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TÍTULO: Evaluar los riesgos de utilizar los principios de la ingeniería de valor en la implementación de proyectos civiles.

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RESUMEN: En este artículo, intentamos evaluar los riesgos más importantes de la aplicación en proyectos civiles y priorizarlos en función de los riesgos identificados, y luego proporcionar soluciones para abordar estos riesgos. Los resultados de la investigación muestran que los seis factores principales (1) los factores generales, (2) los factores de la ley, (3) los factores estructurales, (4) los factores del campo de los asesores, (5) los factores de la fase de los estudios preparatorios y (6) los factores de la fase de los estudios de ingeniería de valor, se consideran como los principales riesgos identificados en la aplicación de la ingeniería de valor en proyectos civiles.

PALABRAS CLAVES: gestión, riesgos y obstáculos, utilización de Ingeniería de Valor, proyectos civiles, metodología de toma de decisiones de criterios superiores.

TITLE: Evaluting the risks of using the principles of value engineering in implementing civil projects

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ABSTRACT: In this article, we tried to evaluate the most important risks of the application of civil projects and to prioritize them based on the identified risks, and then provide solutions to address these risks. The results of the research show that the six main factors (1) the general factors, (2) the factors of the law, (3) the structural factors, (4) the factors of the field of advisers, (5) the factors of the phase of the preparatory studies, and (6) factors of the phase of value engineering studies are considered as the main risks identified in the application of value engineering in civil projects.

KEY WORDS: management, risks and obstacles, utilization of value engineering, civil projects, Topsis Multi-criteria Decision-Making Methodology.

INTRODUCTION.

The value engineering approach is a committed and systematic approach to analyzing activities to achieve optimal value per unit of cost [1-4]. The application of any technique and technology in the first experiences always has various risks and obstacles [5]. The use of the value engineering technique in the construction industry is also no exception [6]; in developing countries, where new problems are constantly encountered with transient and surface collisions, it is rapidly increasing and rapidly decreasing. There is always this threat, that a technique and more important than that, value engineering request, will face superficial and unsustainable views [5].

Therefore, any failure to institutionalize and use efficiently the method that has been experienced for more than 50 years in the world is more than the result of its own weakness, it is a consequence of repeating similar past encounters with new thoughts and tools [6].

Value engineering as a technique with three basic elements of systematic approach, creativity and teamwork, has sought to raise the value of projects, has been able to attract the view of experts in this field itself by providing valuable expertise in the construction industry of leading countries [4-8].

On the other hand, the transition from the training phase to the implementation of the value engineering technique in real projects will lead to problems and obstacles to the use of this approach [4]. The accurate identification of these obstacles and considering ways to remove these obstacles is one of the most important points to keep in mind in order to maintain the ever-increasing trend of value engineering [5, 7].

In this article, it has been tried to take a general look at the process of applying the value engineering technique in the construction industry of the advanced countries and the increasing trend of this technique in developing countries, to examine the most important risks of its application in civil projects, and based on Identified risks, they be prioritized, and then solutions to address the risks be presented.

Accordingly, the main purpose of the present article is to identify the causes and reveal the most important factors which, as risks, have led to the limitation of the use of value engineering and the provision of their prioritization model in civil projects in developing countries. Therefore, efforts have been made to evaluate the results of a comprehensive research on identifying and prioritizing the most important risks of using the value engineering technique in the construction industry with a case study in Iran's civil projects by using multi-criteria decision making (TOPSIS) methodology.

DEVELOPMENT.

Literature review.

Value engineering is a systematic, based on creativity and teamwork for problem solving, reducing costs, and improved performance and quality of projects, products, and processes. Value engineering presents the project, product, or process of the applicable results for improvement with the help of a wide range of expert knowledge and experiments and with focus on the functions of the project [9]. According to the definition of the International Project Management Institute (PMI), creative value atomic engineering is designed to optimize lifecycle costs, saving time, increasing profits, improving the quality, increasing market share, solving problems and making optimal use of resources [9]. Association of project management (APM) defines the value management as follows: "Achieving optimal value requires balancing the opposite parameters to achieve a suitable position. While value management is confronted with strategic issues, value engineering is optimizing concepts, technical points, aspects Executable and configuration values" [10-13].

Institute of value management of Australia (IVMA) defines value management as "Value management is an analytical and structured process that, try to keep the customer satisfied and to further increase Worth trying by ensuring the necessary functions with the lowest possible cost and maintaining the level of quality and function "[12].

Value Engineering Work Program.

General Diagram of Value Engineering Process.

With the receipt of project or product information, inputs required for engineering value is provided and afterwards, alternative solutions and alternatives as outputs of value engineering are presented in order to reduce costs and improve the quality of a project or product [13-16].

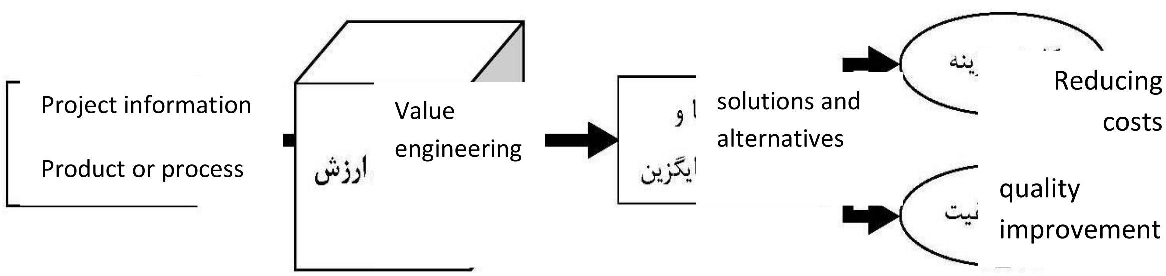

Figure 1- The overall diagram of study of value [15 and 16].

The value-engineering process is carried out in the form of three major phases, which are [15]:

1- Preliminary study phase.

2- The main study phase.

3- Post-study phase (supplementary study).

Each of these three phases will be divided into important phases or activities that will be presented separately.

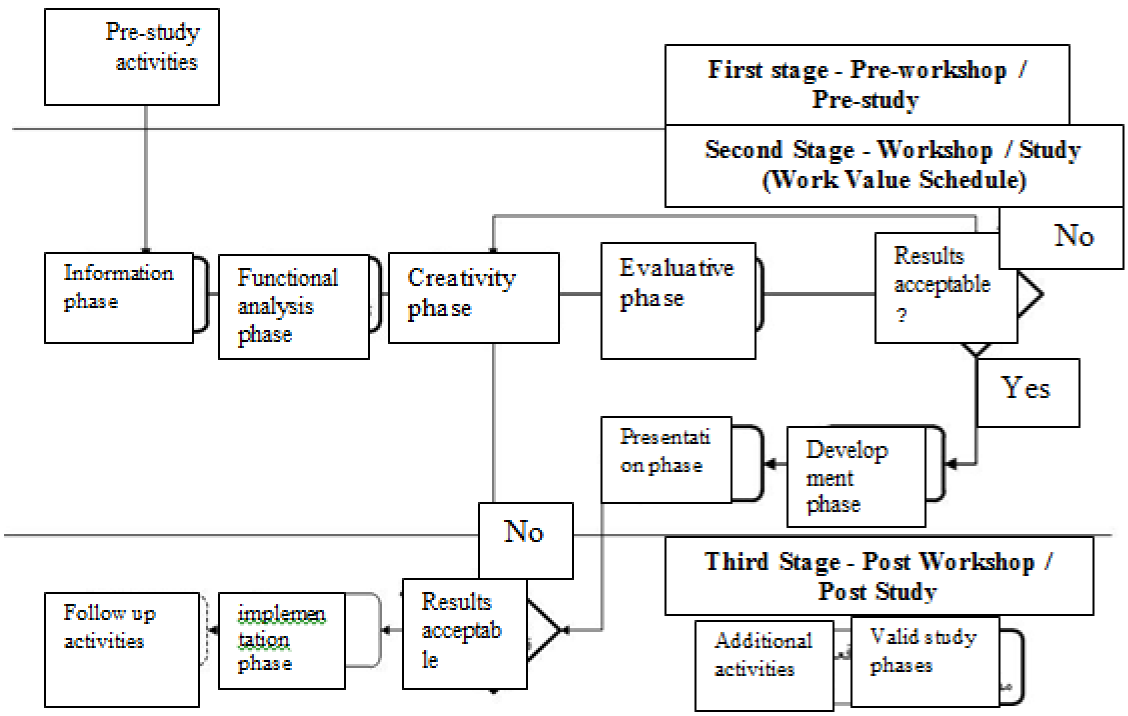

Figure 2 - Study of value processes [13].

Preliminary study stage.

The goal of this stage is to plan and organize the study of value. Some of the activities required to achieve this goal include obtaining senior management approval and supporting the work plan, roles and responsibilities, developing the scope and goals of the study of value, obtaining project data and information, obtaining key documents such as defining the scope of work, plans, specifications, reports and evaluations of the project, determine and prioritize strategic Issues, determine the scope and objectives of the study, develop the study schedule, perform reverse-competitive analysis, determine the members of the value team, obtain the commitment of the selected members of the team to achieve the project objectives, review project costs, collect the required information user / customer about the project Inviting suppliers, customers, stakeholders to participate in study of value, if needed, distribute information between team members to evaluate, develop diagrams and project information models, determine the date, time, location, and other study needs, define explicit study requirements with senior management direction achieving successful results is a study of value [13]. The desirable outcome of this stage is a clear understanding of the requirements of senior management, strategic priorities, and how to increase organizational value through improvement. During this stage, the view is formed whether the next phases are likely to provide enough value to justify the cost of the study. At this time, it may be necessary to increase or decrease the parameters of the study. Team members are aware of the project's goals and are committed to achieving them [14-16].

Main study stage.

1. Information phase.

The purpose of this phase is to understand and define the status of the project and the constraints affecting the project's results, as well as determining the goals of the study. Some of the necessary activities to achieve these goals are as [10-17]:

- ✓ Provide key data and information and project key documentation such as defining the scope of work, plans, specifications, reports, details of project cost information, qualitative data, marketing information, process flow charts, etc. For this purpose, you can use tools such as the development of the qualitu function development (QFD) and the voice of customer (VOC).

- ✓ Identify and Prioritize Strategic Issues. Also define the scope and objectives of the study (management expectations). For this purpose, tools such as SWAT analysis (strength, weakness, opportunity, and threat) and the charter of the project can be used.
- ✓ Presenting the original design or presenting the design/ product / process concepts by the project team
- ✓ Conduct a reverse competitive analysis. For this purpose, tools such as benchmarking, dismantling analysis, Pareto Analysis, design for assembly (DFA) can be used.
- ✓ Determine the study schedule including date, time, place and other requirements.
- ✓ Distribute project information to evaluate team members.
- ✓ Understand the scope, timetable, budget, costs, risk, issues, non-financial performance of the project.
- ✓ Confirmation of the project's basic basis.
- ✓ Determine the high level of project performance.
- ✓ Field visit of the project or facility.

Conclusion: This phase evaluates all members of the team for a general understanding of the project, including tactical, operational and study subjects' characteristics.

2- Functional Analysis phrase.

The goal of this phase is to understand the project from a functional point of view, which means what project, should do, rather than what the project is now. Some of the activities required to achieve this goal are [14 and 15]:

- ✓ Identify project functions with tools such as random assignment of functions.
- ✓ Classification of project functions.
- ✓ Development of a: Function Analysis System Technique with tools such as a system diagram of functional analysis and functional tree.

- ✓ Measuring the model with cost parameters, performance characteristics and user behavior in order to select non-conforming values to focus on creativity phase. The tools used in this case include:
- ❖ Cost-to-Function Analysis (Functional Matrix),
- ❖ Analyzing Performance to Function.
- ✓ Estimates of cost-effectiveness in order to select non-conforming values and focus of creativity on them with tools such as value indices (cost per sector function per function value).

Conclusion: This step focuses the team on verifying the fulfillment of customer needs and goals by the project. It also provides a more comprehensive understanding of the project by focusing on what the project does or should do, rather than what it is, and ultimately the team defines non-conforming value functions to focus on them in order to improve the project [13, 16].

Creativity Phase.

The purpose of this Phase is to generate a number of ideas in relationship with other ways of implementing the functions. Some of the activities required to achieve the goal of this phase are [11 and 14]:

- ✓ Perform creativity readiness exercises.
- ✓ Applying rules that provide space for creativity, such as Ground Rules.
- ✓ To apply the techniques of motivation of group ideation.
- ✓ Production of alternative ideas with the possibility of improving value through techniques such as brainstorm, Gordon techniques, nominal techniques, and Tries.

Conclusion: The team develops a list of ideas that provide a wide range of possible alternatives for implementing the functions to improve the value of the project.

Evaluation Phase.

The goal of this Phase is to reduce the number of ideas and provide a short list of the most potent ideas for improving and realizing the project's performance in terms of quality requirements and resource constraints. Some of the activities that are necessary to achieve the goal of this Phase are as [13]:

Explain and categorize each of the ideas in order to create a common understanding.

- ✓ Discuss about how the ideas influence the performance and cost parameters of the project by using tools such as the T-Chart comparison table.
- ✓ Select and prioritize ideas for further development with the help of tools such as Pugh analysis, Kepner-Tregoe, life cycle costing, choosing by advantages (CBA) and value standards.
- ✓ Explain how to write ideas as Stand-alone Risk-Reward Investment recommendations.

Conclusion: The team provides a centralized list of concepts that Guarantees quality time to develop into value-based solutions in one or a combination of projects.

Development Phase.

The purpose of this Phase is to further explore and develop a short list of ideas and their proper development into alternative value options. Some of the activities required to achieve the goal of this phase are [11-13]:

- ✓ Compare the results of the study about the success requirements that have been approved during the information and performance analysis phases.
- ✓ Create a documentary value option for each of the selected ideas for further development.
- ✓ Evaluation and assessment of risk and cost judgments in case of need.
- ✓ Perform cost to benefit analysis.
- ✓ Developing the plans and requirements for the transfer of concepts.
- ✓ Confirmation of the need for further development of an option.

- ✓ Provide an executive plan to define the implementation stages, dates and responsibilities for each value option.

Conclusion: The value study team has created the alternative options and low, medium and high-risk scenarios, and presents them with senior management as choices that determine the strategic objectives of the pre-auction.

Presentation Phase.

The purpose of this Phase is to provide value options to the management team and other stakeholders or project decision-makers. Some of the activities required to achieve the goal of this phase are as [13 and 16]:

- ✓ Provide presentation and its supporting documentation
- ✓ Compare the results of the study with the success requirements that have been approved during the information and performance analysis phases.
- ✓ Offer Stand-alone Risk-Reward scenarios for management in order to select the value options for implementation
- ✓ Exchange information with the project team.
- ✓ Ensure that management has complete and realistic information for decision making.
- ✓ Provide a summary of the draft of the executive plans.
- ✓ Preparation of the official report.

Common results of value study will include justification documents, risk analysis, cost and value comparisons, current value analysis, and benefits and disadvantages.

Conclusion: Ensuring understanding of the main causes of value options by management and other key stakeholders. It also creates a desire to determine the performance guarantee.

Post-study activities.

The purpose of this Phase is to ensure the implementation of accepted value options and the realization and validation of the planned benefits of value study. Some of the activities required to achieve the purpose of this phase are [13 and 16]:

- ✓ Review the initial report.
- ✓ Hold a meeting with subject of implementation to determine the formulation of each value option
- ✓ Set up executive plans for accepted options and document the main causes of failed options
- ✓ Obtaining a performance guarantee
- ✓ Determine a time interval for evaluating and implementing each value option
- ✓ Tracking value gains resulting from implemented options
- ✓ Delivering deliverable items.
- ✓ Confirmation of the benefits of the changes made.
- ✓ Ensuring the inclusion of new experiences by creating and managing an executive plan.

Project stakeholders determine which items change as a result of value studies in the project. These are changes in the initial concept or the basis of a study, which are derived from value options and combined into project development in future plans or product development activities.

An overview of the research literature.

Recently, value engineering experts have focused more on the quality modeling system. Kirk, for example, has evaluated quality-oriented models in value engineering technique, and has described the characteristics, characteristics, and the necessity of using them in various industries [11]. In a study by Jumas et al., a value engineering approach has been developed to save costs in urban transport and management systems in the United States [12].

In another research, Chen and Wei identified the initial evaluation elements for developing a study model in value engineering, and then evaluated the three stages (designing a questionnaire in two stages, testing and applying a model in a project), and accordingly Have proposed a model [13]. In another research, Meng has studied the effect of link management on the performance of the construction project in terms of value.

His analysis showed that the deterioration of the relationship between the project parties may increase the likelihood of poor performance and poor performance effectively reduce the relationship between some cases [10]. Ibusuki and Kaminski, in another research, evaluated the process of developing and applying the principles of value engineering with a focus on construction projects. In their study of spontaneous knowledge-based companies, they study the principles of applying the value engineering technique and, based on the purpose of time and cost optimization, have evaluated how these principles are applied in projects [14].

Pascoal et al., In another research, examined the purpose of time and cost optimization in construction projects, how to evaluate the seven principles of value engineering in these types of projects with the purpose of optimal production and expansion [15]. Albert et al., in their study evaluated the functions of the systematic principles of value engineering in various projects and found that the basis of value engineering is the finding of the relationship between cost, tasks, and analysis of tasks. This study leads to finding different ways to achieve lower costs and provide more services, and among these different methods, one should choose a method that has the lowest cost [16].

Shen and Liu, in a research entitled successful critical factors in the study of value management in construction projects, concluded that studies of construction projects often face shortage of time and resources and identify key factors that are effective in value management allows for a better output by allocating time and resources. In this article, the researchers seek to identify these factors in terms of their importance in the success of value management. The findings of this study showed that two factors that had no significant effect on previous research were considered as two factors with significant effect on value management [17].

Among the researches carried out on the subject of the present article in developing countries such as Iran, one can indicate the Zarif and Noori research on the indigenization of value thinking during the life of the civil projects, Nazari and Rukoyi [19] study With weaknesses in the implementation of value engineering in terms of the content and structure of projects, the article by Medqalchi et al. [20] regarding the study of research on the integration of value engineering with techniques related to quality management, Sadeghi et al., [21] to study the evolution of the integrated models of risk and value, and to answer the reason for their emergence by reviewing, criticizing and categorizing Layers that have been suggested so far and provide a novel and innovative model for combining value engineering and risk management, Rehani Hamedani et al. [22] to investigate the impact of value engineering in removing the causes of delayed civil projects in the country, Mirani et al.[23], In the specialty and developing a mechanism for energy efficient use as the model of sustainable value engineering, Nurang and Mohammad Khani [24], on the application of the model proposed to change the value engineering method at the construction stage with the aim of reducing the risks of the project and providing the optimal options for doing The project, the study of Esfandiarpour et al. [25] regarding the development of a value model for the calendar Implementation of civil engineering projects using the Value Engineering Work Program, Mazaheri et al. [26] on the application of the concepts of value engineering, such as the application of techniques for analyzing the value of a functional evaluation in a creative context and functional analysis as the core of value engineering, Sadeghi and Azadi's article [27] on considering all aspects, unnecessary delays in development projects in terms of time optimization and proposing proposed strategies, Ghahremani et al. [28], on identifying and analyzing the most important risks of using value engineering and presentation Strategies for using it, Neyestani's and Talibian's essay on Bereh Value engineering position and providing the best and most effective way to do business and returning the highest value for the cost spent on the project, Rasoul and Arab article [2] on the assessment and evaluation of the value of the value engineering in various project management techniques.

In order to provide appropriate solutions to improve, accelerate and value projects with a focus on using the Value Engineering Technique, Emami and Karimi's article on proposing a change to the Value Engineering method, Seraj et al. [31], in the study of the presentation of an integrated management model Quality and value engineering, Sadeghi and Azadi's article [32] regarding the study of unnecessary project delays civil projects are based on time optimization with value engineering technique.

Materials and methods.

Research methodology.

The type of research method in this article is descriptive-analytical and survey. Accordingly, firstly, the most important risks of using the value engineering technique in civil projects were identified by using descriptive and survey methods and then using analytical methods and necessarily analytical method of multi-criteria decision making (topsis), to provide a prioritization model has been implemented with the use of SPSS and TOPSIS software.

Statistical population and sample.

Considering that the parameters presented in this study include a wide range of variables in the study of important factors affecting the risks of using value engineering in civil projects, so the statistical population should include specializations, skills and various fields of work that are relevant to this flow; for this purpose, the four main categories of contractor, consultant, researcher and employer are evaluated for the statistical population.

In this research, simple random sampling has been used to collect the required information. Considering that the members of the statistical population have similar characteristics, the homogeneous statistical population is considered, and the Morgan table has been used to select the sample that the number of samples with 95% reliability is determined equal to 60. For this purpose, 60 questionnaires were distributed that finally, 54 questionnaires were collected.

In the following, the results of describing the demographic characteristics of respondents to the questionnaires include age, education, work experience and place of respondents.

According to data from 54 respondents, 8 people between 20 and 30 years old, 18 people between 30 and 40 years old, 15 people between 40 and 50, and 13 people are over the age of 50 years. The abundance percentage of respondents in each group was 18%, 32%, 27% and 23%, respectively. Therefore, the highest abundance is in the age group between 30 and 40 years. The abundance percentage distribution of respondents, based on age, is shown in the following figure.

Of the 54 respondents, 20 have a work experience of less than 5 years, 26 people aged 5 to 15 years, 6 people 15 to 25 years, and 4 people over 25 have years of experience. The abundance percentage of respondents in each of the above groups is 36.36%, 50%, 7.57%, and 6.07%, respectively. The results of the distribution of respondents based on work experience are shown in the figure below. Accordingly, the highest abundance is related to the work experience group between 5 and 15 years, and the least abundance is the group with experience of more than 25 years.

Based on the data obtained from 54 respondents, 3 had a diploma, 5 had an undergraduate degree, 18 had a bachelor's degree, and 25 had a master's degree and 3 persons among the respondents have PHD. The percentage of respondents in each of the above groups was 4.54%, 7.57%, 34.84%, 48.48% and 4.54%, respectively. The highest abundance is related to the group with a master's degree and the least abundance is related to the group with diplomas and PHD.

Reliability.

The reliability of a measurement shows the stability and logical coordination of responses in a measurement tool and helps to evaluate a "correctness" of a version [33]. In fact, reliability is one of the technical characteristics of a measuring instrument, which means that the same measuring instrument under the same conditions how much does gives the same results.

In this research, Cronbach's alpha method has been used and its reliability has been proven to determine the internal reliability of the test. This method is used to compute the internal coordination of a measuring instrument that measures various characteristics, and each test question is compared with the others [33]. The higher the Cronbach's alpha value in a research project means that the questionnaire has high reliability. The Cronbach Alpha coefficient can be calculated using the following equation

$$r_\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum_{i=1}^{j} \sigma_j^2}{\sigma^2}\right) \tag{1}$$

That in this equation, r_α is the total reliability of the test, k is the total number of test questions, σ_j^2, the variance of the question marks (division) j, and σ^2 is the total score of the question. Also, if the alpha coefficient be more than 0.7, it has an acceptable reliability [34].

A questionnaire prepared in the previous stages to determine the validity of several relevant experts and professors, whose content validity was confirmed. Then, 20 questionnaires were tested experimentally and the alpha coefficient for the total of 0.93 questions was obtained by using SPSS software, which indicates the reliability.

Validity.

Validity is a term that refers to the purpose that the test is designed to realize. In fact, Validity is an evaluation of the adequacy of interpretations and the use of measurement results [35]. In general, there is no tool to determine the Content Validity Coefficient. Instead, to determine the content's Validity, a test is used by experts to determine how much testing questions are representative of the content and objectives of the program or content domain [33].

For this purpose, after formulating the initial framework, to evaluate the research questions, the questions have been reviewed by collecting the views of the professors and, we ultimately reached the final questionnaire by removing some questions and changing the way of expressing the questions. In other words, Validity of the questionnaire has been confirmed by the expert group. The questions of the questionnaire were found by the panel of experts after review, and in the content of a large number of questions, overall changes were made and a number of questions changed from negative to positive. The questions asked by the expert group were included in the questionnaire questions. After the changes, the questions returned to the panel of experts and its distribution started after the final approval.

Measuring the desirability of indicators.

In general, there are two perspectives to measure the desirability of indicators. In the first perspective, qualitative (sequential scale) clauses are considered and a binomial test is then evaluated. But in the second perspective, the quantitative terms (distance scale) are considered, and in this way calculate the average and standard deviation are significant. In the second view, the average test is used. In this test, the average of society is evaluated at the level of error α [34]. In this research, also the average test has been used to analyze the data and the desirability of the indicators has been defined as above the average of 3 (average value).

Topsis Methodology.

The Topsis methodology was first developed by Huang and Yun in 1981. Based on this technique, the best option is the ideal ideal solution, the closest distance, and the positive ideal solution to the farthest distance. The positive ideal answer is the answer, which has the most profit and the least damage, and the negative ideal answer is the negative answer, which results in the lowest profit and the highest cost [36]. However, if the hierarchical structure of the problem has more than three levels, the topsis methodology cannot be used and the hierarchical topsis approach is suggested [37].

The word topsis means preferred methods based on similarity to the ideal solution. This model was first proposed by Huang and Yun in 1981. In this method, the m option is evaluated by the n index. The principle logic of this model defines the ideal solution (positive) and the negetive ideal solution. An ideal solution is solutions that increases the profit criterion and reduce the cost criterion. The optimal option is an option that has the least distance from the ideal solution, while at the farthest distance from the negative ideal solution [36].

In other words, in ranking the options in the topsis methodology, the options that have the most similarity with the ideal solution will rank higher. The target space between two criteria has been shown as an example in Fig. 1. Here A + and A are, respectively, the positive ideal solution and the negetive ideal solution. Option A1 is less than the A2 option, has less distance to positive ideal solution and more distance to the negetive ideal solution. [37].

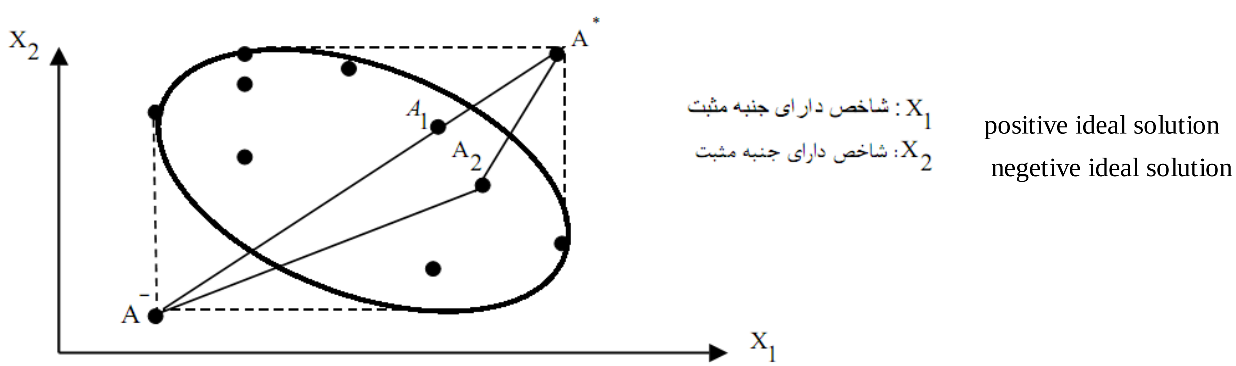

Figure 3: The target space between two criteria in the topsis technique [37].

Generally, the topsis methodology has 7 phases, which in each of the calculation and prioritization phases is presented with this methodology [37].

Phase 1) Forming decision matrix.

In the Topsis technique, the evaluation m option is dealt with by using the criterion n. Therefore, each option is given a score based on each criterion. These scores can be quantitative or realistic, or qualitative and theoretical. In either case, a decision matrix m * n must be formed as follows [37]:

$$D = \begin{matrix} A1 \\ A2 \\ . \\ A_m \end{matrix} \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1n} \\ X_{21} & \dots & \dots & X_{2n} \\ \dots & \dots & \dots & \dots \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{bmatrix}$$

So in this case A_i the *i*-th option X_{ij} is the numerical value obtained from the *i*-th option with the *j*-index option.In this matrix, the indicator with positive desirability, the index of profit and the indicator with negative desirability is the cost index.

Phase 2) Normalize decision matrix.

Like many other decision-making methodologies, the decision matrix should be normalized. Normalizing the values is used by the vector methodology. Unlike the simple linearization methodology, is determined by transforming the existing decision matrix into an unbalanced matrix by using the following equation:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}}$$

Phase3) the formation of a normal harmonic decision matrix.

The next phase is the formation of a normal harmonic matrix based on the weight of the criteria. The alignment is very simple, and the weight of each criterion is multiplied by the dimensions of that criterion. Creating a weightless matrix with the assumption of the W vector as input to the algorithm is determined as follow equation:

$$\text{assumed } W=\{w_1, w_2, ..., w_n\} \approx \text{ DM} \tag{4}$$

$$\text{Weightless matrix } V = N_D * W_{n*n} = \begin{vmatrix} V_{11}, ..., V_{1j}, ..., V_{1n} \\ V_{m1}, ..., V_{mj}, ..., V_{mn} \end{vmatrix} \tag{5}$$

In this regard, N_D is a matrix in which scores of indicators are scalar and comparable, and W_{n*n} is a matrix of diagonals whose only elements of the main diameter will be non-zero.

Phase 4) Calculate the positive and negative ideals.

Calculating PIS and NIS is the next phase of the process. In this phase, for each indicator, a positive ideal point (A +) and a negative ideal point (A-) are calculated. For positive measures, the positive ideal is the largest criterion, and for the criteria with positive load, the negetive ideal is the smallest value of that criterion. Also for negative measures, the positive ideal is the smallest criterion, and for the negative measures, the negetive ideal is the largest value. We define for the positive ideal point (A +) and the negetive ideal point (A-):

$$\begin{aligned} A+ &= \left\{\left(MaxV_{ij} \mid j \in J\right), \left(MinV_{ij} \mid j \in J'\right) \middle| i = 1, 2, ..., m\right\} = \left\{V_1^+, V_2^+, ..., V_j^+\right\} \\ A- &= \left\{\left(MinV_{ij} \mid j \in J\right), \left(MinV_{ij} \mid j \in J'\right) \middle| i = 1, 2, ..., m\right\} = \left\{V_1^-, V_2^-, ..., V_j^-\right\} \end{aligned} \tag{6}$$

So that in the above equations:

$$\begin{aligned} J &= \{ j = 1, 2, ..., n \mid j \ for \ \text{cost} \} \\ J' &= \{ j = 1, 2, ..., n \mid j \ for \ \text{cost} \} \end{aligned} \tag{7}$$

Phase 5) Calculate the Ideal Solution.

In this phase, the relative proximity of each point is considered to be an ideal solution. The Euclidean distance of each point from the positive and negative ideal will be calculated by the following formulas:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^+)^2} \qquad for\ i = 1, 2, ..., m$$
$$d_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2} \qquad for\ i = 1, 2, ..., m \qquad (8)$$

Phase 6) Calculate the ideal solution or relative proximity.

In this phase, the relative proximity of each point is considered an ideal solution. To do this you can use the following formula:

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+} \qquad for\ i = 1, 2, ..., m \qquad (9)$$

The CL value is between zero and one. The closer this approach to the one, the solution is closer to the ideal solution and will be considered a better solution. It is understood that if it be $A_i = A+$, then it will be and $d_i^+ = 0$ will be accordingly, and if so, then it will be $CL_i^+ = 0$. Therefore, as much as the option A_i is closer to the ideal solution ($A+$), the CL_i^+ value will be closer to the unit

Phase 7) Final phase for rating options.

In the last phase, based on descending order, the available points of the given problem can be ranked

Results.

Identifying risks of value engineering in civil projects.

Value engineering as a new management technique has created a new dimension in looking at projects and civil and industrial designs. In developing countries such as Iran, where new issues are constantly rising rapidly and rapidly with transient impacts, there is always the threat that the technique and, more importantly, the need for value engineering to have these superficial and non-persistent views. In the rest of the research six important identified areas has been explored for the risks associated with the use of value engineering in civil projects, including (1) public risks, (2) rules and regulations, (3) obstacles to structures, (4) risks related to the realm Value consultants, (5) the specific risks of the phase of the preliminary studies of the project, (6) the risks associated with the phase of value studies. Then, tables and classes were performed and in the first phase, determination of the importance of risk was done by SPSS analysis and hypothesis analysis has been presented. In the next step, the most important identified risks are prioritized by the TOPSIS analytical methodology.

Descriptive and Inferential Analysis of Data.

At this stage, the results of the descriptive analysis of the selected points regarding the factors (main variables) and the sub factors (sub variables) of the research were collected from the raw data obtained from the questionnaires. Then, by using SPSS software, the data collected through questionnaires were analyzed to achieve the research objectives. Therefore, hypothesis testing was first used to determine the most important factors (main variables) and sub-factors (sub variables) affecting the implementation of value engineering in civil projects.

Testing the hypothesis of the factors (main variables of the research).

Subsequently, we test the hypotheses to measure the main factors identified in the research for the purpose of productivity and human resource management. As previously stated, the most important factors affecting productivity and human resources management in civil projects can be evaluated on the basis of the following five main factors: the following assumptions can be defined as follows.

- ✓ Hypothesis 1: General factors and related risks are effective in reducing the application of value engineering in civil projects.
- ✓ Hypothesis 2: The existing rules and regulations in the field of value engineering in its application for civil projects are effective.
- ✓ Hypothesis 3: Risks associated with structures in the application of value engineering are effective for civil projects.

- ✓ Hypothesis 4: The factors related to consultants in the application of value engineering in civil projects have a significant role.
- ✓ Hypothesis 5: Risks associated with the preliminary study phase of the project of projects in the implementation of civil projects are effective in value engineering methodology.
- ✓ Hypothesis 6: Risks of the Phase of Value Engineering Study have a significant role in the application of this technique in civil projects.

In the following, the test methodology used for comparing the average with a specific number (an average of 3 in this research) is presented in Table 1.

Table 1: Test methodology used to compare the average with a specific number.

Row	The significance level	Under evaluate variable	Test type
1	More than 0.05	normal	One-sample test (T-Test)
2	Equal to or less than 0.05	abnormal	Wilcoxon Binomial Test

As shown in the above table, when the variables are normal, one-sample test (T-test) is recommended, otherwise the use of nonparametric non-parametric Wilcoxon binomial tests will be considered. In this research, the Kolmogorov-Smirnov test (K-S) has been determined the best point for the normal variables. Therefore, hypothesises are as follows.

- ✓ The under evaluate variable has a normal distribution. $H0$
- ✓ The under evaluate variable does not have normal distribution. $H1$

If the significance level of the test increases from 0.05, we can say that the under evaluate variable is normal and otherwise the variable is not normal. The results of evaluation of the distribution of factors (main variables) are presented in Table 2. It should be noted that each of the main research variables is represented by a distinct symbol.

Table 2: Results of the Kolmogorov-Smirnov test (K-S) for the main research variables.

Decision making	Significance level	T test statistic	Parameter		number	factors	Row
			Standard deviation	average			
proving a hypothesis	0.0123	0.926	0.624	3.33	54	General factors (A)	1
proving a hypothesis	0.0442	0.878	0.599	3.41	54	Factors of rules (B)	2
proving a hypothesis	0.0283	0.981	0.538	3.95	54	Structural factors (C)	3
proving a hypothesis	0.0041	0.898	0.611	3.96	54	The factors of the field of consultants (D)	4
proving a hypothesis	0.0377	0.943	0.607	3.22	54	preliminary study phase factors E)	5
proving a hypothesis	0.0463	0.851	0.585	3.88	54	Factors of the Phase of Value Engineering Study (F)	6

As shown in the above table, the significance level of all major variables in the research (main factors) is less than 0.05, and therefore, zero assumptions are rejected in all variables and all of these main variables are normal and proving the hypothesises has been made and the results Shows that all identified risks in the application of value engineering in civil projects are effective as the main risks.

Ranking risks of the application of value engineering in civil projects by using topsis.

In this section of the data analysis chapter, given the significant difference between the risks of application of value engineering in civil projects, it is necessary that these criteria be ranked according to the degree of desirability. Therefore, multi-criteria decision-making techniques were used to re-evaluate the criteria. In this research, TOPSIS technique has been used to rank the criteria.

Ranking criteria related to the general issues of civil engineering project.

In Table 3, the ranking and positive and negative designation of points for the public domain of civil projects has been shown.

Table 3: Ranking the criteria of the public sector section.

Rating	cli	di-	di+	**General dimension criteria**
10	0.354	0.346	0.63	Lack of acceptance change culture (A1)
4	0.645	0.63	0.364	Plan designers resistance (A2)
5	0.6312	0.628	0.369	Organizational extent of civil Companies (A3)
1	0.622	0.67	0.312	Lack of value engineering professionals (A4)
6	0.56	0.61	0.37	Misinterpretation of value engineering (A5)
3	0.65	0.649	0.344	Invalid implement of value engineering technique steps (A6)
7	0.525	0.56	0.414	Failure to implement value engineering at the right time (A7)
9	0.48	0.452	0.56	The lack of a timetable for the implementation of workshops with the current activities of the participants in the workshops (A8)
8	0.518	0.431	0.474	Absence of enough time to run workshops due to project time constraints (A9)
22	0.657	0.654	0.32	Failure to correctly define the criteria for referencing projects for value engineering (A10)

According to the hypothesis test, this index has a favorable status and has been approved; according to the Topsis ranking (above table), public issues in civil projects have also important role in value engineering.

Ranking the criteria of the field of rules and regulations.

In table 4 the ranking and positive and negative ideal points for the field of rules and regulations has been shown.

Table 4: Ranking of the Criteria for the Rules and Regulations.

ranking	cli	di-	di+	The criteria of the rules and regulations dimension
1	0.57	0.8	0.34	Absence of Execution Bills (B1)
3	0.39	0.37	0.66	Ambiguity in the responsibility of the proposed points of the Value study Team (B2)
2	0.48	0.42	0.43	Ambiguity in Proposed Fee (B3)

The Hypothesis test has confirmed the importance of issues related to rules and regulations, and in this section, by addressing the factors affecting this indicator by using the Topsis technique; one can conclude that the option of lack of enforcement of existing rules is at the forefront of the importance of this section.

Ranking the criteria of the structural area of civil projects.

In table 5 the ranking and the positive and negative ideal points for structural criteria has been shown.

Table 5- Ranking of Structural Criteria in Development Projects.

Rating	cli	di-	di+	**Structural criteria**
3	0.654	0.38	0.46	Lack of proper understanding of the status, process and targets of value study (C1)
6	0.54	0.21	0.621	Inappropriate selection of projects for studying value (C2)
4	0.625	0.32	0.51	Inability to control studies (C3)
1	0.731	0.49	0.432	Lack of proper organizational structure and specialized unit (C4)
2	0.688	0.43	0.458	Lack of management support (C5)
5	0.59	0.267	0.559	Lack of consultants' participation in Studies (C6)

According to hypothesis test, this indicator is desirable, and the ranking of the topsis is also evidence of this hypothesis. The lack of proper organizational structure and specialized unit and lack of management support and lack of understanding of the status, process and targets of value study are seriously damaging.

Ranking the criteria for consultants.

In Table 6, the ranking and definition of positive and negative ideal points has been shown for consultants ' criteria.

Table 6- Ranking of Criteria for consultants.

ranking	cli	di-	di+	Criteria in he field of consultants
3	0.62	0.81	0.53	Work program violation (D1)
4	0.59	0.769	0.541	Violation of usual time (D2)
9	0.504	0.587	0.658	Select a wide range for study (D3)
8	0.51	0.623	0.636	Mismatch of studies with conditions (D4)
10	0.5	0.53	0.68	Selecting an Inappropriate Framework for Studies (D5)
5	0.587	0.743	0.57	Disturbance and Confusion in the Study Team (D6)
1	0.658	0.87	0.471	Failure to choose the correct team (D7)
6	0.564	0.71	0.595	Inappropriate guidance and support for meetings (D8)
2	0.64	0.845	0.49	Not choosing the correct domain and type of output (D9)
7	0.53	0.649	0.611	Layering and providing multiple points (D10)
12	0.47	0.46	0.75	Failure to comply with ethical principles (D11)
11	0.49	0.494	0.737	Disbelief in national interests (D12)

According to the hypothesis test, this indicator is approved and the criterion for not selecting the correct team and not choosing the correct domain and type of output and violation of the work plan, are the most important criteria of this section.

Ranking preliminary study phase criteria of value engineering for civil projects.

In Table 7, the ranking and definition of positive and negative points for the preliminary study phase of the value engineering has been shown for the civil projects.

Table 7: Ranking of Criteria for Preliminary Study.

ranking	cli	di-	di+	Criteria for Preliminary Study
6	0.51	0.58	0.56	Lack of participation of all beneficiaries and effective team members due to the busy work (E1)
7	0.49	0.541	0.584	The presence of uUnethical and lacking expertise in the team (E2)
8	0.48	0.505	0.619	The abundance of the value engineering team of some projects due to the involvement of various units in the project (E3)

9	0.46	0.49	0.663	The lack of regular people and their replacement during the workshop (E4)
10	0.712	0.745	0.412	Lack of proper responsible selection for the value engineering team (E5)
5	0.52	0.625	0.536	Failure to pay attention to the principal concerns of project implementers and utilities (E6)
3	0.54	0.697	0.468	Failure to fully and accurately meet the constraints that the organization or project implementer faces with (E7)
2	0.605	0.728	0.437	Failure to conduct sufficient studies in the preliminary study phase to identify the problem (E8)
4	0.531	0.666	0.49	Carrying out incomplete feasibility studies (E9)

According to the hypothesis test, this dimension has been approved. In this group, the lack of appropriate selection criteria for the value engineering team and the lack of sufficient studies in the preliminary study phase to identify the problem and the lack of complete and accurate knowledge of the constraints that the organization or executor of the project with them facing and performing incomplete feasibility studies are important in the first rank.

Ranking of the criteria of the information of the value engineering phase.

In table 8 the ranking and the definition of the positive and negative ideal points for the information of value engineering phase has been shown.

Table 8: Ratio of Value Engineering Information Phase Criteria.

ranking	cli	di-	di+	**All the criteria**
9	0.542	0.635	0.62	Do not give information at the required time (F1)
1	0.61	0.78	0.397	Present incorrect and inaccurate Information (F2)
10	0.529	0.606	0.647	Provide Uncertain Hypotheses as Final Information (F3)
2	0.606	0.754	0.416	Failure to correctly define functions (F4)
7	0.568	0.683	0.58	Incorrect FAST Value Chart (F5)
8	0.56	0.675	0.602	Lack of correct resolution of the problem to its constituent components (F6)
6	0.57	0.698	0.537	Allocation of costs to functions (F7)
11	0.515	0.592	0.645	Idea without regard to the desired functions (F8)
12	0.508	0.584	0.664	Idea without Cost Function (F9)
3	0.601	0.731	0.428	Failure to apply proper evaluation methods (F10)
4	0.596	0.72	0.458	Lack of proper use of criteria and constraints in the evaluation of ideas (F11)

15	0.473	0.527	0.722	Failure to provide a transparent document (including all advantages and disadvantages) for recommendations (F12)
5	0.588	0.705	0.491	Lack of proper information and required expertise (F13)
14	0.485	0.568	0.7	Do not pay attention to the obstacles of the implementation of the change proposals (F14)
16	0.46	0.496	0.739	Non-coordination of relevant units for the full development of ideas (F15)
13	0.49	0.57	0.682	Problems in Calculating Quantitative Results and Costs of Some Ideas (F16)
17	0.428	0.438	0.712	Poor presentation and incorrect defense of ideas and recommendations (F17)
18	0.397	0.42	0.735	Failure to explain the need for proposed changes for decision makers (F18)

According to the hypothesis test, this factor and its sub-elements have been approved for the value engineering function, and the ranking of topsis shows that the obstacles, such as the provision of inaccurate and incorrect information and the lack of proper definition of the functions, and the inappropriate use of the methods of evaluation and non-compliance The proper application of criteria and constraints in the evaluation of ideas and the lack of proper information and required expertise are among the most important criteria.

General ranking criteria.

After determining the ranking for each of the identified risks associated with the various phases of implementation of the value engineering of the civil projects, in this section the results of comparing and prioritizing all the sub-criteria with the technique of topsis has been presented to make this happen that it should be possible to determine which of the sub-indicators are in the top priority and should be given more attention to them. In the table and the figure below, the results of the overall ranking of identified risks for the application of value engineering in developing countries' civil projects is reported.

Table 9: General ranking of identified risks of value engineering applications in civil projects.

ranking	cli	di-	di+	**sub-indicators**
58*	0.354	0.346	0.63	Lack of acceptance change culture
9*	0.645	0.63	0.364	Plan designer's resistance
11*	0.6312	0.628	0.369	Organizational extent of civil companies
4*	0.622	0.67	0.312	Lack of value engineering professionals
27*	0.56	0.61	0.37	Misinterpretation of value engineering
8*	0.65	0.649	0.344	Invalid implement of value engineering technique steps
35*	0.525	0.56	0.414	Failure to implement value engineering at the right time
48*	0.48	0.452	0.56	The lack of a timetable for the implementation of workshops with the current activities of the participants in the workshops
37*	0.518	0.431	0.474	Absence of enough time to run workshops due to project time constraints
5*	0.657	0.654	0.32	Failure to correctly define the criteria for referencing projects for value engineering
23*	0.57	0.8	0.34	Absence of Execution Bills
57*	0.39	0.37	0.66	Ambiguity in the responsibility of the proposed points of the Value study Team
49*	0.48	0.42	0.43	Ambiguity in Proposed Fee
7*	0.654	0.38	0.46	Lack of proper understanding of the status, process and targets of value study
31*	0.54	0.21	0.621	Inappropriate selection of projects for studying value
12*	0.625	0.32	0.51	Inability to control studies
1*	0.731	0.49	0.432	Lack of proper organizational structure and specialized unit
3*	0.688	0.43	0.458	Lack of management support
19*	0.59	0.267	0.559	Lack of consultants' participation in studies
13*	0.62	0.81	0.53	Work program violation
20*	0.59	0.769	0.541	Violation of usual time
42*	0.504	0.587	0.658	Select a wide range for study
39*	0.51	0.623	0.636	Mismatch of studies with conditions
43*	0.5	0.53	0.68	Selecting an Inappropriate Framework for Studies
22*	0.587	0.743	0.57	Disturbance and Confusion in the Study Team
6*	0.658	0.87	0.471	Failure to choose the correct team
26*	0.564	0.71	0.595	Inappropriate guidance and support for meetings
10*	0.64	0.845	0.49	Not choosing the correct domain and type of output
33*	0.53	0.649	0.611	Layering and providing multiple points
53*	0.47	0.46	0.75	Failure to comply with ethical principles
44*	0.49	0.494	0.737	Disbelief in national interests
40*	0.51	0.58	0.56	Lack of participation of all beneficiaries and effective team members due to the busy work
45*	0.49	0.541	0.584	The presence of unethical and lacking expertise in the team
50*	0.48	0.505	0.619	The abundance of the value engineering team of some projects due to the involvement of various units in the project

52*	0.46	0.49	0.663	The lack of regular people and their replacement during the workshop
2*	0.712	0.745	0.412	Lack of proper responsible selection for the value engineering team
36*	0.52	0.625	0.536	Failure to pay attention to the principal concerns of project implementers and utilities
30*	0.54	0.697	0.468	Failure to fully and accurately meet the constraints that the organization or project implementer faces with
16*	0.605	0.728	0.437	Failure to conduct sufficient studies in the preliminary study phase to identify the problem
32*	0.531	0.666	0.49	Carrying out incomplete feasibility studies
29*	0.542	0.635	0.62	Do not give information at the required time
15*	0.61	0.78	0.397	Present incorrect and inaccurate Information
34*	0.529	0.606	0.647	Provide Uncertain Hypotheses as Final Information
14*	0.606	0.754	0.416	Failure to correctly define functions
25*	0.568	0.683	0.58	Incorrect FAST Value Chart
28*	0.56	0.675	0.602	Lack of correct resolution of the problem to its constituent components
24*	0.57	0.698	0.537	Allocation of costs to functions
38*	0.515	0.592	0.645	Idea without regard to the desired functions
41*	0.508	0.584	0.664	Idea without Cost Function
17*	0.601	0.731	0.428	Failure to apply proper evaluation methods
18*	0.596	0.72	0.458	Lack of proper use of criteria and constraints in the evaluation of ideas
51*	0.473	0.527	0.722	Failure to provide a transparent document (including all advantages and disadvantages) for recommendations
21*	0.588	0.705	0.491	Lack of proper information and required expertise
47*	0.485	0.568	0.7	Do not pay attention to the obstacles of the implementation of the change proposals
54*	0.46	0.496	0.739	Non-coordination of relevant units for the full development of ideas
46*	0.49	0.57	0.682	Problems in Calculating Quantitative Results and Costs of Some Ideas
55*	0.428	0.438	0.712	Poor presentation and incorrect defense of ideas and recommendations
56*	0.397	0.42	0.735	Failure to explain the need for proposed changes for decision makers

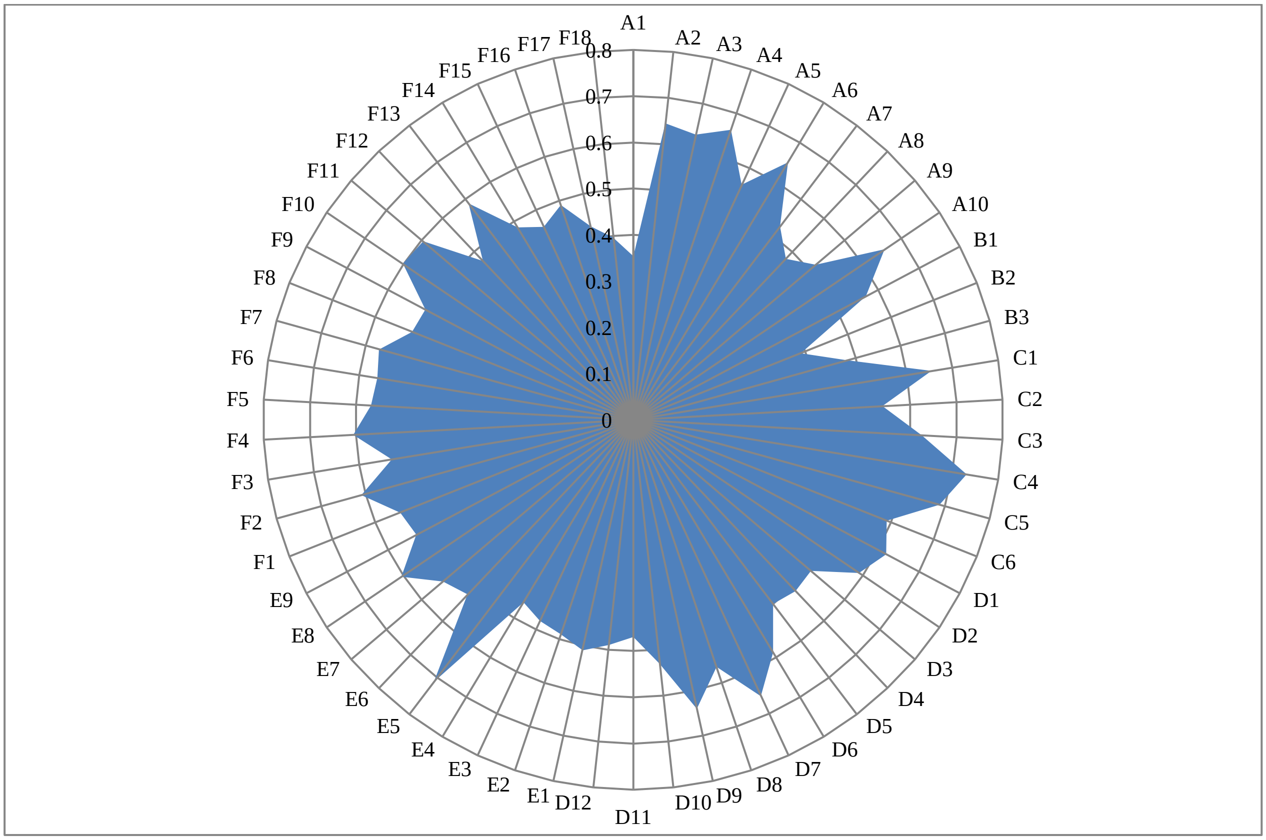

Figure 4: Data Envelopment Coverage Diagram.

After analyzing the results and the results of the TOPSIS method, out of the 59 identified risks related to the obstacles to the application of value engineering in civil projects, the results of prioritizing 20 of the most important risks and related issues are listed below.

1. The existence of an appropriate organizational structure and specialized unit.

Value engineering coordinator offices in the structure of many leading employer collections, while guiding value consultants, coordinate other factors and resources for conducting studies, contact design consultants, supervise the free flow of information, identify the appropriate time and project. They provide training for employer collections and bring the results of studies to all units (expanding the culture of dissemination of results), documenting the process and delivering the results, and conducting numerous other activities to facilitate studies. The absence of such units (whose existence is necessary) will reduce the speed and quality of the output of the study results.

2. No appropriate responsible selection for the value engineering team.

3. Lack of management support.

Supreme Management Support is the guarantor of the success of the research team. Understanding the results and goals while creating and believing in this methodology leads to an agreement and consensus among the complex managers (including senior executives) and understanding the necessity of its implementation. The need for the support of managers has been referred in the instructions of value engineering of Ashto also.

4. Lack of Value Engineering Professionals.

Compared to the magnitude and abundance of civil projects and their complexity, the number of value engineering professionals who are familiar with this, is very small and therefore it seems that in order to overcome this problem, the company should plan to train internal value engineering tutors.

5. Lack of proper definition of the criteria for referencing projects in order to carry out value engineering.

6. Lack of proper team selection.

The multidisciplinarity and encompassing of the team on the project's problem / opportunity is one of the key factors in the success of the studies. Team deficiencies or lack of experience and expertise of the team members can undermine the accuracy and adequacy of the results of value studies and bring it to the point of worthless results and lack of operational capability. In each study, it is necessary to be present at the workshop in order to address the various factors involved in the preparatory and detailed design.

7. Lack of proper understanding of the status, process and targets of value studies.

This issue that afflicts many countries in the field of science and technology and new techniques is also observed in Iran. A group of employers of the value engineering team is considered to be an additional factor in other factors, and cause of increasing the complexity. A group of value engineering is confused with similar methods such as cost reduction, project control, quality management, etc.

A group of employers also have inappropriate ideas of value engineering such as design control tools, best option selection tools, consultant tools, and tools to raise costs to the budget. Each of the foregoing implications is the result of inadequate information transfer, inadequate research and development in the field of value engineering, and lack of transparent information space, and can hinder the demand for these services.

8. Invalid implements of value engineering technique steps.

9. Plan designers' resistance.

10. Not choosing the correct domain and type of output.

The breadth and complexity of the team's work's domain varies depending on the specialty, the time and the feasibility of the change. Further studies and insistence on providing detailed plans (rather than schematic designs) and completing calculations to a detailed design (overreaching to technical issues) are among the livestock that often leads to costly consultants and employers. The adequacy of value engineering outputs is equivalent to schematic design and calculations (especially cost calculations) should be estimated.

11. Organizational Extent of civil companies.

12. Inability to control studies.

Due to lack of information backgrounds and enough experience, employers are not able to control and direct the value consultants to their organizational goals and projects. This lack of proper look makes consultant's work harder and slower. In addition, it causes that low-level consultants, will create an inappropriate mentality of value engineering by unsuccessful and harmful studies. For example, a sample of long-term studies (more than 4 months) is a major obstacle to avoiding employers from referring to value consultants.

13. Work program violation.

Violation of the work plan is the most common mistake in consultants who claim to implement and use this method. Violation of the work plan is unauthorized, except in cases where the supervisor has seen the full study of experiences and training and is doing that with enough reason. However, often (almost all the time), this violation of the program by unintentional people is carried out in two ways, either by shifting the work program or not performing some of the steps, often due to the lack of training and sufficient experience for the study.

14. Failure to correctly define functions.

15. Present incorrect and inaccurate Information

16. Failure to conduct sufficient studies in the preliminary study phase to identify the problem

17. Failure to apply proper evaluation methods

18. Lack of proper use of criteria and constraints in the evaluation of ideas

19. Lack of consultant's participation in Studies

One of the major obstacles to the development of value engineering in Iran is the lack of active consultants or resistance and their frontier in the course of studies. This case, which is due to the inadequate space of the culture and the lack of appropriate culture and the transparent relationship between the factors, tend to slow down the studies, reduce the validity of the outputs, and deprive the study team of experience, knowledge and consultancy surrounding the project.

20. Violation of the usual time.

Value engineering is a short-term process with the start time, duration, and end time. Typical studies vary from one to ten weeks and the workshop varies from 3 to 5 days. If the time goes beyond what is usual, then the reason and the reasons for it should be studied and analyzed so that studies do not become a long-term review or continuous improvement.

Less than one-month studies can only be carried out with educational targets (such as short-term studies in the design of a UVA) or fixing a crisis.

Presentation of the solution.

After identifying the most important risks of using value engineering in civil projects in developing countries, this section attempts to present proposed solutions based on Project Management Standard (PMBOK) on some of the risks.

❖ **Risk related to existing rules.**

✓ Solution: Developing and implementing value engineering implementation programs in the country can partly compensate for this weakness.

❖ **The risk of specialist of value study and their responsibility.**

✓ The employer will take on the risk as a representative of the main stakeholders (people and users) for the benefit of value proposition studies. Of course, the technical weakness of the employer's collections may be a major obstacle to this suggestion.

✓ Each group should accept responsibility for its work. The actual and legal persons participating in the study will be responsible for the general suggestions and the consultant extending the value study suggestions, the responsibility of the detailed design and the contractor to be responsible for its implementation. This solution may interfere with the employer's overall responsibility.

❖ **Cost-related risk.**

✓ Two types of calculation can be based on. Percentage of the calculated benefits during the project's lifetime or for several years is limited to the consultant and team members, or an approved methodology (with or without a working hour’s basis). The second method reduces the employer's resistance to suggestions because of the lack of beneficiary of the value consultant but reduces the incentives of the consultant.

- ❖ The risk of a lack of understanding of the position, process and goals of value studies.
- ✓ High-level culture making and the establishment of an interconnected management system at the level of target groups can be effective in overcoming this problem. Of course, the above methodologies are not so simple. Even in road and transportation departments of the United States, only 11 states use it extensively and enforce it in another state at law enforcement level. Culture making is still one of the most important missions in leading countries.
- ❖ Risk of inappropriate selection of projects to value study
- ✓ Because of the emergence of this methodology in Iran, these are unavoidable. The identification of projects in the design and justification of employers at this stage, along with legal coercion and allocation of budget allocations, can be used to some extent.
- ❖ Risk of lack of proper organizational structure and specialized unit and lack of management support
- ✓ Responsible organizations can introduce typical and active managers in this field or take special privileges in the government's encouragement system.
- ❖ The risk of non-participation of the design consultants in studies
- ✓ The final solution can be the requirement for consultants and contractors to work with value consultants. However, encouraging strategies seem to be more appropriate.
- ❖ Risk of violation of the usual time.
- ✓ The causes and factors of increasing time should be carefully considered by the leader. Lack of information, uncertainty of existing information, lack of cooperation of the consultant, weakness of employer management, high bureaucracy in contracting, lack of readiness of plan factors and the like, can be due to this delay.

- ❖ Risk of choosing a wide range for study.
- ✓ In large projects, studies can be limited in several studies and focusing on a single study or focusing the team only on costly and specific points of project.
- ❖ Risk of choosing an inadequate framework for studies
- ✓ Thinking and holding problem identification sessions or using problem definition tools can be effective. According to the employers' acknowledgment, the main difference between the value consultants in Iran and the reason for some of them, as well as others, is to conduct precise pre-study phases and formulate appropriate frameworks
- ❖ Disturbance and Confusion in the Study Team.
- ✓ Modern management considers the company's life conditional on continuous training of human resources. The weakness of the culture and the lack of familiarity with the national engineering community requires a thorough and proper training to explain the type of outputs and expectations, the domain of application, the tools used (such as performance analysis, brainstorming, etc.) before implementation of process.

Leading teamwork, and also principles such as teamwork, creativity and so on, should be given to the team. Each of this information can prevent the waste of time and energy in large measure and correct the direction of movement of all team members and peripheral agents in order to achieve the results.

- ❖ Failure to choose the correct team.
- ✓ The lack of acceleration in the formation of a workshop, the suggestion of appropriate fees, changing the time of the workshop and adapting to the ability of team members and the half-use of busy people can help to create a strong team.
- ❖ Risk of inappropriate guidance and support of sessions.
- ✓ The leader should have managerial knowledge and familiarity with other management tools. The leader should be a risk taker, a friend and a team lover, and at the same time a rigorous and serious

one. In addition, he must have an accepted, patient, engaging, communicative, follow up, and creative personality. He must be able to develop the team's creativity, teamwork and team-building abilities.

- ❖ Risk of disbelief in national interests.
- ✓ The designation and approval of awards for national interests as well as humanitarian projects in the country can have many benefits. Cultural and national-religious self-reliance is the guarantor of long-term moves and sustainable development.
- ❖ The risk of mismatching the timing of the implementation of workshops with the activities of the participants in the workshops.
- ✓ Implementation of workshops by half a day and increasing the number of workshop days
- ❖ Risk of not defining the correct criteria for referencing projects in order to carry out value engineering**.**
- ✓ Editing of criteria of selecting projects for value engineering
- ❖ Restrictions on members of the Value and Information Engineering Team.
- ✓ Identify frameworks and information forms.
- ❖ Information Phase Risks.
- ✓ Provide checklists and related information frameworks.
- ❖ Risks of analysis functionality and flexibility phase
- ✓ Editing and use of standards and guidelines for value engineering, preparation of a draft report type to facilitate the presentation of results, preparation and guidance of the use of engineering economics techniques, obliging contractors and moderators through the Project policing headquarters and the investment committee.

CONCLUSIONS.

It is simply not possible to start any new movement and work, and naturally there will be risks and obstacles to it. However, identifying these risks and other factors affecting the success or failure of a technique with regard to the existing environmental conditions will help to confront these risks.

The results of the hypothesis test on various variables include six main factors: (1) general factors, (2) factors of the law, (3) structural factors, (4) factors of the consultants field, (5) factors of preliminary study phase, and (6) factors of the phase of value engineering studies showed that the level of significance of all main variables of research (main factors) was less than 0.05 and therefore, zero assumptions were rejected in all variables and all of these main variables were normal and confirmation of assumptions was made and the results shows that all identified risks in the application of value engineering in civil projects are effective as the main risks.

After analyzes and results from the TOPSIS method, out of the 59 identified risks related to the obstacles of the application of value engineering in civil projects, prioritized results showed that such issues as lack of proper organizational structure and specialized units, lack of choosing the right manager for the value engineering team, lack of management support, lack of value engineering specialists, lack of proper definition of the criteria for referencing projects for value engineering and lack of proper team selection, among the most important risks associated with not using value engineering in civil projects. Its number Accordingly, detailed solutions are presented. In justifying these risks, it is worth noting that the following three types of solutions will be usable as the main ways of eliminating identified risks.

1. Public culture making: Since the main cause of the current resistance and mistakes is not familiar with the methodology and the usual results of this methodology, it is necessary in the form of multilateral programs such as the printing of a poster, a booklet, a magazine, the production of educational films, an awareness seminar, the use of the media General, initial information about the

value methodology, as well as the successful results and examples of value studies, rules and regulations in the country, and other information needed by the audience, will be transferred to the engineering community.

2. Establishing a legal framework and appropriate structure: Developing a program for recognizing the suitability and referral of appropriate work in the country's professional environment, anticipating incentive programs, and considering facilities for consultants and contractors active in this sector can lead to the development and prosperity of this process. In addition, the organizational structure and the establishment of the relevant units are the basis for accepting and using these services in the country's projects.

3. Advanced test: The current weakness of value consultants and employer collections and, consequently, weakness in holding workshops and conclusions, fixes only by holding standard training courses and accepting a system of qualification recognition, activating related associations, compiling specialized books, etc.

BIBLIOGRAPHIC REFERENCES.

1- Value Engineering Society (Publication No. 290), Publications Office of Management and Planning.

2- Rasooli, Reza; Arab, Davoud (2007) Value of Engineering in Different Methods of Project Management; National Conference on Development of the Executive, Executive, Urban and Industrial Projects, Tehran, Iran.

3- Hosseinian, S.S., Nouri, S. (2008) Presentation of a Model for Value-Based Project Management in Construction Projects, National Conference on Value Engineering in the Construction Industry.

4- Nazari, A., Rukhui, A. (2009) Physical and Pathology of Value Engineering in Iran; Third National Conference on Value Engineering.

5- Karimi, M., (2008), Undoubted Improvement: Applied Training of Value Engineering (Second Edition), Tehran, Rasa Cultural Service Institute.

6- Jebal Ameli, M. S., Qavamifar, K., Abayi, M. (2004) Status of Value Engineering in Project Management, Tehran, Publication of Management and Planning Organization of Iran.

7- Younker D (2003). Value Engineering: Analysis and Methodology, Winter Springs, Florida, U.S.A.

8- VALUE METHODOLOGY STANDARD and BODY OF KNOWLEDGE", SAVE International, 2007.

9- David, H. (2013). “Ancient Roman concrete could hold secrets to improving modern construction.” Civ. Eng., 32(9), 44–49.

10- Meng, X., (2012), “The effect of relationship management on project performance in construction, Original Research Article International Journal of Project Management, Volume 30, Issue 2, February 2012, Pages 188-198.

11- Kirk, SJ., 1994. Quality Modeling: Defining Project Expectations. International Conference of the Save. Retrieved from http://www.value-eng.com.

12- Jumas D.Y, Peli M.,Putra W, Arnaldi S (2002).Value Engineering & Cost Saving Issues on USA Department of Transportation(DOTS), [Online] Available From <URL: http://www.fhwa.dot.gov>.

13- Chen, T., Wei, E., 2006, Performance evaluation for construcyion Value Engineering, Nos. 347-352.

14- Ibusuki, U., Kaminski, P., 2005, Product development process with focus on value engineering and target-costing a case study in an automotive company.

15- Pascoal, F., Kliementneto, T., Duffey, R.M., 2008, Target Costing operationalization during product development in construction management.

16- Albert P., Womack, D.T.J., 2012, Contributor, Contributor, Harperperennial Library, The Machine That Changed the World: The Story of Lean Production.

17- Shen, Q. and Liu, G., 2013, Critical Success Factors for Value Management Studies in Construction, Journal of Construction Engineering Management, 129(5), 485-491.

18- Zarif Hosseinian, S. S., Nouri, S., 2008, Presentation of a Model for Value-Based Project Management in Development Projects ", National Conference on Value Engineering in the Construction Industry.

19- Nazari, A., Rukhui, S., 2008, Physical and physical pathology of value engineering in Iran, Third National Conference on Value Engineering.

20- Medagluchi, AS, Sobhieh, M. H., Reyhani Hamedani, H., 2007, An Investigation of the Efforts to Optimize Value Engineering Using Total Quality Management, Third International Management Conference.

21- Mir Mohammad Sadeghi, A. R., Jebel Factor, M. S., Tavakoli Darani, M. R., 2009, Presentation of Integrated Model of Value Engineering and Risk Management in Major Civil Engineering Projects, First National Conference on Engineering and Construction Management.

22- Reyhani Hamedani, H., Parezgar, S. H., Karimi, M., Samadiinia, P., Fathaliyan, F., 1391, Investigating the Impact of Value Engineering on Elimination of the Causes of Late Development Projects of the Country, Based on the Main Areas of Project Management Knowledge (PMBOK), The 8th Inter-Conference Project Management.

23- Mirani, S., Saeedi Parsa, Z. S. Amirkhani, A. H, 2012, Presentation and Review of Sustainable Engineering Engineering Model in Energy Consumption Management, National Conference on Value Engineering in Energy Management.

24- Norang, A., Mohammad Khani, H., 2009, Presentation of the proposed model for changing the value engineering method in three-factor projects, Fifth International Project Management Conference.

25- Esfandiarpour S., Hamidizadeh M. R., Najaf Beigi, R., Farhang, A. A., 2010, Improvement of Valuation Model of Value Engineering Work Program in Development Projects, Fourth National Conference on Value Engineering.

26- Mazaheri, A. R., Mohammadi, A., Jafari, M., 2010, Status of Value Engineering in the Management of Development Projects, Third Conference on Rehabilitation and Urban Management.

27- Sadeghi, R. A., Azadi, M., 2014, Using Value Engineering in optimizing the time of implementation of development projects with an approach to achieving the desired quality in the construction and reduction of delays, the National Conference on Architecture, Civil and Urban Development.

28- Ghahremani, R., Panahi, R., and Saybani, M., 1394, Challenges of Using Value Engineering in Iran, Second National Congress on Construction and Evaluation of Construction Projects, Semnan, Department of Education and Research, Barroozgar Engineering Co. Pars, Pahron Water Supply Consultant Engineers Co.

29- Sabet, MD, 2009, Investigating the application of the value engineering system in the hospital projects of the Ministry of Health and Medical Education and providing appropriate guidelines, research project of the Ministry of Health, Medical Education and Medicine.

30- Emami, K., Karimi, AH. 2012, The importance of proposing a change in the method of value engineering in explaining the scenario of all the winners in large projects, the third international conference of the construction industry.

31- Seraj, F, Taghipour, M., Seraj, M., 2014, Achieving superior quality management with the TQM approach based on the VA / VE technique, International Management Conference.

32- Sadeghi, R.A., Azadi M., 2014; using value engineering in optimizing the time of implementation of development projects with an approach to achieving optimal quality in the construction and reduction of delays, the National Conference on Architecture, Civil and Urban Development.

33- Sakaran, Uma (2007) Research Methods in Management, Saibi, Mohammad and Shirazi, Mahmoud, Tehran: Management and Planning Education and Research Institute, Fifth Edition.

34- Momeni, Mansour and Qayomi, Ali (2007) Statistical analysis using New Book Publishing.

35- Danaee Fard, Hassan, Alvani, Mahdi, Azar, Adel (2008) Quantitative Research Methodology in Management, A Comprehensive Approach, Tehran: Saffar Eshraghi Publishing.

36- Maleki, Masoud, Rajaei Hossein (2009) Selection of the project implementation method using the hierarchical fuzzy TOPSIS method, International Project Management Conference.

37- Asgharpur, J. (2008) Multi-criteria decision-making methods, Tehran University Press.

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