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Selection of Functional Logistics Service Providers: AHP and DEMATEL Application*

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Abstract

Despite the widespread establishment of logistics service providers, the largest integrated logistics service providers (ILSPs) cannot offer customers a fully customised supply chain without outsourcing some logistics functions, not their strengths, to local companies or specialised service providers. Accordingly, this study investigates the outsourcing of functional logistics activities from logistics integrators, or ILSPs, by focusing on the selection process for functional logistics service providers (FLSPs), especially on the attributes that affect the selection decision. This study uses the hybrid multiple criteria decision-making approach, the AHP-DEMATEL integrated model. The findings include the characterisation of eight main factors affecting the FLSPs' selection decision, regarding their degree of particular importance and their reciprocal influence inside the decision-making system, from the ILSPs' perspective. Additionally, the dominance of cost factors is emphasised through a double-analysis using the AHP and DEMATEL methods, while the importance of the remaining factors is also indicated. The final analysis results are discussed with conclusions for detailed insights. Through this study, decision-makers of ILSPs enable the review of the selection process and its standards.

Keywords : integrated logistics service providers, functional logistics service providers, Vietnam, AHP, DEMATEL.

1. Introduction

Organisations across industries have largely outsourced their logistics functions for decades as a strategy to optimise cost-effectiveness, shorten transport lead time, and increase supply

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chain performance as a whole. Thus, companies can concentrate on their core businesses, providing them with a competitive advantage and actual revenue (Rushton, 2007). Therefore, in today's business, logistics partners are as important as the company itself, and the more services that can be obtained from a single provider, the more seamless, scalable, and cost-effective the supply chain. Thus, companies usually prefer to cooperate with logistics partners who can offer integrated services than many different suppliers for various single logistics tasks.

Typically, a logistics service provider (LSP) provides single or extended services, including warehousing, packaging, labelling, and transportation. However, nowadays, customers sometimes require their LSPs to be more customised, such as fleet management, handling, or assembly service; hence, LSPs must be involved in the customer management system. This is one reason behind the emergence of third-party (3PL) and fourth-party logistics (4PL) services. According to Rushton (2007), 3PL or 4PL can be defined as an integrated logistics service, including the design, operation, and management of the whole supply chain, in addition to typical logistics activities. A well-integrated logistics service provider (ILSP) will completely consider the logistics aspect of their customer's business from raw materials or components, manufacturing to warehousing, and the final finished product delivery to dealers, distributors, and end-users. Honest ILSPs build on their strengths and solicit the assistance of other best-in-class providers with specific expertise in areas where they are not as strong (Bouchard, 2014).

Naturally, no logistics integrator can provide a fully extended supply chain solution, regardless of its size. They can claim dominance in specific supply chain fields, such as air or road transportation, ocean shipping, packaging, or labelling, but not in every field or country where their customers operate. As a result of business expansion, all logistics operators usually set goals to offer combined logistics functions that constitute a total service package for a customer (Bouchard, 2014). Many leading logistics service integrators outsource some functional logistics activities such as warehousing, single or multimodal transportation, customs clearance, terminal services, packaging, and other relevant value-added services to smaller-scale sub-suppliers, called functional logistics service providers (FLSPs) to satisfy customers with end to end logistics solutions against capacity deficiency (Liu et al., 2017). There is a vast choice of different logistics functions and supply chain activities that can be outsourced in an industrial context. As many companies realise the benefits of supply chain outsourcing to gain cost-effectiveness and the entire customised logistics procedure from external suppliers, a logistics service operator is required to expand its business in a competitive marketplace.

Logistics connects production and consumption and supports companies in controlling the flow of goods, services, and information (Bartolacci et al., 2012). Therefore, selecting one or more suitable FLSPs is essential for ILSPs, especially when entering a new operation market. Local knowledge and resource deficiencies, usually more serious initially, are the obstacles

forcing global logistics service integrators to build local partnerships for their customised supply chain. This research aims to learn about the local logistics partner selection procedure of international logistics service firms.

Much research has been conducted in the academic field to identify appropriate criteria to select or evaluate logistics suppliers with different techniques, in which multiple-criteria decision making (MCDM) methods have been applied. The most popular approaches include tools such as data envelopment analysis (DEA), the analytical hierarchy process (AHP), analytical network process, genetic algorithms, mathematical programming, fuzzy set theory, rough set theory, simple multi-attribute rating technique, and technique for order of preference by similarity to ideal solution. These methods are widely used in various topics (e.g., Yoon et al., 2007; Park, 2013; Ha, Han, 2019; Han, 2019). The majority of MCDM methods support researchers in ranking and scoring criteria, indicating which criterion matters and which does not. These tools are built based on the independent characteristics of attributes assumed by many researchers in the past. In reality, especially in supplier selection (SS), the criteria of a set of assessments may interact with each other, and a cause-effect relationship is developed among them (Yang et al., 2008).

Among these methods, AHP and the integrated method of AHP are the most-cited for supplier evaluation and selection (Mukherjee, 2014). They were developed to obtain the relative weights among the factors and the total values of each alternative based on these weights. Using pairwise comparisons, AHP concludes the preference rating for all criteria and options so that researchers can draw a hierarchical structure. The drawback of this method is that it does not provide any interdependencies between and among the variables. Like any other single model, this disadvantage prevents the decision-makers from using a single model in their decision-making process, as it can be biased and insufficient. Instead, they prefer multiple integrated models that support and compensate for each other, making the entire selection process more accurate and practical (Ordoobadi, Wang, 2011).

Accordingly, this study also applies the decision-making trial and evaluation laboratory (DEMATEL) method, first introduced by the Battelle Memorial Institute (Gabus, Fontela, 1972). One of the weaknesses of AHP is in the fact that deos not allow to evaluating interrelations and influences between the elements that compose the decision-making process where DEMATEL method can visualise and construct interrelations between criteria and sub-criteria and helps to uncover the causal interactions among the variables based on their cause-effect groups (Si et al., 2018). The purpose of utilising the DEMATEL method in this research is to investigate the cause-effect relationship among service provider selection criteria in the logistics industry.

Unlike previous studies, this research is conducted in an Asian developing country, Vietnam, where the logistics industry is not standardised like the main logistics hubs in

Europe or America, even though the government has released many policies to facilitate the development of this industry in recent decades. This study focuses on the current condition of the Vietnamese market and applies a novel hybrid academic model, based on the opinions of experts in global logistics firms operating in Vietnam, to assess how they select logistics partners. Although LSP or 3PL evaluation and selection are not novel topics in academic research, there is room for improvement. First, studies on SS in the past primarily focus on physical product suppliers and not service suppliers, especially logistics and supply chain-related services. In other words, product procurement has gained greater attention from academia than service procurement. Second, in rare cases that study the selection of logistics partners, the service buyers whose procurement behaviour is investigated are usually manufacturers, while that of service providers has gained much less attention in academia. Therefore, the examination of FLSPs in this study represents the service SS issue from the service firm's novel perspective. Third, the hybridisation between two techniques to identify the standards in logistics partner selection has not been reported until recently; hence, the number of studies is limited. Finally, this study is based in Vietnam, an Asian developing country where the logistics market has a unique and unusual way of operation, influencing the choice of criteria from experts and their opinion on how they are applied. This study aims to provide new insights to fill these gaps.

The research objective is to understand the logistics SS process to customise logistics service integrators. Thus, the following extended relevant questions are presented to answer this question:

- What are the main attributes of the judicious selection of FLSP(s) from the angle of an integrated logistics provider?

By answering this question, various viewpoints are investigated to identify and characterise the factors that influence decision-makers of an ILSP in selecting the logistics supplier(s).

- How important are the attributes of the entire decision-making process individually? How do they influence the process interdependently?

This question focuses on constructing a hierarchical model in which the relative importance of each factor is shown, and the interrelationships among factors are examined using the AHP-DEMATEL hybrid model.

- How does this framework contribute to the practical situation in logistics service organisations?

Practically, this study's main motives are to provide empirical insights for logistics experts. Through the AHP-DEMATEL analysis findings, integrated logistics service firms can review their own selection procedure and the standard established in this process, while the local potential logistics sub-contractors can improve their own service.

2. Logistics service procurement

The procurement or purchasing process is a business function that belongs to the supply chain management sector, supporting companies in identifying, sourcing, evaluating, and management of external resources (CIPS, 2005). In the past, it was common for the purchasing function of a company to be associated with buying goods or production materials. However, in the last few decades, as the public has realised the value of service, and many companies have increasingly added services to their core operations, service procurement has gained as much attention as product procurement (Murray and Kotabe, 1999; Van der Valk, 2008). Consequently, the number of academic studies on service procurement has surged. Many researchers point out that the difference between service and product buying is huge and that service procurement needs to be considered from a specific supply chain perspective (Nie, Kellogg, 1999; Ellram, Tate, Billington, 2004).

Nevertheless, the special characteristics of services differ from physical products in the market: intangibility, inseparability, variability, and perishability (Kotabe, Murray, 2004). Furthermore, the customer and seller continuously interact from the production to consumption process of services (Grönroos, 2000), unlike in goods production. It is harder to evaluate service purchasing management if applying similar theories in the manufacturing sector. Accordingly, service procurement is more challenging to decide on the 'product', and its benefits are not evident (Kotabe, Murray, 2004).

There are two types of service firms that are categorised by their unique intangibility characteristics. The first type covers pure service providers, who lend themselves to the delivery of non-product-related services such as consultancy, advertising, insurance, and travel, among others. The second type is service operations which accompany tangible products, or in other words, product-related (PR) service providers (Patterson, Cicic, 1995). Examples of PR services include restaurants, retailing or construction, to name a few. Due to the broad range of services, it is not easy to classify logistics operators as pure or non-pure service providers. Trucking, warehousing, and packaging are among PR logistics services, while logistics solution consulting, freight forwarding, and warehouse software management is examples of many emerging value-added logistics services which belong to the non-product-related category.

The biggest advantage of outsourcing logistics is core competence concentration. A product manufacturer decides to outsource their logistics activities because they wish to focus their resources on core production, bringing them revenue. Similarly, for manufacturers, service firms would benefit from providing their core services to customers and relying on external suppliers for their supplementary services (Kotabe, Murray, 2004). The same applies to logistics integrators who have outsourcing strategies for their non-core logistics functions. Naturally, a detailed and deliberate evaluation process is needed to decide which service can be outsourced, as they do not want to lose any competitive advantage.

As various available services are covered, several studies have been conducted regarding a

single logistics service or an entire supply chain to obtain viewpoints from more angles in this field. König, Spinler (2016) found that outsourcing logistics can have an ambiguous effect on the supply chain vulnerability and is influenced by several internal and external factors. Lee, Dong, Bian (2010), Xifeng, Ji, Peng (2013) and Abbasi, Nilsson (2016) are some of the studies that focused on sustainable logistics. Meanwhile, many researchers focused on specific industries such as fashion and textile or construction (Jia et al., 2015; Ekeskär, Rudberg, 2016; and Guarnieri, Trojan, 2019).

Prior studies have set a broad vision for logistics outsourcing. The SS process, belonging to the initial stages of service procurement, the focus of most earlier research (Van der Valk, 2008), has also gained significant attention from academia. The next section addresses this particular stage from an industrial and academic perspective.

3. Logistics supplier selection criteria

Logistics suppliers can provide a wide range of logistics activities combined in a full-service package or offer customers a single service specialisation. Therefore, it is challenging to establish a common evaluation structure for all LSPs, especially when their customer－global logistics integrators－operate in the same industry. Nevertheless, relevant research has been conducted to understand the criteria developed in this field, as displayed in Table 1. Notably, some researchers used different terminologies for the same criterion.

Table 1 Most cited factors of logistics supplier selection

Criteria	Razzaque and Sheng (1998)	Selviaridis and Spring (2007)	Aguezzoul (2014)	Mukherjee (2014)	Jothi Basu et al. (2015)
Data preceding ability	x				
Financial stability	x	x	x		
Location	x		x		
Relationship	x		x	x	
Service cost	x	x	x	x	x
Reputation	x	x	x	x	
Service quality	x	x	x	x	x
Delivery	x		x	x	x
Supplier certification	x				
Flexibility	x	x	x		
Responsiveness		x			
Reliability		x		x	
Customer feedback		x			
Professionalism		x	x	x	x
IT / facility			x	x	
Billing accuracy					x
Sustainability				x	
Commercial plan				x	
Risk management				x	

Razzaque, Sheng (1998) assessed various issues within the outsourced logistics sector in 103 research papers to highlight the gaps in the research field. The outsourcing problems mentioned included the drivers, the importance, types of contract logistics vendors, opportunities and obstacles, success factors, and the selection of 3PL providers. Among all evaluation criteria listed by the authors, it is essential to introduce data preceding ability, business experience, competency, technology compatibility, financial stability, location, long-term relationship opportunity, price, reputation, service quality, speed, supplier certification, and system flexibility. The use of MCDM methods and quantitative analytical methods to evaluate LSPs has also been suggested. In 2007, Selviaridis, Spring (2007) studied 114 papers published during 1990–2005 to create a taxonomy of 3PL for both academia and practitioners. They identified and addressed two main issues regarding the procurement of 3PL services, including purchasing frameworks and selection criteria. The choice of logistics partner usually depends on quantitative criteria—cost, service quality, reliability, flexibility, responsiveness and financial stability, and qualitative factors such as reputation, customer feedback, and customers' industry experience. Finally, the authors recommended further research to consider organisational and operational uncertainties and special buyer requirements.

Unlike other studies, the research conducted by Aguezzoul (2014) concentrated on the literature review of the logistics provider selection problem. By analysing 68 scientific papers during 1990–2005 using the Pareto method, this study summarised 11 key criteria and five main research methods identified in the past. The main selection drivers included cost, relationship, services, quality, information and equipment system, flexibility, delivery, professionalism, financial position, location, and reputation. However, each main criterion also contained sub-criteria. For example, the cost attribute referred to cost reduction, low-cost distribution, expected leasing cost, operation cost, warehousing cost, and cost savings. Another important attribute—relationship—is a combination of reliability, truth, dependence, alliance, compatibility, and reciprocity. The dominant factor is the 'cost', mentioned in nearly 70 per cent of reviewed papers.

Finally, the literature review by Jothi Basu, Subramanian, Cheikhrouhou (2015), covering research papers during 2000–2014, divided the criteria for full truck transportation (FTT) service procurement into two groups of objectives, cost and non-price objectives. The cost group included two factors, 'maximise profit' and 'minimise transportation costs'. Meanwhile, the non-price group contained several criteria, namely 'on-time performance', 'familiarity with shipper operations', 'availability of appropriate equipment', 'pick-up performance', and 'billing accuracy'.

Table 1 presents the most preferred criteria. Considering the objective of this research—the investigation of the FLSP(s) selection process from the perspective of logistics service firms, the research time (August 2020), and the geographical location (Vietnam)—some attributes are eliminated so that only appropriate criteria are used for further stages. The criteria shortlisted include eight factors that were most cited in the literature, service cost, service quality, professionalism, delivery, financial stability, relationship, reputation, and flexibility.

4. Research framework

4.1. Proposed structured framework

Figure 1 shows the structured framework for FLSP selection, based on the integrated AHP-DEMATEL approach, consisting of two phases. The implementation of this framework later can support decision-makers in determining the core factors for the selection process and their degree of importance and interrelationship within the system.

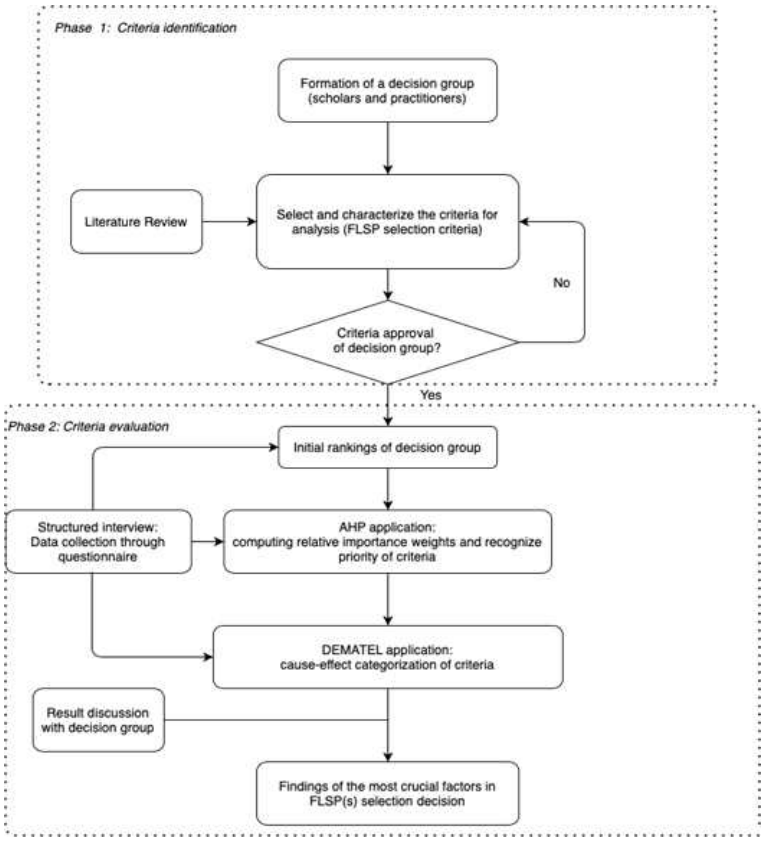

Figure 1. The proposed framework

In Phase 1 (Criteria identification), the research topic criteria are chosen from the literature and later approved by a decision group, including scholars and practitioners with experienced logistics backgrounds. The target experts for this case study were based in Vietnam and had various occupations. The logistics supplier-related selection criteria are compiled and finalised to eight criteria using the relevant literature. Phase 2 consists of two computation stages, integrating the AHP and DEMATEL techniques. Once the decision group approves the set of criteria, they intuitively assign initial rankings, then conduct the pairwise comparison to assess the relative importance and influence of the two criteria simultaneously.

Weight calculation and cause-effect categorisation are performed based on these judgements. At the end of phase 2, the decision-makers can recognise the crucial factors involved in the logistics partner selection procedure and compare the analysis results using the AHP-DEMATEL approach with their intuitive initial rankings.

4.2. The theoretical diagram

As this research used existing theories and studies to define criteria and their relations, a theoretical framework should be devised from the literature for further directions for data analysis (Saunders, Lewis, Thornhill, 2009). Figure 2 illustrates the concept this study aims. This framework can be divided into two parts.

- The arrows show the possible influence of the eight attributes derived from literature on the final FLSP(s) selection decision of the logistics integrator's management. This part is presented in the AHP analysis.
- The outside dotted circle which connects all attributes indicates the possible interrelationship among attributes and is tested by DEMATEL analysis.

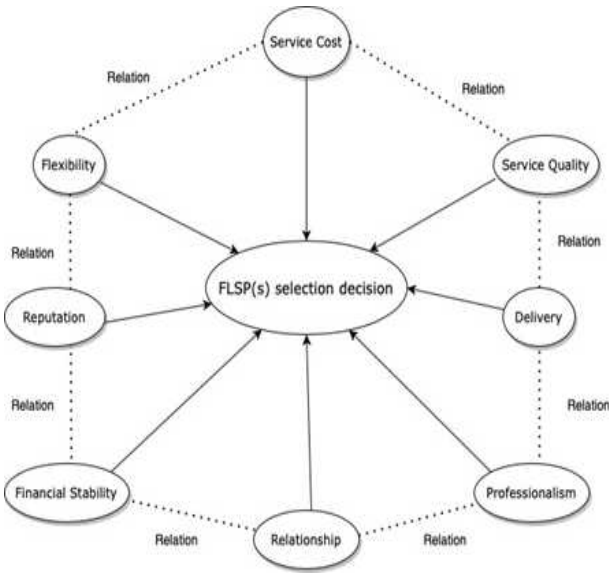

Figure 2. The theoretical diagram

Due to the geographical characteristics of Vietnam, an Asian developing country where this research was conducted, and the nature of the FLSP selection process from the perspective of logistics integrators, eight attributes were chosen for further analysis. The definition of each attribute is provided using the research of Aguezzoul (2014) with appropriate amendments.

- Service cost (SC): The total cost of using the service provided by FLSP each time. It can include the basic service rate, average extra charges, supervision cost, negotiation cost, and risk management cost.

• Service quality (SQ): The availability and variety of services offered by FLSPs. It is also related to the specialisation of services and quality commitment.

• Professionalism (PRO): The knowledge and experience of FLSPs in the industry where their service is performed and how they interact with customers.

• Delivery (DE): The time of service delivery, such as on-time performance, delivery speed, accuracy ratio, and damage ratio, among others.

• Financial stability (FS): The continuous investment of FLSPs – including equipment, human resources, facility and technology – to ensure the quality of logistics services.

• Relationship (REL): The opportunity to have a long-term collaboration between FLSP and ILSP, which means compatibility in culture, truth, and reliability.

• Reputation (REP): The feedback of local organisations on the FLSPs and the result of the customer satisfaction investigation during the initial screening.

• Flexibility (FLE): The problem-solving ability when dealing with customers' special requirements or unexpected interruption events. The flexibility and responsiveness level to service requests are also included in this attribute.

5. Methodology

This study examines the theoretical SS concept within an economic sector (integrated logistics service industry) and a location (Vietnam). Accordingly, the chosen methodology for this research was the deductive approach. This study combined two of these methods, the descriptive and explanatory method. This study first used description (presenting an accurate profile of the FLSP(s) selection process) as a predecessor to explanation (presenting how the process is performed under interdependent factors). Additionally, a case study is chosen as the research strategy. The 'case' in this paper refers to Vietnam—a small market in South East Asia that has experienced significant development in the logistics industry over the last few decades. This study uses the explanatory case study as the research strategy, based on Saunders, Lewis, Thornhill (2009), confirming the theoretical proposal of logistics SS to test its applicability in a specific case, Vietnam. Finally, a cross-sectional time horizon is used.

The primary data were collected through structured interviews, called 'quantitative research interview', one of the most widely used data collection methods within the survey strategy considering the quantitative research method and the case study strategy (Saunders, Lewis, Thornhill, 2009). The questions were designed to match the AHP-DEMATEL technique in a self-completed questionnaire, requiring full completion by the interviewees. The structured interview was designed for every interviewee with the same set of questions using a common questionnaire. The responses of a detailed questionnaire with 41 questions were collected from several highly skilled and experienced professionals with a background in the logistics industry in Vietnam. Table 2 shows responses from four experts.

Table 2. The background information of interviews

Interviewee	Date	Background	Experience
E1	8/15/2020 - 8/15/2020 13:54:05	Economic	Singapore Airline, OOCL Logistics, DB Schenker, Dachser
E2	8/15/2020 - 8/17/2020 00:55:02	Academic	MSc degree in Supply Chain Management
E3	8/15/2020 - 8/17/2020 12:52:09	Economic	American airlines, OOCL Logistics, DHL
E4	8/15/2020 - 8/18/2020 18:33:17	Economic	OOCL Logistics, APL Logistics

Corresponding to the questionnaire's consecutive sections, the data analysis procedure of this research consists of two stages: AHP computation and DEMATEL analysis. The first stage was implemented using AHP. The purpose of this stage is to quantify managerial judgments on the relative importance of conflicting criteria used in the decision-making process. Individual experts' experiences were utilised to estimate the relative magnitudes of factors through pairwise comparisons, displayed under special 9-1-9 scale measurements. Originally, the hierarchical model structure of AHP incorporated three levels—objectives, criteria, and alternatives—and the final level assisted decision-makers in choosing the best option among potential solutions. However, the purpose of ranking specific suppliers was not included in this study. Thus, the AHP method is completed at the second level, criteria weight calculation. The second stage of the data analysis was the DEMATEL application. With the advantage of confirming influences among criteria and developing a causal effect map to reflect their relationships, DEMATEL can assist decision-makers in recognising the dominant factors that significantly influence others and therefore focus on them during the selection process.

6. Findings

6.1. Initial information and intuitive rankings

The four interviewees had backgrounds in the logistics industry with varying years of experience and management levels. It is indicated that three of them, E1, E3, and E4, acquired managerial positions and were involved in the decision processes of their companies. However, interviewee E2 was a scholar with an academic certificate in logistics and supply chain and consultants with several logistics service firms. This group of interviewees initially approved a set of eight factors related to logistics SS.

Before the AHP-DEMATEL pairwise evaluation, the interviewees were asked to provide initial intuitive rankings for all eight factors (Table 3). This is the foundation supporting the interviewees, and helps the interviewer remain consistent throughout the interview. The most notable point of these intuitive rankings is the dominance of SC and SQ, as they mostly occupy the first and second places.

Table 3. Initial intuitive rankings

Attributes	Intuitive Rankings before MCDM method			
	E1	E2	E3	E4
SC	4	1	1	1
SQ	2	2	2	2
PRO	6	5	4	3
DE	1	3	3	4
FS	3	7	8	7
REL	8	4	6	5
REP	7	8	7	6
FLE	5	6	5	8

6.2. Results of AHP analysis

Based on the FLSP(s) selection decision criteria and their definitions, the experts provided their opinion on the relative importance of each criterion using the AHP pairwise comparison method. The results of the AHP calculation, after discussion with experts, indicate that all four responses were consistent with E1, E2, E3, and E4 having 0.094, 0.074, 0.089, and 0.082, CRs respectively, shown in Table 4. The weights are shown to be consistent and they are acceptable (Dagdeviren, Yavuz, Kihnc, 2009). As four professionals participated in the interview and all four responses were consistent after several amendments, the weighted geometric mean method was used to aggregate individual judgments (see results in Table 5).

Table 4. AHP consistency ratio of individual responses

	E1	E2	E3	E4
Consistency Ratio	0.094	0.074	0.089	0.082

Table 5. AHP pairwise comparison geometric mean matrix

Criterion	SC	SQ	PRO	DE	FS	REL	REP	FLE
SC	1	1.189	1.732	3.224	6.640	2.692	2.711	3.742
SQ	0.841	1	1.136	1.861	3.500	1.732	1.934	1.934
PRO	0.577	0.880	1	1.000	4.054	0.537	1.778	2.115
DE	0.310	0.537	1.000	1	3.464	2.340	1.800	2.225
FS	0.151	0.286	0.247	0.289	1	0.236	0.760	0.568
REL	0.372	0.577	1.861	0.427	4.229	1	2.213	1.414
REP	0.369	0.517	0.562	0.556	1.316	0.452	1	0.795
FLE	0.267	0.517	0.473	0.449	1.760	0.707	1.257	1

In general, the SC factor showed the highest relative weight of 0.458, influencing the FLSP selection decision. Therefore, it is ranked first in priority. The four following factors: SQ, DE, PRO, and REL, showed similar importance weights, and thus, ranked second to fifth in priority. Notably, there is a significant difference in the weight of SC, the first rank,

compared to SQ which holds the second rank, as shown in Table 6. This demonstrates the dominance of the cost factors in the decision-making process within the context of this study.

Table 6. AHP ranking and relative weights

Factor	Overall Relative Weight	Rank
SC	0.458	1
SQ	0.300	2
DE	0.241	3
PRO	0.232	4
REL	0.225	5
FLE	0.129	6
REP	0.123	7
FS	0.070	8

Following REL, FLE and REP factors sequentially ranked sixth and seventh in priority. The FS factor is the least important factor according to AHP outcomes, as it is ranked the lowest with a significantly small weight of 0.07. This parameter shows that the decision-makers rarely considered FS as an influencing factor in selecting logistics partner(s) in this study.

6.3. Result of DEMATEL analysis

After identifying the eight main factors and interviewing professionals, the matrices of the influence relationships among factors were formed. The average initial direct relation matrix A and the normalised initial direct-relation matrix D were obtained using equations. Next, the total relations matrix T is constructed using the equation. The sum of all the rows (R) and columns (C) of T was calculated. Thereafter, the prominence (R + C) and the relation (R – C) were computed. Table 7 presents the values of R, C, (R + C), and (R – C), helping in arranging all the factors in order of their influential importance level (R + C) and categorising the eight factors of FLSP(s) selection into two groups: cause group for factors having (R – C) value greater than zero, and effect group for factors having (R – C) value less than zero.

Table 7. The direct and indirect influence matrix

Factors	R	C	R+C	R-C
SC	5.553	5.770	11.323	-0.216
SQ	5.312	5.776	11.088	-0.464
PRO	4.382	5.899	10.281	-1.517
DE	5.845	4.910	10.755	0.935
FS	4.536	4.426	8.962	0.110
REL	4.297	5.663	9.960	-1.365
REP	4.389	3.763	8.152	0.626
FLE	5.901	4.009	9.910	1.892

The importance of factors can be ranked by (R + C) values in DEMATEL (Wu, Tsai, 2012). The highest (R + C) score of 11.323 is the SC factor, followed by SQ > DE > PRO > REL > FLE > FS > REP. Notably, this importance order is similar to the rankings from the AHP analysis. Only REP and FS factors switched their ranks between the seventh and eighth places. Based on the overall (R + C) values, SC and SQ are two factors that play a central role in the overall decision-making process and should be given the greatest attention. Additionally, considering the (R – C) values of the factors, there are four factors in the cause group: DE, FS, FLE, and REP. The remaining four factors belong to the effect group. The causal map of all the factors is shown in Figure 3.

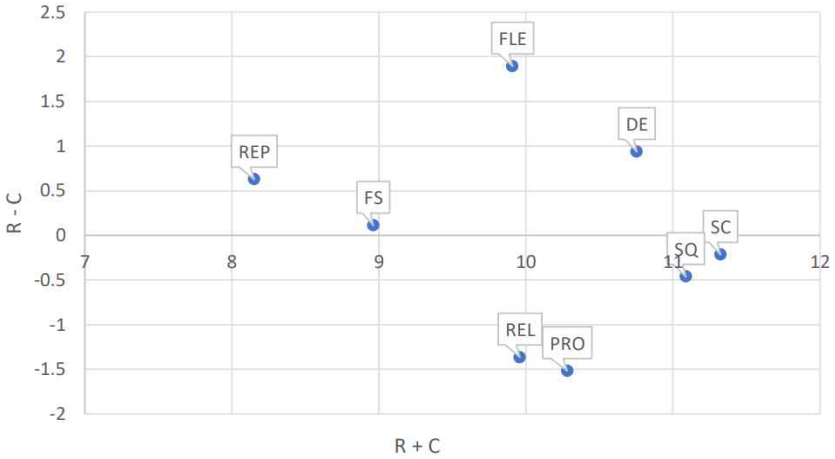

Figure 3. The causal diagram

As factors in the cause group should be given more attention due to their vital impact on other factors and the overall system, the highest positive (R – C) value of factor FLE could have a significant causal influence on other factors and is most important. It has a positive (R – C) score of 1.892. However, its importance (R + C) score of 9.910 is comparatively low among other factors, suggesting that it receives less attention in the decision system. The other cause factors—DE, REP, and FS—have (R – C) scores of 0.935, 0.626, and 0.110, respectively, suggesting that these factors also control the net causal influence in a successful logistics partner selection system. Among the causal factors, DE is the highest factor in the (R + C) column with a score of 10.755, implying the greater importance of delivery time in the selection procedure.

In the effect group, the four factors PRO, REL, SQ, and SC are recognised as the influence-receiving end and are affected by other causal factors. PRO has the lowest (R – C) score of -1.517, meaning that this factor is the biggest recipient of the net influence generated by other factors. Notably, as PRO is also among the four prioritised factors due to the (R + C) score, the professional service performance of logistics suppliers plays an important role in the buyer's selection decision. The second-largest influence-receiving factor is REL, with an (R

– C) value of -1.365, whereas its (R + C) value of 9.960 takes the lowest priority. REL is affected significantly by the remaining factors and is not a core factor within the system. The other two effect factors, SC and SQ, have higher (R – C) scores of -0.216 and -0.464, respectively, while they are also the top prioritised pair of factors with the highest (R + C) values. This indicates the moderate impact that they receive from other factors, but simultaneously, they are the key factors in the FLSP(s) selection process according to the expert's opinion.

7. Conclusion

This research started with the notion that logistics service procurement within the logistics and supply chain industry itself has not gained adequate attention despite its significant development in recent decades. Many leading global logistics service integrators have outsourced part of their offered logistics services as a result of their business expansion, mass-customised supply chain service offerings, the deficiency of resources and cost inefficiency, among many other difficulties, challenging them from implementing the entire supply chain system by themselves (Bouchard, 2014). Using the eight factors derived from the literature and approved by experts, this research implemented an analysis using MCDM hybrid methodology in which the viewpoints of experienced logistics experts in Vietnam were assessed and evaluated as a case study. The results indicated the eight most important criteria affecting decision makers' selection, their relative importance weights, and their interrelations. Therefore, ILSP decision-makers and local FLSPs enable the necessary review of their standardised selection process and service performance consecutively. Additionally, this research contributes to the investigation of logistics service partner selection in a developing country, lower on a logistics maturity scale, such as Vietnam. This is the managerial contribution of this research to the industry.

In this study, applying the AHP-DEMATEL hybrid approach can support decision-makers in dealing with complicated problems, avoiding vague judgments, and investigating the interdependence among assessment factors. This is a novel perspective, as managers usually do not consider the cause-effect relationship that connects the attributes in the selection procedure (Gandhi et al., 2015). The DEMATEL technique also fixes the irrational assumption of equal importance among attributes using the AHP method, a contribution to the academic field. The controlling factors offered by the proposed framework assists in improving the FLSP(s) selection procedure of a logistics integrator owing to their importance weights and interdependency relation. The ILSPs can recognise the most critical factors, consisting of the high AHP ranking factors and the DEMATEL causal group, and apply this information in their practice. Additionally, the proposed findings can be used for multiple organisational business strategies, such as reducing cost, improving SQ, increasing reputation, and customer

satisfaction to help the company stay competitive in the market.

This study has limitations. From the perspective of future research, it is suggested that scholars either research in a similar context to an Asian country, compare the findings with this study, or apply the proposed framework to a specific company. There is also the potential to use other MCDM applications. For instance, future researchers might use AHP-DEMATEL integrated with a fuzzy approach to deal with uncertainties usually contained in complicated decision-making processes or upgrade the advantage in investigating the intertwined hierarchical relations among factors by using analytical network process and technique for order of preference by similarity to ideal solution instead of the AHP method. Due to the increased focus on green supply chain and reverse logistics, the proposed criteria can be extended with sustainable supply chain-related factors, including three aspects of the triple bottom line theory: economic, environmental, and social attributes. Finally, to increase the validity of future studies, researchers can also expand the number of professionals.

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