An AHP Model for Choosing Value Creation Factors in Logistics Service for the Logistics Customer

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Abstract. During the last decades, the role of logistics in organizations has been changed. Prahaland and Hamel (1990) and Stalk et al. (1992) realize that there has been an increasing attention directed towards logistics as a competitive weapon. Sustainable supply chain optimization does not require a choice between making economic sense and ensuring that environmental factors are addressed. It needs a fine balance between both. So that the logistics value creation can arrange. The service functions may benefit on the value creation through the organization network. The term Value Chain, a well known strategic concept developed by Porter (1985), enables one to establish how value is being added across enterprise. The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production delivery to final consumers, and final disposal after use. In this paper, a decision-support approach has been developed based on the analytic hierarchy process. AHP is an excellent approach that can be used in a multifactor decision making and especially when subjective and or intuitive consideration has to be incorporated. The main purpose of the study is to determine the ranking of Porter's value chain factors by logistics customers.

1. Introduction

The idea of the value chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and outputs. Inputs, transformation processes, and outputs involve the acquisition and consumption of resources - money, labour, materials, equipment, buildings, land, administration and management. How value chain activities are carried out determines costs and affects profits.

Most organizations engage in hundreds, even thousands, of activities in the process of converting inputs to outputs. These activities can be classified generally as either primary or support activities that all businesses must undertake in some form.
According to Porter (1985), the primary activities are:

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1. **Inbound Logistics** - involve relationships with suppliers and include all the activities required to receive, store, and disseminate inputs.
2. **Operations** - are all the activities required to transform inputs into outputs (products and services).
3. **Outbound Logistics** - include all the activities required to collect, store, and distribute the output.
4. **Marketing and Sales** - activities inform buyers about products and services, induce buyers to purchase them, and facilitate their purchase.
5. **Service** - includes all the activities required to keep the product or service working effectively for the buyer after it is sold and delivered [1].

2. AHP

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.

A decision making problem can be resolved with AHP as followed by the stages; identification of decision-making problem, creation of the comparison matrix between the criteria that effect decision points, consistency measurement of criteria benchmarking by determining the percentage of distribution [2]. When creating a binary comparisons matrix, the relative importance ratings are used in Table 1 considering the value of importance of the criteria heaving to each other [3]. This table comprises of integer numbers (1-9), which one number has been considered for any comparison mode.

Table1. Relative Importance Ratings

Scale	Definition	Explanation
1	Equally Important	Practical knowledge and experience assert that criterian i is equally important when compared to criterion j
3	Moderately Important	Practical knowledge and experience assert that criterian i seems moderately more important when compared to criterion j
5	More Important	Practical knowledge and experience assert that criterian i is more important when compared to criterion j
7	Strongly Important	Practical knowledge and experience assert that criterian i is strongly important when compared to criterion j
9	Extremely Important	Practical knowledge and experience assert that criterion i is extremely important when compared to criterion j, and totally out weights it
2,4,6,8	Intermediate values	When the above scales can't reflect the rate of importance between two element, intermediate values are used.

For example, if two elements are assumed equally important, the comparison will have a scale of 1. If one element is strongly more important than the other, the analysis will have a scale of 5. Subsequently, scales 7 and 9 are used to describe very strongly more important and extremely more important respectively. The corresponding reciprocals 1, 1/2, 1/3… ,1/9 are used for the reverse comparison. where aij ¼ 1 and aij ¼ 1=aji; i; j ¼ 1; 2; . . . ; n. In matrix A, the problem becomes one

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of assigning to the n elements C1, C2, . . . , Cn a set of numerical weights W1, W2, . . . , Wn that reflect the recorded judgements. If A is a consistency matrix, the relations between weights Wi and judgements aij are simply given byWi=Wj ¼ aij (for i, j ¼ 1, 2, . . . , n) and matrix A is as follows [4].

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \end{array}$$

2.1 Consistency test

Although AHP is a consistent method in itself, it depends on the consistency between the literal comparisons that the solution gives realistic results. This consistency is being tested with "Consistency Rate" (CR). Consistency rate is realized by dividing consistency indicator (CI) of the matrix contained in table 2 by the n value that corresponds to the value of index (RI) called the random indicator. Consistency indicator is calculated using the formula
$CI = (\lambda_{max} - n) / (n-1)$.

If CR is under 0.1 there is consistency, if it is over 0.1 there is no [5]. The consistency ratio (CR) is introduced to aid in deciding whether to revise the matrix. It is defined as the ratio of the CI to the so-called random index (RI), which is a CI of randomly generated matrices

Table 2.
Random Indicator

N	1	2	3	4	5	6	7	8	9	10
RI	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

AHP method has been successfully applied to numerous areas, such as education, marketing, finance, logistics, ayditing, economy and management problems [3].

2.2 The pairwise comparison matrix

The elements at each level are compared pairwise, considering their relationship to a particular element in the next higher level. Beginning from the top of the hierarchy and working down, at each level, square matrices called comparison (or preference) matrices are created by pairwise comparisons.

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Table 3.
Pairwise comparison for criteria

	INBOUND LOGISTICS	OPERATIONS	OUTBOUND LOGISTICS	SERVICE	MARKETING & SALES
INBOUND LOGISTICS	**1**	**3**	**2**	**3**	**3**
OPERATIONS	**1/3**	**1**	**1/2**	**3**	**2**
OUTBOUND LOGISTICS	**1/2**	**2**	**1**	**2**	**2**
SERVICE	**1/3**	**1/3**	**1/3**	**1**	**1/3**
MARKETING & SALES	**1/3**	**1/2**	**1/2**	**2**	**1**

In this case, outbound logistics (got 2) is more important than operations criteria. If we compare operations to outbound logistics, it is expressed ½ automatically. Individual or group decision are applied when decision are being made in binary comparisons. Those two methods are being applied in case of having problems in the groups to get the decisions together.

1) Group Decision Making
2) Combining individual opinions.

1) Group Decision Making: Group defines the value in binary matrix comparisons. The plurality take into consideration in case there cannot be an agreement on opinions. These groups may have troubles in polling process. All group members must be present during this process. Members can be aggressive or calm in decision making process depending on their personality. If certain number of members radical opinions this time majoritys'opinion take into consideration and also hierarchy can be problem in the group. Therefore it would be much better to combine opinions of individuals if they could not reach an agreement [6].

2) Combining Individual Opinions: Geometric Average Method and Weighted Average Method are widely used. In this case binary comparisons and polling methods are applied the group of graduate students of Istanbul University Department of Maritime Transportation Management Engineering who are working for logistics companies.

Table 4.
Weighted Criteria Matrix

	INBOUND LOGISTICS	OPERATIONS	OUTBOUND LOGISTICS	SERVICE	MARKETING & SALES	PRIORITY
INBOUND LOGISTICS	**1,00**	**3,00**	**2,00**	**3,00**	**3,00**	**0,38674**
OPERATIONS	**0,33**	**1,00**	**0,50**	**3,00**	**2,00**	**0,18284**
OUTBOUND LOGISTICS	**0,50**	**2,00**	**1,00**	**2,00**	**2,00**	**0,22876**
SERVICE	**0,33**	**0,33**	**0,33**	**1,00**	**0,33**	**0,0773**
MARKETING & SALES	**0,33**	**0,50**	**0,50**	**2,00**	**1,00**	**0,12436**
TOTAL	**2,49**	**6,83**	**4,33**	**11**	**8,33**	**1**

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Step 1:

$[\ b_{ij}\ ]_{nx1}$ **i=1,2,…., n** $\quad b_{ij} = \dfrac{aij}{\sum_{i=1}^{n} aij}$ **(1)**

$$b11 = \frac{1}{2,49} = 0,401 \qquad b13 = \frac{0,50}{2,49} = 0,200$$

$$b12 = \frac{0,33}{2,49} = 0,132 \qquad b14 = \frac{0,33}{2,49} = 0,132$$

$$b15 = \frac{0,33}{2,49} = 0,132$$

$$b21 = \frac{3}{6,83} = 0,439 \qquad b22 = \frac{1}{6,83} = 0,146$$

$$b23 = \frac{2}{6,83} = 0,292 \qquad b24 = \frac{0,33}{6,83} = 0,048$$

$$b25 = \frac{0,50}{6,83} = 0,073$$

$$b31 = \frac{2}{4,33} = 0,461 \qquad b32 = \frac{0,50}{4,33} = 0,115$$

$$b33 = \frac{1}{4,33} = 0,230 \qquad b34 = \frac{0,33}{4,33} = 0,076$$

$$b35 = \frac{0,50}{4,33} = 0115$$

$$b41 = \frac{3}{11} = 0,272 \qquad b42 = \frac{3}{11} = 0,272$$

$$b43 = \frac{2}{11} = 0,181 \qquad b44 = \frac{1}{11} = 0,090$$

$$b45 = \frac{2}{11} = 0,181$$

$$b51 = \frac{3}{8,33} = 0,360 \qquad b52 = \frac{2}{8,33} = 0,240$$

$$b53 = \frac{2}{8,33} = 0,240 \qquad b54 = \frac{0,33}{8,33} = 0,0396$$

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$$b55 = \frac{1}{8,33} = 0,120$$

$$B_1 = \begin{pmatrix} 0,401 \\ 0,132 \\ 0,200 \\ 0,132 \\ 0,132 \end{pmatrix} \quad B_2 = \begin{pmatrix} 0\ ,439 \\ 0,146 \\ 0,292 \\ 0,048 \\ 0,073 \end{pmatrix} \quad B_3 = \begin{pmatrix} 0,461 \\ 0,115 \\ 0,230 \\ 0,076 \\ 0,115 \end{pmatrix} \quad B_4 = \begin{pmatrix} 0,272 \\ 0,272 \\ 0,181 \\ 0,090 \\ 0,181 \end{pmatrix}$$

Step 2: Calculate the overall weights

$$C = [\, b_{ij} \,]_{nxn} \qquad i = 1,2,\ldots, n \qquad\qquad j = 1,2,\ldots n$$

$$W_i = \frac{\sum_{j=1}^{n} cij}{n} \qquad (2) \qquad\qquad W = [\, W_i \,]_{nx1} \qquad (3)$$

$$C = \begin{pmatrix} 0,401 & 0,439 & 0,461 & 0,272 \\ 0,132 & 0,146 & 0,115 & 0,272 \\ 0,200 & 0,292 & 0,230 & 0,181 \\ 0,132 & 0,048 & 0,076 & 0,090 \\ 0,132 & 0,073 & 0,115 & 0,181 \end{pmatrix}$$

$$W_i = \begin{pmatrix} 0,401 & 0,439 & 0,461 & 0,272 & /5 \\ 0,132 & 0,146 & 0,115 & 0,272 & /5 \\ 0,200 & 0,292 & 0,230 & 0,181 & /5 \\ 0,132 & 0,048 & 0,076 & 0,090 & /5 \\ 0,132 & 0,073 & 0,115 & 0,181 & /5 \end{pmatrix} \qquad W_i = \begin{pmatrix} 0,38674 \\ 0,18114 \\ 0,22876 \\ 0,0773 \\ 0,12436 \end{pmatrix}$$

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Step 3: Consistency test

$$D = [a_{ij}]_{nxn} * [w_i]_{nx1} = [d_i]_{nx1} \quad (4)$$

$$D = \begin{pmatrix} 1,00 & 3,00 & 2,00 & 3,00 & 3,00 \\ 0,33 & 1,00 & 0,50 & 3,00 & 2,00 \\ 0,50 & 2,00 & 1,00 & 2,00 & 2,00 \\ 0,33 & 0,33 & 0,33 & 1,00 & 0,33 \\ 0,33 & 0,50 & 0,50 & 2,00 & 1,00 \end{pmatrix} * \begin{pmatrix} 0,38674 \\ 0,18114 \\ 0,22876 \\ 0,0773 \\ 0,12436 \end{pmatrix} = \begin{pmatrix} 1,9926 \\ 0,90374 \\ 1,18773 \\ 0,38107 \\ 0,61151 \end{pmatrix}$$

$$E_i = \frac{di}{wi} \qquad i = 1,2,\ldots,n \quad (5)$$

$$E = \begin{pmatrix} 5,152 \\ 4,989 \\ 5,192 \\ 4,929 \\ 4,917 \end{pmatrix}$$

$$\lambda = \frac{\sum_{i=1}^{n} Ei}{n} \qquad \lambda = \frac{25,1792}{5} = 5,03584 \quad (6)$$

$$CI = \frac{\lambda - n}{n-1} \qquad CI = \frac{5,03584-5}{5-1} \qquad CI = 0,00896 \quad (7)$$

$$RI = 1,12$$

$$CR = \frac{CI}{RI} = \frac{0,00896}{1,12} = 0,007 < 0,1 \quad (8)$$ efficient consistent matrix.

3. Summary

Value chain analysis studies the operations in order that are applied product and service oriented in a organization. At this point it is important to set determine and evaluate the strong and weak points systematically for the competition. "Value Chain "is strategic notion that has been developed by Michael Porter and this model aims to discover how value ads come up in a company. Value chain holds entire product and service operations from the point of conceptual development to end product and service. Value chain supports the decision makers for their strategic actions such as which

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operations should be developed or refer out of company to see their position in global competition and get an advantage against rivals.

In this study, AHP technique was analyzed which is commonly used in multi criteria decision making processes and effective results were gotten. Especially by adding personal opinions and experiences into the decision making process expand the sensitivity of methodology. This puts of destructive difference of AHP compared to others.
In this study, the materiality of the elements one another in Porter's value chain has been identified. Binary comparisons and polling methods are applied the group of graduate students of Istanbul University Department of Maritime Transportation Management Engineering who are working for logistics companies. There has not been any problem due to the small group. All the uploaded to the criteria resulted as below. Regarding these results, most important element is “Inbound Logistics" with the value of" 0,38674". "Outbound Logistics" comes second with the value of 0,22876. “Operations" comes third with 0,18114." "Marketing & Sales" comes fourth with 0,12436 and "Service" comes fifth on the line with "0,0773".

According to this ranking of elements, logistics is the most valuable actions of the company's value chain. Logistics actions must be managed as a very important chain that keeps and enhance the strength of the company.

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