Performance Indexes Evaluation and Ranking of the Industrial Laboratory Equipment’s Importers in Iran by TOPSIS-AHP

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ABSTRACT

One of the most important ways of determining performance deficiencies, strong points, identifying the external opportunities and threats to the companies which import industrial laboratory equipments is to evaluate the performance and ranking of these importers. This evaluation is highly difficult and requires its particular expertise. The purpose of the present article is to describe an appropriate method to rank and evaluates performance of the aforesaid companies and proposes a ranking and evaluation model based on TOPSIS-AHP method. This model consists of financial, human force, after-sale services, customers’ satisfaction components and the related sub-criteria. The findings indicate that financial, human force, after-sale service, and customers’ satisfaction criteria are some of the important issues in ranking and effective in evaluating the performance of the equipment importing companies. This evaluation is done on 8 companies and results show that, Bush, Siemens and Komatsu are companies between those according to performance index.

Key words: ranking, performance evaluation, TOPSIS, AHP

Introduction

Ministry of Industries and Mines is the only governmental section for importing industrial laboratory equipments. On the other hand, the companies which import such equipments are considered as one of the most important sections of this ministry. Owing to the revolutions in the controlling system of these importers and the obvious difference among companies, it is necessary to rank them and evaluate their performance. Precise evaluation of these companies is very difficult. Many methods have already been proposed for the evaluation and ranking of different companies. Saaty has suggested a multi-criterion method like Analytic Hierarchy Process which is considered as an efficient decision-making technique. This technique is the basis of the binary comparisons and enables managers to study different scenarios [1]. Some of the conducted researches on the evaluation and ranking methods indicate that the statistical decision-making method utilizes different data in evaluation. This method does not evaluate qualitative data, though [17].

There are different models for performance evaluation and some of them have deficiencies. Emphasis on the a major index such as selling, income, and not being comprehensive are considered as the main problems of the current methods in ranking the importers of the industrial laboratory equipments. In other words, such methods determine the biggest companies instead of the superior ones [4].

In evaluating these companies, the expense indexes including managerial expenses, loss, etc. should be analyzed in addition to studying the effective index. Evaluation and ranking the aforesaid importing companies by such methods is not perfect and requires a more precise evaluation method for implementation.

The major applied objectives of the companies ranking and evaluation are as the following:
1. Comparing the company with its rivals, determining the internal strong and weak points and the environmental threats and opportunities to facilitate codifying strategies appropriate to the company environment and competence
2. Improving, guiding, and directing the performance of the company superior manager and the different sections based on the evaluation
3. Revising the prior investments and making decision about new investments based on the conducted ranking according to performance evaluations
4. Helping the creditors in selecting the future top crediting companies
5. Reconsideration and making decision on purchase and making the customers loyal to the superior companies
6. Helping the government and the governmental organizations in their reconsideration and decision-making on protecting, intervening, punishing and encouraging, and directing the companies [17].

This project investigates the data properties and builds an evaluation model based on TOPSIS-AHP to do an elaborate and precise evaluation of the other alternative methods. Next section reviews the research literature and third section presents the model of evaluation and ranking through TOPSIS method. The research methodology and data are discussed in the fourth section. After that, the results of the practical test of the proposed model are presented in the fifth section for eight industrial laboratory equipments importing companies. Finally, conclusion and the suggestions come in section six.

Literature Review:

Nowadays, there are many ranking organizations and magazines in Iran and other countries. Industry Week, Fortune, and Business Week are some examples of the foreign magazines and the Organization of Industrial Laboratory Management is an example in Iran. The major restriction of most of the evaluation methods and the current ranking inventories at the national and international level is lack of comprehensiveness and the fact that most of them are based on a major index such as selling or income level [4].

The conducted researches design a comprehensive model for the evaluation of companies ranking and performance and present a model according to equivalent evaluation which is mostly different. In other words, there are two other components including human force and management in addition to the four equivalent evaluation components and 422 functional indexes are extracted according to six components of the model for evaluation and ranking. This project utilizes a multi-index decision-making model, TOPSIS techniques, and Shannonanthrop model.

Various questions on the companies ranking according to their function evaluation include: 1) what are the criteria of favorable performance?, 2) what are the companies ranking and performance evaluation models?, 3) the proposed appropriate model of companies ranking should enjoy what properties, characteristics, and contents?

Peter Draker believes that the company completion ability, innovation power, liquidity status, money in circulation, and profiting ability facilitate directing the companies’ performance. He states that the companies performance sync is a function of seven effective criteria including efficiency, quality, profiting, career life quality, innovation, and profitability or budgeting capacity.

Multi-Criterion Decision-Making:

It is a mathematical model and refers to a problem-solving approach which uses a limited number of choices [10]. Multi-criterion decision-making methods are famous for being easily applicable. Compound procedures can keep the strong points and create various sources of knowledge and experience, if they are combined properly [11]. Hence, this project uses the combination of two supplementary approaches, i.e., analytic hierarchy process (AHP) and TOPSIS to achieve more efficient decisions.

AHP:

AHP combines experts’ opinions and converts the complicated decision-making system to a simple hierarchy system. Then, evaluation in scale method is conducted by binary comparisons to investigate relative importance [12]. Figure 1, shows the analytic hierarchy stages (Momeni and Najafimoghadam, 2004).

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**Fig. 1:** Stages of analytic hierarchy.
TOPSIS:

The infrastructure logic of TOPSIS method (method of adjusting preferences with similarity by the ideal solution) is the definition of positive and negative ideal solution [14] and it is based on the idea that the selected choice should be of the shortest distance from the ideal solution. Positive and negative ideal solution is a hypothetic solution where all the indexical values are similar to the maximum and minimum indexical values in the base, respectively [10]. In sum, the positive ideal solution is a combination of the best available values of the criteria and negative ideal solution includes the worst available values of the criteria [14].

Nowadays, the endeavor is to avoid focusing on one particular aspect, such as financial aspect, in evaluating the companies’ performance and cover the entire functional aspects of a company by using a balanced approach. In other words, in order to have a comprehensive description of the company’s performance, a balanced set of indexes is required to establish a logical appropriate balance and adjustment among the domestic and foreign factors, monetary indexes, and the indexes of revolution capacity and organizational learning, duty indexes, process indexes as well as individual indexes and team indexes. The most important models of companies’ performance are as the following:

1. Financial evaluation models of companies
2. Profiting evaluation models of companies
3. Organizational effective evaluation models of companies
4. Balanced performance evaluation models of companies

The financial evaluation of companies is one of the oldest and the most important approaches of the companies’ performance evaluation and ranking. It is often based on financial inventories. Financial analyses present valuable data on the procedures, cohesions, quality, profit and income per share, and the weak and strong points of the companies and their financial status [15]. Four major methods in such analyses include horizontal analysis, vertical analysis, round analysis, and the relations analysis.

Multi-index decision-making is a problem-solving approach which utilizes a limited number of choices in selecting a choice [10].

Research Conceptual Model: Combined Technique (TOPSIS-AHP):

TOPSIS and AHP methods are widely used. AHP application has become significantly restricted due to the human being limited capacity in data processing and the highest point of the binary comparisons is considered to be 7≠2. TOPSIS method can meet the needs of binary comparisons and capacity limitations would not emerge [11]. This approach requires an efficient procedure which presents the relative importance of different indexes based on the goal [10]. Hence, a combination of the methods is utilized to take benefit of the advantages of both methods. Here, this procedure is clarified step by step:

Step 1: Objectives determination and identification of the related evaluation indexes

Step 2: Decision-making matrix based on the indexes current data. In this matrix, $d_{ij}$ indicates the value of the $j$th index for the $i$th choice.

Step 3: Obtaining the normal decision matrix $R_{ij}$ by relation 1:

$$R_{ij} = \frac{d_{ij}}{\sum_{j=1}^{M} d_{ij}^{0.5}}$$

(1)

Step 4: Formation of binary comparison matrixes. Element $a_{ij}$ indicates the preference of index $i$ in relation to index $j$ according to the experts opinion. If $i = j$, then $a_{ij} = 1$. Numbers 3, 5, 7, and 9 indicate “medium”, “strong”, “completely strong”, and “absolute”. In addition, we have $a_{ij} = \frac{1}{a_{ji}}$ in this matrix and binary comparison matrixes should be compatible for the confirmation of the questionnaire validity.

Step 5: Formation of binary matrix. It is made of combining the elite’s opinions (binary comparison matrixes) and it is calculated based on the criteria weights. The aforesaid matrix is obtained by relation 2.

$$GM_i = \left\{ \prod_{j=1}^{N} a_{ij} \right\}^{1/N}$$

(2)

Step 6: Determination of each index relative importance. The relative weight of each index is calculated through relation 4 after removing the scale of comprehensive binary comparison matrix of relation 3.

$$a_{ij} = \frac{a_{ij}}{\sum_{i=1}^{N} a_{ij}}$$

(3)

$$w_j = \frac{\sum_{i=1}^{N} n_{ij}}{n}$$

(4)

Step 7: Calculation of the heavy normal matrix $v_{ij}$. This matrix is obtained by multiplying the coefficient of matrix $R_{ij}$ by the weight of the diametric matrix $W$. Relation 5 displays this calculation.

$$v_{ij} = w_j \times R_{ij}$$

(5)

Step 8: Obtaining the positive ideal solution (the best solution) and the negative ideal solution (the worst solution). These solutions come as relations 6 and 7.
There are some profit and some expense indexes. Regarding the profit indexes, they indicate the higher and lower value of the index, respectively. For the expense indexes, they indicate the lower and higher value of the index, respectively.

Step 9: Measuring the distances. The distance between each choice to the positive and negative ideal solutions is computed by Euclid distance based on relations 8 and 9.

\[
S_i^- = \left( \sum_{j=1}^{N} (V_{ij} - V_j^-)^2 \right)^{0.5} \quad i = 1, 2, \ldots, M
\]

\[
S_i^+ = \left( \sum_{j=1}^{N} (V_{ij} - V_j^+)^2 \right)^{0.5} \quad i = 1, 2, \ldots, M
\]

Step 10: Computing the relative closeness of each choice to the ideal solution by relation 10.

\[
C_i = \frac{S_i^-}{S_i^- + S_i^+}
\]

Step 11: Choices are arranged in a descending order based on the preferred values which indicate the highest and lowest preference of the solutions. Hence, compound method could be shown in three general stages as Figure 2.

**Fig. 2: Research Conceptual Model.**

**Methodology:**

The research utilizes a descriptive-analytic method and uses multi-criteria mathematic program to investigate the effect of financial sources, human force, after sale service, and customers’ satisfaction when selecting the companies in agreement with company centers.

The project computes the performance of the industrial laboratory equipments importers concerning financial resources, human force, after sale service, and customers’ satisfaction in an annual period. The data is extracted from the Ministry of Industries and Mines and the existing ranking software which are the basis of the computing the criteria relations. They are secondary relations and their mean forms the matrixes of the initial decisions. In the continuance, the criteria weights are calculated by analytic hierarchy process after building the hierarchy and doing the binary comparisons and the final results of ranking are obtained through TOPSIS by the research conceptual model.

**Research results:**

This section studies and evaluates several Iranian companies which import industrial laboratory equipments.

Evaluating the indexes system – this system is evaluated to show the real status and situation of the industrial laboratory equipment’s importers. We can collect data through this system. The data is able to confirm and backup the evaluation to make appropriate decisions about different importers of industrial laboratory equipments. Collecting the evaluation data of the industrial laboratory equipments importers – the evaluation data is collected from the annual statistics of the Ministry of Industries and Mines for eight Iranian industrial laboratory equipments importers. During the evaluation process, it seemed that the importers were similar to alternatives and data or the relations values of the indexes that which should be evaluated. Indexes A1 (Financial) A2 (After-Sale Service) A3 (Human Force) to A4 (Customers’ Satisfaction) are the effective indexes.
Data Pre-process and Evaluation Execution:

This project uses data pre-process which is based on TOPSIS. Owing to this method, we can obtain the original matrix from Table 1.

\[
\begin{pmatrix}
432.37 & 45.14 & 16.14 & 28.05 \\
643.09 & 41.56 & 18.04 & 43.05 \\
621.28 & 52.74 & 32.76 & 41.06 \\
627.23 & 39.04 & 23.58 & 30.05 \\
610.80 & 37.37 & 16.96 & 28.04 \\
518.83 & 30.29 & 14.09 & 19.92 \\
486.14 & 74.98 & 32.92 & 45.38 \\
464.06 & 22.02 & 10.02 & 30.80 \\
\end{pmatrix}
\]

Since each index has a different weight, it deems necessary to study and measure the index for the main matrix. We hypothesize that the measurement values are as \( w = (0.25, 0.40, 0.16, 0.18) \) for A1 to A4 indexes. We can compute standard matrix \( p \) by formula 1 and weight vector (value measurement).

\[
\begin{array}{cccc}
\text{Table 1: Indexes Computation.} \\
\hline
\text{Industrial Laboratory Equipment's Importing Companies} & \text{Financial A1} & \text{After-Sale Service A2} & \text{Human Force A3} & \text{Customers' Satisfaction A4} \\
\hline
\text{Comatso} & 432.37 & 45.14 & 16.14 & 28.5 \\
\text{Zimense} & 643.09 & 41.56 & 18.4 & 43.5 \\
\text{BOSCH} & 621.28 & 52.74 & 32.46 & 41.6 \\
\text{Bakku} & 627.23 & 39.04 & 23.58 & 30.05 \\
\text{Toshiba} & 610.80 & 35.37 & 16.96 & 28.4 \\
\text{Lavato} & 518.83 & 30.29 & 14.09 & 19.92 \\
\text{Yolico} & 486.14 & 74.98 & 32.92 & 45.38 \\
\text{Metvario} & 464.06 & 22.02 & 10.2 & 30.8 \\
\hline
\end{array}
\]

The entire evaluation indexes should be of the same type and order.

The favorable alternative vector could be selected from matrix \( P \) as \((70.83, 12.0, 7.86, 8.6)\). Simultaneously, the ideal and favorable alternative point could be computed as negative ideal – proportion= \((47.56, 35, 2.45, 3.8)\).

By formula 4, we can compute Euclidean distance from each alternative to another ideal alternative as the following.

\[
\text{Appropriate Distance}= (129.76, 7.29, 6.56, 6.62, 16.75, 22.5, 20, 27.24)
\]

Euclidean distance from each alternative to the unfavorable alternative could be obtained as the following:

\[
\text{Negative Favorable Distance}= (100, 53.12, 50.97, 97.55, 14.41, 41.39, 36.89, 42.46, 35.15)
\]

Combining the favorable and unfavorable distance, we can obtain \( F \), where each alternative which goes towards the favorable side goes away from the negative alternative simultaneously.

\[
F= (0.435, 0.879, 0.8859, 0.8928, 0.7119, 0.62, 0.6798, 0.564)
\]

According to the approximated \( F \), we rank all the alternatives from good to bad and determine their level. Hence, we rank the results as the Table 2.

\[
\begin{array}{cccc}
\text{Table 2: Ranking the importers of industrial laboratory equipment's.} \\
\hline
\text{Industrial Laboratory Equipments Importing Companies} & \text{Favorable Distance} & \text{Rank} \\
\hline
\text{Bakku} & 0.435 & 8 \\
\text{Comatso} & 0.879 & 3 \\
\text{Simens} & 0.8859 & 2 \\
\text{BOSCH} & 0.8928 & 1 \\
\text{Toshiba} & 0.7119 & 4 \\
\text{Lavato} & 0.62 & 6 \\
\text{Yolico} & 0.6798 & 5 \\
\text{Metvario} & 0.564 & 7 \\
\hline
\end{array}
\]

Since each index has a different weight, it deems necessary to study and measure the index for the main matrix. We hypothesize that the measurement values are as \( w = (0.25, 0.40, 0.16, 0.18) \) for A1 to A4 indexes. We can compute standard matrix \( p \) by formula 1 and weight vector (value measurement).

Comparative Study:

According to the report of the Ministry of Industries and Mines, BOSCH, Simens, and Comatso are the best importers in 2011. Concerning financial criteria, after sale service, human force, and the customers’ satisfaction, BOSCH is at the top. The ranking was conducted based on 4 variables in a
particular time period. Considering several indexes, performance evaluation and ranking is highly reliable. On the other hand, TOPSIS is a method of multi-criteria decision-making which can consider the entire presented conditions of the research. Utilization of this method in ranking the industrial laboratory equipments importers put BOSH in the first position. It was studied at 95% reliability level to compare the combined model with TOPSIS model by F statistical test and the diagnostic superiority of the combined approach over TOPSIS approach was approved.

Conclusion:

The current ranking methods are not perfectly comprehensive and sufficiently efficient in clarifying the strong points, deficiencies, opportunities, and threats, because they mostly rely on one index. This project identified four major components, including financial sources, after sale service, customers’ satisfaction, and human force, to determine the effective qualitative and quantitative components. Measurement (weight) components were determined by analytic hierarchy process after determining weight components. Finally, the existing choices were ranked to rank the industrial laboratory equipments importers through TOPSIS technique. Regardless of the obtained results of the aforesaid ranking, we may conclude that this ranking method provides the future data requirements of company evaluation and facilitates comprehensive ranking. The proposed model observes all the major functional aspects of the company in a way that clarification of the strong points, deficiencies, opportunities, and threats would be easily facilitated. In addition, the function improvement plans could be codified, enforced, and supervised more accurately. The findings indicate that evaluation method is appropriate and feasible.

References