We refer to this paper as a literature review on Third-Party Logistics (3PL) selection decision in terms of criteria and methods. Based on the analysis of 67 articles published within the 1994–2013 period, this review reveals that 3PL selection is empirical in nature and is related to a region/country, industrial sector, and logistics activities outsourced. In terms of 3PL selection criteria, 11 key criteria are identified; each one is defined by a set of attributes. Cost is the most widely adopted criterion, followed by relationship, services, and quality. In terms of methods for 3PL evaluation, they can be categorized in 5 groups, namely: MCDM techniques, statistical approaches, artificial intelligence, mathematical programming, and hybrid methods.

1. Introduction

In today's business world, it becomes very difficult for a company to be competitive without working in close collaboration with external partners. The concept of supply chain management emerged in this direction and seeks to optimally manage the physical and information flows exchanged among all players in a supply chain, with the objective of achieving simultaneous cost reduction throughout the supply chain and a perceived increase in value of goods and/or services.

The 3PL has been widely promoted by the phenomenon of outsourcing, on which companies increasingly rely. Logistics outsourcing growth is mainly attributed to the benefits it brings in terms of reducing costs, improving performance, focusing on their core business and building virtual enterprises through strategic alliances. Approximately, 60% of the Fortune 500 companies in US reported having at least one 3PL contract, and that the market for logistics providers continues to grow [1]. Most 3PL have specialized their services through differentiation, with the scope of services encompassing a variety of options ranging from limited services to broad activities covering the supply chain. Based on [2], an overview of supplied logistics processes and activities is tabulated in Table 1.

Most recent studies conducted on 3PL are empirical and focus on reasons for benefits and risks of outsourcing decision [3–6],

Abstract

This paper presents a literature review on Third-Party Logistics (3PL) selection decision in terms of criteria and methods. Based on the analysis of 67 articles published within the 1994–2013 period, this review reveals that 3PL selection is empirical in nature and is related to a region/country, industrial sector, and logistics activities outsourced. In terms of 3PL selection criteria, 11 key criteria are identified; each one is defined by a set of attributes. Cost is the most widely adopted criterion, followed by relationship, services, and quality. In terms of methods for 3PL evaluation, they can be categorized in 5 groups, namely: MCDM techniques, statistical approaches, artificial intelligence, mathematical programming, and hybrid methods.

Keywords: Third party logistics, Logistics outsourcing, Performance measurement, Decision making process, Multicriteria.
modeling, planning and evaluation of the integrated logistics network for 3PL [7–9], analysis of 3PL/customers relationships [10–12], and finally 3PL selection and evaluation. The latter is the objective of this paper.

Literature reviews considering logistics outsourcing from a broader standpoint have already been published [13–16]. However, the 3PL selection is mentioned in these studies as being only a critical decision in the outsourcing process. For example, in [15], the authors proposed that criteria have to take into account organizational and operational contingencies and special buyer requirement.

To study the 3PL selection problem in detail, this paper aims to answer the following main questions: (1) which evaluating criteria are mostly used? (2) Which approaches are prevalently applied? And (3) what are the limitations of these criteria and approaches?

The paper is organized as follows. The methodology applied for this study is illustrated in the next section. A review of literature on selection criteria of 3PL is discussed in Section 3. Section 4 is devoted to different methods for evaluating the 3PL performance. The last section analyses the most used criteria and approaches, and presents some future research.

2. Methodology

The literature review analyzed in this paper was based on 87 articles published within the 1994–2013 period in international journals in logistics/supply chain, transport/distribution and purchasing domains, collected from ScienceDirect, Emerald, and Business Source Complete Databases. We note that working papers, Master’s and Doctoral theses, and articles published in conferences proceedings are not reviewed.

For the literature research, “3PL selection”, “Third-Party logistics selection”, “logistics outsourcing”, “3PL evaluation”, “3PL/customers relationships”, and other relevant descriptors were used. The full text of each article was reviewed in order to eliminate those that are not related to 3PL selection problem. As a result, 87 articles were identified; 67 of them are specific to 3PL selection problem in the sense that they deal with criteria, methods, and also factors for the success of 3PL/customers relationships. The other 16 articles are related to logistics outsourcing decision, modeling, planning, and evaluation of the logistics network for 3PL. Their analysis helps to understand the phenomenon of logistics outsourcing, the role of 3PL in a supply chain and services they offer.

In order to deduce the elements of differentiation between the supplier selection of goods and those of 3PL selection in terms of criteria and methods, an additional research was conducted using the descriptors on supplier selection. Thereby, 4 articles were identified. Thus, a total of 87 articles were analyzed.

Table 2 presents a list of journals in which the 67 articles specific to the problem of 3PL selection were published. The indicated time frame has been divided into three periods of about 7 years each in order to identify trends in the chronological progression of research on 3PL selection. This table shows that research in this area began to appear significantly in 1994 and has slowly increased since then. Indeed, the number of articles published increased from 17 (25.37%) during 1994–1999 period, to 23 (34.33%) between 2000 and 2006, and reached 27 (40.30%) in the last period (2007–2013). The majority of these articles (8.96%) appeared in International Journal of Physical Distribution & Logistics Management and Expert Systems with Applications, followed by Journal of Business Logistics (7.46%), International Journal of Production Economics and Transportation Journal (5.97%), the others journals represent 4.48%, 2.99%, and 1.49%.

These 67 articles were then classified according to their research nature: empirical vs. theoretical. 55 articles (82.09%) are empirical in nature while theoretical studies are only represented in 12 articles (17.91%).

The empirical studies are based on 2 types:

- Surveys studies with 34 articles (50.75%), conducted in these different geographical regions: US with 17 (50%), followed by Asia Pacific (Australia, China, India, Japan, Singapore, South Korea, New Zealand, Taiwan) with 13 (38.24%), and Europe (Belgium, Italy, UK/Ireland) with 4 (11.76%).
- Case studies with 21 articles (31.34%), divided into the following regions: Asia (China, India, Korea, Taiwan, Turkey) with 17 (80.95%), followed by Europe (Italy, Belgium) with 3 (14.29), and Brazil with only 1 (4.76%).

3. Selection criteria of 3PL

The 3PL selection is a multi-criteria problem and hence a complex process where multiple, both tangible and intangible, criteria need to be considered. Some criteria are developed with specific customer needs while others are common for all circumstances.

In their survey with 154 firms listed in the American Public Warehouse Register, Spencer et al. [17] identified 23 specific criteria used by these firms to choose their 3PL in the JIT context. These criteria are in the following order of importance: on-time performance, service quality, good communication, reliability, service speed, flexibility, customer support, easy to work with, management quality, early notification of disruptions, order cycle time, willingness to customize service, reputation, price, location, variety of available services, cost reduction, special expertise, decreased labor problems, technical competence, decreased asset commitment, increased competition, and global capabilities.

Through his survey of 105 firms, membership of the Council of Logistics Management and the Warehousing Education and Research Council in US, Maltz [18] studied the importance of cost and quality criteria in the use of 3PL warehousing. Three types of warehousing are tested: private, contract, and public. The study shows that public and contract warehouses do not provide the same level of service quality as private warehousing. In contrast, cost differentials do not seem to be critical to 3PL use.

The exploratory study conducted among 41 firms by McGinnis et al. [19] and Menon et al. [20] in the US depicts that both the
firm’s competitiveness strategy and external environmental affect the selection criteria. They also show that there are 8 important criteria, namely: on time shipment and deliveries, superior error rates, financial stability, creative management, ability to deliver as promised, availability of top management, responsiveness to unforeseen occurrences, ability to meet performance requirements, and price.

In a study exploring the competitive strategies followed by 131 firms under North American Free Trade Agreement (NAFTA), Fawcett and Smith [21] identified 5 criteria to evaluate the 3PL performance, namely quality, delivery, flexibility, cost, and innovation in services.

The survey conducted by Morash et al. [22] among 65 US companies in the furniture industry suggested that logistics performance is determined by “demand capabilities” which include pre-sale and post-sale customer services, delivery speed, delivery reliability, and responsiveness to target market and “supply capabilities” which comprise widespread distribution coverage, selective distribution coverage, and low total cost distribution.

In their exploratory study of 84 users of 3PL in Australia, Dapiran et al. [23] and Millen et al. [24] showed that cost is the most important selection factor of 3PL. Other important criteria are: services, personal knowledge of the contractor, coverage provided, previous experience and references, experience in project management and new systems’ implementation, and perceived competence.

Stank and Maltz [25] presented an exploratory review on factors that influence the decision to purchase 3PL services in the domestic versus international logistics environment. The 6 keys factors proposed are: asset investment, learning capability, long-term cooperation, organizational characteristics, service capability, and uncertainty/volatility.

Daugherty et al. [26] suggested that the logistics service capabilities provided by a 3PL should include dedication to emergency assistance, ability in handling changes of environment, flexibility in meeting external needs, provision of emergency service, ability in proposing recommendations to potential problems, helping corporation in implementing cost reduction and analysis of problem solution, ability in responding to the uncertain needs of operational situations, ability in anticipating transportation problems, ability in proposing counter measures when unable to provide service, and ability in providing service or operational status report.

The study conducted by Murphy and Daley [27] with 375 members of the Council Logistics Management in the US, showed that 12 factors of international freight forwarders selection are placed in the following order of importance: expertise, reliability, ability to provide relevant information, attention, reputation, price, financial condition, convenient to use, services, geographical specialization, product specialization, and size.

The study conducted among 126 firms in Singapore by Bhatnagar et al. [28] showed that service quality and cost are considered as the most important criteria in selecting 3PL, followed by reputation, range of services, and relevant past experiences.

In their empirical study with 463 companies in US, Boyson et al. [29] showed that in selecting 3PL, companies rank financial stability, customer service capability, and price as the most important criteria. The second most important criteria were identified as creativity in problem solving, information system and technology capabilities, general reputation, reputation for continuous problem solving and the compatibility of cultures. These were followed by size, asset ownership, and international scope as the third most important criteria. The least important criteria included prior relationship with the company, and the 3PL’s human resources policy.
In [30], the authors conducted a survey among 134 companies in Hong Kong and showed that the performance evaluation in transport logistics concerns the cost and the asset. The cost is related to 5 operations: transportation, warehousing, costs associated with the facilities and manpower used in providing the services, order processing, and logistics administration. For the asset, it is developed according to the 3 measures suggested by SCOR model—cash-to-cash cycle time, utilization of facilities and manpower in providing the services, and asset turns.

Anderson and Norrman [31] showed that 3PL selection criteria depend on the outsourced activity. The company which wanted to outsource the execution of the inbound logistics system focused on operational factors such as capacity, equipment and cost, while for companies which were more complex and involved transferral of responsibilities, the emphasis was put on information technology, management and cultural aspects.

Colson and Dorigo [32] presented a software tool which allows the selection of 280 public warehouses in Belgium. Many criteria are proposed for a preliminary selection and they are gathered in 4 families which are: 1 – Buildings with criteria such as surface/volume of storage, temperature-controlled storage, certified to ISO 9001/9002 or SQAS or HACCP, daily opening hours. 2 – Customs with 3 criteria which are: customs on site, bonded warehouse, and feigned warehouse. 3 – Logistics with criteria such as inventory management, use of bar codes/tags, communication, and transport/distribution. 4 – Handling with criteria like open or covered loading/unloading docks, automatic docks, and docks for swap bodies/semi-trailers. Cost and location are then used in the final negotiation with the 3PL.

Similarly, Moberg and Speh [33] studied the process of selecting 3PL in order to outsource warehousing. Their empirical survey among 155 firms in the US showed that the 12 important indicators used for choosing a particular 3PL can be placed in the following order of importance: responsiveness to service requests, quality of management, track record of ethical performance, ability to provide value-added services, low costs, specific channel expertise, knowledge of market, personal relationships with key contacts, willingness to assume risk, investment in state-of-the-art technologies, size, and national market coverage.

As per [34], the author conducted a survey among 72 exporters in Hong Kong and showed that 4 factors are used to evaluate the 3PL performance, namely timeliness of services, price, quality of delivery, and customized supplementary services.

Sheen and Tai [35] conducted a study of 64 firms from in direct sales in Taiwan and showed that the selection criteria of 3PL depend on history, capitalization and revenues of a company. For instance, a company with history between 3 and 10 years views ability and compatibility of 3PL more important than a company with history of less than 3 years. Similarly, the companies with capitalization between NT$10 and NT$50 millions view the quality, cost and accommodation more important than the companies with capitalization smaller than NT$10 millions.

In their empirical study with 7 European manufacturers operating in several industrial sectors, Mortensen and Lemoine [36] showed that the reasons for selecting a specific 3PL and entering into the cooperation are primarily related to the quality and reliability of the transport and delivery and thereafter to the 3PL market coverage, especially at the international level. Price and competences are also considered in this selection.

The exploratory study conducted by Briggs et al. [37] with 109 membership of the Council of Supply Chain Management Professionals on the influence of 3PL velocity performance showed that 4 criteria are considered, namely: speed of service, reliability, information accessibility, and services availability.

Moreover, in their study of 37 logistics providers in US, Leahy et al. [38] provided a list of 25 factors for the successful of 3PL/customers relationships. These factors are in this importance order: customer orientation, dependability, change orientation, timeliness, convenience, control and performance appraisal, improved service, mutual trust and consideration, focus on core competency, total organizational involvement, knowledge of customer operations, cost savings, long-term relationships, management expertise, sharing relevant information, access to latest technology, financial strength, channel perspective, sharing of common goals, guidelines exit to resolve disputes, number of services offered, sharing of benefits and risks, provider’s knowledge of external environment, exit provisions exist, and sharing human resources and facilities.

Tate [39] provided 7 factors that have made possible the long-term relationship between 3PL and their customers and which are: compatibility, deep understanding of a partner’s business needs, open communications, commitment, fairness, flexibility, and trust.

As per [40], the author proposed to use agency theory to assist 3PL/customers relationships success. Cost reduction and services improvement criteria are most expected by clients to avoid conflicts with their 3PL.

To help make the relationship with 3PL successful, Aghazadeh [41] presented 5 relevant factors, which are: similar value and objectives, information technology systems, trust, mutual respect, and shared willingness to make the relationship work. He also illustrated the five steps involved in this selection, which are: making a decision on the necessity of using a 3PL, developing criteria and objectives which the provider should meet, the process of weeding out by making a list of possible 3PL, determining the top prospect to meet the potential 3PL, and beginning the new partnership with the chosen provider.

In the empirical work with 142 firms in UK and Ireland, Sinkovics and Roaht [42] showed that a manufacturer and 3PL relationship is impacted by customer orientation, operational flexibility, competitor orientation, and collaboration. Four indicators are suggested to measure 3PL performance which are: improved service levels, reduced cycle time, efficient handling of exceptions, and improved end-customer satisfaction.

In their survey conducted in US, Kneemeyer and Murphy [43–45] showed that 9 key dimensions of relationship marketing that influence the 3PL performance are trust, communication, opportunistic behavior, reputation, satisfactory prior outcomes, specific investments, attachment, dependence, and reciprocity.

In their empirical study conducted among 105 firms in US, Yan et al. [46] demonstrated that relational commitment and trust of suppliers/3PL are important for firms in developing stable relationships with their suppliers in supply chain alliance, which in turn is critical for alliance performance.

Finally, Chu and Wang [47] conducted a survey with 134 members of China Federation of Logistics and Purchasing, in order to examine the drivers that impacted the 3PL and customers relationship quality. The study showed that 4 main factors positively influenced that relationship, namely: 3PL importance, logistics performance (delivery, value-added services, flexibility, quality), information sharing, and legal contract.

As shown by the various studies discussed above, 3PL selection is a multi-objective decision because it requires taking into account several criteria. In addition, the number of firms involved in these studies is high, which demonstrates the importance of this decision. Finally, the activities most outsourced are transportation and warehousing.

To solve this multi-objective problem, the existing literature proposes some methods which are detailed in the following section.

### 4. Selection methods of 3PL

Based on our investigation, the different techniques used for the performance measuring of 3PL can be classified on 5 categories:
multiattribute decision-making (MCDM) techniques, statistical approaches, artificial intelligence, mathematical programming, and hybrid methods. We refered to the recent study of Chai et al. [48] to use this categorization and also to the studies cited in [49,50] for further explanation of these methods.

In the following, Sections 4.1–4.4 present the studies that proposed individual approaches, and Section 4.5 presents those that combined several methods. Individual approaches are particularly proposed to demonstrate their application in the 3PL selection.

4.1. Multiattribute decision-making (MCDM) techniques

MCDM is a methodological framework that aims to provide decision makers a knowledgeable recommendation amid a finite set of alternatives, while being evaluated from multiple criteria. The main MCDM methods used in the case of 3PL selection are: Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Interpretive Structural Model (ISM), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Multi-criteria optimization and compromise solution (VIKOR), Decision-Making Trial and Evaluation Laboratory (DEMATEL), Elimination and Choice Expressing Reality (ELECTRE), Fuzzy Sets Theory (FST), utility theory, and Quality Function Deployment (QFD). Only 7 of 67 articles (10.45%) applied some of these individual methods.

In [51], AHP is used to select the best 3PL warehousing in automotive industry according to 3 main criteria, namely: reliability, flexibility, and strategic compatibility. Each one is defined by a set of sub-criteria. So et al. [52] applied AHP to evaluate the service quality of 3PL in Korea. This service takes into account 5 quality dimensions which include tangibles, reliability, responsiveness, assurance, and empathy. In [53], AHP is used to select 3PL in the case of a Turkish automotive industry. A total of 27 criteria were considered with respect to the general company considerations (price, financial considerations, experience in the same industry, location, asset ownership, international scope, growth forecasts, yearly efficiency), capabilities (optimization capabilities, creative management, customer service, supply chain vision, responsiveness), quality (service quality, continuous improvement, KPI measurement and reporting), client relationship (availability of top management, cultural fit, service cancellation, reputation) and labor relations (human resource policies, availability of qualified talent).

ANP approach, which is a more general form of AHP, represents the interdependencies of the higher-level elements from lower-level elements and also of the elements within their own level. Meade and Sarkis [54] used ANP for selecting 3PL in the context of reverse logistics. For such, 4 organizational performance criteria are considered, which are time, quality, cost, and flexibility. As per [55], ANP is applied to classify the 3PL criteria selection into 3 levels. The first one contains strategic criteria or determinants which include compatibility, cost, quality, and reputation. At the second level, the dimensions, which support the achievement of the upper-level determinants, are identified as well long-term relationship, operational performance, financial performance, and risk management. The last level contains 16 enablers, which support their respective dimensions and have some interdependencies among themselves. Similarily, Cheng and Lee [56] used this approach for selecting reverse 3PL in high-tech manufacturing in Taiwan. The main criteria used are related to warehouse, transportation, IT, and value-added services. Each criterion is defined by a set of factors.

Finally, Govindan et al. [57] used ISM model to illustrate the interactions among 3PL selection criteria, in the case of reverse supply chain. The 7 attributes considered are services, reverse logistics functions, organizational role, customer satisfaction, impact of 3PL use, organizational performance, and IT applications. A total of 35 sub-attributes are identified and the model is applied to a tire manufacturing company in India.

4.2. Statistical approaches

There are 27 articles (40.30%) proposing statistical approaches to deal with 3PL selection problem. The correlation method (23 articles) is mostly used and refers to the data gathered from the empirical studies [17–24, 27–30, 33–35, 37, 38, 42–47]. Other statistical methods cited in literature are cluster analysis, and logit regression such as binary logit and multinomial logit (MNL).

As per [58,59], the authors used the cluster analysis to group 221 logistics providers in Hong Kong into 4 clusters according to service capability. These groups are traditional freight forwarders that have a low capability to carry out VAL (value-added logistics services) and TEL (technology-enabled logistics services); transformers that achieve a medium level of capability to perform VAL and possess a high level of capability in TEL and FFD (freight forwarding services); full service providers that possess a high level of capability in VAL, TEL and FFD; and niches that are weak in FFD but possess a medium level of capability in carrying out VAL and TEL.

Tsai et al. [60] used a binary logit model to investigate the 3PL behavior of high-tech industry in Taiwan. The variables considered in this model are of two types: generic and specific. The first type includes cost, performance (speed and punctuality, security, service channels and destinations, and capability of exceptional management), value-added services, and perceived capability (expertise, past experiences, culture recognitions, and financial status). The second type includes company size in sale, product status, shipment size, and shipment destinations. The proposed model allows the selection of twenty four 3PL, organized into two groups: express and forwarder.

As per [61], the authors examined the main criteria used by 309 Asia Pacific industries (Australia, New Zealand, China, India, Japan, South Korea, and Singapore) in selecting their 3PL. The multinomial logit (MNL) is applied to predict the 3PL behavior, using the following 7 factors: reliable performance, price, customer interaction, customer service recovery, supply chain capacity, supply chain innovation, and professionalism.

4.3. Artificial intelligence

Artificial intelligence aims to integrate qualitative factors and human expertise in the selection process. CBR/RBR (Case-Based Reasoning/Rule-Based Reasoning), inference method, Artificial Neural Networks (ANN), Delphi method, and Data Mining are the main methods used in the case of 3PL selection. Only 1 article (1.49%) is proposed to evaluate and select 3PL by using CBR/RBR as an individual method.

Yan et al. [62] proposed CBR/RBR model for 3PL selection. For each, 6 criteria are used, namely: source allocation (logistic network, transportation power, storage source, etc.), organization allocation, service quality, financial power, information system, and value-added services.

4.4. Mathematical programming models

Mathematical programming models consist generally of an objective function to be optimized and not a set of constraints faced by the decision-maker. In this category, the following methods can be distinguished: dynamic programming (DP), linear/nonlinear programming (LP/NLP), mixed integer programming (MIP), multi-objective programming (MOP), and Data Envelopment Analysis (DEA). They are used for modeling, evaluating or
planning the logistics network for 3PL [7, 8]. Wu and Huang [63] show, from their empirical study in Taiwan, that the operation research techniques are not widely used in the logistics activities. In the case of 3PL selection, 5 articles (7.46%) suggested the use of mathematical programming models.

Chen et al. [64] proposed a DP model for selecting the optimal 3PL warehousing contracts with space commitments. The objectives to minimize are total expected leasing cost and commitments’ space sizes. The demand for warehouse space considered in the model can be ordinary, divergent, or seasonal.

Kumar et al. [65] formulated a MOP model for 3PL allocation problem in India. The objectives to minimize are cost of service, the model can be ordinary, divergent, or seasonal.

As per [66], the authors proposed a MOP model, using tabu search algorithm, for a location-routing problem that is used to select 3PL and their corresponding transport platforms. Total cost of the transport network is the only objective to minimize. The model is applied to a case study of Toyota in Belgium.

As per [67], DEA is used to evaluate the operational efficiency of ten 3PL in China, classified into 3 categories like port management, transportation services, and warehousing services. Likewise, 4 inputs that represent physical and financial resources are considered, namely net fixed assets, salaries and wages, operating expenses, and current liabilities, while operating income is the only output of the model. Similarly, Hamdan and Rogers [68] proposed DEA to select the best 3PL from 19 warehouses logistics providers based in US. The selected warehouses have common processes, similar product of consumer electronics and telecommunication equipment, and similar inputs and outputs. Labor hours, warehouse space, technology investment, and materials handling equipment are the inputs of the model, while shipping volume, order filling, and space utilization are the outputs of the model.

4.5. Integrated approaches

Integrated approaches are also discussed in the literature and are generally used in the different stages of 3PL selection process such as the identification of important evaluation criteria, the elimination of unsuitable 3PL, and the final selection of the best 3PL. In this sense, 19 papers (28.36%) proposed these methods to tackle this process.

As per [69], an integrated approach combining AHP and MIP is applied to evaluate the performance of truck carriers. Nine sub-criteria are used and grouped into 3 main criteria: customer service (reliability, flexibility, quality, and facilities/equipment), pricing and rates (basic rates, and flexibility of rates), and strategic compatibility (long-term relationship, strategic fit, and continuous improvement).

Degraeve et al. [70] proposed a model that integrates MIP and TCO (Total Cost of Ownership) in the case of airline selection in Belgium. TCO is used to evaluate the cost, objective to minimize in the model, under the airline market share per destination, and the discounts offered by the airlines constraints.

Thakkar et al. [71] used an approach integrating ISM and ANP for a proper selection of 3PL in the case of food sector in India. Their model takes into account 15 criteria grouped into 4 areas like autonomous (readiness to work under the brand name of the contract-giving organization, necessary certifications), dependent (readiness to enter into a long-term contract, geographical coverage, proactiveness/readiness to share experiences in system design and reconfiguration, trust worthiness, attitude toward open-book accounting, readiness to work under a computerized system), linkage (sound financial background, previous experience, trained logistics personnel, availability of computer network), and driver/independent (ability to react to the changing needs-flexibility, margins provided to contractor, attitude toward hygienic practices).

As per [72], a hybrid system combining Data Mining and CBR is proposed to assist 3PL on logistics strategy development in China. Through this system, 3PL performance is measured by 8 factors, namely: price, real time information, delivery accuracy, stock status, communication, customer service, reporting, and stock spacing.

To model uncertainty and inaccuracy of the criteria weights, Bottani and Rizzi [2] proposed a fuzzy TOPSIS method that they applied to the case of a company operating in the dairy products in Italy. The 12 criteria used are: breadth of services, business experience, characterization of service, compatibility, financial stability, flexibility, performance, price, physical equipment and information systems, quality, strategic attitude, and value and fairness.

Işıklar et al. [73] suggested a hybrid intelligent decision support framework for 3PL selection in Turkey, which integrates CBR/RBR and MOP techniques in fuzzy environment. Two groups of criteria are used. The 1st group focuses on the strategic aspects of the 3PL and identifies them as follows: financial stability, successful track record, similar size, comparable culture, similar values and goals, and fit to develop a sustainable relationship. The 2nd group is developed to measure important aspects of the 3PL business in 5 main categories: information technology, performance, quality, cost, and services.

Almeida [74] proposed a multicriteria model for 3PL selection in Brazil based on utility function and ELECTRE method. The utility function is introduced to incorporate the uncertainty evaluation of criteria while ELECTRE tool determines the final selection of 3PL. The evaluating criteria considered are: cost, delivery time, and dependability.

As per [75], a hybrid approach is proposed to evaluate 3PL in the Turkish logistics sector. This approach included a fuzzy AHP method to determine the relative weights of evaluation criteria, and a fuzzy TOPSIS to achieve the final partner-ranking. Two dimensions of criteria are considered. The 1st one, named strategic dimension, includes similar values-goals, similar size, financial stability, comparable culture, successful track record, and a fit to develop a sustainable relationship. The 2nd one, named business excellence dimension contains technical expertise, performance, market knowledge, and managerial experience.

Efendigil et al. [76] proposed an integrated fuzzy AHP–ANN model for selecting 3PL in the context of reverse logistics. For such, 12 performance indicators are considered which are: on time delivery ratio, confirmed fill rate, service quality level, unit operation cost, capacity usage ratio, total order cycle time, system flexibility index, integration level index, increment in market share, research and development ratio, environmental expenditures, and customer satisfaction index.

As per [77], a hybrid model integrating CBR and NLP techniques is suggested to select suitable 3PL among 13 transporters and 12 freight forwarders, in the use of the re-configuration of supply chain network in China. The performance criteria considered are related to cost, delivery, quality, services, flexibility, and relationship.

Liu and Wang [78] used an integrated fuzzy approach for the evaluation and selection of 3PL in Taiwan. This method consists of three different techniques: the Delphi method to identify important evaluation criteria, an inference method to eliminate unsuitable 3PL, and a LP model for the final selection. In this sense, 17 criteria are considered: logistics information system, customer service, on-time shipments/deliveries, capability to handle specific business requirements, responsiveness, and accessibility to contact persons in urgency are the most important criteria. However, price, experience in similar industry, service quality, and general reputation are not as important. The other criteria used are:
location, market share, logistics equipment, EDI capacity, continuous improvement, value-added services, and cultural fit.

Kannan et al. [79] proposed an integrated ISM–TOPSIS approach for the selection of reverse 3PL in fuzzy environment in the case of battery manufacturing industry in India. For this, 7 main criteria are considered which are: quality, delivery, cost, rejection rate, technical and engineering capability, inability to meet future requirement, and willingness and attitude.

As per [80], the authors suggested a hybrid multi-criteria approach for 3PL selection in Taiwanese airline, which combined three models: DEMATEL to construct the interrelationship between criteria, ANP to determine the criteria weights, and VIKOR to prioritize the 3PL. Therefore, 12 criteria are used and classified on 4 dimensions: compatibility (relationship, flexibility, information sharing), quality (knowledge and skills, customer’s satisfaction, on time rate), cost (cost savings, flexibility in billing), and risk (labor union, loss of management, control, information security).

Sasikumar and Haq [81] applied a fuzzy VIKOR method to reverse 3PL selection for the case of battery recycling in India. The authors used the same evaluating factors and dataset as that used by authors as per [80] to illustrate their model.

Li et al. [82] used fuzzy sets to evaluate 3PL performance in terms of management success, business strength, service quality, and business growth criteria. The model is represented by a LP model that maximized the comprehensive evaluation result of 3PL according to these criteria. That model is illustrated by a real case of an air conditioner manufacturer in China.

As per [83], the authors proposed a method that combines AHP, DEA and LP in order to support the multi-criteria evaluation and selection of 3PL. The 7 criteria considered in their proposal model are: reliability of quality, speed of service, flexibility, cost, equipment, operators’ safety, and environmental safeguard. The validation of the model is focused on 3 sectors in Italy, namely: industry and defense, perishable products, and consumer goods.

Ho et al. [84] developed an integrated QFD and fuzzy AHP for 3PL selection and evaluation. The 6 main criteria considered are: cost, delivery, flexibility, quality, technology, and risk. The model is applied to the case of a supplier of hard disk components in China.

As per [85], a decision-aid tool combining QFD, fuzzy linear regression and MOP is used to select the best 3PL for Turkish auto part manufacturers. Five main criteria are considered, namely: cost, timeless, service quality, flexibility, and reputation.

Recently, Hsu and Liou [86] developed an integrated model that combined DEMATEL and ANP by considering the same criteria as those used in [80]. The model is applied to the Taiwanese airline case.

### Table 3

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Definition</th>
<th>Authors</th>
<th>Nb. papers</th>
<th>% Cumulative %</th>
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<tbody>
<tr>
<td>Cost</td>
<td>It refers to the total cost of logistics outsourcing. Its related attributes include price, cost reduction, low cost distribution, expected leasing cost, operation cost, warehousing cost, and cost savings.</td>
<td>[2,17–24,26–36,38,40,53–55,57,60,61,64–66,69,70,72–74,76–81,83–86].</td>
<td>46</td>
<td>13.41</td>
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<tr>
<td>Relationship</td>
<td>It includes shared risks and rewards, ensure cooperation between the user and the 3PL. It also helps in controlling the 3PL opportunistic behavior. Reliability, truth, dependence, alliance, compatibility, reciprocity are among its attributes.</td>
<td>[2,17,23–25,27–29,31,33,35–47,51–53,55,57–61,60,71,73–75,77–82,86].</td>
<td>44</td>
<td>12.83</td>
</tr>
<tr>
<td>Services</td>
<td>It is related to attributes such as breadth of services, characterization/specialization of services, variety of available services, pre-sale/post-sale customer services, and value-added services.</td>
<td>[2,17,19–34,37–39,47,53,55–62,64,67–69,72,73,77,78–84].</td>
<td>42</td>
<td>12.24</td>
</tr>
<tr>
<td>Quality</td>
<td>Quality of the 3PL includes many aspects such as, commitment to continuous improvement, SQAS/ISO standards environment issues, and risk management.</td>
<td>[2,17–21,28,32–36,38,40,42–45,47,52–55,57,60,62,69,71,73,76–86].</td>
<td>40</td>
<td>11.66</td>
</tr>
<tr>
<td>Information &amp; equipment system</td>
<td>It corresponds to physical equipment and information system that has a 3PL to facilitate communication and execution of logistics operations of its customers. It is related to attributes such as EDI, tracking/tracing, technology capabilities, information accessibility, availability of computer network, informatization level, technical/engineering capability, materials handling equipment, and information security.</td>
<td>[2,17,25,29–33,37,38,41,43–45,47,52,53,55–59,62,67–69,71–73,76,78–84,86].</td>
<td>38</td>
<td>11.08</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Ability to adapt to changing customers requirements and circumstances. Its attributes include ability to meet future requirement, capacity to accommodate and grow the client’s business, system flexibility index, responsiveness to target market or service requests, capability specific business requirements, and time response capability.</td>
<td>[2,17,19–22,25,26,33,34,38,39,42,47,51–55,57–59,61,69,71,76–81,83–86].</td>
<td>35</td>
<td>10.20</td>
</tr>
<tr>
<td>Delivery</td>
<td>It is represented by attributes such as: time, on-time performance, on time shipment and deliveries, delivery speed, accuracy of transit/delivery time, shipment delivery, and on-time delivery rate.</td>
<td>[2,17,19–22,34,36,37,42,47,54,55,57,60,61,65,72–79,83–85].</td>
<td>28</td>
<td>8.16</td>
</tr>
<tr>
<td>Professionalism</td>
<td>3PL exhibit sound knowledge of services in the industry and display punctuality and courtesy in the way they interact and present to the customers. It is characterized by attributes such as expertise, competence, and experience.</td>
<td>[2,17,23–27,29,33,34,36,38,52,53,55,60,61,71,75,78,80,81,84,86].</td>
<td>24</td>
<td>7.00</td>
</tr>
<tr>
<td>Financial position</td>
<td>A sound financial performance of the 3PL ensures continuity of service and regular upgrading of the equipments and services, which are used in logistics operations.</td>
<td>[2,19,20,27,29,38,53,55,60,62,67,70,71,73,75,76,78,82,84].</td>
<td>19</td>
<td>5.54</td>
</tr>
<tr>
<td>Location</td>
<td>It is related to attributes such as distribution coverage, geographical specialization and coverage, international scope, market coverage, shipment destinations, and distance.</td>
<td>[17,22–24,27,29,32,33,36,53,55,60,65,70,71,78].</td>
<td>16</td>
<td>4.66</td>
</tr>
<tr>
<td>Reputation</td>
<td>It refers to the opinion of the customers about how good are the 3PL in satisfying their needs. This is more relevant in the initial screening of 3PL.</td>
<td>[17,27–29,43–45,53,55,78,85].</td>
<td>11</td>
<td>3.21</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>343</td>
<td>100.00</td>
</tr>
</tbody>
</table>
Table 4
Summary of evaluating methods.

<table>
<thead>
<tr>
<th>Category</th>
<th>Methods</th>
<th>Authors</th>
<th>Nb. papers</th>
<th>%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCDM</td>
<td>FST</td>
<td>[2,73,75,76,78,79,81,82,84,85].</td>
<td>10</td>
<td>11.24</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>AHP</td>
<td>[51–51,69,75,76,83,84].</td>
<td>8</td>
<td>8.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ANP</td>
<td>[54–56,71,80,86].</td>
<td>6</td>
<td>6.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOPSIS</td>
<td>[2,75,79].</td>
<td>3</td>
<td>3.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ESM</td>
<td>[57,71,79].</td>
<td>3</td>
<td>3.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VIKOR</td>
<td>[80,81].</td>
<td>2</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DEMATEL</td>
<td>[80,86].</td>
<td>2</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QFD</td>
<td>[84,85].</td>
<td>2</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELECTRE</td>
<td>[74].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Utility theory</td>
<td>[74].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cluster analysis</td>
<td>[58, 59].</td>
<td>2</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Binary logit</td>
<td>[60].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MNL</td>
<td>[61].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>Mathematical programming</td>
<td>LP/NLP</td>
<td>[77,78,82,83].</td>
<td>4</td>
<td>4.49</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>MOP</td>
<td>[65,66,73,85].</td>
<td>4</td>
<td>4.49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DEA</td>
<td>[67,68,83].</td>
<td>3</td>
<td>3.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MIP</td>
<td>[69,70].</td>
<td>2</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>[64].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCO</td>
<td>[70].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>Artificial intelligence</td>
<td>CBR/RBR</td>
<td>[62,72,73,77].</td>
<td>4</td>
<td>4.49</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Data mining</td>
<td>[72].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ANN</td>
<td>[76].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delphi method</td>
<td>[78].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inference method</td>
<td>[78].</td>
<td>1</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Conclusions, limitations and future research

In this paper, 67 articles on 3PL selection are analyzed in deep to identify the criteria and methods most used in this selection.

In terms of criteria, this review shows that the 3PL selection process is based on a large number of attributes; this reflects the richness of the bundle of services that a 3PL offers as well as the usual difficulties of precisely defining the nature of quality dimensions in a service environment. For example, Spencer et al. [17] listed 23 potential factors, Leaby et al. [38] used 25, and Govindan et al. [57] identified 35 in their studies. In broad terms, our analysis allows to organize the 3PL selection criteria in 11 main groups, as listed in Table 3.

According to the Pareto method, Table 3 lists that the most commonly used criteria are: cost, relationship, services, quality, information/equipment system, flexibility, and delivery. These criteria represent 79.59%, while professionalism, financial position, location, and reputation represent the remaining 20.41%. Each criterion is described and defined by a set of attributes.

There are 46 articles (68.66%) considering “cost” in the 3PL selection process. This criterion is related to attributes including price, cost reduction, low cost distribution, expected leasing cost, operation cost, warehousing cost, and cost savings.

The 2nd most used criterion is “relationship” with 44 papers (65.67%) and its related attributes include sustainable relationship, long-term cooperation, alliance, compatibility, comparable culture, similar values and goals, dependence, attachment, reciprocity, willingness and attitude, trust, and integration level index.

The 3rd most used criterion is “services” with 42 papers (62.69%) and it is defined by a group of attributes such as breadth or range of service, characterization/specialization of services, variety of available services, pre-sale/post-sale customer services, and value-added services.

The criterion “quality” is also important and comes at 4th position, with 40 papers (59.70%) and it is related to attributes such as service quality, continuous improvement, SQAS/ISO standards, customer satisfaction, and risk management.

In terms of methods, Table 4 summarizes most of those discussed in this paper while Table 5 gives some strengths and weaknesses of these methods.

According to Table 4 results, MCDM are widely cited with 38 papers and the most of them (81.58%) are integrated with methods in this same category or with other techniques such as ANN, MIP, and DEA. Statistical methods arrive at 2nd position with 28 papers, followed by mathematical programming with 15 papers, and artificial intelligence with 8 papers.

Individually, the correlation method is widely applied with 24 papers (26.97%). This is due to the fact that the majority of studies on 3PL selection is of empirical type. FST comes at 2nd position with 10 papers (11.24%) and is used to model uncertainty and inaccuracy of the criteria weights. AHP is also cited with 8 papers (8.99%) due to its simplicity, its easiness of use, and its great flexibility. The methods such as ELECTRE, utility theory, logit regression, DP, TCO, and others artificial intelligence techniques are rarely used.

Although the above mentioned approaches can deal with multiple and conflicting criteria, they have not taken into consideration the impact of business objectives and requirements of company stakeholders on the evaluating criteria. In reality, the weightings of criteria depend a lot on business priorities and strategies. In cases where the weightings are assigned subjectively without considering the “voice” of company stakeholders, the 3PL selected may not provide what the company exactly wants.

Thus, an overall suggestion for future research in the 3PL selection field will take into account the following elements:

- The consideration of the “voice” of company stakeholders in the determination of the criteria weightings. In this sense, it could be more useful to integrate quality tools such as QFD. This method is only mentioned in two recent publications [84, 85].
- The exploration of others methods such as ABC [87], PROMETHEE, SMART and others artificial intelligence techniques [48], widely used in the case of supplier selection of goods.
Finally, this paper may help researchers for understanding the 3PL selection studies are weakly theoretical with only 17.91%–[8] Ko HJ, Evans GW. A genetic algorithm-based heuristic for the dynamic

References

Table 5

<table>
<thead>
<tr>
<th>Category</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCDM</td>
<td>Quick and easy to use.</td>
<td>Weights assigned to criteria depend on human judgment.</td>
</tr>
<tr>
<td></td>
<td>Can cope with multiple qualitative and quantitative criteria.</td>
<td>No possibility to introduce constraints in the model.</td>
</tr>
<tr>
<td></td>
<td>Consider the dependency between criteria.</td>
<td>Formation of pairwise comparison matrices is a time-consuming and complex task.</td>
</tr>
<tr>
<td>Statistical approaches</td>
<td>Allow to analysis of large databases.</td>
<td>No optimal solution.</td>
</tr>
<tr>
<td></td>
<td>Can be applied to a complex problem, such as that represented by hierarchical structure of decision criteria.</td>
<td>No possibility to introduce constraints in the model.</td>
</tr>
<tr>
<td></td>
<td>Possibility to introduce, or not introduce, constraints in the models.</td>
<td>Difficult to define “clusters” when the criteria are highly dependent.</td>
</tr>
<tr>
<td>Mathematical programming</td>
<td>The criteria do not necessarily have a common dimension.</td>
<td>Difficult to measure qualitative criteria.</td>
</tr>
<tr>
<td></td>
<td>Difficult to design the model.</td>
<td>Difficult to analyze the results in the case of MOP.</td>
</tr>
<tr>
<td></td>
<td>Computing optimal solution might be time-consuming in the case of NP-hard problems.</td>
<td></td>
</tr>
<tr>
<td>Artificial intelligence</td>
<td>Offer a flexible knowledge base.</td>
<td>The collection of knowledge about 3PL and access to expertise is long and difficult.</td>
</tr>
<tr>
<td></td>
<td>Take into account qualitative factors.</td>
<td>Very expensive.</td>
</tr>
<tr>
<td></td>
<td>Can scope better with complexity and uncertainty as it designed to operate in a similar way to human judgement.</td>
<td></td>
</tr>
</tbody>
</table>

– The majority (82.09%) studies are empirical in nature and are generally related to a geographical region or country. The few comparative studies between countries or regions that have been conducted are those of Fawcett and Smith [21], and Millen et al. [24]. It would be interesting to do further studies in this direction, especially in the current context of markets’ globalization and increased international logistics.

– The 3PL selection studies are weakly theoretical with only 17.91% of the articles. A more comprehensive conceptual framework is needed, and must consider all qualitative, quantitative, tangibles, intangibles, strategic, and operational criteria.

– This review can also be extended to the analysis of doctoral thesis, conference articles and other databases.

– Finally, this paper may help researchers for understanding the inadequacy in the 3PL selection literature and finding the gaps for work to be done in future.

References
