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Application of the AHP for Evaluating Third-Party Logistics Service Quality: Shipper's Perspective*

제3자물류 서비스 품질 평가를 위한 AHP의 적용에 관한 연구: 화주기업의 관점에서

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목 차

Key Words: Third-Party Logistics, Analytic Hierarchy Process, Service Quality, Multi-Criteria Decision-Making

Abstract

This study applies the Analytic Hierarchy Process (AHP) to evaluate service quality of Third-Party Logistics (3PL) providers. For this, 3PL service quality is conceptualized and measured using SERVQUAL's five dimensions such as tangibles, reliability, responsiveness, assurance and empathy. Then, the AHP method is applied to determining the relative importance of five service quality dimensions and eventually selecting the best 3PL provider. Finally, this study conducts an empirical case study on four companies providing 3PL services in Korea to demonstrate the basic idea suggested in this paper. The results obtained in the present study indicate that responsiveness to customers is the most important factor perceived by 3PL customers and 3PL *C* is the best 3PL provider according to the overall service quality scores. In contrast to some previous researches, this study examined issues of service quality from the perspective of 3PL customers as opposed to the perspective of 3PL providers. In order for this study to be more complete, future research is needed in establishing a set of metrics to quantify each dimension of 3PL service quality proposed.

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Ⅰ. Introduction

The outsourcing of the logistics functions to third-party logistics (3PL) service providers has grown up rapidly during the last few years. 3PL refers to hiring outside specialized logistics companies to perform logistics functions that can be the entire logistics process or selected activities within that process.[1] As a consequence of the rapid growth of 3PL service applications and the abundance of service providers, the customer (i.e. shipper) is faced with the inevitability of selecting an appropriate service provider. In such scenarios, service quality becomes a benchmark to differentiate services and providers. Therefore, 3PL providers should understand how customers evaluate service quality, because service quality is related to customer satisfaction, which in turn influences the performance of their organizations.

Until now, the most widely used instrument to measure customers' perception of service quality is the SERVQUAL scale developed by Parasuraman, Zeithaml and Berry.[2] According to SERVQUAL, the level of service quality experienced by customers is determined by the gap between their expectations of the service and their perceptions of what the actually receive from a specific service provider. The SERVQUAL model consists of five dimensions, such as tangibles, reliability, responsiveness, assurance and empathy, upon which customers evaluate perceived service quality. However, although SERVQUAL is a popular tool for measuring service quality, empirical research that uses this scale in the 3PL services context is vary rare. Therefore, this study utilize the five dimensional structure of SERVQUAL to evaluate the overall 3PL service quality.

In order to prioritize 3PL providers in terms of service quality, it is important that the overall service quality of 3PL providers has to be measured from the customers' perspective and customers' preference structure has to be reflected on

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1) Lieb, R.C., Millen, R.A., and Van Wassenhove, L.N., "Third Party Logistics Services: A Comparison of experienced American and European Manufacturers", *International Journal of Physical Distribution and Logistics Management*, Vol. 23, No. 6, 1993, pp. 35-44.

2) Parasuraman, A., Zeithaml, V.A., and Berry, L.L., "SERVQUAL: A multiple-item scale for measuring consumers perceptions of service quality", *Journal of Retailing*, Vol. 64, No. 1, 1988, pp. 22-37.

the decision-making process. One of the extensively used methods for multiple criteria decision-making is the Analytic Hierarchy Process (AHP) developed by Saaty.[3] The major advantage of this approach is that it can process the importance of evaluation criteria and the assessment of alternatives based on each criterion. In this paper, the AHP approach is applied to determine the relative importance of the five service quality dimensions by performing pairwise comparisons and eventually prioritize 3PL providers in the order of the overall service quality scores.

Finally, this study conducts an empirical case study on four companies providing 3PL services in Korea to demonstrate the basic idea suggested in this paper.

Ⅱ. Literature Review

1. Service Quality of Third-Party Logistics

The third-party logistics (3PL) industry is now one of the most rapidly growing industries in the developed world. 3PL means that using external organizations to perform logistics functions that can encompass the entire logistics process or selected activities within that process and that have traditionally been performed within an organization. Accordingly, 3PL providers act as intermediaries in a supply chain that enable the organized movement of goods from a point of origin to a point of destination (i.e. from shippers to consignees).[4] According to a survey on 3PL customers,[5] the activities most frequently outsourced to 3PL providers are warehousing, outbound transportation, customs brokerage, customs clearance, crossdocking/shipment consolidation, inbound transportation, and freight bill auditing/payment.

In face of fierce competition in the 3PL market, service quality has become an important factor in determining the utility of 3PL services. The concept of service

3) Saaty, T.L., The Analytic Hierarchy Process, New York: McGraw-Hill, Inc., 1980.

4) Lai, K.H., Ngai, E.W.T., and Cheng, T.C.E., "An empirical study of supply chain performance in transport logistics", *International Journal of Production Economics*, Vol. 87, 2004, pp. 321-331.

5) Langley, C.J., Allen, G.R., and Dale, T.A., THIRD-PARTY LOGISTICS: Results and Findings of the 2004 Ninth Annual Study, 2004.

quality goes beyond the technical aspects of providing the service－it includes customers' perception of what the services should be and how the services is to be conveyed.[6] Until now, the instrument to measure customers' perception of service quality that is the most widely used, in academic research but also in practice,[7] is the SERVQUAL scale developed by Parasuraman et al.(1988). This measurement of perceived service quality by means of SERVQUAL is based on five generic service quality dimensions including reliability, responsiveness, assurance and empathy.[8] In line with the Gap Analysis model, this instrument measures service quality as the gap between perceptions and expectations for each of the five dimensions.

However, although SERVQUAL is the most widely spread instrument for measuring service quality, empirical research that uses this scale in the 3PL services context is very rare. Therefore, this study utilize the SERVQUAL's five-dimension structure to evaluate service quality of 3PL providers.

In this paper, 3PL service quality is defined as the satisfaction of customer wants, needs and expectations, which is evaluated in five dimensions as shown in Table 1.

Table 1. Five dimensions of 3PL service quality

Dimension	Definition
Tangibles	the physical components, such as vehicles or personnel
Reliability	the conformance to specification or agreement
Responsiveness	the willingness to respond to customers wishes
Assurance	the skill, knowledge and courtesy of service providers and the confidence that they convey to customers
Empathy	the caring and individual attention

6) Tsaur, S.H., Chang T.Y, and Yen, C.H., "The evaluation of airline service quality by fuzzy MCDM", *Tourism Management*, Vol. 23, 2002, pp. 107-115

7) Lam, S.S. and Woo, K.S., "Measuring service quality: a test-retest reliability investigation of SERVQUAL", *Journal of the Market Research Society*, Vol. 39, 1997, pp. 381-396.

8) Parasuraman, A., Zeithaml, V.A., and Berry, L.L., "Refinement and Reassessment of the SERVQUAL Scale", *Journal of Retailing*, Vol. 67, No. 4, 1991, pp. 420-450.

2. Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) has been widely used in multiple criteria decision-making situations and has been applied by a number of researchers and practitioners.[9] [10] Some of its applications include transportation problems, corporate planning problems, budget allocation, project selection and so on. The AHP is aimed at integrating different measures into a single overall score for ranking decision alternatives.

This study utilizes the AHP method to solve a 3PL provider selection problem because the AHP approach is well suited for attaining the purpose of study that is related to determining the relative importance of five dimensions and choosing the best 3PL provider that satisfies customer needs. The use of AHP method to determine how customers evaluate 3PL providers' service quality and make a selection would make the managers understand clearly more which service quality factors is more important, thus providing insights to formulate strategies and enhance performance.

The AHP is based on the principles of decomposition, pairwise comparisons, and priority vector generation and synthesis. The process of AHP applied to this study can be summarized as follows:

(1) Structure the decision hierarchy by decomposing the problem into a hierarchical structure of interrelated decision elements. The top level of the hierarchy represents the ultimate goal, while the lowest level is composed of all possible alternatives. One or more intermediate levels contain the decision criteria and sub-criteria.

(2) Construct a set of pairwise comparison matrices between the decision elements. The decision maker is required to provide his/her preferences by comparing all criteria, sub-criteria and alternatives with respect to upper level decision elements.

(3) Compute the relative weights of each element in the decision hierarchy using

9) Nydick, R.L. and Hill, R.P., "Using the Analytic Hierarchy Process to Structure the Supplier Selection Procedure", *Journal of Purchasing and Materials Management*, Vol. 28, No. 2, 1992, pp. 31-36.

10) Barbarosoglu, M. and Yazgac, T., "An application of the Analytic Hierarchy Process to the supplier selection problem", *Production and Inventory Management Journal*, First Quarter, 1997, pp. 14-21.

the eigenvector method. Individual pairwise comparison matrix is aggregated using the geometric mean method and its consistency ratio is checked.

(4) Use the hierarchical synthesis procedure to determine the overall score of each alternative and selection of the best one. The overall score of the alternatives is a weighted average of the relative weights computed in Step 3.

Ⅲ. Empirical Results

This study conducted an empirical case study on four companies providing 3PL services in Korea to select the best 3PL provider in terms of service quality by applying the AHP method. For convenience, four companies are relabeled as 3PL *A* through 3PL *D* instead of using their real names.

First, the decision hierarchy is structured with all decision elements classified into four levels as shown in Figure 1. The highest level (Level 1) of the hierarchy stands for the ultimate goal that is to evaluate 3PL service quality and select an ideal 3PL provider. The five dimensions identified to achieve this goal are located at the second level (Level 2). At the third level (Level 3), the five-point rating scale [11) 12)] is introduced into this model to rate each alternative according to each criteria in the level just above. In this case, since the decision maker has not enough knowledge or experience about all the alternatives, it is quite difficult to directly compare the alternatives with each other. Therefore, differently from the usual AHP approach, the use of a rating scale can eliminate these difficulties as the decision maker can assign a rating to an alternative without making direct comparisons. The lowest level (Level 4) contains the alternatives to be evaluated, namely four different 3PL providers.

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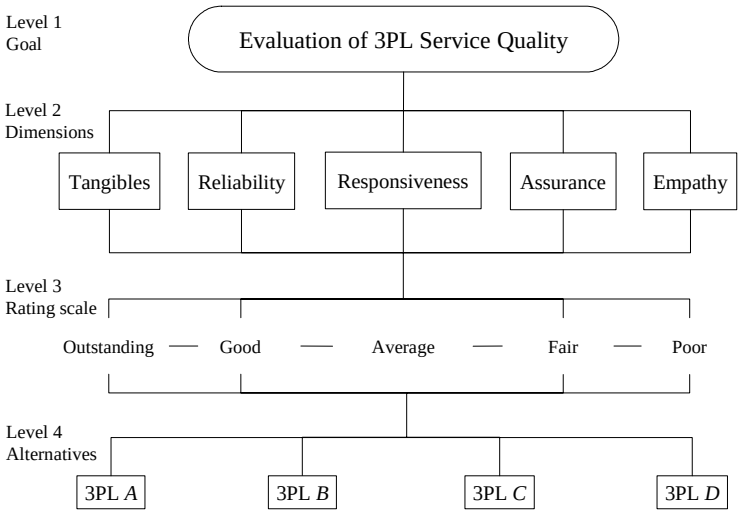
11) Liberatore, M.J., "An Extension of the Analytical Hierarchy Process for Industrial R&D Project Selection and Resource Allocation", *IEEE Transactions on Engineering Management*, Vol. EM-34, No. 1, 1987, pp. 12-18.

12) Liberatore, M.J., Nydick, R.L., and Sanchez, P.M., "The Evaluation of Research Papers (Or How to Get an Academic Committee to Agree on Something)", *Interfaces*, Vol. 22, No. 2, 1992, pp. 92-100.

Figure 1. Decision hierarchy for evaluating 3PL service quality



After structuring the decision hierarchy, the next step is to make a pairwise comparison matrix in order to determine the relative importance (priority) of five dimensions in level 2. Notationally, the pairwise comparison matrix A for comparing n elements is $A=[a_{ij}]$ (where $a_{ij}=1/a_{ji}$, $a_{ii}=1$, $i,j=1,2,\ldots,n$). If element i is more important than element j then a_{ij} gets assigned a numerical value from the ratio scale of 1 to 9, where 1 indicates equal importance and 9 indicates extreme importance(see Saaty, 1980).

In order to perform pairwise comparison among five dimensions, a questionnaire was designed and sent out to the customers of the four alternative 3PL providers in February 2005. The target respondents were the marketing managers or logistics managers of the sampled shippers companies. A total of 89 customers, comprising of 23 customers of 3PL *A*, 21 customers of 3PL *B*, 26 customers of 3PL *C* and 19 customers of 3PL *D*, replied to the questionnaire for a response rate of 49.5%.

The pairwise comparison data collected from the questionnaire were organized in the form of a matrix and the consistency ratio of the matrix was checked to be less than 0.1 which is typically considered acceptable. The consistency ratio (CR) is defined as $CR=CI/RI$ where consistency index (CI) is given by $CI=(\lambda_{max}-n)/(n-1)$, with λ_{max} as the principal eigenvalue for the matrix, and

random index (RI) is the mean random consistency index for a matrix of order n (see Saaty, 1980).

As a result, 67 individual pairwise comparison matrices with consistency ratio of less than 0.1 were aggregated using the geometric mean method. The aggregate pairwise comparison matrices are presented in Table 2.

Table 2. Aggregate pairwise comparison matrix for five dimensions

	Tangibles	Reliability	Responsiveness	Assurance	Empathy	Priority
Tangibles	1.000	1.267	0.915	1.036	0.962	0.205
Reliability	0.789	1.000	0.790	1.088	1.005	0.185
Responsiveness	1.093	1.266	1.000	1.272	1.036	0.224
Assurance	0.965	0.920	0.786	1.000	0.859	0.180
Empathy	1.040	0.995	0.965	1.164	1.000	0.205

*) λ_{max} = 5.011, CI = 0.002, RI = 1.12, CR = 0.002

After the pairwise comparison process is completed, the priority vector for five dimensions is obtained by the following two-stage procedure.

First, each entry in column i of the matrix A is divided by the sum of the entries in column i. This yields a normalized matrix $\overline{A}$ which is defined as:

$$\overline{A}=[\overline{a_{ij}}] \text{ where } \overline{a_{ij}}=a_{ij}/\sum_{k=1}^{n}a_{ik} \text{ for } i,j=1,2,\ldots,n$$

Second, the average value of the entries in row i of the normalized matrix $\overline{A}$ is computed to get the priority weights or eigenvector, which is determined by:

$$W=[w_k] \text{ where } w_k=\sum_{i=1}^{n}\overline{a_{ij}}/n \text{ for } j,k=1,2,\ldots,n$$

According to the calculation procedure described above, the priority vector for five dimensions was determined as shown in the last column of Table 2. It denotes the order of relative importance of five dimensions and also demonstrates that *Responsiveness* is considered as the most important dimension perceived by 3PL

customers in this study.

As mentioned earlier, Liberatore's five-point rating scale of outstanding (O), good (G), average (A), fair (F) and poor (P) was used to rate alternative 3PL providers according to five dimensions in level 2. Using pairwise comparisons as suggested by Liberatore(1987), the priority weights of these five scales were determined as 0.513, 0.261, 0.129, 0.063 and 0.034, respectively.

The customers of the four alternative 3PL providers were then asked to assign the rating scale to their 3PL provider with respect to each of the five dimensions in the questionnaire. The resulting consensus ratings, expressed in the geometric mean of individuals' judgments, are presented in column 3, 5, 7 and 9 of Table 3.

Table 3. Overall scores of four alternative 3PL providers

Dimensions	Priority weights	3PL *A*		3PL *B*		3PL *C*		3PL *D*	
		Rating score	Global weights	Rating score	Global weights	Rating score	Global weights	Rating score	Global weights
Tangibles	0.205	0.261	0.054	0.129	0.026	0.129	0.026	0.063	0.013
Reliability	0.185	0.129	0.024	0.063	0.012	0.261	0.048	0.034	0.006
Responsiveness	0.224	0.261	0.058	0.129	0.029	0.513	0.115	0.063	0.014
Assurance	0.180	0.063	0.011	0.063	0.011	0.129	0.023	0.034	0.006
Empathy	0.205	0.129	0.026	0.063	0.013	0.261	0.054	0.063	0.013
Overall scores	-	-	0.174	-	0.091	-	0.266	-	0.052
Renormalized scores	-	-	0.298	-	0.156	-	0.456	-	0.090

The final step of the AHP is to synthesize the priority weights of the elements at each level of the decision hierarchy in order to determine the overall score for each 3PL provider and selection of the best one. The overall score S_i for the i^{th} 3PL provider is computed as follows:

$S_i = \sum_{j=1}^{n} w_j r_{ij}$ for $i = 1, 2, \ldots, n$ where w_j is the priority weight of j^{th} dimension in level 2 of the hierarchy and r_{ij} is the rating scale of i^{th} 3PL provider with respect to j^{th} dimension.

Based on the (renormalized) overall scores of the four 3PL providers shown in Table 3, we can find that 3PL *C* has the highest overall score among four alternatives. Therefore, it must be selected as the best 3PL provider satisfying all evaluation criteria for 3PL service quality.

Ⅳ. Discussion and Conclusion

This study have presented an application of the AHP to determining the best 3PL provider based on service quality measurement. In contrast to some previous researches, this study examined issues of service quality from the perspective of 3PL customers as opposed to the perspective of 3PL providers.

To measure customers' perception of 3PL service quality, this study have utilized SERVQUAL's five dimensions. Although the conceptualization, dimensionality, operationalization, measurement and applications of SERVQUAL have been subjected to some severe criticisms,[13] there is a general agreement that the five dimensions are reasonably accurate predictors of perceived service quality.[14]

However, it still lacks explanation of how customers evaluate service quality and select a service provider. Therefore, this study have applied the AHP approach to solve a 3PL provider selection problem because the AHP is well suited for attaining the purpose of study that is related to determining the relative importance of 3PL service quality and selecting the best 3PL provider satisfying all evaluation criteria for 3PL service quality.

To demonstrate the basic idea presented in this paper, this study have conducted an empirical case study on four 3PL providers in Korea. The result shown in Table

13) Buttle, F., "SERVQUAL: review, critique, research agenda", *European Journal of Marketing*, Vol. 30, 1996, pp. 8-32.

14) Sureshchandar, G.S., Rajendran, C., and Anantharaman, R.N., "The relationship between management's perception of total quality service and customer perceptions of service quality", *Total Quality Management*, Vol. 13, No. 1, 2002, pp. 69-88.

2 indicates that *Responsiveness*, the willingness to respond to customers wishes, out of the five dimensions is considered as the most important dimension perceived by 3PL customers in this study. Furthermore, according to the overall service quality scores shown in Table 3, 3PL *C* has been chosen as the best 3PL provider with respect to service quality.

In order for this study to be more complete, future research is needed in establishing a set of metrics to quantify each dimension of 3PL service quality proposed.

References

Barbarosoglu, M. and Yazgac, T., "An application of the Analytic Hierarchy Process to the supplier selection problem", *Production and Inventory Management Journal*, First Quarter, 1997, pp. 14-21.

Buttle, F., "SERVQUAL: review, critique, research agenda", *European Journal of Marketing*, Vol. 30, 1996, pp. 8-32.

Donnelly, M. and Dalrymple, J.F.], "The Portability and Validity of the SERVQUAL Scale in Measuring the Quality of Local Public Service Provision", *Proceedings of the International Conference on Quality*, Union of Japanese Scientists and Engineers, Yokohama, Japan, 1996, pp. 245-249.

Lai, K.H., Ngai, E.W.T., and Cheng, T.C.E., "An empirical study of supply chain performance in transport logistics", *International Journal of Production Economics*, Vol. 87, 2004, pp. 321-331.

Lam, S.S. and Woo, K.S., "Measuring service quality: a test-retest reliability investigation of SERVQUAL", *Journal of the Market Research Society*, Vol. 39, 1997, pp. 381-396.

Langley, C.J., Allen, G.R., and Dale, T.A., THIRD-PARTY LOGISTICS: Results and Findings of the 2004 Ninth Annual Study, 2004.

Lieb, R.C., Millen, R.A., and Van Wassenhove, L.N., "Third Party Logistics Services: A Comparison of experienced American and European Manufacturers", *International Journal of Physical Distribution and Logistics Management*, Vol. 23, No. 6, 1993, pp. 35-44.

Liberatore, M.J., "An Extension of the Analytical Hierarchy Process for Industrial R&D Project Selection and Resource Allocation", *IEEE Transactions on Engineering Management*, Vol. EM-34, No. 1, 1987, pp. 12-18.

Liberatore, M.J., Nydick, R.L., and Sanchez, P.M., "The Evaluation of Research Papers (Or How to Get an Academic Committee to Agree on Something)", *Interfaces*, Vol. 22, No. 2, 1992, pp. 92-100.

Nydick, R.L. and Hill, R.P., "Using the Analytic Hierarchy Process to Structure the Supplier Selection Procedure", *Journal of Purchasing and Materials Management*, Vol. 28, No. 2, 1992, pp. 31-36.

Parasuraman, A., Zeithaml, V.A., and Berry, L.L., "SERVQUAL: A multiple-item scale for measuring consumers perceptions of service quality", *Journal of Retailing*, Vol. 64, No. 1, 1988, pp. 22-37.

Parasuraman, A., Zeithaml, V.A., and Berry, L.L., "Refinement and Reassessment of the SERVQUAL Scale", *Journal of Retailing*, Vol. 67, No. 4, 1991, pp. 420-450.

Saaty, T.L., *The Analytic Hierarchy Process*, New York: McGraw-Hill, Inc., 1980.

Sureshchandar, G.S., Rajendran, C., and Anantharaman, R.N., "The relationship between management's perception of total quality service and customer perceptions of service quality", *Total Quality Management*, Vol. 13, No. 1, 2002, pp. 69-88.

Tsaur, S.H., Chang T.Y, and Yen, C.H., "The evaluation of airline service quality by fuzzy MCDM", *Tourism Management*, Vol. 23, 2002, pp. 107-115