set of process details and performance metrics (Wang et al., 2018). The main performance attributes developed by SCOR are Agility, Responsiveness, Reliability, Cost and Efficiency in Assets Management. The definition for performance attributes can be seen on Table 3. SCOR adoption is reinforced for by its wide usage in logistics according to Huang et al. (2020), Prasetyaningsih et al. (2020) and Wang et al. (2018).

Table 3. SCOR performance attributes.

Performance Attributes	Definition
Agility	The ability to answer to external influences; the ability to answer to market changes or maintain competitive advantage. Agility SCOR metrics include flexibility and adaptability.
Responsiveness	The speed at which tasks are performed. The speed at which the supply chain delivers products to customers. Examples include metrics of time cycle.
Reliability	Ability to perform tasks according to what is expected. Reliability focuses on forecasting results of a process. Typical metrics include on time, good quality and the right amount in deliveries.
Costs	Operation costs of supply chain processes. This includes material, labor, transportation, and management costs.
Assets Management Efficiency	Ability to use assets effectively and performance management strategies of assets include warehousing in sourcing versus outsourcing and reduction. Metrics include number of storage days in suppliers and capacity usage.

Source: Wang et al. (2018).

2.5. Performance management of third-party logistics

Performance management occurs through key-meetings at strategic, tactical, and operational levels and with intensive use of visual management tools, like checklists and control panels. Logistics can also use performance management techniques, operational processes, financial results in accordance with standards and processes of a company (Cha, 2020).

Performance management should be linked to a certain expected service level which allows measurement of the provided services. The level of service is not an arbitrary variable and is connected not only to clients' requirements, but also to competitors and a company capacity (Gleissner & Femerling, 2013).

The results measured by performance indicators will only be valid if endorsed by data and solid and truthful information in case there is a performance management process focused on company strategy. Performance indicators should allow comparison with the past, to the performance standard, commitments made and performance goals. Performance management must be connected to one or more performance indicators (Andreola et al., 2019).

3PL should identify aspects related to their performance that do not completely satisfy contractors expectations. Therefore, they will be able to develop means to soften such deviations, enhancing performance, specially about criteria important to partner companies (Vasconcelos & Fontana, 2020).

Effects of 3PL employment occur on service levels, which allow companies to correctly place their outsourcing activities and improve performance. It's not always that companies are assured outsourcing will meet the desired results, whether reducing costs or improving quality and productivity. Thereby, managers of those companies should establish a detailed analysis process with internal and external information, precise and complete, to manage 3PL performance (Vivaldini, 2019).

Given the relevance of logistics services, companies should monitor outsourced services. Performance and results achieved by 3PL have strong dependency on the company that hires them. In this sense, their evaluation through performance indicators should be followed by explicit specifications, especially those required by the final clients, minimizing contesting. Performance management should be supported by data collecting and analysis, regardless if they are acquired by information systems or by human resources (Gerbl et al., 2016).

2.6. Relationship management of third-party logistics

Relationship management is a complex matter, not only for the dedication and the involvement level of parties, but also for requiring a collaborative posture. Therefore, the partnership needs an active management, once noninvolvement or even inflexibility between companies and 3PL may cause disbalance in the relationship. It is necessary to find an optimal level of efforts to avoid that benefits are turned into costs or risk (Abdel-Basset et al. 2019).

The benefits of collaboration in relationship management are achieved when companies and 3PL share information and cooperate in a relation focused on improving business performance. Openness to new ideas and knowledge between the parties not only level up the performance but demonstrate trust and respect, strengthens partnership, and generates opportunity to a productive relationship in the future (Vivaldini, 2020).

Companies should manage and build long term relationships with their 3PL, but this is not a simple task, once it involves intangible items and relational exchange. Relationship management should yield rewards to all people involved; it is one of the factors which help to understand why commercial relationships are continued or ended. Rewards are not only monetary or tangible, but also involve values like reputation and feeling of belonging (Balci et al., 2019).

Competitive advantages result from a good relationship between 3PL and firms; It results from trust, collaboration and stability, interdependency and communicating information. Furthermore, a mutual dependency relation should include rewards sharing, losses and risks and should support close and lasting partnerships between the chain members (Koch & Gasparetto, 2019).

Relationship management in a logistics chain made clear the perception that all departments should communicate, emphasizing that the lack of a collaborative and communicating relationship compromise profit and efficiency of all members. Transparent and reasonable information sharing stimulates trust and supports conflicts solution, then being a fundamental to relationship success (Lambert & Enz, 2017).

3. Methodology

3.1. Research method

The qualitative approach is used to identify variables, as well as items and measuring scale for research development. The interest of qualitative method is not only the results, but the path to get to them, making it possible for the researcher to have some autonomy in research development (Miguel, 2018).

The act of measuring research variables is the most distinct and comprehensive characteristic of the quantitative approach. This type of approach is mostly preoccupied with measurability, causality, generalization, and replication. One of the most common ways to manipulate models and data is through evaluating a mathematical model's variables (Miguel, 2018).

Model-based quantitative research can be defined as the study where control and performance variables are developed, analyzed, and tested. Performance variables can be physical, such as the stock of a certain product, or economical, such as a company's profit (Bertrand & Fransoo, 2002).

Modeling and Simulation was used as a procedure that composes the quantitative approach. It represents a situation or reality in a systematic way. This method has five steps, as proposed by Miguel (2018), these being: problem definition, model construction, model solution, model validation and solution implementing.

Thus, this research is of applied nature and has an exploratory approach, using several studies to develop ideas and investigative questions. The problem approach is combined (employing quantitative and qualitative processes). The technical procedure applied was modeling and simulation. Research phases are illustrated in Figure 3.

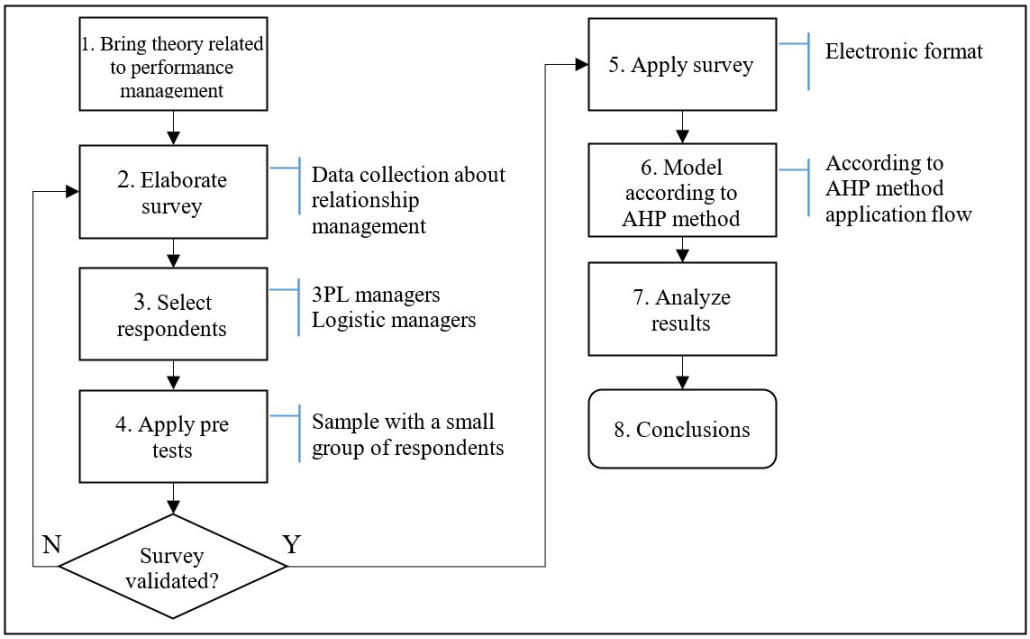

Figure 3. Research phases.

3.2. Analytic hierarchy process (AHP)

Among discrete methods of Multiple Criteria Decision-Making (MCDM), AHP is one of the most used methods found in literature (Tramarico et al., 2015). One main reason for the AHP's leadership in publications on multiple criteria decision-making is its solid mathematical foundation (Salomon & Gomes, 2024). Another main reason for the great number of AHP publications is the need to solve practical problems with a handy tool (Petrillo et al., 2023; Saaty, 2001). AHP was developed in the 1970s by Professor Thomas L. Saaty and is still widely used in solving multi-criteria analysis problems. It allows decision-makers to use various criteria, including those of distinct nature, in a quantitative manner to evaluate available options and then decide on the one that best addresses the need in question (Darko et al., 2019).

According to Saaty (2008) the method is comparable the human mind functioning when facing a complex situation composed by various elements, these are reunited in groups according to their common characteristics. Such groups can then be grouped in a superior level, with another set of common characteristics, until a maximum level is reached, which constitutes the final objective of the decision-making process.

AHP's foundations include the Fundamental Scale of Absolute Numbers (Saaty, 2010). The process involves creating a pairwise comparison matrix (A), followed by using Linear Algebra concepts to determine the eigenvector (w) and eigenvalue (λ_{max}). This enables the derivation of relative priorities, providing a robust framework for decision-making. In AHP, priorities are determined by applying the Perron-Frobenius theorem, as outlined by Saaty (1977) and expressed in Equation 1.

$$Aw = \lambda_{max} w \quad (1)$$

Consistency is an essential property of the matrix (A). If (A) exhibits consistency in its comparisons, then $a_{ij} = w_i / w_j$, for $i, j = 1,2,\ldots n$, where n is the order of A. In this manner, $a_{ij} = a_{ik} a_{kj}$. If A is not a perfectly consistent matrix, then $\lambda_{max} > n$. The Consistency Index (CI), calculated by (2), serves as a measure of the deviation between λ_{max} and n:

$$CI = (\lambda_{max} - n) / (n - 1) \quad (2)$$

The Consistency Ratio (CR), calculated using (3), also considers a random index (RI) associated with n. If the (CR) exceeds 0.10, a review of the comparisons may be necessary (Saaty, 2010).

$$CR \quad CI / RI \quad (3)$$

AHP application occurs in many areas and subjects, among them logistics and manufacturing can be highlighted. As a multiple criteria decision-making method, AHP was structured to support the formulation and analysis process of decisions. With this method it is possible break complex problems into pieces, according to a given hierarchy degree which facilitates its analysis and solution of a given problem (Ortiz-Barrios et al., 2020). It is a method based on evaluating alternatives within a complex decision problem. AHP can be divided in three phases (Tramarico et al., 2019):

1) Definition of a decision hierarchy;

2) Attribute relevant values to decision criteria, building a matrix;

3) Review and summarize results.

AHP method allows measurement to be made through relative or absolute comparison. In relative measurement, alternatives are compared in pairs while in absolute measures alternatives are compared to a pre-stablished standard (Silva & Salomon, 2019; Silva & Tramarico, 2022).

The adoption of AHP is justified by several studies in the field. For instance, Chejarla et al. (2021) and Castro et al. (2021) investigated the applications of MCDM in logistics performance evaluation, demonstrating the relevance of AHP in this context. Additionally, researchers such as Kumar & Singh (2012), Daim et al. (2013), and Perçin (2009) have utilized AHP for the evaluation of 3PL providers, further supporting its effectiveness and applicability in assessing complex decision-making scenarios within the realm of 3PL.

In this research, performance levels were used (Table 4), alternatives were compared one by one to a scale like, for example: excellent, very good, good, medium, and weak (Tramarico et al., 2019).

Table 4. Performance levels.

Level	Priority
L1 (excellent)	1
L2 (very good)	0.83
L3 (between good and very good)	0.67
L4 (good)	0.50
L5 (between weak and good)	0.25
L6 (weak)	0

Source: Tramarico et al. (2019).

4. Analysis of performance management of third-party logistics

4.1. Company description

The research was conducted within a private Brazilian banking services company operating in the financial sector, boasting approximately 1500 employees and 24 years of operational history. Notably, one of its core business areas revolves around the credit card machines product.

The logistics area is the study object. It has three Distribution Centers (DC) managed by a single 3PL. In these centers are performed input receiving, sample tests of quality, warehousing, expedition, screening and send to discard. Last mile 3PL serve 98% of Brazilian cities and each one is supplied by a specific DC. Al services to the final costumer can be summarized in three categories:

- Delivery: delivery service of a new product;
- Maintaining: change for some physical damage of the product or for not meeting immediate customers' needs;
- Recall: product collection from customers for physical malfunction.

The three 3PL within this company are: DC 3PL, transportation 3PL and last mile 3PL. Logistics chain is managed by direct employees. The structure includes a General Manager, four Coordinators and about 33 analysts in junior, regular, and senior positions. In Figure 4 the logistics flow can be observed.

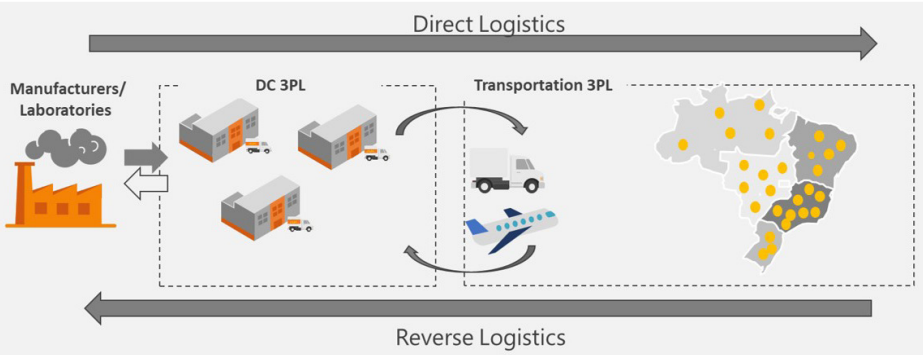

Figure 4. Logistics flow.

Logistics is managed through performance indicators and includes several 3PL. The 3PL more relevant are the DC, transportation, and last mile 3PL. There are many indicators to manage them, latter the three most relevant performance indicators of each 3PL are detailed.

The DC 3PL use as a performance management tool the Terminal Receiving (TR) indicator, which refers to terminals in DC. It also uses the Terminals Production (TP) and Terminals Dispatch (TD) indicators. Transportation 3PL are based on OTIF indicator, which manages out of date invoices, in RL that measures the number of collected invoices and Retention (R) that demonstrates the number of Retained Invoices (RI) in Secretariat of Finance (SEFAZ).

Last mile 3PL have as focus the SLA indicator to follow on the time services performed, Backlog of Orders indicator (BO) that shows the number of available services to perform and the Cancelation (CAN) that measures unsuccessful answering services. The main performance indicators used to manage 3PL performance, as well as measurement frequency and description can be found in Table 5.

4.2. Multi-criteria analysis

This research analysis includes performance management evaluation of the studied company. From performance indicators (Table 5) a survey was developed and was applied to employees responsible for the direct management of 3PL to evaluate qualitative requirements used in performance management of 3PL.

Table 5. Main performance indicators.

3PL	Performance Indicator	Measurement	Description
DC	Terminals Dispatch (TD)	Daily	Number of terminals dispatched from DC to last mile 3PL
	Terminals Production (TP)	Daily	Number of terminals produced by DC
	Terminals Receiving (TR)	Daily	Number of new terminals and reverse logistics received in DC
Transportation	Reverse Logistics (RL)	Daily	Number of invoices collected and awaiting collection
	On Time In Full (OTIF)	Daily	Number of invoices expired
	Retention (R)	Weekly	Number of invoices retained by SEFAZ
Last Mile	Cancellation (CAN)	Daily	Percent of unsuccessful answered services per month
	Backlog of Orders (BO)	Daily	Number of available services to answer
	Service Level Agreement (SLA)	Daily	Percent of on time answered services per month

Table 6 provides an overview of the respondents' profiles based on their position, tenure in the company, and college education area. The data indicates the distribution of respondents across different positions, ranging from Manager to Senior Analyst, along with their respective years of experience in the company and areas of academic specialization.

Table 6. Respondent profile overview.

Position	Number of respondents	Time in company	College education area
Analyst	10	Up to 4 years	Engineering/Business Administration
Coordinator	4	Up to 9 years	Business Administration
Jr analyst	5	Up to 2 years	Economy/Advertising
Manager	1	More than 10 years	Logistics
Senior analyst	11	Up to 7 years	Engineering/Business Administration

4.2.1. Evaluation of performance indicators

The performance indicators cancelation, backlog of orders, terminals dispatched, RL, OTIF, terminals Production, terminal receiving, retention and SLA were evaluated by 31 respondents who answered the evaluation survey. The results are presented on Table 7.

Table 7. Number of evaluations.

Level/Performance Indicators	BO	CAN	TD	RL	OTIF	TP	R	TR	SLA
Excellent (1)	6	7	3	0	6	2	3	2	10
Very good (0.83)	13	9	14	9	9	13	5	15	13
From good to very good (0.67)	7	11	8	10	10	9	10	5	6
Good (0.5)	5	2	6	6	5	6	11	6	2
From weak to good (0.25)	0	2	0	6	1	1	2	2	0
Weak (0)	0	0	0	0	0	0	0	1	0

The priority attributed to each indicator (Table 8) can be obtained weighting number of evaluations (Table 7) by the level of evaluation (Table 4). Table 8 shows priority attributed to the evaluated performance indicators.

Table 8. Aggregate priority.

Level/Performance indicators	BO	CAN	TD	RL	OTIF	TP	R	TR	SLA
Excellent (1)	0.19	0.23	0.1	0	0.19	0.06	0.1	0.06	0.32
Very good (0.83)	0.35	0.24	0.37	0.24	0.24	0.35	0.13	0.4	0.35
From good to very good (0.67)	0.15	0.24	0.17	0.22	0.22	0.19	0.22	0.11	0.13
Good (0.5)	0.08	0.03	0.10	0.10	0.08	0.10	0.18	0.10	0.03
From weak to good (0.25)	0	0.02	0	0.05	0.01	0.01	0.02	0.02	0
Weak (0)	0	0	0	0	0	0	0	0	0
Aggregate priority	0.77	0.75	0.74	0.6	0.74	0.71	0.64	0.69	0.83

Priority was calculated to each indicator multiplying the result by the quality level divided by the total number of respondents. For example, for C, the result is:

- 6 people evaluated BO as excellent; therefore, $(6 \times 1) \div 31 = 0.19$;
- 13 evaluated BO as very good; therefore, $(13 \times 0.83) \div 31 = 0.35$;
- 7 evaluated BO as entre very good and good; therefore, $(7 \times 0.67) \div 31 = 0.15$;
- 5 evaluated BO as good; therefore, $(5 \times 0.50) \div 31 = 0.08$;
- 0 evaluated BO as between weak and good; therefore, $(0 \times 0.25) \div 31 = 0$.

In summary, according to these evaluations, priority attributed to C is: $0.19 + 0.35 + 0.15 + 0.08 + 0 = 0.77$. The same procedure was performed to the others performance indicators CAN, TD, RL, OTIF, TP, TR and SLA.

According to Table 8, it can be observed that SLA indicator achieved an attributed priority of 0.83. SLA also received higher evaluation and was classified as very good. Later we have W and CAN indicators classified between very good, with 0.77 to 0.75, respectively. All the performance indicators (SLA, BO and CAN) are related to the last mile 3PL.

Performance indicators TD, OTIF, TP and TR were classified on levels between good and very good with attributed priorities of 0.74, 0.71 and 0.69, respectively. OTIF belongs to transportation 3PL and other performance indicators belong to DC 3PL. Performance indicators R and RL obtained the lowest attributed priority, 0.64 and 0.60, respectively, which classifies them as good in the adopted performance levels. Both belong to transportation 3PL.

According to the research, it was asked to respondents if there was possibility of any other performance indicator: 64.3% of 31 respondents said yes. The respondents suggested new performance indicators which measure not only logistics procedures effectiveness, but also customers perception. Some examples of those indicator are supply, critical channels, FTT, productivity, recurrence, customer satisfaction, average service time and average waiting time. Table 9 shows suggested performance indicators.

Table 9. Suggestion to creation of new performance indicators.

Performance Indicator	Description
Supply	Amount of available material to service orders answering.
Critical Channels	Number of customers orders from critical channels, like complaints and legal pleas.
First Time Through	Number of service orders successfully answered at the first try.
Productivity	Number of service orders answered per day
Recurrence	Numbers of service orders not answered successfully at the first time, and the reasons
Customer Satisfaction	Customers evaluation about their relationship with the company
3PL Satisfaction	3PL evaluation about their relationship with the company
Average Service Time	Average service time of answered orders.
Average Waiting Time	Measurement of customers waiting time to answer his order.

4.2.2. Prioritization proposal to new 3PL performance indicators

This section presents a procedure to prioritization when developing 3PL performance indicator. The procedure was based on new indicators (Table 9) suggestions and on performance attributes such as agility, responsiveness, and reliability from SCOR (Table 3). SCOR was applied in multi-criteria evaluation (Huang et al., 2020; Wang et al., 2018).

A new hierarchy was created, with the objective (prioritize performance indicators proposal) in the first hierarchy level. At the second level are the criteria selected based on the literature outlined in Section 2.4 and Table 3: agility, responsiveness, and reliability. At the third level are the sub-criteria: FTT (A1), productivity (A2), recurrence (A3), critical channels (R1), average service time (R2), average waiting time (R3), supply (C1), customer satisfaction (C2) and 3PL satisfaction (C3). To alternatives DC 3PL, transportation 3PL and last mile 3PL were considered. The hierarchy for prioritizing performance indicators proposals is illustrated in Figure 5.

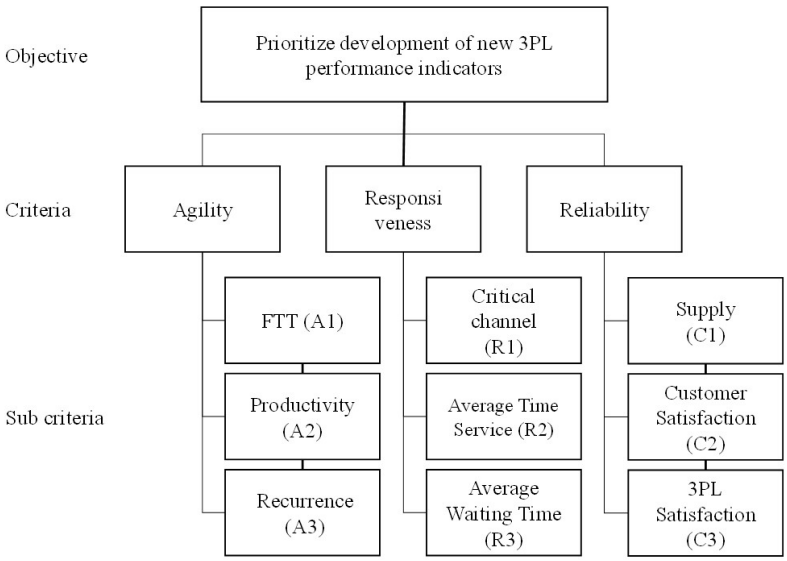

Figure 5. Hierarchy to prioritize development of new 3PL performance indicators.

Based on hierarchy, an AHP analysis was performed. Its base includes Fundamental Scale of Absolute Numbers, Saaty suggested a scale from 1 to 9, when comparing two components – numbers 1, 3, 5, 7 and 9 correspond respectively to the evaluations "equal importance", "weak importance", "strong importance", "very strong importance" and "absolute importance" (Saaty, 2008).

This evaluation reflects the consensus among five experts, including one manager and four coordinators. The resulting criteria are Agility, Responsiveness, and Reliability. The process of determining priorities involves several sequential steps. First, experts engage in pairwise comparisons of criteria, assigning values to indicate the relative importance of one criterion compared to another. These values are then entered into a comparison matrix. Next, the values in the comparison matrix are normalized by dividing each element by the sum of the elements in its respective column. Following this, the eigenvector is computed to establish the relative priority of each criterion. This entails finding the average of the rows in the normalized matrix. Finally, the priority of each criterion is determined by dividing the value of its eigenvector by the total number of criteria. Table 10 displays the evaluation for each criterion and their corresponding priorities, indicating that Agility has the highest priority (63.70%), followed by Reliability (25.83%) and Responsiveness (10.47%).

Table 10. Priorities and criteria comparison matrix.

Criteria	Agility	Responsiveness	Reliability	Priority
Agility	1	5	3	63.70%
Responsiveness	1/5	1	1/5	10.47%
Reliability	1/5	3	1	25.83%

The consistency, calculated according to Section 3.2, Equations 2 and 3, is 3%. Priorities can be accepted when this value is lower than 20%, according to Saaty (2008). Experts also evaluated Agility (A1, A2 and A3), responsiveness (R1, R2 and R3) and reliability (C1, C2 and C3). Table 11 presents evaluations for each sub- criteria of agility and priority, showing that A1 hast the highest priority result (64.9%), followed by A3 (27.90%) and A2 (7.19%).

Table 11. Comparison matrix and agility sub-criteria priority.

Sub-criteria	A1	A2	A3	Priority
FTT (A1)	1	7	3	64.91%
Productivity (A2)	1/7	1	1/5	7.19%
Recurrence (A3)	1/3	5	1	27.90%

Table 12 presents evaluation to each sub-criteria of Responsiveness and Priorities, showing that R1 has the highest priority result (73.83%) followed by R2 (17.02%) an R3 (9.15%).

Table 12. Comparison matrix and responsiveness sub-criteria priority.

Sub-criteria	R1	R2	R3	Priority
Critical channels (R1)	1	7	5	73.83%
Average Service Time (R2)	1/7	1	3	17.02%
Average Waiting Time (R3)	1/5	1/3	1	9.15%

Table 13 presents evaluations to each sub-criterion of Reliability and Priority, showing that C1 has the highest priority result (60.18%), followed by C2 (32.26%) and C3 (7.46%).

Table 13. Comparison matrix and sub-criteria priority for reliability.

Sub-criteria	C1	C2	C3	Priority
Supply (C1)	1	3	5	60.18%
Customer Satisfaction (C2)	1/3	1	7	32.36%
3PL Satisfaction (C3)	1/5	1/7	1	7.46%

After making evaluations of all criteria and sub-criteria, global priorities were calculated multiplying priority values to each criterion by the sub-criterion weight, for example: $A1\,global\ priority = 64.91\% \times 63.70\% = 41.35\%$; $A2\,global\ priority = 27.90\% \times 63.70\% = 17.77\%$. The same procedure was performed for C1, C2, C3, R1, R2, R3. Local and global priorities can be observed on Table 14.

Table 14. Local and global priorities.

Criteria and Sub-criteria		Local	Global
		Priority	Priority
Agility		63.70%	63.70%
	FTT (A1)	64.91%	41.35%
	Productivity (A2)	7.19%	4.58%
	Recurrence (A3)	27.90%	17.77%
Responsiveness		10.47%	10.47%
	Critical Channels (R1)	73.83%	7.73%
	Average Service Time (R2)	17.02%	1.78%
	Average Waiting Time (R3)	9.15%	0.96%
Reliability		25.83%	25.83%
	Supply (C1)	60.18%	15.54%
	Customer Satisfaction (C2)	32.36%	8.36%
	3PL Satisfaction (C3)	7.46%	1.93%

Global priority to criteria A1 and A3 associated to agility criterion and C1 associated to reliability criterion indicated higher level of importance among sub-criteria. Those results interpreted show which should be the company prioritization to indicators creation. Alternatives were classified in relation to sub-criteria, as shown in Table 15. For such evaluation performance levels were used (Table 4).

Table 15. Qualitative performance of alternatives.

	A1	A2	A3	R1	R2	R3	C1	C2	C3
DC	L4	L5	L3	L4	L4	L6	L4	L5	L5
Transportation	L2	L2	L2	L6	L3	L6	L3	L6	L4
Last mile	L3	L2	L4	L6	L2	L5	L2	L4	L3

Quantitative performance is based on a performance levels (Table 4), on qualitative performance (Table 15) and on global priorities (Table 14). Priorities to alternatives (Table 16) were added to bring priorities together, sum quantitative performance values, weighted by global priorities of sub-criteria. Results (Table 16) show priorities to each alternative: 65% for Transportation 3PL, 60% for Last mile 3PL and 49% for DC 3PL.

Table 16. Performance of quantitative alternatives.

	A1	A2	A3	R1	R2	R3	C1	C2	C3	Priority
	41.3%	4.6%	17.8%	7.7%	1.8%	1.0%	15.5%	8.4%	1.9%	
DC	0.50	0.25	0.67	0.50	0.50	0	0.50	0.25	0.25	0.49
Transportation	0.83	0.83	0.83	0	0.67	0	0.67	0	0.50	0.65
Last mile	0.67	0.83	0.50	0	0.83	0.25	0.83	0.50	0.67	0.60

5. Discussion and conclusions

This paper objective was accomplished, a procedure to performance management of 3PL contracted by the studied company was developed. The study results were satisfactory, since they have brought clarity over the relevance of indicators currently used to the company's 3PL's performance management, aside from showing the necessity of creating new performance indicators.

Nine performance indicators currently in use by the company were evaluated. SLA performance indicator was classified as "very good", six performance indicators were classified "between good and very good" and two as "good".

Based on this research, new performance indicators and their respective priority evaluation, based on SCOR, were established. The Agility criterion obtained the highest priority result. Operations Managers noted that the paper organized and provided visibility to indicators already used for company performance management. Among the benefits already obtained, it's highlighted the knowledge of where to adjust goals and performance measurements, according to employees responsible for logistics management. These findings are consistent with the performance measurement attributes of the SCOR model, emphasizing the significance of agility, responsiveness, and reliability, as highlighted in prior literature (Çıkmak et al., 2023). Looking ahead, future benefits include the development of new customer-centered indicators, according to the results of this article.

The study's theoretical implications lie in its alignment with the SCOR model's performance measurement attributes, emphasizing agility, responsiveness, and reliability. By establishing new performance indicators based on SCOR and prioritizing them, the research contributes to the theoretical understanding of performance management in logistics. Additionally, it provides insights into how these indicators can be used to enhance operational efficiency and customer satisfaction in logistics management.

The study's implications for managers of banking services companies are significant. Firstly, the establishment of new performance indicators based on the SCOR model provides managers with a structured framework for evaluating and managing logistics performance. The prioritization of these indicators, with agility receiving the highest priority, offers valuable insights into where managers should focus their attention and resources to optimize logistics operations.

Furthermore, the organization and visibility provided by the paper regarding existing performance indicators enable managers to better understand their company's performance management practices. This knowledge empowers them to make informed decisions about adjusting goals and performance measurements to align with strategic objectives and improve overall efficiency.

Moreover, the emphasis on agility, responsiveness, and reliability underscores the importance of these attributes in logistics management, which is particularly relevant for banking services companies that rely on efficient supply chains to deliver services to their customers. By adopting the proposed procedure and applying performance management analysis, managers can enhance operational efficiency, streamline logistics processes, and ultimately improve customer satisfaction.

The research was conducted with an acknowledgment of its limitations. While the model and results of the multi-criteria assessment were initially developed and obtained in a banking services company in the financial sector, located in the Brazilian state of São Paulo, it is important to recognize that the findings may not be universally applicable. Limitations include the study's focus on a company with its branches, which may restrict the generalization of results to other organizations within the same sector or different geographical regions. Additionally, while efforts were made to ensure the validity and reliability of the assessment model, further

validation and adaptation may be necessary for its applicability to diverse contexts. Future research could involve testing the model in varied organizational settings to enhance its robustness and applicability across different industries and regions.

In conclusion, the research not only provides theoretical insights into performance management in logistics but also offers practical guidance for managers in financial companies to optimize their logistics operations. The tested procedure can be generalized and applied across industries, contributing significantly to the literature on 3PL and performance management.

Another potential approach is to conduct an evaluation using the Benefits, Opportunities, Costs, and Risks (BOCR) model, based on AHP theory, which allows for a more flexible and potentially richer analysis compared to a simple cost-benefit analysis. Therefore, a new approach based on BOCR is suggested for further research in this field.

The Mutually Exclusive and Collectively Exhaustive (MECE) model is designed to filter out irrelevant, redundant, and biased variables in a model. It comprises three steps: measuring independence, assessing importance, and ensuring data integrity (Lee & Chen, 2018). Future research could benefit from applying the MECE approach.

The LARG (Lean, Agile, Resilient, and Green) model represents a modern approach in the field of Supply Chain Management. This model underscores the importance of companies aligning their strategies with the pillars of simplicity, agility, resilience, and environmental impact reduction (Mohammadzadeh et al., 2020). It is recommended to conduct a complementary study on the application of the LARG model in a specific company context.

In this research, Microsoft Office Professional Plus Excel (2013) was utilized for multi-criteria analysis due to its suitability for handling complex analysis with relatively low data volume. However, other software options such as Web-Based Software Comparison Suite by Expert Choice Company and Super Decision by Creative Decisions Foundation are available and commonly used for decision-making processes involving many criteria and peer evaluation, which could be considered for future research endeavors.

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