

# Third-Party Logistics Provider Selection By Using AHP and CODAS Methods

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**Abstract** – Companies would like to gain a competitive advantage in today's world where global competition is intense by focusing on their main activities. Therefore, most of the companies use outsourcing for their logistics activities. Third-party logistics providers are outsourcing organizations that perform some or all of the logistics activities of companies. In order for the logistics activities to continue accurately in the medium and long term, companies need to establish a strategic partnership with a good third-party logistics provider. To achieve this goal, companies should identify the best third-party logistics provider. Many factors and alternatives need to be considered in the problem of selecting third-party logistics providers. Therefore, this problem can be called a multi-criteria decision-making (MCDM) problem. In this study, third-party logistics provider selection will be made for a textile company with the Analytic Hierarchy Process (AHP) and Combinative Distance-Based Assessment (CODAS) methods. In this study, four alternatives were evaluated with respect to six criteria.

**Keywords** – Third-party logistics provider, AHP, CODAS, MCDM, Logistics.

## I. INTRODUCTION

Companies attempt to gain competitive advantage in today's world where global competition is intense. Companies need to focus on their core activities in achieving a competitive advantage. Therefore, most of the companies outsource their non-core activities, such as logistics. Third-party logistics providers are contracting organizations carrying out some or all of the company's logistics operations.

In order to continue the logistics operations effectively in the medium and long term, companies need to develop a strategic partnership with a good third-party logistics provider. Companies should determine the best third-party logistics provider to achieve this goal. Many factors and alternatives need to be considered in the problem of selecting third-party logistics providers. Thus, this problem can be called a multi-criteria decision-making (MCDM) problem. In this study, an integrated MCDM model including AHP and CODAS is used to identify the best third-party logistics provider for a textile company. The next section will indicate literature review.

## II. LITERATURE REVIEW

The articles regarding the selection of third-party logistics providers in recent years are shown in Table 1.

Table 1. Literature Review

Authors	Methods	Year
Sremac et al. [1]	SWARA-WASPAS	2018
Zarbakhshnia et al. [2]	SWARA-COPRAS	2018
Singh et al. [3]	AHP-TOPSIS	2018
Pamucar et al. [4]	BWM-WASPAS-MABAC	2019
Govindan et al. [5]	ELECTRE I-SMAA	2019

Ayçin [6]	DEMATEL	2019
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## III. METHODOLOGY

In this study, AHP and CODAS methods will be used to address third-party logistics provider selection problem.

### A. AHP

The steps of AHP [7] are indicated as follows [8].

Step 1: The pairwise comparison matrix ( $C$ ) is constructed by using a 1 to 9 scale.

$$C = [c_{ij}]_{n \times n} \quad (1)$$

Step 2: This matrix is normalized by equation 2. Then the weights of criteria ( $w_j$ ) are calculated by equation 3.

$$c'_{ij} = \frac{c_{ij}}{\sum_{i=1}^n c_{ij}} \quad (2)$$

$$w_j = \frac{\sum_{j=1}^n c'_{ij}}{n} \quad (3)$$

Step 3: Consistency Index ( $CI$ ) and Consistency Ratio ( $CR$ ) of the matrix are computed as [9].

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (4)$$

$$CR = \frac{CI}{RI} \quad (5)$$

### B. CODAS

The steps of CODAS are indicated as follows [10].

Step 1: Decision matrix is constructed by using a 1 (very low) to 9 (very high) scale.

$$E = [e_{ij}]_{m \times n} \quad (6)$$

Step 2: Values in the matrix are normalized.

$$e'_{ij} = \frac{e_{ij}}{\max(e_{ij})} \quad (\text{for beneficial criteria}) \quad (7)$$

$$e'_{ij} = \frac{\min(e_{ij})}{e_{ij}} \quad (\text{for non-beneficial criteria}) \quad (8)$$

Step 3: Weights are multiplied with normalized values.

$$e^*_{ij} = e'_{ij}w_j \quad (9)$$

Step 4: Negative ideal solution ( $ns_j$ ) is obtained for each criterion.

$$ns_j = \min(e^*_{ij}) \quad (10)$$

Step 5: Euclidean ( $P_i$ ) and Taxicab ( $T_i$ ) distances are calculated as.

$$P_i = \sqrt{\sum_{j=1}^n (e^*_{ij} - ns_j)^2} \quad (11)$$

$$T_i = \sum_{j=1}^n |e^*_{ij} - ns_j| \quad (12)$$

Step 6: Relative assessment matrix ( $R_a$ ) is computed as.

$$R_a = [h_{ik}]_{m \times m} \quad (13)$$

$$h_{ik} = (P_i - P_k) + (\omega(P_i - P_k) \times (T_i - T_k)) \quad (14)$$

$$\omega(x) = \begin{cases} 0, & |x| < \nabla \\ 1, & |x| \geq \nabla \end{cases} \quad (15)$$

In equation 15,  $\omega(x)$  is a threshold function and  $\nabla$  is the threshold parameter. This parameter is taken as 0,02 in this study.

Step 7: The last score ( $S_i$ ) for each alternative is computed as.

$$S_i = \sum_{k=1}^n h_{ik} \quad (16)$$

#### IV. APPLICATION

The best third-party logistics provider is chosen for a textile company in this study. All data used in this study were obtained from the distribution manager of the company. In this study, four alternatives are evaluated under six criteria. Only one criterion (transportation cost) is non-beneficial criterion and others are beneficial criteria. Table 2 indicates the pairwise comparison matrix.

Table 2: The Pairwise Comparison Matrix

Criteria \ Criteria	Delivery	Reliability	Transportation Cost (TC)
Delivery	1	2	0,5
Reliability	0,5	1	0,333
Transportation Cost (TC)	2	3	1
Criteria \ Criteria	Reputation	Services	Flexibility
Reputation	0,333	0,5	0,5
Services	0,25	0,25	0,333
Flexibility	0,2	0,2	0,2
Delivery	3	4	5
Reliability	2	4	5
Transportation Cost (TC)	2	3	5
Reputation	1	1	2
Services	1	1	5
Flexibility	0,5	0,2	1

The weights of criteria are obtained using AHP. These weights are indicated in Table 3.

Table 3: The Weights of Criteria

Criteria	Weights
Delivery	0,255

Reliability	0,185
TC	0,317
Reputation	0,099
Services	0,101
Flexibility	0,043
CR	0,071

After obtaining the weights of criteria, decision matrix, which is indicated in Table 4, is constructed.

Table 4: Decision Matrix

Criteria \ Alternatives	Delivery	Reliability	TC
A11	5	8	6
A12	7	6	8
A13	6	6	6
A14	7	6	6
Criteria \ Alternatives	Reputation	Services	Flexibility
A11	5	6	6
A12	7	7	8
A13	6	6	7
A14	4	4	6

Equations 7-8 are used to normalize this matrix. Normalized decision matrix is indicated in Table 5.

Table 5: Normalized Decision Matrix

Criteria \ Alternatives	Delivery	Reliability	TC
A11	0,714	1	1
A12	1	0,75	0,75
A13	0,857	0,75	1
A14	1	0,75	1
Criteria \ Alternatives	Reputation	Services	Flexibility
A11	0,714	0,857	0,75
A12	1	1	1
A13	0,857	0,857	0,875
A14	0,571	0,571	0,75

The results of equations 9-12 are indicated in Table 6.

Table 6: Weighted Normalized Decision Matrix

Criteria \ Alternatives	Delivery	Reliability	TC	$P_i$
A11	0,182	0,185	0,317	0,097
A12	0,255	0,139	0,238	0,095
A13	0,219	0,139	0,317	0,096
A14	0,255	0,139	0,317	0,108
$ns_j$	0,182	0,139	0,238	
Criteria \ Alternatives	Reputation	Services	Flexibility	$T_i$
A11	0,071	0,087	0,032	0,168

A12	0,099	0,101	0,043	0,169
A13	0,085	0,087	0,038	0,179
A14	0,057	0,058	0,032	0,152
$ns_j$	0,057	0,058	0,032	

Relative assessment matrix is computed by using equations 13-15. This matrix is indicated in Table 7.

Table 7: Relative Assessment Matrix

Alternatives \ Alternatives	A11	A12
A11	0	0,002
A12	-0,002	0
A13	-0,001	0,001
A14	0,011	0,013
Alternatives \ Alternatives	A13	A14
A11	0,001	-0,011
A12	-0,001	-0,013
A13	0	-0,012
A14	0,012	0

The last score ( $S_i$ ) for each alternative is calculated by using equation 16. Scores of alternatives and rankings of alternatives are indicated in Table 8.

Table 8: The Results of CODAS

Alternatives \ Results	$S_i$	Rankings
A11	-0,008	2
A12	-0,016	4
A13	-0,012	3
A14	0,036	1

### V. CONCLUSION

In this study, an integrated MCDM model including AHP and CODAS is proposed to determine the best third-party logistics provider for a textile company. According to the results of the integrated model, the order of alternatives are as follows;  $A14 > A11 > A13 > A12$ . Future research may use different MCDM models to solve the same problem.

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