Application of Multi-Criteria Decision-Making Models to Prioritization of Production: A Case Study in Hashem Machining Company

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ABSTRACT

The present research studies the effect of applying multi-criteria decision-making models in order to choose the best option for production of industrial goods as a case study in Tarash Hashem Machining Company. Research has shown that MCDM not only provides strategies for large projects, but can also be effectively applied in medium-sized enterprises. The required data are collected from all the managers and experts of the said company and its peers by means of questionnaires and interviews. The collected data are then analyzed using AHP and TOPSIS and finally the optimal choice is selected from decision making options (including production of automobile parts, rolling mill, gas cylinders, and parts for petrochemical industry) with respect to the criteria of interest (including employment, profitability, company’s reputation, investment, production facility, self-sufficiency, industrial stability). In addition, both the decision making options and the criteria are prioritized via AHP and TOPSIS and the effect of each criterion on each of the options is ranked. The results of the present research are presented to the management of Hashem Machining Company and the peer companies so as to provide them with proper, scientific strategies while taking into account the issues of investment and company strategies. Thus, the company will best allocate its potential and actual resources for growth and development.

Key words: quality, investment, company’s reputation, industrial stability, profitability, employment, self-sufficiency.

Introduction

In the contemporary age many enterprises are faced with turmoil and bankruptcy and maybe one of the main reasons behind it is the lack of a proper economic model, lack of correct information, and wrong management decisions. The present research aims to demonstrate the application of scientific methods in decision making and implementation of economic policies in the short and long-term so as to help the company achieve its goals. Regarding decision making and the complex nature of this process, various criteria, measures, and methods for evaluation of production options of the company have been applied [1]. Hashem Machining Company is presently producing Pride and Nissan automobile parts. The issue that convinced me to carry out the research was the concerns of the management and the board of directors about the instable conditions of automobile industry in Iran; given the issue of entering World Trade Organization (WTO) and the investment threat that this company and its peers are faced with due to the high marginal price of automobile parts in the country. In this research we try to identify a proper strategy taking into account the criteria of interest of the management. Then, using MCDM as well as AHP and TOPSIS, the optimal decision option is presented to the management from a series of candidates. [2] The population of the research consists of all the managers and experts of the studied company and its peers with similar products who are mainly members of the company’s board of directors or the high strategic council [3]. Field and library studies have been carried out for data collection. AHP and TOPSIS have been applied for data analysis so as to prioritize the decision options and the criteria, and the effect of each defined criterion on each decision option is taken into consideration and the final result is presented to the management as the company’s strategy [4].

Review of the Literature:

The optimization models in decision making have always been considered by mathematicians and
practitioners of industries. Many organizations have used these models for optimization and achieving their higher goals; organizations such as economic enterprises, Post and Telegraph Department, Ministry of Cooperatives, and the Ministry of Roads and Transportation. Of course these techniques have often been used subjectively, but unfortunately little research has been carried out at the national level in the form a clear, scientific method. Yet in the developed world, using these scientific techniques in every step of decision making is inevitable. Reviewing the literature, so far there has been no research on automobile industry and production of equipment and machinery. [5]

Appropriate allocation of limited resources such as workforce, capital, and management is one of the primary preconditions of economic advancements. Thus, limited resources must be employed properly for achieving economic goals. Employing limited resources for achieving certain goals means lack of access, or to be optimistic, scant access to resources for other goals. In other words, reasonable, effective use of resources prepares the grounds for achieving the goals, priorities, and effectiveness programs. Correct decision making in the modern concept of management is recognized as the most important responsibility. Therefore, before anything else it seems necessary to investigate decision making and its relationship with other new organizational phenomena [6]. Taylor, just obliquely, considers the scientific method as a desirable decision making method and as the beginning of the modern concept of decision making through the relevant techniques [7].

The success of the management in facing the uncertain and variable conditions in today’s modern organizations is the result of proper leadership and depends on the decisions made and the degree to which these decisions are valid and reasonable. Traditional management was defined by employing all the facilities of the organization in order to achieve the desired goals, but in the modern definition of management the main responsibility of the manager is logical, wise decision making which reflects their knowledge in management and leadership. Indeed the manager is not responsible for making decisions; rather, they have other executive duties such as guiding, coordinating, planning, satisfying the personnel, analyzing, and controlling [2].

Despite technological advancements in production, service, and management styles, still most public and private organizations spend large sums on fixed assets, investment projects, and incentives. If most of the investment projects were examined and evaluated through certain methods and criteria, much of this spending would have been curtailed or at least reconsidered with a broader perspective and based on objective criteria so as to serve the interests of the country. The evidence for this claim is the number of projects that failed or were left incomplete [8].

Planning must be done in line with the goals of economic development, creation of value added, reduction in foreign dependence, and building technological capacities. Thus, all the financial and economic policies as well as investigation, selection, and implementation of investment projects must be done in line with these goals. Accordingly, we refer to the investment project of Hashem Machining Company and examine the application of multi-criteria decision making to the production projects of the company.

Definition of the Subject:

The present research takes a step toward determining the future strategy of the company and providing an appropriate policy which corresponds to the existing facilities and capacities. For that purpose, the criteria and options of the organization were obtained through questionnaires and interviews, [9]. In fact, in the present research all the assumptions and theories that have been considered by the management with regards to decision making criteria are reintroduced to them in the form of decision making models and techniques using software applications. In this case, the management will have no concerns regarding the defined strategy because the research has been carried out according to scientific techniques, aiming for greater profitability and reduced risk which are the ultimate goals of the organization [4].

Problem Statement:

Hashem Machining Company seeks to invest in one of the project candidates referred to in the present research. Choosing these projects and necessarily one of them is due to the limited resources which is the main concern of the company [10].

Four options have been examined in the present research and finally prioritized and as well qualitative and quantitative criteria have been prioritized by taking into account the views of managers and experts. Usually such decisions are made by the management as speculations and unscientific predictions and the present research aims to present such speculations based on established scientific techniques so that it will pave the way of managers of industries in prudent decision making [11].

The Necessity of Research:

In this research we try to provide the company with a future strategy and the necessity of the issue arises when we consider the issues associated with entering WTO and the industry in which the
company has invested. After examining all the aspects of the issue and identifying the priorities, we can think of organizational development only if we are one step ahead of the others and this is not feasible unless decisions are made scientifically [12].

Reasons for Choosing This Subject:

This subject was chosen for analysis because of my experience in this company and the need of the board of directors for identifying the strategies and prioritizing the projects of the company. This research tries to answer the following questions:

1. How can the criteria and measures identified in the questionnaires and interviews be prioritized?
2. Has the decision making options and criteria been prioritized?
3. Can such decision making theories be applied to several manufacturing companies and are they effective for promoting the organizational level objectively?

Application of such optimization and prioritization techniques in industries, in particular automobile piece manufacturing companies, has not yet been carried out and the present research can be of help to managers of this company and similar organizations in learning scientific decision making and being able to use it in practice.

Purpose of Research:

The primary purpose of the present research is using multi-criteria decision making models for prioritizing the production options and industrial projects of the company. In addition, in case of obtaining successful results, other companies and institutions can be induced to use such models as MCDM and MADM and step toward progress and eminence [3].

Research Questions:

- Can one classify the products of the company through MCDM and by means of certain qualitative and quantitative criteria?
- Is it effective to apply of MCDM in identification of the criteria intervening in the choice of options?

Research Hypotheses:

Multi-criteria decision making methods have an established application in industrial manufacturing companies.
1. Considering the determined criteria, production of rolling mill is the main priority.
2. Considering the determined criteria, production of parts for petrochemical industry is a priority in the development of the company.
3. There is a significant relationship between decision making options.
4. There is a significant relationship between decision making variables and criteria.

Methodology:

The present research is non-experimental; an error-driven empirical study in which the researcher has no control over the independent variables, because their manifestations have already occurred or because they are inherently not manipulable. Inferences about relations among variables are made, without direct intervention, from concomitant variation of independent and dependent variables [3]. The similarity between experimental and quasi-experimental (non-experimental) issues is that both entail the comparison of two or more independent groups with respect to a variable. The present research is carried out in order to prioritize the production of goods with respect to the criteria of interest in Hashem Machining Company. Descriptive statistical method is used, for an attempt is made to describe the conditions the way they are with no manipulation. Scoring is done using a questionnaire and the criteria and options are examined by applying AHP and TOPSIS; finally, by taking into account the library and field studies, proper strategies will be identified and provided for management for coordinating the activities. The present research is descriptive and the population consists of all the experts and managers of the studied company and its peers. Data was collected using interviews and questionnaires in the form of field study as well as making reference to the extant literature in order to use multi-criteria decision making theories in the form of library study. TOPSIS and AHP are applied in the present research and decision matrices will be used for data analysis [12].

Another difference between non-experimental and experimental studies is that in experimental studies the subjects are assigned to different groups by the researcher; that is, the subjects are randomly assigned to two or more groups. But in quasi-experimental studies assigning subjects to the groups is done naturally and without the interference of the researcher, like when a sample group of women are compared with a sample group of men with respect to one of more variables. Identifying and distinguishing between natural groups (ex post facto) from experimental groups is of utmost importance. Only when subjects are assigned to groups experimentally do we have an experimental study [13].

Population:

The population of the present research consists of all the experts and managers of Hashem Machining Company and its peers such as Yadak-Resan, Abzar-Javan, and Ebtkekar companies who were working as temporary or contract personnel in 2002. The reason for studying this population is that the process of production and supply of goods to the market is specialized and the technical experts can understand the quality of the effective parameters.

Sample:

All the population underwent examination so that the validity of the research would be higher. In other words, the sample of the research is the same as population and includes 12 experts and managers.

Material:

Due to the lack of any standard questionnaire, a researcher-made questionnaire was used for data collection. Generally, calculation in the present
research is bifurcated; first it involves the identification and choosing the most important factors that affect the increase in productivity of the company and then prioritizing these factors based on library studies and familiarity with the industries in Semnan Province, economic opportunities threats, and strengths and weaknesses of the company.

The questionnaire includes 27 items in which an inquiry is made into the priority of criteria and options with regards to criteria and the respondents are asked to evaluate the importance of these items by assigning them a score from 1 to 9 (1 meaning least important and 9 meaning most important). The questionnaires are distributed among the managers and experts of different units of Hashem Machining Company and are rated after being collected. The pairwise comparisons in this questionnaire are made from equal to extreme importance. As was mentioned, the data required for implementing the AHP model must be collected based pairwise comparisons. Thus, the comparison matrix was designed based on AHP decision tree (top-bottom) with the dimensions related to the criteria and options; matrices for pairwise comparisons between the factors affecting the goal, the quadruple factors (the factors at the base of the two decision trees), and a matrix for comparing these factors in relation to the goal. Considering the fact that the dimensions of each matrix are equal to the number of elements that are to be compared, these elements are all displayed in the rows and columns of the matrix. Each entry of the matrix corresponds to two factors, one in the row and the other in the column. After making comparisons between these two factors, the preference is entered in the respective entry in the matrix based on a scale of $\frac{1}{9}$ to 9, but before this it must be specified whether the row is compared to the column and vice versa. If the preference of two factors is reciprocal the numerical value is also expressed as a reciprocal quantity. For instance, if the comparison mode involves comparing the row entries with column entries, if the row entry is evaluated as extreme importance, $\frac{1}{9}$ is entered into the respective entry and vice versa. The usual recommendation is to use Delphi technique in determining the most important factors. In Delphi technique, the views and opinions of experts are collected through questionnaires.

**Designing AHP Model:**

Modeling based on AHP method is according to AHP decision tree. At the first level, there is goal and the last level consists of competing options, and the middle level consists of decision making criteria [14]. In modeling the problem of the present research, the goal is briefly mentioned as increased productivity. The competing options are final factors that affect the goal which have been chosen after statistical analysis. Seven factors have been mentioned as decision making criteria for evaluating the competing options—i.e., productivity, company’s reputation, investment, production facility, self-sufficiency, industrial stability, and employment.

**Validity of the Model:**

In the present research, priority of production is determined by means of AHP method. The consistency rate is the greatest strength of this method. This leads to the reliability of the data and subsequently the results. This is also one of the major weaknesses of this method; the increase in the number of factors in the levels of AHP decision tree, the existence of consistency rate in comparisons become difficult, where increase in the number of factors to more than 15 will make the existence of consistency rate almost impossible.

**Data Collection:**

Three sources were used for data collection: (1) questionnaire, (2) library, and (3) interview. After determining the subjects of the research, they participated in a 10-minute interview. Then the questionnaires were distributed among them. At this point, first the data were processed using descriptive statistics and then the options and criteria are examined and prioritized using AHP and TOPSIS.

**Calculation Using AHP:**

The geometrical mean is the basis of solving the problem. First, the questionnaires were collected and the data were presented in the following matrices. For convenience, each of the criteria is denoted by a letter.

In decision making, people always try to create a balance between their needs and goals and in how to choose the best option. His increasing attempt has led humans toward “multi-criteria decision making” as a fundamental solution in situations where one faces several variables and criteria which are often complex and contradictory.

**Conclusion:**

The present research has seven criteria including employment, profitability, investment, company’s reputation, industrial stability, production facility, and self-sufficiency. These criteria along with four decision options were analyzed using decision making model and the following results were obtained:

1. Each criterion has different effects on decision making options. This shows that each of the criteria has a specific contribution in the four options of the problem and thus the criteria that have the greatest effect on the options must be underlined. According
to AHP and TOPSIS techniques, “rolling mill” is very important and must be taken into consideration.

2. The criteria have different rankings. The findings suggest that due to the unequal weight of the criteria, the importance of each is different. Thus, the criteria must be identified and prioritized with respect to the best or the most optimal options. The priority of the criteria was as follows: profitability, industrial stability, investment, company’s reputation, production facility self-sufficiency, and employment.

3. The decision options have different ranking. This research identifies the actual position of the decision options which include production of automobile parts, rolling mill, capsule production, and parts for petrochemical industry. These options are also prioritized as follows: (A) rolling mill is the first priority, (B) parts for petrochemical industry is the second priority, (C) production of automobile parts is the third priority, and (D) gas cylinder production is the fourth priority.

4. The present research revealed that application of MCDM models can be effective for many large national projects and as well be applicable to companies and industries and help the managers in choosing the best strategies.

Recommendations:

A. Increasing investment in production of rolling mill and supplying the facilities and equipment necessary for the production line as well as increasing production capacity.
B. Supporting the personnel in R&D for keeping pace with the latest technologies and equipment in relation to production of rolling mill.
C. Hashem Machining Company can consider other options along with production of rolling mill, but must allocate less capital to it.
D. The company must allocate enough resource to promote its R&D so as to be able to have a share in domestic and foreign markets.
E. Industrial stability as well as the factors affecting it must be taken into consideration.

References