

IDENTIFYING AND RANKING VALUE ENGINEERING INDICES AND EVALUATING THEIR INTERACTIONS USING THE DEMATEL METHOD

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Abstract

The aim of this research is to identify the main indices of value engineering, and evaluating their interactions, as well as ranking development projects of Qazvin Municipality according to these indices. For this purpose, three different phases are considered. In the first phase, seven key indices that are of the highest importance are identified. In the second phase, three development projects of Qazvin Municipality, which are of a non-level intersection, are ranked using the hierarchical analysis technique and based on the main indices of value engineering.

Finally, in the third phase, DEMATEL method is used in order to identify the most influential and impressionable indices, and the order for the influenceability and impressionability of the indices is analyzed.

Key words: value engineering, function, value, Analytic Hierarchy Process, DEMATEL

INTRODUCTION

Annually, a large part of the country's remittances and resources is invested in the country's construction and development projects, while these projects whether in national or provincial and regional sectors, on average has faced with more than 50% delay in the process of progress. The delay in progress not only ends in prolonging project execution time and spending considerable expenses in order to restart or complete them, but also ends in imposing the cost of lost opportunities in economic sectors, and unjustifiableness of the plans in the next stages as well. To improve the efficiency of the projects, along with the development of technology of the day, and the change of human attitudes, ideas, tools and new methods were created. Freud, Drucker, and Herzberg proposed special methods, most of the methods were forgotten as the time passed, and most of the rest new technologies were blurred in the new techniques. Among the huge pile of ideas and techniques developed, one of the most effective and accepted methods is the Value Engineering technique which has been expanded and developed by Lawrence Di Miles. (Ahad Nazari, Yaser Goldoost, 2008)

Value engineering, whose desirable results has been proven in advanced countries, is one of the methods and techniques that can be used to deal with the problems described. This is an attempt to reduce unnecessary costs, the costs that have no effects on quality, beauty, reliability and other important features of the project, while at the same time in primary analysis and designs are ignored and considered intangible (Kavoos Navidan, 2005).

The concept of value engineering value engineering is one of the most successful and most efficient methodologies for problem solving, cost reduction, performance improvement and quality improvement, and based on the definition by the International Association of Value Engineers, it is a systematic and functional team work owning professional application that is used to evaluate and improve the value of a product, design a device, a system, or the implementation of industrial, developmental, educational and service projects, etc. Value engineering utilizes the knowledge, experience, expertise, and creativity of the team members, and brings it into more valuable results through the regional and standard phases that it has.

Research background

A number of research papers in the field of value engineering have been presented below. In the article by Massoud Saber, entitled "Evaluation of the Performance of Value Engineering Workshops Using the Analytic Hierarchy Process Method", which was registered in 2011 at the Islamic Azad University of Qazvin, the performance of three workshops of value engineering in Tehran was evaluated and were prioritized according to the engineering indices. (Massoud Sabet, 2011)

The thesis of Mr. Sharifi Milani, Hamoun entitled "Designing a suitable model for value engineering in the printing and compiling its proper components" which was conducted at the Islamic Azad University of Qazvin in 2006, value engineering indices in the country's printing industry have been identified and according to the analysis done, a proper model that is composed of the three main elements of inputs, the influential factors on value engineering and outputs (Hamon Sharifi Milani, 2006).

A research article entitled "Identifying Key Success Factors in Value Engineering Studies" by Mr. Yaser Goldoost, Ahad Nazari and Khosrow Behrang Nobari, is another example of the research. In the research the number of thirty four success factors in value engineering studies has been identified. Then, based on statistical methods, these thirty four factors have been divided into eight main factors which has been included in three groups: factors of first priority, factors of second priority, and factors of third priority. (Yaser Goldoost, Ahad Nazari and Khosrow Behrang Nobari, 2008).

In an article entitled "A Case Study on Implementation of Value Engineering" published in the International Journal of Engineering and Technology in 2011, the basis of value engineering technique and its various phases, which can be used to improve the value of each product, has been presented in this article. In the research, a manufacturing company in India that is active in the field of the production of hygiene products, has been studied on. (Amit Sharma, Dr. Blokar, 2011)

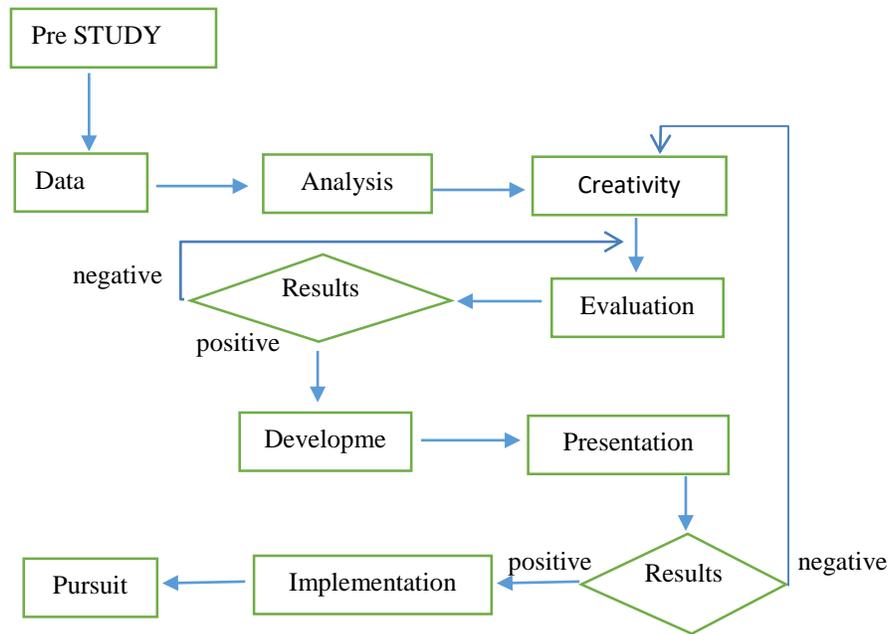
Among other research activities carried out outside of the country, is an article entitled "Application of value engineering in the construction of highways", published in the International Journal "Engineering and Applied Science" in 2010. In this article, a linear programming model is proposed to implement this approach in highway construction projects. The proposed model is

presented to examine the relationship between value engineering and cost, time, and quality, and presents this relationship with a linear function (Amiraddin Ismail, 2010).

Value engineering methodology

In most of the proposed methodologies about value engineering, there are three stages of pre-study, study, and supplementary study. The only difference between them should be the number of phases in the study of value. Some of the methodologies, have presented the number of phases of the main study stage or the study of value, five phases, and some others presented six phases or more. It is worth noting that the differences in the various methods are mostly in the phase of appearance and there is no significant difference inside them. The value engineering methodology is shown in Fig. 1.

Fig.1.The phases of value engineering techniques(Mansoureh Yadgari,Majmoud Ghorbani, 2007)



Research method

The methodology of this research is that it operates in three different phases. In the first phase, from the research principles and library resources, a series of value engineering indices related to the research topic are identified and based on a questionnaire that was completed by a number of engineers who had worked in Qazvin municipality development projects and have mastered the subject of value engineering, and after analyzing the results, seven of the highest-rated indices were identified.

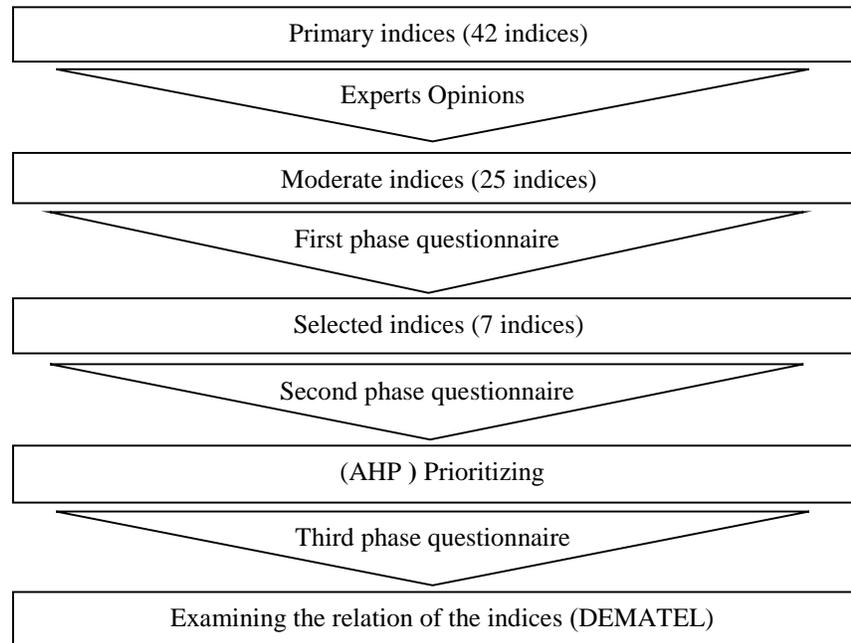
In the second phase, according to these indices, three important developmental projects of Qazvin Municipality has been ranked according to the hierarchical analysis method. And in the third phase, DEMATEL method has been used to determine the influenceability and impressionability of the indices. The phases in the present study can be represented as a symbol. Figure 2 illustrates the model of various phases of the present study.

The process of extracting indices

After the necessary studies in the field of value engineering, the number of 41 value engineering indices have been extracted from various sources and are called primary indices. After using experts' opinions, some of the primary indices that have not been effective in the developmental projects of Qazvin have been put aside and only 25 indices were selected and called moderated indices.

To determine the importance of indices, a first phase questionnaire has been used. In this phase of questionnaire, we used the opinion of 12 experts, then after analyzing the results of the first phase questionnaire, 7 indices that were of the highest importance were considered as selected indices. After identifying the selected indices that were of the highest importance, the second phase of questionnaire is discussed. The purpose of this phase is to prioritize three projects of NASR, SARDARAN and MOTAHARI. Finally, the third phase questionnaire is used to investigate the influenceability and impressionability of selected indices on each other. In this phase, the DEMATEL technique is used and the relations of the indices are examined.

Fig.2. The phases of the present study



Considering that value engineering is applicable to different industries such as industry, services, agriculture, education, transportation, civil engineering and developmental projects, the indices that can affect value engineering in these fields can be different. For this purpose, forty-two value engineering indices that have been applied in various fields, have been identified and are referred to as primary indices in Table (3).

After the indices of value engineering were identified using various scientific texts, some of these indices were put aside by experts of the statistical society due to their lack of utilization in Qazvin developmental projects. These indices, which are called moderate indices, are presented in Table (4).

Statistical population and sample

The statistical population of the present study consists of people having B.A. and M.A. degree in architectural engineering and civil engineering who were familiar with the value engineering studies and had experience of being involved in the developmental projects of Qazvin. The number of twelve individuals who have been identified as having the so-called characteristics has been considered as the statistical population of the present study.

Data analysis

In each phase of questionnaire, a specific method of statistical analysis is used. Methods such as geometric mean, hierarchical and DEMATEL analysis methods have been used. In the first phase, in order to determine the importance of each index, the geometric mean method has been used. In the second phase, in order to determine the priority of each project compared to other projects, the hierarchical analysis method has been used. Finally in the third phase, in order to investigate the influenceability and impressionability of the indices on each other, the decision making trail and evaluation laboratory (DEMATEL) method has been used. In order to prioritize the three developmental projects named NASR, SARDARAN, and MOTAHHARI intersections, hierarchical analysis method has been used. For obtaining the necessary data for this method, the second phase questionnaire was prepared and adjusted.

Fig. 3. The process of the present study

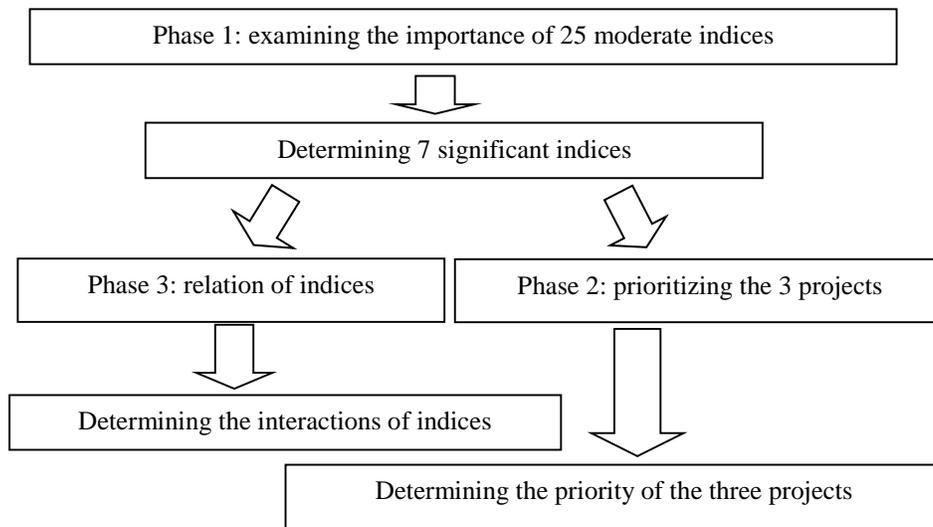
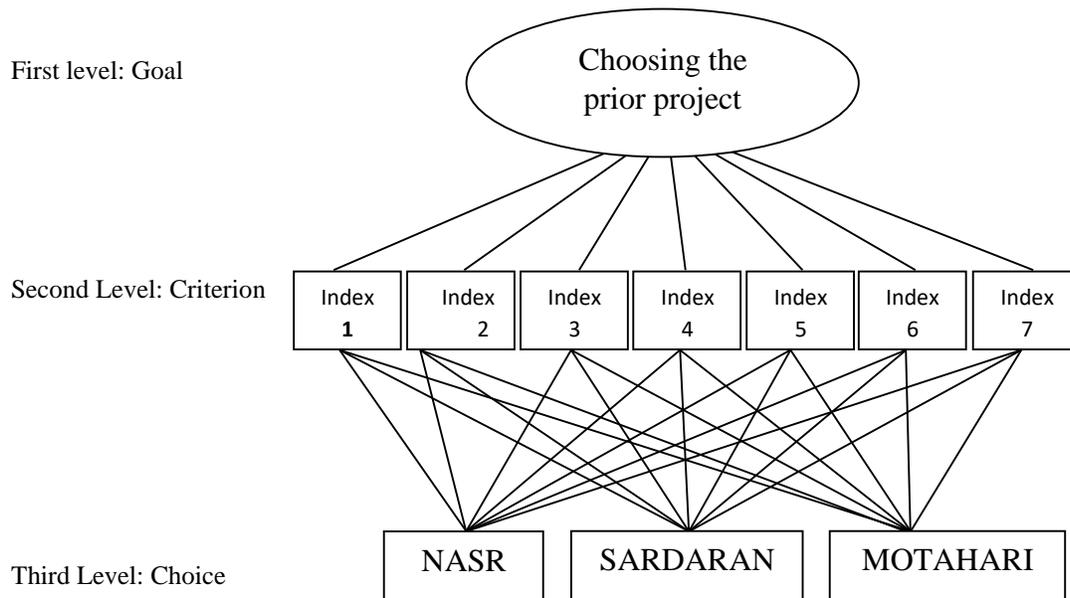


Fig. 4. Research models related hierarchy



Using the data from the third phase of the questionnaire, we can examine the influenceability and impressionability of value engineering indices on each other. In other words, using the results of this phase we can analyze the relationships between the indices. The method used to analyze the data from third phase is a technique called the “decision making trail and evaluation laboratory”.

The highest sum of rows (R) represents the order of elements that strongly influence other elements (such as the element B in the first column of matrix 5). The highest sum of the column (J) represents the order of the elements that are affected. (Like the element B in the third column of the matrix 5, which is not influenced by any element, but D receives the most influence from the rest of the elements). Therefore, the order of the elements of the column (R) represents the hierarchy of the affecting elements, and the order of the elements of the column (J) represent the hierarchy of the elements under influence.

The actual location of each element in the final hierarchy is determined by columns (R-J) and (R+J), so that (R-J) is the position of an element (along the width of the axis), and this position, if being negative, will be clearly under the influence. (R+J) represents the sum of the intensity of an element (along the length of the axis), both influencing and being under influence. The final

hierarchy of direct and indirect relationships, according to the values of (R-J) and (R+J), is as in figure (5).

Fig. 5. The elements location in the hierarchy

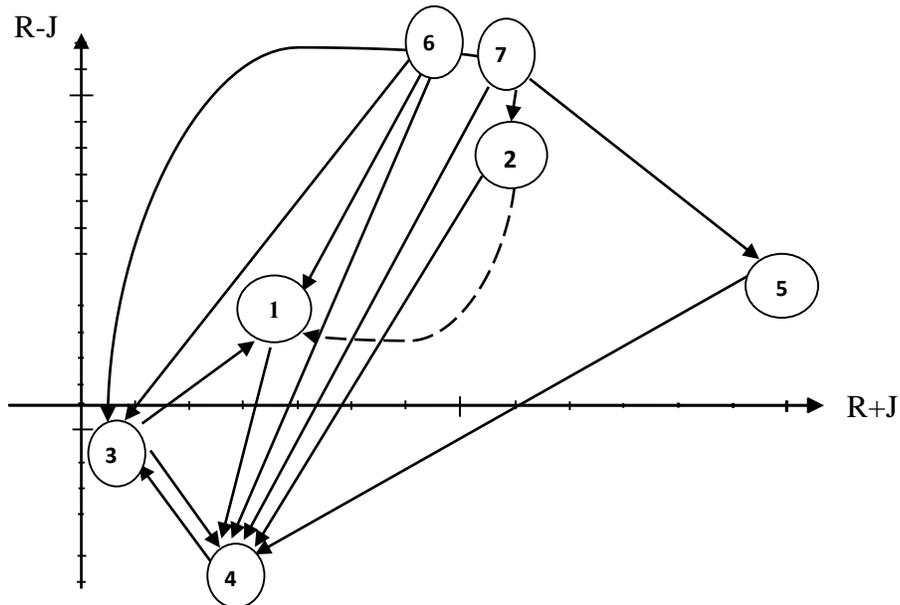


Table 1. Influence of indicators on each other

index	J	R	R+J	R-J
Quality Improvement	0.881452451	0.537985498	1.419437949	-0.3434669
Creativity	0.163934426	0.723884824	0.88781925	0.55995039
Saving capital and resources	1.239768363	0.442325427	1.682093789	-0.7974429
Customer satisfaction	1.385734702	0.118223396	1.503958098	-1.2675113
Long-term goals of the organisation	0.147540984	0.238309904	0.385850888	0.09076892
Technical knowledge of human resources	0	0.935297007	0.935297007	0.93529700
Management skills	0	0.82240487	0.82240487	0.82240487

CONCLUSION

Due to the existence of three different phases in this study, the data of the first, second and third phases of the questionnaire were analyzed. In the first stage, using the geometric mean, the importance of the twenty-five indices under study was determined and a number of seven indices that were of the highest importance were as follows:

- "Quality Improvement"
- "Creativity "
- "Saving Capital and Resources"
- "customer satisfaction"
- "Long-term goals of the organization"
- "Technical Knowledge of Human Resources"
- "Management Skills"

In the second stage, the data of the second phase questionnaire were analyzed using hierarchical analysis method, and based on the seven selected indices in the first phase, the priority of the three projects were respectively NASR, SARDARAN and MOTAHHARI intersection. At the third stage, the relationship between selected indices was investigated by the DEMATEL method and it was found that the most influential index was "technical knowledge of human resources" and the most influenced index was "customer satisfaction." The order of influenceability and impressionability of the indices were determined as follows.

table 2. The order of influenceability and impressionability of the indices

Influenceability of indices	Impressionability of indices
1- Customer satisfaction	1- Technical knowledge of human resources
2- Saving capital and resources	2- Management skills
3- Quality improvement	3- Creativity
4- Creativity	4- Quality improvement
5- Long-term goals of the organization	5- Saving capital and resources
6- Management skills	6- Long-term goals of the organization
7- Technical knowledge of human resources	7- Customer satisfaction

Therefore, it can be stated that the index of "technical knowledge of human resources" is the most influential index and influences the other indices. Also, the "customer satisfaction" index is the most influenced index and is influenced by other indices.

According to the results obtained from this study, we can suggest Qazvin municipality managers to focus on improving technical knowledge of human forces involved in developmental projects, and motivating creativity and increasing managerial skills, because these factors are known as the most influential indices, and they are highly regarded as having significant role in getting optimum results in the field of value engineering.

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