Chapter

A Framework for Detecting the Proper Multi-Criteria Decision-Making Method Taking into Account the Characteristics of Third-Party Logistics, the Requirements of Managers, and the Type of Input Data

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Abstract

The aim of the paper is to propose a framework for improving the process of choosing an appropriate multi-criteria decision-making (MCDM) method in the selection of a third-party logistics provider (3PLP). A systematic combining process was used, along with two literature reviews, one empirical survey and a case study. A four-step framework was proposed, starting with identifying common criteria that are harmonised to the 3PLP selection process, followed by analysing all aspects of the 3PLP selection problem and the selected MCDM methods in view of common criteria, finishing with a decision tree, divided into seven branches that orient the decision-maker towards his decisions. The paper also contributes to the theory by identifying and evaluating criteria that characterise 3PLP decision-making and by suggesting a suitable order of criteria. A numerical example was implemented to evaluate a proposed framework.

Keywords: third-party logistics provider (3PLP), multi-criteria decision-making (MCDM) methods, selection process, supply chain

1. Introduction and background

Competitive supply chain management is largely dependent on the efficient management of the logistics chain [1]. Since companies (shippers) spend more and more time focusing on core competencies, they increasingly outsource logistics in parts or in their entirety to 3PLPs, which assist them in gaining competitive advantage [2–4]. However, logistics outsourcing can fail if not done properly, which can be very costly, even fatal.

There are many reasons for outsourcing failures. Of the most frequently is relationship failure between the buyer and the provider of logistics outsourcing

[5, 6], caused by 'possible defects in a partner, perception of opportunistic behaviour, lack of understanding between partners, conflict risk, lack of competence, loss of core proprietary capabilities and encroachment risk' [7, 8], lack of expertise of a partner, lack of information, etc. [9].

Some features of 3PLP come to light when performing outsourcing and are therefore difficult to predict in advance. But many risks related to 3PLP can be predicted and eliminated, reduced or elided in the early build-up stage of 3PL relationship development. This is the stage during which potential 3PLP are selected by the buyer to negotiate and develop a contract. This study is only focused on the 3PLP selection process, which covers the selection of criteria, of the appropriate decision-making method or methods to evaluate the criteria, and final selection of potential 3PLP [10–14]. Negotiations and development of a contract were not considered in this article.

Identification of selection criteria, representing the first phase of the selection process, was outlined in two the authors' previous papers [15, 16]. Four groups of criteria (C_1, C_2, C_3 and C_4) were proposed. The C_1 group covers vitally important criteria for the success of the supply chain, C_2 are very important criteria, C_3 group are important criteria and C_4 are less important elements and therefore completely left to the discretion of the decision-maker.

The second phase of the 3PLP decision-making problem relates to the selection of the appropriate method. There is a wide range of MCDM methods, but not every method can be used for solving every decision-making problem. The characteristics as well as the advantages and disadvantages of each method are very different. The use of different methods can therefore result in different solutions to the same problem [17]. The approach for selecting the appropriate method should be tailored to each single decision-making process and not vice-versa [18]. Thus, the selection of the appropriate method is one of the most difficult problems in the selection process [19–22].

A very extensive and deep review of the literature on the most frequently used MCDM for selecting the 3PLP (108 scientific papers, published from 1999 (when the first articles in this field began to appear) to 2016, were systematically reviewed) revealed that many MCDM methods and combinations of methods have been used. The most frequently used method was the analytic hierarchy process (AHP), followed by the technique for order of preference by similarity to ideal solution (TOPSIS), analytic network process (ANP), Linear programming, data envelopment analysis (DEA), VIKOR, DELPHI, quality function deployment (QFD), decision-making trial and evaluation laboratory (DEMATEL), the preference ranking organisation method for enrichment of evaluations (PROMETHEE), elimination and choice expressing reality (ELECTRE) and interpretive structural modelling (ISM). Other methods were used once or never.

A vast array of MCDM methods has been applied. The applied methods have very different characteristics, which raises doubts over whether the method is harmonised with the characteristics of the 3PL industry, the single selection process and its objective. Discussions regarding the harmonisation of the applied MCDM with the 3PL characteristics or even single selection process have been very sparse. Explorations of the concrete use of MCDM methods, from the point of view of the decision-makers, have been very limited as well. Authors [23] in one of their studies assume that the MCDM method is still selected arbitrarily (the method is popular). Authors [18] share very similar opinion, arguing that decision-makers have an affinity for the chosen MCDM method, or they apply it, because it is easy to use. However, no research has yet been launched into the real circumstances of the reasons for choosing a particular method, problems associated with the use of different methods, plus challenges and needs of decision-makers.

To solve these issues an e-survey was used. A preliminary survey questionnaire was firstly developed and distributed to three researchers from three different logistics faculties, and to three decision-makers, familiar with the subject topic area, to ensure the survey was thorough and understandable. Following several modifications from this first review, the web-based survey was developed and then sent to producers, retailers, and suppliers located in Slovenia. Only companies that have had experiences with logistics outsourcing and only employees familiar with the selection process were contacted. Of the 50 e-mails 2 were not delivered and 25 were fully answered. The survey examined three main topics: the first was general (number of participants in the selection process, insourcing or outsourcing of selection process; the second relates to those that outsource the selection process and the third to those that insource selection process. Close-ended and open-ended questions were used. The following results were outlined:

The 3PLP selection process is mainly done by the buyers of outsourcing (16 of 25 companies). They are used to it and they are familiar with the used methodology. However, they are not satisfied with the method's ability or with its results. It seems that they are familiar with the method they are using but not with other methods that exist (**Table 1**).

Those that outsource the selection process either because it is time and staff consuming or because of lack of knowledge and experience request tailor made solutions regarding the type of results and methods used, but are disappointed with

Reasons for not outsourcing the selection process / Reason for dissatisfaction with the results of selection process	Time consuming.	Method is not able to use any type of data.	The results were not in the form we desired.	Too few possibilities that are offered by the method.	Complex software.	Method is not able to manage subjectivity.
We are doing the selection process ourselves from the very beginning.	21	20	18	16	15	14
We are familiar with the methodology.	21	20	18	16	15	14
Don't trust external company (fear to lose the input data).	17	16	14	12	11	10
Too high cost of external company.	15	14	12	10	9	8
We were not satisfied with the external company.	8	7	5	3	2	1

Table 1.
Correlation between reasons for not outsourcing the selection process and reasons for dissatisfaction with the results of the performed selection process.

Reasons for outsourcing / Reasons for dissatisfaction with the selection process	External provider was not able to offer tailor made selection process.	We were not able to influence the choice of methodology because we are not familiar with.	Poor communication between the partners.	The results were not in the form we desired.	We were not sufficiently involved in the selection process.	We were not able to influence the choice of methodology of the selection process, although we would	The selection procedure was not explained to us at all.	Inaccurate input date because of fear to loss them.
Time consuming.	9	8	8	7	7	7	6	6
Human resource consuming.	9	8	8	7	7	7	6	6
Don't have software and any other tools.	9	8	8	7	7	7	6	6
Don't have knowledge nor experience.	8	7	7	6	6	6	5	5
Fear to fail.	6	5	5	4	4	4	3	3
Rarely implementation of the selection process.	5	4	4	3	3	3	2	2

Table 2.
Correlation between reasons for outsourcing and reasons for dissatisfaction with the selection process.

the performance of the external provider (**Table 2**). It seems they are very well aware of the abilities the process of selection can offer, but have a lack of knowledge and experience.

Both those that insource and those that outsource the selection process are not satisfied. The selection process is dissatisfactorally performed. Moreover, the final result of the selection process may not be appropriate. This increases the risk of relationship failure. Again, more than half of logistics partnerships end within three to 5 years [24]. Decision-makers therefore need a reliable means for choosing the right method or combination of methods.

In summary, the extensive literature review found: (1) a lack of critical analysis of the published knowledge on the MCDM methods which would help to reveal the appropriate methods or group of methods for the logistics industry and (2) a dearth of studies determining the specific context of the 3PL industry and 3PLP decision-making. The empirical survey furthermore indicated that companies are setting up more tailor made requirements.

The main research questions (RQ) of this research are therefore three:

RQ1. What are the characteristics of the 3PLP decision-making?

RQ2. What are the most appropriate criteria for selecting MCDM method in the 3PLP decision-making?

RQ3. How can decision-makers combine the characteristics of the 3PLP decision-making with criteria and their individual requirements to help them choose the most appropriate MCDM method?

In line with the above thinking and research questions, the purpose of this paper is to propose a framework to help detect the appropriate MCDM method or methods in the selection of 3PLP within the early build-up stage of 3PL relationship development.

2. Research methodology

The aim of this article is not new theory development but grounded theory refinement and adaptation to the 3PL industry. The authors aim to discover potential new criteria and determine a new hierarchical order of criteria appropriate for MCDM method selection in 3PLP decision-making process within grounded and general theory.

Although the article contains a bit of testing of the current theory, 'which suggests a deductive approach, and although a quasi-deductive theory testing means is used [25], the paper is ultimately closer to the inductive approach, which helps the researchers to delineate important variables and directs interpretation of findings' [26], but does not help to develop new theory. Mixed method research, which uses both quantitative and qualitative data, is preferred for allowing a better understanding [27] and spurring progress in a new field, but is not so fruitful for theory development and does not investigate the relationship between reality and grounded theory [26].

A systematic combining process was, on the other hand, found to be particularly useful in the refinement of existing theories and even in matching theory and reality [26, 28]. It was therefore used in this paper for the creation of the framework that facilitates the choice of a MCDM method in 3PLP selection. In line with the systematic combining process a five-phase methodology was adopted, as shown in **Figure 1**.

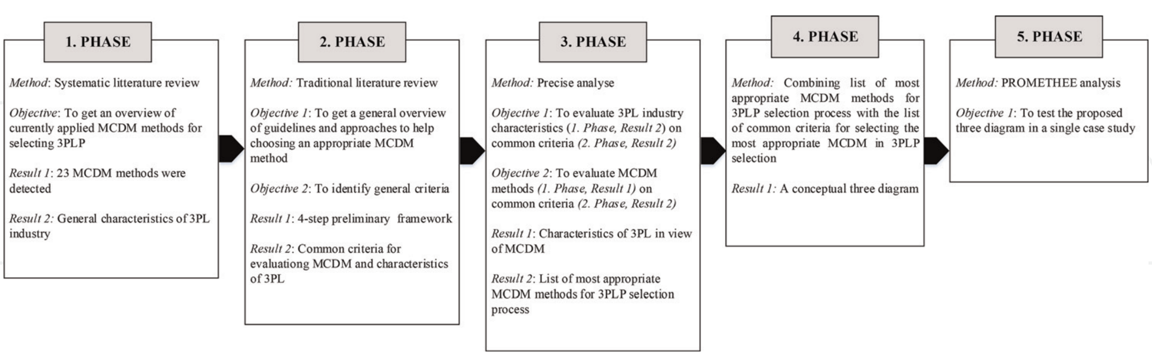

Figure 1.
Phases of the research.

3. A framework facilitating choosing an appropriate MCDM method

A framework proposed in this article builds on the interactive decision support system (IDSS) of [29], on the general tentative guidelines of [21], on the multi-criterion evaluation approach of [23] and on two rather new studies, by [20, 30].

Authors [29] stated that the particular IDSS should be based on a set of selected methods and on a suitable approach for the specific problem. Authors [23] proposed defining common criteria as a basis for establishing a correspondence between characteristics of the spatially-referenced decision problems and characteristics of the multi-criterion aggregation procedure. Authors [23] suggested starting the study of MCDM methods first by identifying a set of criteria for each method. After that a comparative study using a carefully crafted simulation is made.

The selection of the MCDM method depends on specific characteristics of the decision-making problem, characteristics of MCMD methods and resource constraints [19, 21–23, 29]. To select an appropriate MCDM method all three groups of characteristics should correspond among themselves and correspondence should be established in accord with common criteria [21–23, 29].

Keeping in mind the views of these researchers, the following 4-step framework is proposed: (1) Identifying common criteria (limits, conditions of application for MCDM method) for evaluation and identification of the characteristics of the 3PLP selection process and characteristics of MCDM groups of methods or single methods that are harmonised in regard to the 3PLP selection process. (2) Analysing all aspects of the 3PLP selection problem in view of common criteria. The result of this step is to elucidate the characteristics of the 3PLP selection problem. (3) Analysing the selected MCDM methods in view of common criteria, which highlights the appropriate groups of methods or a single MCDM method. (4) Proposing a decision tree to facilitate selecting the appropriate MCDM method.

3.1 Identifying common criteria

Authors [23] suggested the evaluation of the decision problem and MCDM methods based on three common criteria: (1) type of decision problem, (2) nature of the set of alternatives and (3) nature and features of input information. Authors [29] stated that the particular decision-making system should be based on the set of ordinary criteria, pseudo-criteria and quasi-criteria. Authors [21] identified the following groups of common criteria: (1) the input data, (2) the preference elucidation, (3) the aggregation procedure, (4) the quality and quantity of the input information, (5) the compensation degree of the method and (6) the decision support system (software, user friendly aid packages).

Authors [30] claimed that the choice of criteria is very dependent on the decision-making context. A crucial parameter in their view is the adaptation of the type of results the method is expected to deliver, following with the correct handling of input information and adaptation of the degree of compensation.

In view of these findings two groups of common criteria were identified: primary and secondary (**Figure 2**). Criteria are presented in a hierarchical order (from the most important to the least important) to help the decision-maker chose the most appropriate method. However, the order of criteria within the key criteria related group is not mandatory.

The decision-maker can choose mainly between following types of results: a numerical value that is, available for each potential action, ranking of potential actions, without assignment of a numerical value for each potential action, selection of a subset of actions in preparation for making a final choice and assignment of actions to some a priori defined categories.

Kind of input information determines whether the information is qualitative, quantitative or mixed. An information feature deals with the information determinism or non-determinism (certain, uncertain, ambiguous, non-ambiguous information, etc.) [21]. There are three crucial types of problem statements:
(1) The choice problem statement in which one or more alternatives are selected.
(2) The sort problem statement in which various alternatives are sorted in classes.
(3) The rank problem statement that ranks alternatives according to a preference structure [22, 29].

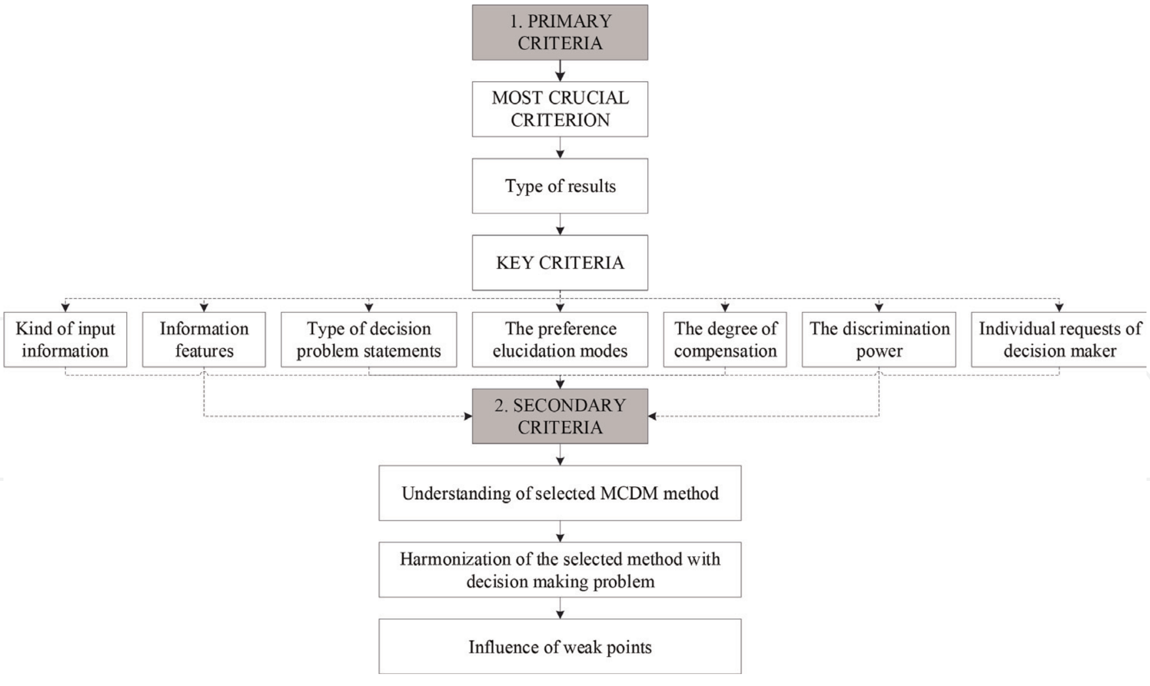

Figure 2.
Classification of common criteria.

MCDM methods have different forms of preferences: trade-offs, assessment of lotteries, direct rating and pairwise comparison, presence of veto, etc. The degree of compensation which concerns the 'trade-offs; that is, the possibility of offsetting a "disadvantage" of some criterion with a sufficiently large "advantage" of another criterion—whereas smaller advantages would not do the same' [22].

There are also some criteria that determine the use of the MCDM method but are totally dependent on the need or request of each individual decision-maker. These criteria often relate to user-friendliness [21, 31], intelligibility and the structure of the method [18], ease of computation and costs of adopting methods [31].

Authors [20] suggested also using secondary parameters in case the decision-maker after taking into account various parameters still hesitates between several methods.

3.2 Analysing all aspects of 3PLP selection problem in view of common criteria

A literature review on selection criteria in 3PL found that the number of criteria vary from 6 to more than 20 [15]. In all reviewed articles mixed types of criteria (qualitative and quantitative data) were applied. Costs were found to be the most frequently used criterion, closely followed by many qualitative criteria [16]. Based on these results, it is clear that the 3PL industry is characterised by the mixed types of input data (quantitative and qualitative) and many input data which are usually conflicting (lower costs, high quality).

The most frequently used method was found to be the AHP, followed by TOPSIS and ANP. DEA, VIKOR, DELPHI, DEMATEL, QFD, ISM, PROMETHEE and ELECTREE were used more rarely [15]. Based on these results, it is clear that the pairwise comparison of criteria is the most desired preference elucidation mode. The results of decision-making are most frequently presented as numerical values (score for each alternative) or as ranked alternatives.

The fuzzy optimised method has been applied the most frequently (in 38 of 108 articles) [15]. Based on this fact, it is clear that the 3PL industry is characterised by input data, which are usually uncertain.

In 35% of the reviewed articles, software tools were used. Frequent use of software tools may prove that user friendly solutions are required. Moreover, ease of use and low level of complexity are desired.

3.3 Analysing the selected MCDM methods in view of common criteria

A selection of MCDM methods has been made on the basis of the literature review. Twenty-six methods in total, used in the 3PLP selection process, were found to exist, but only the most frequently used (in 75% of cases) were selected to be evaluated according to the criteria presented in the section "Identifying common criteria".

The comparison of the methods (**Table 3**) is based on a review of the literature [18, 20, 22, 29, 32–37] and not on expert study of each of the methods. Any method not considered in this table can be added to the table and analysed in the same way.

According to comparative analysis, the AHP, ANP, TOPSIS, ISM, VIKOR, DEMATEL and ELECTRE methods were found to be the most appropriate for the 3PLP decision-making problem and were later used in typological decision tree.

3.4 A typological decision tree diagram for the selection of the appropriate MCDM method

Based on the insights presented mainly in Sections 3.1, 3.2 and 3.3, the three diagram (**Figure 3**) which helps decision-maker to narrow down opinions following the branches was prepared [21, 29, 38]. A typological tree was used, because of its ability to capture all the sides of the decision-making problem (different methods, many parameters, extensive information) [21].

On the top of the tree are listed MCDM methods that, in Section 3.3 were found to be most appropriate in the selection of 3PLPs. The tree structure is then divided into seven nodes with questions which guide decision-makers in selecting the most appropriate MCDM. Questions are criteria identified in Section 3.1. The questions

MCDM method	Type of results	Kind of info	Type of problem statement	The preference elucidation mode	Compensation
AHP	numerical value	mixed	choice, ranking	pairwise comparison	yes, partially
TOPSIS	numerical value	mixed	choice, ranking	direct rating	yes, totally
ANP	numerical value	mixed	choice, ranking	pairwise comparison	yes, partially
DEA	ranking	mixed	ranking	pairwise comparison	yes, partially
VIKOR	numerical value	mixed	choice, ranking	trade-offs/rating	yes, partially
DEMATEL	ranking	mixed	ranking	pairwise comparison	yes, partially
ELECTRE	ranking	mixed	ranking	pairwise comparison	yes, partially
PROMETHEE	ranking	mixed	ranking	pairwise comparison	yes, partially

Table 3.
Comparison of selected MCDM methods on the basis of common criteria.

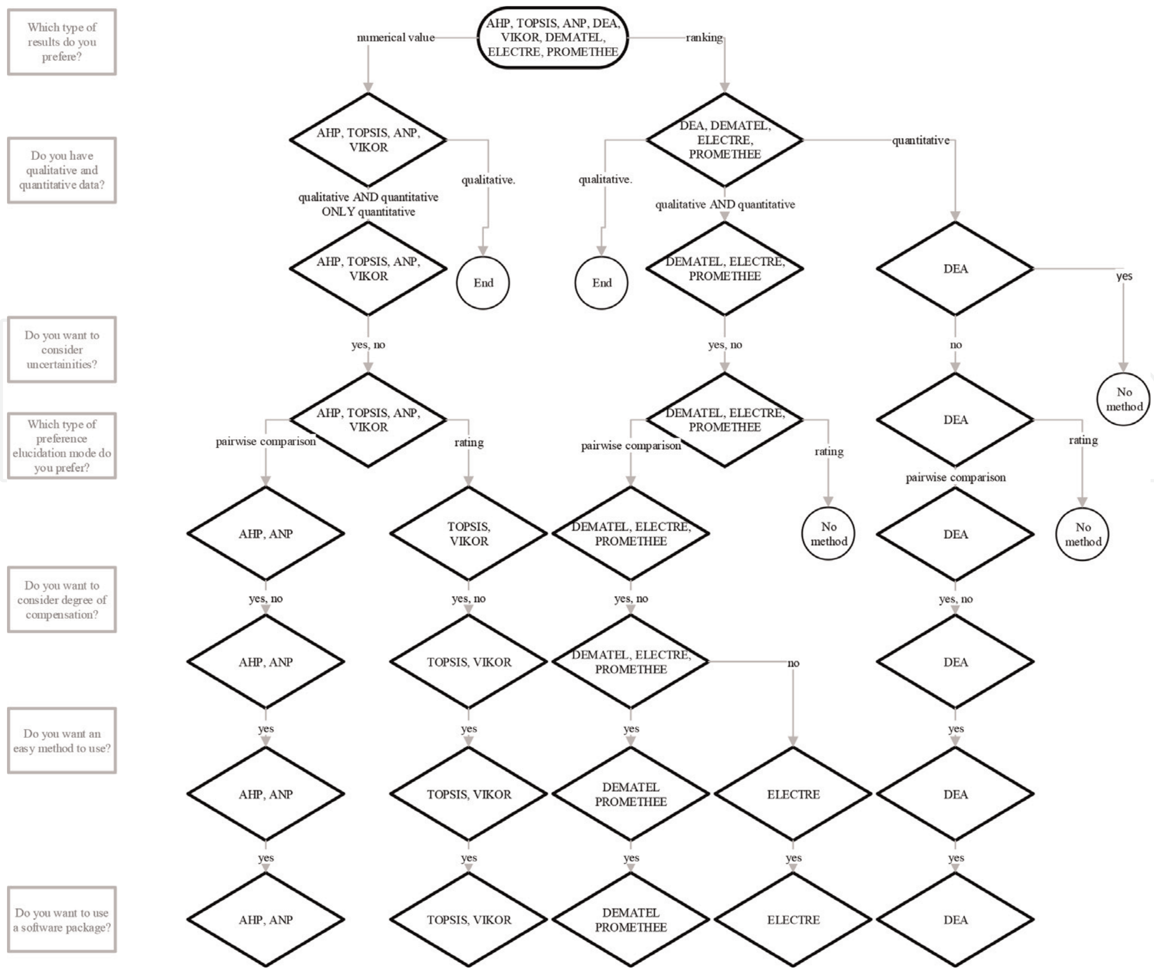

Figure 3.
The decision tree for selecting MCDM method in 3PLP decision-making.

are in a hierarchical order, from the most general and pertinent to the least pertinent [20].

The tree diagram can include any other method and may be upgraded with additional questions from the third group of parameters as well.

4. Validation of the proposed decision tree using a case study of local spare parts for a construction and agricultural machinery dealer

To validate the usefulness and practicality of the proposed approach we present a case study of a local spare parts company dealing with construction and agricultural machinery. The management intends to outsource all parcel delivery and occasionally value added services (repackaging of goods) to a single 3PLP. Thus far they have worked with five domestic and international parcel distributors. Due to a large number of contacts, different pricing, operating conditions and even quality of services, the situation can be quite chaotic at times. The dealer therefore decided to cooperate with one or at most two logistics providers who are favourable, offer a high quality of service particularly in terms of time, quality and quantity of package accuracy, flexibility, responsiveness, high frequency of delivery, etc.

To define the criteria set, the list of the most frequently used criteria detected by [15] was submitted to the top management of a spare parts dealer. According to the dealer's requirements and the nature of its business, the following criteria were selected: costs (C_1), warehouse services (C_2), added value services (C_3), accurate time, quality and quantity (C_4), flexibility (C_5), responsiveness (C_6), frequency of delivery (C_7), staff quality (C_8), information exchange capability (C_9). Some of them are qualitative, some quantitative. Mixed types of data were therefore used in this selection process, which answered the second question of a tree diagram proposed in Section 3.4.

Selection of the most appropriate MCDM started with answering the six questions of the decision tree, since the second question was already answered with the selection of the criteria for choosing the 3PLP. The top management was not familiar with MCDM methods. The authors, therefore, need to explain questions 1, 3, 4, 5, 6 and 7 of the decision tree in order to receive proper answers. The top management preferred to have 3PLPs ranked from the best to the worst. They wished to eliminate subjectivity. Pairwise comparison and not direct rating was selected. They wanted to take into account compensation and preferred to use an easy method. Using the tree diagram proposed in **Figure 3**, the PROMETHEE and DEMATEL methods were found to be the most appropriate for the requirements of the top management. But since 'PROMETHEE shows better balance between theory and implementation, it is easier to use and the software is simple to understand [18] the present decision-making process used PROMETHEE.

PROMETHEE requires the use of weights of relative importance $\{w_1, w_2, ..., w_m\}$ to associate with the criteria set $C = \{C_1, C_2, ..., C_m\}$, $m = 9$. The following weights are obtained with the AHP method: $w_1 = 0.24$, $w_2 = 0.06$, $w_3 = 0.05$, $w_4 = 0.20$, $w_5 = 0.11$, $w_6 = 0.10$, $w_7 = 0.18$, $w_8 = 0.03$, $w_9 = 0.03$. They are based on the nine stage Saaty comparison scale [39] and form the pair-wise comparison matrix M.

The consistency index (CI) of the comparison matrix M is computed using the normalised principal Eigen vector method and the approximate value of the maximum eigenvalue λ_{max} which is 9.83 [40]. The consistency index is $CI \cong 0.1$, divided with the random consistency index (RI), which is 1,45, results in the consistency ratio $CR \cong 0.07$, which is <10%. Therefore, the comparison matrix M is consistent and the weights have been properly computed. In the next step, the set of alternatives $A = \{a_1, a_2, ..., a_n\}$ must be evaluated with respect to the proposed criteria. In the case study $n = 5$ and $\{a_1 = TNT, a_2 = DHL, a_3 = GLS, a_4 = Posta\ SLO,$ $a_5 = FEDEX\}$. Evaluations are defined in the matrix $\{f_i(a_j), 1 \le i \le 9\ ; 1 \le j \le 5\}$ and values of evaluation (**Figure 4**) are based on the five stage scale where intermediate evaluations are also allowed (1 = very low,..., 5 = very strong).

Now the preference structure of the PROMETHEE method is defined. For this purpose the range of evaluations of alternatives is computed with respect to each criterion:

$$d_k(a_i, a_j) = f_k(a_i) - f_k(a_j) \tag{1}$$

and the preference function $P(x)$ is defined as:

$$P(x) = \begin{cases} 0, & x \le q \\ \dfrac{x-q}{p-q}, & q \le x \le p\ ; \\ 1, & x \ge p \end{cases} \tag{2}$$

where q and p are, respectively, the smallest and the largest threshold deviation values sufficient to generate a full preference. In our case $q = 0.2$ and $p = 0.6$.

Preferences are values between 0 and 1 and are defined as:

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
a_1	4	5	5	3.5	4	3	3	4	4
a_2	4	5	4	4	4	3	4	4	4
a_3	4	5	4	3.5	3	3	4	4	4
a_4	3	4	3	3	3	2	3	4	3
a_5	4	5	4	3.5	3	3	3	4	4

Figure 4.
Evaluation matrix.

$$P_k(a_i, a_j) = P[d_k(a_i, a_j)]. \tag{3}$$

The preference degree of criteria a_i with respect to a_j is defined as:

$$\pi(a_i, a_j) = \sum_{k=1}^{m} P_k(a_i, a_j) w_k \tag{4}$$

and the preference degree of criteria a_j with respect to a_i is defined as:

$$\pi(a_j, a_i) = \sum_{k=1}^{m} P_k(a_j, a_i) w_k. \tag{5}$$

The multi-criteria preference flows (out and in) are defined as:

$$\phi^+(a) = \frac{1}{n-1} \sum_{i=1}^{n} \pi(a, a_i); \tag{6}$$

$$\phi^-(a) = \frac{1}{n-1} \sum_{i=1}^{n} \pi(a_i, a); \tag{7}$$

The positive preference flow ϕ^+ measures the given alternative's global preference with respect to the preferences of all other alternatives. The negative preference flow ϕ^- measures the global preference of all the other alternatives with respect to a given alternative. The PROMETHEE complete ranking is obtained by ordering the actions according to the decreasing values of the flow scores:

$$\phi(a) = \phi^+(a) - \phi^-(a);\ \phi(a) \epsilon [0, 1] \tag{8}$$

For functions defined by Eq. (1)–(8), it has been verified that all request conditions are fulfilled [41]. Using Eq. (6) the out multi-criteria preference flows are computed: $\phi^+(a_1) = 0.11$, $\phi^+(a_2) = 0.01$, $\phi^+(a_3) = 0.09$, $\phi^+(a_4) = 0.75$, $\phi^+(a_5) = 0.18$. Then using Eq. (7) the in multi-criteria preference flows are computed: $\phi^-(a_1) = 0.27$, $\phi^-(a_2) = 0.46$, $\phi^-(a_3) = 0.28$, $\phi^-(a_4) = 0$, $\phi^-(a_5) = 0.15$. The ranking of alternatives is obtained using Eq. (8): $\phi(a_4) = 0.75 \geq \phi(a_5) = 0.04 \geq \phi(a_1) = -0.15 \geq \phi(a_3) = -0.18 \geq \phi(a_2) = -0.45$. The best alternative is Posta SLO and the least useful is DHL.

To check the usefulness of the proposed framework and the obtained results the authors asked the spare parts dealer to validate five logistics service providers using customer relationship management (CRM) software. The software enables management of the database of logistics service providers and also offers some extra services including an evaluation of the service providers. In order to be as objective as possible authors decided not to inform the dealer of the results of the PROMETHEE ranking. Authors suggested they use the same criteria as in the PROMETHEE ranking, while everything else was left to their choice. Posta SI was found to be the best alternative, followed by FEDEX, TNT, GLS and DHL. The same results were obtained using the PROMETHEE method.

5. Discussion

After proposing a typological tree and testing its usefulness it can be concluded that the tree cannot be simply used by a decision-maker in the same way as it was presented, but must be tailored to each specific 3PL selection process. Each 3PL selection process is unique and each decision-maker has different requirements in regard to the questions (criteria) and also different levels of knowledge about MCDM methods.

Moreover, due to the diversity of methods, the answers to the questions presented in the tree are often quite complicated. The comparison of MCDM methods presented in Chapter 3.3 also revealed that by some criteria methods cannot simply be compared [20] because of diversity of calculation, lack of an approach, for example, to characterising the degree of compensation, etc. [22] etc.). Authors [21], therefore, argue that a comparative analyse of different MCDM can only be used to identify in what circumstances (by which criteria) one method is appropriate.

Accordingly, it is impossible to describe all the 3PL decision-making situations and to formulate a tree diagram with a family of questions that would simply allow choosing the appropriate method [20]. The tree diagram presented here, as a final stage of the proposed framework, is therefore not a miraculous tool which enables the choosing of the proper methods, but only a general guideline that facilitates the choice of the proper methods.

The proposed framework is based on three different characteristics: 3PL characteristics; those of MCDM methods; and individual requirements of each single decision-making process. When selecting an appropriate method all three characteristics need to be matched [22], which is not an easy task, one requiring knowledge of the MCDM methods. The MCDM methods resulting from the tree diagram are frequently also equivocal, which requires a deep and axiomatic study in order to confidently make a choice.

6. Conclusion

Decision-making in 3PLP selection has an important impact on logistics outsourcing success. Therefore, the appropriate MCDM method or methods must therefore be used to select the most appropriate 3PLP. Because of the sheer volume and variance among MCDM methods, decision-makers face a difficult dilemma.

To solve this problem a four step approach facilitating the choosing of an appropriate method was proposed. The first two steps relate to criteria identification, the third to the identification of the right MCDM methods for 3PLP selection and the last combines all of the first three steps' results on order to construct a typological tree.

The typological tree is divided into branches (simple questions) which orients the decision-maker, guiding him towards an eventual opinion. The questions relate the characteristics of the logistics industry, aspects of MCDM methodology and the preferences of the decision-maker. The order in which questions follow is chosen according to the priorities in making choices. The authors argue that the most relevant criteria to consider is the type of the results, followed by the type of data, elimination- or degree of limitation- of subjectivity, preference elucidation mode, degree of compensation, and finally, the ease of use and the availability of software. The tree diagram could be upgraded with additional branches but it will nevertheless remain easy to understand, even for those decision-makers who are not familiar with MCDM methods.

The proposed guideline was illustrated by a single case study of a local spare parts company. The decision-making process was made using the PROMETHEE. The PROMETHEE ranking of alternatives was at the end compared with results obtained by the CRM software tool. The evaluation of the framework in the case study demonstrated its utility.

The paper upgrades the general theory of IDSS and tailors it to the 3PL purposes, contributing to the theory by firstly suggesting a novel framework for facilitating the selection of the MCDM method. Further, it identifies and evaluates the criteria that characterise 3PLP decision-making in view of MCDM as well as individual criteria. The paper also suggests a suitable order of criteria and makes a comparative analysis of MCDM based on the criteria.

From a managerial perspective, this paper provides a kind of a tool for guiding decision-makers selecting an MCDM method. A decision-maker should first decide how many and which criteria are relevant for the decision-making process. Then, a decision-making tree helps the decision-maker focus on the proper MCDM method.

Moreover, the proposed framework makes a significant contribution to the choice of the 3PLP that best suits decision-maker needs and consequently decreases relationship risks and increases performance outcomes for the 3PLP and its buyer.

The paper has some limitations. First, the drawback of a single-case design is its inability to provide a generalised conclusion. To strengthen the external validity of guideline, further empirical studies are necessary. The authors suggest testing the guideline in other case studies. Second, an issue that remains open, one that was not considered in this paper, is the importance of each criterion within the framework. Not all criteria are equally important. Further studies that will measure the weight of each criterion should be conducted.

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