Supplier Selection Process Using ELECTRE I Decision Model and an Application in the Retail Sector

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Extensive Summary

Introduction
Supplier chain management is the main topic for the business management, nowadays. There are some activities, which have to be decided by the supply chain managers such as supply chain performance, supplier selection, management information systems and data mining etc. Supplier selection and evolution are decisions of strategic importance to companies. Suppliers are the vendors who provide raw materials, components and services that a company cannot self provide. The selecting supplier process mainly involves evaluation of different alternative suppliers based on different criteria. This process is affected by different financial and non-financial criteria including costs, quality, delivery and flexibility. In this study, the supplier selection problem was discussed in order of importance between energy drinks suppliers of food business in the retail sector, and costs, quality, delivery and flexibility variables were analyzed to select suppliers using ELECTRE (The Elimination and Choice Translating Reality) I method.

Methods and Findings
The ELECTRE method was used to analyze the data of a decision matrix to rank a set of alternatives. ELECTRE method reflect the dominance of relations among alternatives by outranking relations. It is possible that the alternatives can be compared by these outranking relations built in this way. Different ELECTRE method, concordance and discordance indexes are two types of indices pair-wise comparison between alternatives in ELECTRE I. The computation flow process of ELECTRE I method (Pang, Zhang and Chen, 2011. pp. 897,897) and the results of this study are stated in seven steps;

Step 1. Normalization of matrix and weighted matrix: Considering concepts on the interval numbers of decision matrix, the normalized matrix of $R_{ij} = [r_{ij}]$ is
calculated and the weighted matrix depends on normalized matrix assigned to it is given by:

\[
V = \begin{bmatrix}
0.1 & 0.1 & 0.04 & 0.05 \\
0.48 & 0.1 & 0.04 & 0.05 \\
0.06 & 0.1 & 0.19 & 0.05 \\
0.07 & 0.1 & 0.04 & 0.05
\end{bmatrix}
\]

\[
\text{Step 2. Ascertainment of concordance and discordance interval sets:} \text{ The concordance interval set is applied to describe the dominance query and the discordance interval set is opposite of it. The concordance and discordance interval sets are given by:}
\]

\[
\begin{align*}
C_{14} &= \{2, 4\} & C_{41} &= \{2, 4\} & D_{14} &= \{4\} & D_{41} &= \{1\} \\
C_{21} &= \{1, 2, 3, 4\} & C_{42} &= \{2, 4\} & D_{21} &= \{1\} & D_{42} &= \{1\} \\
C_{23} &= \{1, 2\} & C_{43} &= \{2, 4\} & D_{23} &= \{3, 4\} & D_{43} &= \{1\} \\
C_{24} &= \{1, 2, 3\} & C_{44} &= \{1, 2\} & D_{24} &= \{4\} & D_{44} &= \{3, 4\}
\end{align*}
\]

\[
\text{Step 3. Calculation of the concordance interval matrix: The concordance interval index (Cab) between Aa and Ab can be obtained using following equation and the concordance interval matrix can be formulated as follows:}
\]

\[
c_{ab} = \sum_{j \in C_{ab}} w_j
\]

\[
C = \begin{bmatrix}
- & 0.5 & 0.7 & 0.9 \\
1 & - & 0.7 & 0.9 \\
0.5 & 0.5 & - & 0.5 \\
0.5 & 0.5 & 0.7 & -
\end{bmatrix}
\]

\[
\text{Step 4. Calculation of the discordance interval matrix: First, we consider the discordance index of } d(a,b). \text{ Then, using discordance interval index sets, we can obtain discordance interval matrix as:}
\]

\[
d_{ab} = \frac{\max_{j \in D_{ab}} |v_{aj} - v_{bj}|}{\max_{j \in D_{ab}} |v_{aj} - v_{bj}|}
\]

\[
D = \begin{bmatrix}
- & 1 & 1 & 0.02 \\
- & - & 0.4 & 0.001 \\
0.3 & 1 & - & 0.05 \\
1 & 1 & 1 & -
\end{bmatrix}
\]

\[
\text{Step 5. Determine the concordance index matrix: The concordance index matrix for satisfaction measurement problem can be written as follows and Boolean matrix (E) is given by:}
\]

\[
\bar{c} = \sum_{a=1}^{m} \sum_{b=1}^{m} c(a,b) / m(m-1)
\]

\[
\begin{align*}
e(a, b) &= 1 \text{ eğer } c(a, b) \geq \bar{c} \\
e(a, b) &= 0 \text{ eğer } c(a, b) < \bar{c}
\end{align*}
\]
Step 6. Determine the discordance index matrix: On the contrary, the preference of dissatisfaction can be measured by discordance index, and based on the discordance index mentioned above, the discordance index matrix \( F \) is given by:

\[
F = \begin{bmatrix}
- & 1 & 1 & 1 \\
1 & - & 1 & 1 \\
0 & 0 & - & 1 \\
0 & 0 & 0 & -
\end{bmatrix}
\]

\[
d = \frac{\sum_{a=1}^{m} \sum_{b=1}^{m} d(a, b)}{m(m-1)}
\]

\[
f(a, b) = \begin{cases} 
1 & \text{if } d(a, b) \geq d \\
0 & \text{if } d(a, b) < d
\end{cases}
\]

Step 7. Calculate the net superior and inferior value: Let \( c_a \) and \( d_a \) be the net superior and net inferior value respectively. \( c_a \) sums together the number of competitive superiority for all alternatives, and the more and bigger, the better. The \( c_a \) is given by (Table 1):

\[
c_a = \sum_{b=1}^{n} c_{(a,b)} - \sum_{b=1}^{n} c_{(b,a)}
\]

On the contrary, \( d_a \) is used to determine the number of inferiority ranking the alternatives (Table 1):

\[
d_a = \sum_{b=1}^{n} d_{(a,b)} - \sum_{b=1}^{n} d_{(b,a)}
\]

Conclusions and Discussions

There are several results of this study to select supplier according to costs, quality, delivery and flexibility variables using ELECTRE I method. First, The Supplier 2 is the more important company, who supply energy drinks, according to the net superior and net inferior value than the other suppliers for the retailer company. Considering variables which are defined by the experts, non-financial variables have the same results of four companies, but, The Supplier 2 has great advantages considering the variables costs. The conclusion of this study is that the suppliers can be selected by ELECTRE I method and the retailer company should continue to establish good relations.