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Published in:

Korean Journal of Logistics

DOI:

[10.15735/klj.2018.26.4.007](https://doi.org/10.15735/klj.2018.26.4.007)

Publication date:

2018

Link:

[Link to publication in PEARL](#)

Citation for published version (APA):

Roh, S., & Jang, H.-M. (2018). Strategic logistics outsourcing in humanitarian supply chain: a fuzzy AHP approach. *Korean Journal of Logistics*, 26(4).
<https://doi.org/10.15735/klj.2018.26.4.007>

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Strategic Logistics Outsourcing in Humanitarian Supply Chain: A Fuzzy AHP Approach*

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Abstract

This research paper investigates an under-researched topic, logistics outsourcing decision issue in the humanitarian supply chain outsourcing environment. Specifically, this research aims to identify the important factors for selecting third-party logistics(3PL) service providers in a humanitarian supply chain. This is based on literature review and interviews from logistics managers in a humanitarian sector which was evaluated with a multiple-criteria decision-making(MCDM) method called the analytical hierarchy process(AHP) under fuzzy environment. Through the use of the AHP, the relative importance of individual criteria was determined. Fuzzy-theory application of the linguistic values handles the vagueness and subjectivity of decisions. The findings of this research offer managerial insight and implication related to the use of a 3PL in the humanitarian supply chain environment to identify the possible optimal providers using a robust MCDM framework.

Keywords: Humanitarian logistics, Humanitarian supply chain, Analytical hierarchy process, Third-party logistics, Outsourcing

I. Introduction

The recent studies evidenced that natural and manmade disaster are occurring more frequently around the world which has increased 80 percent from 1980 to 2009(CRED EM-DAT, 2014). This also indicates that more lives are being affected and more damage is being caused

than before. For the last ten years since 2005, the economic and human impact of disasters were estimated \$1.4 trillion damage, 1.7 billion people affected and 0.7 million people killed(United Nations International Strategy for Disaster Reduction: UNISDR, 2015). Different stakeholders are involved in humanitarian relief

Received: 2018. 10. 26

Accepted: 2018. 12. 11

* This paper has been presented at Logistics Research Network Conference at Southampton Solent University, UK from 6th to 8th September 2017.

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logistics operations having the same goal to help and alleviate suffering from different primary motives, missions and operation constraints (Balcik et al., 2010). Donors take an important part in humanitarian relief because a lot of funding is offered for main relief efforts by them (Kovács and Spens, 2007). Donor's support is crucial for a relief organisations' existence (Kent, 1987) and may limit the kinds of actions that humanitarian organisations can engage (Stephenson and Schnitzer, 2006).

In recent years, humanitarian organisations are under pressure from donors to prove that the relief operation is practised most efficiently and effectively way in order to satisfy their objectives (Hancox and Hackney, 2000). Furthermore, donors are more engaged with scrutinising the organisations regarding the finances and the expenses they use. This caused the humanitarian organisations to monitor their impact of aid not only the input but also the output of the whole operation (Kremic et al., 2006). This leads the humanitarian organisation to consider more in the output of the operation, being more result oriented, accountable and transparent in their operations. In disaster relief, approximately between 40 and 60 percent of disaster efforts are related to logistics activities (Long and Wood, 1995), but this can amount to 80 percent of the total costs – relate to logistics activities, procurement costs included (Tomasini and Van Wassenhove, 2004; Van Wassenhove, 2006). In this respect, various humanitarian organisations collaborate with third-party logistics (3PL) providers to maintain and enhance their performance. Nevertheless, there is little knowledge which describes what are the important factors for selecting 3PL service providers. Therefore, there is an urgent

need for an integrated approach to review the selection indicators of 3PL in the humanitarian sector. This study aims to identify the crucial factors that affect 3PL selection and their priorities from the perspective of humanitarian relief organisation and to explore how these were implemented and practised.

II . Literature review

Lately, Logistics Service Providers (LSPs) have played an important role in humanitarian affairs, supporting NGOs and governments in responding to great disasters. Nevertheless, studies on humanitarian logistics have hardly been conducted on the key indicators of LSP selection and their relative importance. There is a growing interest in outsourcing and offering logistics services in the humanitarian supply chain (Oloruntoba and Gray, 2009) as a tool to attain competitive advantage (Vandermerwe and Rada, 1988).

New trends in logistics outsourcing are emerging in several international organisations including the World Food Programme (WFP) and the International Federation of Red Cross and Red Crescent Societies (IFRC) performed as LSPs. WFP delivers and distributes relief supplies from other humanitarian organisations and the United Nations Humanitarian Relief Depot (UNHRD) or IFRC has set up distribution centres or warehouse hubs for humanitarian organisations by choosing strategically important locations (Heaslip, 2013) or e-procurement in the UN (Walker and Harland, 2008).

Cozzolino (2012) mentioned that four major logistics enterprises in the transport and commercial sector, that is, Agility, A. Moller Maersk, UPS and TNT, created Logistics

Emergency Team(LET) which can act as one business unit in the humanitarian logistics area. According to LogCluster(2008), within the first three to six weeks once the disaster happens, this team supports the humanitarian logistics division through emergency response logistics providing logistics assets and knowledge as well as logistics specialists. In particular, DHL has launched the Disaster Response Team(DRT) aiming to mitigate the potential lack of cooperation and synchronisation in the humanitarian last mile distribution, which works closely with the UN Office for the Coordination of Humanitarian Affairs(UNOCHA)(Abidi et al., 2015). To reduce logistics costs, complexity and lead times and also improve the capability of resource allocation and service quality at the same time, optimally and efficiently coordinated humanitarian logistics is regarded as a significant prerequisite(Schulz and Blecken, 2010; Tomasini and Van Wassenhove, 2004).

Vega and Roussat(2015) inspected the role of LSPs in humanitarian relief and identified activities at other humanitarian relief levels, offering a framework for how the LSPs can perform a diverse role according to the degree of interest/participation that supply different types of services at each stage of the disaster cycle. It has been acknowledged that the concept of fourth party logistics(4PL) providers is one of the popular notions studied in the academic field. For instance, Jensen(2012) demonstrated how 4PL can make good use of the logistics cluster lead, harmonising the necessity to accomplish various organisational buy-ins related to humanitarian relief and the necessity for coordination. Four parts that humanitarian logistics researchers can utilise for humanitarian logistics services were suggested by Heaslip(2013) as follows: 1) servitisation, 2) service developments, 3) the humanitarian organisation as LSPs and 4) service standardisation.

<Table 1> 3PL selection criteria in the industries

Authors	Main Criteria
Bansal and Kumar (2013)	Logistics cost, Quality of service, Compatibility, IT capability, Delivery performance, Trust factor, Geographical range of services, Number of value-added services, Environmental sustainability
Bhatti et al. (2010)	Vendor status, Logistics competence, Quality of service, IT-based competencies
Chen and Wu (2011)	Service cost, Operational performance, Logistics technology, Service quality
Cirpin and Kabadayi (2015)	Cost, Operational performance, Service quality, Technology, Sustainability
Erkayman et al. (2012)	Price, General reputation, Customer services, On-time delivery, IT, Flexibilities
Govindan et al. (2012)	Service quality, On time delivery performance, Flexibility in operations, Cost of services, Customer service, Logistics information system, Financial stability, Reputation, Geographic location, Technological capability, Performance history, Human resource policies
Hwang et al. (2016)	Cost, Intangible, IT, Performance, Quality assurance, Service
Li et al. (2012)	Management success, Business strength, Service quality, Business growth
Perçin (2009)	Strategic factors, Business factors, Risk factors
Rajesh et al. (2011)	Cost, Financial viability, Risk mitigation, IT capability, On-time delivery
Soh (2010)	Finance, Relationship, Management, Infrastructure
Vijayvargiya and Dey (2010)	Cost, Delivery, Value-added services
Wong (2012)	Globalisation considerations, Relationship building and integration, Operational performance, Quality, Finance, IT

Kritchanchai et al.(2010) argued that several reasons including the positive view towards concentrating on core activities and outsourcing non-core activities and deteriorating margins due to a severe competition have facilitated the growth of 3PL in the commercial sector. Moreover, outsourcing was identified to influence in the performance of many firms in positive ways by reducing operating costs, enhancing products' quality, reducing lead times and furthermore, intensifying the competitiveness of supply chains (Mentzer et al., 2001). Narasimhan and Jayaram (1998) underlined the electronically strengthened relationship with suppliers or LSPs so as to formulate advanced interconnection with core customers. Table 1 presents the 3PL selection factors commonly applied in different industries. Aguezzoul(2012, 2014) and Gupta(2011) also published a comprehensive literature review of 3PL selection. However, it cannot be denied that previous studies were likely to investigate the humanitarian 3PL and 4PL's role and significance in humanitarian logistics(e.g., Abidi et al., 2015; Vega and Roussat, 2015; Jensen, 2012) rather than pinpointing what attributes are critical for selecting 3PL humanitarian relief tasks.

III. Methodology

Multi-phased mixed methods, combining semi-structured validation interviews and Analytical Hierarchy Process(AHP), were adopted to achieve the objective of this study. First, the key factors for 3PL selection were chosen through a comprehensive literature review. Secondly, to identify the 3PL selection criteria in the humanitarian sector, a semi-structured interview questionnaire was devised and then, distributed via email and also

face-to-face interviews were conducted with 12 logistics officers and managers in the humanitarian relief organisations. Most of the response was received in the Republic of Korea since this study will focus on this region. Finally, after constructing the 3PL selection factors, AHP analysis was performed to prioritise those recognised 3PL selection criteria.

3.1 Phase 1: Identification of 3PL selection factors in humanitarian logistics

Since the empirical studies on what constitutes the important factors of 3PL selection in the humanitarian sector are scarce within the humanitarian logistics literature, semi-structured validation questionnaire was conducted based on the commercial supply chain and logistics literature. The objective of the validation questionnaire was to identify 3PL selection factors from humanitarian logistics officers' and managers' point of view. The questionnaire was sent via email and 12 respondents working for international humanitarian organisations that deliver relief items globally around the world with 3PL were interviewed face-to-face.

3.2 Phase 2: Analytical Hierarchy Process (AHP) analysis

AHP has been applied for over four decades for making decisions by integrating judgements on both tangible as well as intangible criteria(Badri, 2001). Yoon and Hwang(1995) pointed out that the pairwise comparison procedure of data input is easy and uncomplicated for users in general. Specifically, AHP makes it possible to determine the relative importance of each criterion and the value of the key criteria by forming a pairwise

comparison matrix. For this study, a total of 12 humanitarian logistics officers and managers in the UAE, Jordan and Republic of Korea participated in the AHP evaluation. By using a scale of nine levels, individual evaluation for the priorities of each criterion was rated in the pairwise comparison matrix. The geometric mean is used to estimate the participants' agreement on the preference of the criteria. The reciprocal value of the numerical value of importance was taken to complete the remaining cells of the matrix in comparing two particular criteria.

Next, calculating the priority of each criterion related to their contribution is followed so that the most significant criteria for the humanitarian logistics officers and managers can be determined. This procedure known as the synthetisation can yield the results on the basis of a precise mathematical technique or the application of the procedure which offers an accurate calculation of the synthetisation results. It should be noted that this comparison through personal or subjective judgements may result in a certain degree of inconsistency. In this regard, the consistency verification is performed to confirm that the respondent's judgements are reliable.

Saaty(1980) proposed that the pairwise comparison is deemed to be acceptable and the judgement to be adequately consistent if a consistency ratio(CR) is less than 0.1. However, the decision-maker should reassess the pairwise comparisons before undertaking the analysis if the consistency ratio is greater than 0.1. This study was conducted by following the detailed mechanics of the AHP process in Torfi et al.(2010). When applying this method in many cases, vagueness, ambiguities and uncertainties of unquantifiable, incomplete and non-obtainable information are problematic to deal with. Because these issues cannot be always solved by mathematical models(Chan and Kumar, 2007; Kulak et al., 2005), Farahani et al.(2010) suggested that decision-makers can utilise linguistic values to scrutinise the importance of the criteria particularly in connection with multi-criteria decision-making. For this case, Fuzzy sets theory will be useful to indicate linguistic values instead of numerical values(Yu et al., 2011).

IV. Result

The humanitarian logistics officers and

<Table 2> 3PL selection criteria

Factor	Sub-criteria
A. Customer Service Quality	Scope of services, Flexibility, Reliability, Timeliness, Value-added service, Continuous improvement, Convenience of transaction, Customer satisfaction, Assurance, Empathy, Ease of communication, Cooperation with customers, Trust
B. IT Capability	EDI facilities, IT network availability, Data integrity and reliability, System stability, Data security, Information sharing, Compatibility
C. Global Operational Performance	Delivery performance, Relationship management, Financial conditions, Geographical location fitness, Corporate image and reputation, Global coverage, Transportation safety, Document accuracy
D. Cost	Competitive price, Discount offering, Continuous cost reduction
E. Supply Chain Capability	Trained logistics personnel, Logistics technology, Infrastructure and equipment, Throughput capacity, Risk management capability, Reverse logistics function
F. Sustainability	Economic responsibility, Social responsibility, Environmental responsibility

<Table 3> Pairwise comparison matrix and results obtained with AHP

	A	B	C	D	E	F	Weight
A	1.00	0.71	2.00	1.41	1.41	2.45	0.2098
B	1.41	1.00	0.41	1.41	1.41	2.45	0.1934
C	0.50	2.45	1.00	0.41	2.00	2.45	0.1976
D	0.71	0.71	2.45	1.00	1.41	2.45	0.1977
E	0.71	0.71	0.50	0.71	1.00	2.45	0.1315
F	0.41	0.41	0.41	0.41	0.41	1.00	0.0700

$\Delta_{max} = 6.460$ CI = 0.092 RI = 1.24 CR = 0.074

managers indicated the following factors should be included for 3PL selection process (Table 2).

The computational results of the AHP analysis are presented in Table 3. The consistency ratio for the pairwise comparison matrix was 0.074 < 0.1, meaning the pairwise comparison was acceptable and consistent.

As can be seen from Table 3, Customer Service Quality(A) was considered the most important criteria with a weight of 0.2098. The next two most important criteria are Cost(D) and Global Operational Performance(C) with the weights of 0.1977 and 0.1976 respectively. However, the difference weight of those two is meaningless. Sustainability(F) was considered the least important among the criteria with a weight of 0.0700, following Supply Chain Capability(E) with a weight of 0.1315.

The computational results of the Fuzzy AHP analysis are illustrated in Table 4. Similar to previous results, Customer Service Quality(A)

was considered the most important criteria for a standardised best non-fuzzy performance(BNP) weight of 0.2335. Then the next three most important criteria evaluated are Cost(D), Global Operational Performance(C) and IT Capability(B), have a close standardised BNP weight of 0.2048, 0.1969, and 0.1964 respectively. In fuzzy AHP results, Sustainability(F) factor was considered the least important among the 3PL selection factors with a standardised BNP of 0.0890.

V. Conclusion

From the fuzzy AHP analysis, it was identified Customer Service Quality(A) was considered the most important factor for 3PL selection for the humanitarian sector. Interestingly, this is similar to 3PL selection criteria in the commercial sector where customer delivery time and quality with reduced missing activities is considered the most important factor(Bianchini, 2018). Beaman

<Table 4> Fuzzy pairwise comparison matrix and results

	A	B	C	D	E	F	Std BNP
A	(1.00, 1.00, 1.00)	(0.58, 0.71, 1.00)	(1.00, 2.00, 3.00)	(1.00, 1.41, 1.73)	(1.00, 1.41, 1.73)	(1.41, 2.45, 3.46)	0.2335
B	(1.73, 1.41, 1.00)	(1.00, 1.00, 1.00)	(0.29, 0.41, 0.71)	(1.00, 1.41, 1.73)	(1.00, 1.41, 1.73)	(1.41, 2.45, 3.46)	0.1964
C	(0.33, 0.50, 1.00)	(1.41, 2.45, 3.46)	(1.00, 1.00, 1.00)	(0.29, 0.41, 0.71)	(1.00, 1.41, 1.73)	(1.41, 2.45, 3.46)	0.1969
D	(0.58, 0.71, 1.00)	(0.58, 0.71, 1.00)	(1.41, 2.45, 3.46)	(1.00, 1.00, 1.00)	(1.00, 1.41, 1.73)	(1.41, 2.45, 3.46)	0.2048
E	(0.58, 0.71, 1.00)	(0.58, 0.71, 1.00)	(0.58, 0.71, 1.00)	(1.00, 1.00, 1.00)	(1.00, 1.00, 1.00)	(1.41, 2.45, 3.46)	0.1683
F	(0.29, 0.41, 0.71)	(0.29, 0.41, 0.71)	(0.29, 0.41, 0.58)	(0.29, 0.41, 0.58)	(0.29, 0.41, 0.71)	(1.41, 2.45, 3.46)	0.0890

and Balcik(2008) asserted that the main objective of humanitarian relief logistics is to distribute adequate supplies in the accurate place at the exact time to save human as well as minimise their pain considering financial limitations. A variety of logistics service activities are included in 3PL, such as transportation, warehousing and customer services together with relevant information for other industries(Langley et al. 2003; Hamdan and Rogers, 2008).

Cost(D), Global Operational Performance (C)and IT Capability(B) factors were evaluated as important factors almost equally in 3PL selection in humanitarian logistics. Those first four factors are evaluated mostly on the top important criteria in the literature depending on the industry and the region. However, during the delivery of relief items, logistics officers are more concerned whether the relief items will be delivered as they were scheduled. It is interesting to note that Sustainability(F) factor was considered the least important when it comes to 3PL selection. Findings of Haavisto and Kovács(2014) revealed that few studies are devoted to green goods, services, or operations, and adapting to climate change is only taken into account for the livelihoods of beneficiaries looking for reducing and coping strategies. In addition, Sarkis et al.(2012) showed that people are first while the environment is second to consider to explore later.

Schulz and Blecken(2010) emphasised that humanitarian aid is regarded as a new form of 'industry' emerged to deliver their goods for some of the 3PL companies, whereas other companies view it as a kind of corporate social responsibility activities. Despite the increasing attention for humanitarian relief logistics in the commercial sector, those commercial logistics

providers do not anticipate an outstanding increase in the CSR mostly(Majewski et al., 2010). Besides, Vega and Roussat(2015) found that generally, LSPs take more reactive and less proactive posture towards a humanitarian field, and for example, they are inclined to be involved in humanitarian activities as one of the supporters to implement their CSR strategy in part and also in-kind donations by sharing capacities with NGOs. These activities finally contribute to improving 3PLs' public image and reputation. Yet, it is required for 3PLs by humanitarian organisations to be proactive partners which engage in all stages including the preparedness, response and recovery, provide a range of logistics supports, and also participate in designing, coordinating and implementing all of physical and information management.

This research empirically identified the factors constituting 3PL selection in the humanitarian sector and the priority ranking of those factors applying the fuzzy set theory. Unlike previous studies in which focus on the roles and the value of 3PL in humanitarian relief operations and other topics other than 3PL(e.g., Lee and Kim, 2012; Lim and Song, 2018); Choi and Ha, 2013), the current research approaches find the factors and the priority weights for 3PL selection. As a result, it was found that most of the 3PL selection criteria in the commercial sector are somewhat similar to those of in the humanitarian logistics. Through the AHP analysis, it was evaluated that Customer Service Quality is the most important factor for 3PL selection. The next three important factors, Cost, Global Operational Performance and IT Capability, were evaluated as equally important to each other. However, sustainability was evaluated to be the least important factor. The

priority of the 3PL selection factors evaluated by humanitarian logistics officers and managers could provide useful information to 3PL service providers of what humanitarian organisations consider the most when it comes to the decision-making process of 3PL selection. Given the priorities of the importance of the factors, 3PL service providers are informed of areas to be focused on and that need more interest for improvements.

This research contributes to both existing literature and management practice, as it investigates the 3PL selection criteria in the humanitarian logistics. Nevertheless, there exist various limitations in the current research. Specifically, the sample size is small to generalise the findings because the current research aims to study further as a case study in the future. Nonetheless, the present research could be a stepping stone for further research in constructing 3PL selection criteria in humanitarian aspects for the decision-making process and insight to 3PL service providers in humanitarian relief.

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