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## EVALUATING THE SERVICE QUALITY OF THIRD-PARTY LOGISTICS SERVICE PROVIDERS USING THE ANALYTIC HIERARCHY PROCESS

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### ABSTRACT

In this study we apply the analytic hierarchy process (AHP) to evaluate the service quality of third-party logistics (3PL) service providers. We first conceptualize five dimensions of 3PL service quality (i.e. tangibles, reliability, responsiveness, assurance and empathy). We then apply the AHP method to determine the relative weights of the five service quality dimensions and eventually select the best 3PL service provider. To implement this idea in practice, we conduct an empirical case study on four companies providing 3PL services in Korea. The results indicate that *Responsiveness* out of the five service quality dimensions is the most important factor in the perception of 3PL customers.

**Keywords:** Third-Party Logistics, Analytic Hierarchy Process, Service Quality, Internet Shopping Mall, Logistics Outsourcing

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## 1. Introduction

The concept of third-party logistics (3PL) has become a growing reality in Korea in recent years, allowing shippers to outsource logistical activities that had previously had to be conducted in house. In fact, over 60 percent of Fortune 500 firms have at least one contract with a 3PL service provider (Outsourcing Logistics Report 2006). As a consequence of the rapid growth of 3PL service applications and the abundance of service providers, the customer (i.e. the 'shipper') has been faced with increasing difficulty when trying to select an appropriate service provider. In such scenarios, service quality becomes a benchmark to differentiate services and providers. Therefore, in order to deliver good-quality service and gain customer loyalty, 3PL service providers need to understand how customers perceive and evaluate service quality.

In this paper, we focus on evaluating the quality of service delivered to customers by 3PL service providers. For this, we first conceptualize 3PL service quality as a second order construct, with five dimensions: tangibles, reliability, responsiveness, assurance and empathy. We then apply the analytic hierarchy process (AHP) method to determine the relative importance of five service quality dimensions, and eventually prioritize 3PL service providers in the order of the overall service quality scores. To implement this idea in practice, we conduct an empirical case study on four companies providing 3PL services in Korea.

This paper is organized as follows. First, we present the basic concept of 3PL and the model we used to measure its service quality. Then, we briefly outlined the AHP method adopted in this study, and then applied it to a practical case study to evaluate service quality of 3PL service providers. Finally, we have concluded with a discussion of the implications for management of our findings and thoughts on future research issues.

## 2. Evaluation Criteria for 3PL Service Quality

The outsourcing of logistics functions to 3PL service providers has now become a common practice in many industries. 3PL refers to the use of subcontracted specialized logistics companies 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 (Lieb et al., 1993). According to a survey on 3PL users (Langley et al., 2005), the activities most frequently outsourced to 3PL service providers are outbound transportation (North America, 78%; Western Europe, 88%, Asia-Pacific, 96%; and Latin America, 84%) and warehousing (North America, 63%; Western Europe, 72%, Asia-Pacific, 88%; and Latin America, 55%), followed by customs clearance/brokerage, inbound transportation, freight forwarding, freight bill auditing/payment, cross-docking/shipment consolidation, and order dispatch/distribution. Most companies cite greater flexibility, operational efficiency, improved customer service levels, enhanced supply chain performance, and better focus on their core businesses as part of the advantages of engaging the services of 3PL service providers (Sahay and Mohan, 2006).

As the competition in the 3PL market has intensified, service quality has become an important differentiator among service providers. The concept of service quality goes beyond the technical aspects of providing the service. It includes customers' perception of what the service should be and how the service is to be conveyed (Tsaour et al., 2002). Therefore, 3PL service providers should understand how customers perceive and evaluate service quality, because service quality is related to customer satisfaction, which in turn influences the performance of their organizations. Until recently, the SERVQUAL instrument suggested by Parasuraman, Zeithaml and Berry (1988, 1991) has been the most widely used to measure customers' perception of service quality not only in academic research but also in practice. According to SERVQUAL, perceived service quality is measured along five generic dimensions such as tangibles, reliability, responsiveness, assurance, and empathy. However, despite the wide spread of SERVQUAL, empirical research that uses this scale in the 3PL services context is very scarce. Therefore, we have attempted to use the five dimensional structure of SERVQUAL to measure the quality of service provided by 3PL service providers. The five service quality dimensions are:

- Tangibles: the physical facilities, appearance of personnel, tools or equipment used to provide service
- Reliability: the ability to perform the promised service dependably and accurately
- Responsiveness: the willingness to help customers and provide prompt service, responds immediately to customer request and site problems
- Assurance: the skill, knowledge and courtesy of service providers and the level of confidence that they convey to customers
- Empathy: the care and personalized attention the firm provides for its customers.

### **3. Analytic Hierarchy Process: A Multiple Criteria Decision Making Approach**

The AHP developed by Saaty (1980) has been widely used in multi-criteria decision-making situations and has been applied by a number of researchers and practitioners. Some of its applications include transportation problems, corporate planning problems, and problems concerned with marketing strategies, budget allocation, project selection, and so on. The AHP methodology compares criteria, or alternatives with respect to each criterion, in a natural, pairwise mode to determine the priority weights. In addition, it makes it possible to select the single alternative that best meets a particular decision criterion.

In this paper, we utilize the AHP method to solve a 3PL service provider selection problem because it is well suited to our research purpose of determining the relative importance of the five service quality dimensions and choosing the best 3PL service provider. The use of the AHP method, when used to determine how customers evaluate 3PL service providers' service quality and make a selection, enables the managers to understand more clearly which service quality factors are more important, thus providing insights that can help with strategy formulation and the delivery of enhanced performance.

In the AHP method, there are three basic principles, namely decomposition, comparative judgment, and synthesis of priorities (Saaty, 1994). Based on AHP principles, the recommended procedure for using the AHP methodology can be summarized as follows:

Step 1: Set up the decision hierarchy by decomposing the problem into a hierarchy of interrelated 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 evaluation criteria and sub-criteria.

Step 2: Construct a set of pairwise comparison matrices for each level of the hierarchy, and make all the pairwise comparisons. The pairwise comparison matrix is denoted by  $A = [a_{ij}]$  where  $a_{ij}$  implies the relative importance (or preference) of element  $i$  over element  $j$ . Each entry in matrix  $A$  is positive ( $a_{ij} > 0$ ) and reciprocal ( $a_{ij} = 1/a_{ji}$  for all  $i, j = 1, 2, \dots, n$ ). To fill the matrix of  $A$ , Saaty proposed a 9-point pairwise comparison scale as shown below. For example, if  $a_{ij} = 5$ , this means that  $a_i$  is strongly more important than  $a_j$ .

1/9	1/7	1/5	1/3	1	3	5	7	9
extremely	very strongly	strongly	moderately	equally	moderately	strongly	very strongly	extremely
← less important						more important →		

(1/8, 1/6, 1/4, 1/2, 2, 4, 6, 8 : Intermediate values between the above adjacent values)

Step 3: Calculate the priority vector and consistency ratio for each pairwise comparison matrix. The priority vector  $w = (w_1, w_2, \dots, w_n)^T$  is generated by normalizing the principal eigenvector  $w$  of the matrix  $A$ :  $Aw = \lambda_{max}w$  where  $\lambda_{max}$  is the largest eigenvalue of the matrix  $A$ . To check the consistency in pairwise comparison judgment, the consistency ratio (CR) is calculated using  $CR = CI / RI$  where consistency index (CI) is given by  $CI = (\lambda_{max} - n) / (n - 1)$  and random Index (RI) is obtained by  $n$  from the following random index table. If the value of CR is 0.1 or less, then the judgment is considered to be consistent and acceptable.

Order of matrix ( $n$ )	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Step 4: Synthesize the priority vectors of each level obtained in the Step 3, to produce the overall score for each alternative. The overall score for the  $i^{th}$  alternative ( $S_i$ ) is computed as follows:  $S_i = \sum_{j=1}^n c_j w_{ij}$  where  $c_j$  is the vector of priorities associated with the  $j^{th}$  element of the hierarchy and  $w_{ij}$  is the vector of priorities derived from comparing the alternatives in each criterion.

#### 4. A Case Study of Korean 3PL Service Providers

To demonstrate the practical application of the idea discussed above, an empirical case study was conducted with an Internet shopping mall in Korea, which wanted to contract an appropriate 3PL service provider. Four companies were considered as potential 3PL service providers, which were represented as 3PL A, 3PL B, 3PL C and 3PL D.

##### 4.1 Structuring the decision hierarchy

We first structured the decision hierarchy in which all decision elements were classified into four levels as shown in Figure 1. The highest level (Level 1) of the hierarchy stands for the ultimate goal that was to evaluate 3PL service quality and select an appropriate 3PL service provider. The five service quality dimensions identified to achieve this goal are located at the second level (Level 2). At the third level (Level 3), the absolute measurement mode of the AHP (i.e., a five-point rating scale of outstanding, good, average, fair and poor) is applied to rate each alternative according to each criteria in the level directly above. In our 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, in a deviation from the usual AHP approach, a rating scale was used to eliminate these difficulties and enable the decision maker to 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 service providers.

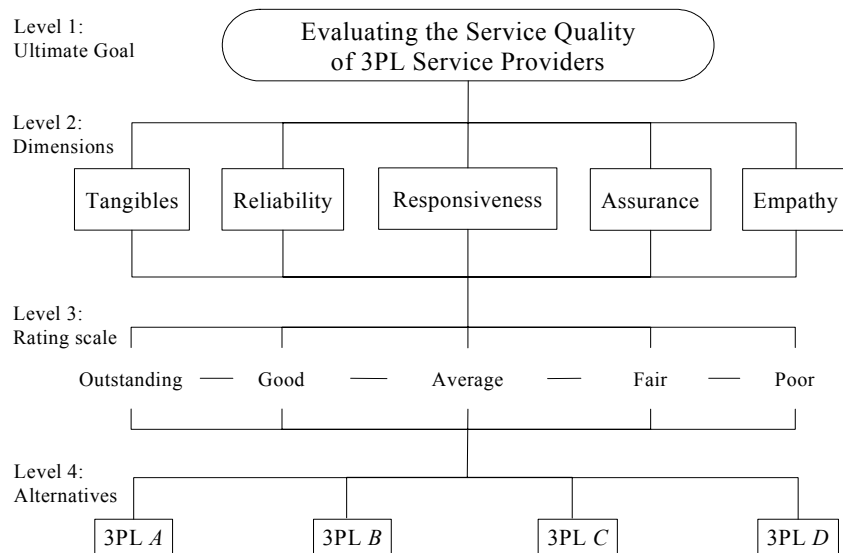


Figure 1. Decision hierarchy for evaluating 3PL service quality

#### 4.2 Making the pairwise comparison matrix

Once the decision hierarchy is constructed, pairwise comparisons are made between the elements at each level of the hierarchy with respect to the connected element in the level above. In order to make pairwise comparison between five service quality dimensions at level 2, a questionnaire was designed and sent out to the customers of the four alternative 3PL service providers in February 2005. The target respondents were the general managers or logistics managers of the sampled shipper companies. 23 customers of 3PL *A*, 21 customers of 3PL *B*, 26 customers of 3PL *C*, and 19 customers of 3PL *D* replied to the questionnaires. Of these, 67 individual pairwise comparison matrices with consistency ratio of less than 0.1 were aggregated using the geometric mean method. The aggregate pairwise comparison matrix is presented in Table 1.

Table 1. Aggregate pairwise comparison matrix for five service quality dimensions

	Tangibles	Reliability	Responsiveness	Assurance	Empathy	Priorities
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

$$\lambda_{max} = 5.011, CI = 0.002, RI = 1.12, CR = 0.002$$

#### 4.3 Calculating the priority vector

After the pairwise comparison process is completed, the priority vector is calculated 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  $\bar{A}$  which is defined as:

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

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

$$W = [w_k] \text{ where } w_k = \sum_{i=1}^n \bar{a}_{ij} / n \text{ for } j, k = 1, 2, \dots, n$$

Using the above calculation procedures, the priority vector for the five service quality dimensions is derived and the result obtained is given in the last column of Table 1. Also, as shown below the matrix, the consistency ratio is found to be less than 0.1, which is typically considered acceptable. The priority vector in Table 1 reflects the 3PL customers' view that the most important dimension in evaluating the service quality of

3PL service providers is responsiveness (0.224), followed by tangibles (0.205), empathy (0.205), reliability (0.185) and assurance (0.180).

As mentioned earlier, we used a five-point rating scale to rate the four alternative 3PL service providers according to five service quality dimensions in level 2. Using pairwise comparison along a five-point rating scale, the relative weights of outstanding (O), good (G), average (A), fair (F) and poor (P) were determined as 0.513, 0.261, 0.129, 0.063 and 0.034, respectively (Liberatore et al., 1992; Liberatore, 1987). The customers of each of the four 3PL service providers were then asked to assign the five-point rating scale to their 3PL service provider with respect to each of the five service quality dimensions in the questionnaire. The resulting consensus ratings are shown in the cells labeled ‘R’ in Table 2.

#### 4.4 Determining overall score for each alternative

Finally, the overall score for each of the four alternative 3PL service providers is computed for the purpose of selecting the most appropriate 3PL service provider in terms of service quality. The overall score  $S_i$  for the  $i^{th}$  3PL service provider is computed as follows:

$$S_i = \sum_{j=1}^n w_j r_{ij} \text{ for } i=1,2,\dots,n \text{ where } w_j \text{ is the priority weight (local weight) of the } j^{th}$$

service quality dimension in level 2 and  $r_{ij}$  is the rating score of the  $i^{th}$  3PL service provider with respect to the  $j^{th}$  service quality dimension.

Table 2. Overall scores of four alternative 3PL service providers

Dimensions	Tangibles	Reliability	Responsiveness	Assurance	Empathy	Overall scores	Normalized scores
Alternatives	L: 0.205	L: 0.185	L: 0.224	L: 0.180	L: 0.205		
3PL A	R: 0.261	R: 0.129	R: 0.261	R: 0.063	R: 0.129	0.174	0.298
	G: 0.054	G: 0.024	G: 0.058	G: 0.011	G: 0.026		
3PL B	R: 0.129	R: 0.063	R: 0.129	R: 0.063	R: 0.063	0.091	0.156
	G: 0.026	G: 0.012	G: 0.029	G: 0.011	G: 0.013		
3PL C	R: 0.129	R: 0.261	R: 0.513	R: 0.129	R: 0.261	0.266	0.456
	G: 0.026	G: 0.048	G: 0.115	G: 0.023	G: 0.054		
3PL D	R: 0.063	R: 0.034	R: 0.063	R: 0.034	R: 0.063	0.052	0.090
	G: 0.013	G: 0.006	G: 0.014	G: 0.006	G: 0.013		

\*) R: Rating Scores, L: Local Weights, G: Global Weights

Based on the (normalized) overall scores of the four 3PL service providers shown in Table 2, we find that 3PL C has the highest overall score among four alternatives. Therefore it must be selected as the best 3PL service provider, as it satisfies all the evaluation criteria for 3PL service quality.

## 5. Conclusions

In this paper, we presented an efficient way of applying the AHP to selecting the best 3PL service provider, based on service quality evaluation. In order to measure 3PL service quality, we utilized the five generic dimensions of SERVQUAL. Although the conceptualization and dimensionality of SERVQUAL have been subjected to some severe criticisms (Buttle, 1996), there is a general agreement that the five dimensions are reasonably accurate predictors of perceived service quality (Sureshchandar et al, 2002). We also applied the AHP approach to solve a 3PL service provider selection problem. The major advantage of this approach is that it gives a relative importance to the evaluation criteria and an assessment of alternatives based upon each criterion.

To explore practically the ideas presented in this paper, we conducted an empirical case study on four 3PL service providers in Korea. The results shown in Table 1 indicate that *Responsiveness* (the willingness to help customers and provide prompt service) out of the five service quality dimensions is considered as the most important dimension perceived by 3PL customers. Furthermore, according to the overall service quality scores shown in Table 2, 3PL C has been chosen as the best 3PL service provider with respect to service quality. However, in order for our results to be more complete, further research should be undertaken to establish a set of metrics to quantify each of the dimensions of 3PL service quality discussed in this paper.

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