USING VALUE ENGINEERING IN PROMOTING AND IMPROVING THE QUALITY OF DESIGNING RESIDENTIAL PROJECTS USING THE ANALYTICAL HIERARCHY PROCESS

Dr. Behnod Barmayehvar
Islamic Azad University, Iran

ABSTRACT
Construction projects are severely dependent on economic justification, in fact construction projects because of high overhead costs, should be selected and analyzed based on efficiency. The projects which haven't used optimization methods especially value engineering not only increase the costs of designing and administration but also ownerships costs including exploitation, repairing and maintaining and the costs of consumption all around resources and expenditures over the period of its useful life. In this research first using studying on research history, the criteria of evaluating the performance for investigating project plan are proposed. These criteria include a wide range. In this research, evaluation criteria were based on value engineering that was done in the form of their importance questionnaire. Questionnaire's items include plan efficiency, sustainable architecture, capital return, reducing costs and so on. The size of sample was calculated considering Cochran formula and based on that the questionnaires were distributed among the elites of designing and construction field. In this research the criteria which have been introduced are based on value engineering that in fact the attitude of this technique is dominant on determining the criterion of evaluation. The AHP approach is also proposed for evaluating the projects' plans. In this research, AHP approach was used that considering pair comparisons among different items, each criterion has a holistic and comprehensive approach to selecting superior items. The results of this research also show that in profit development projects which more look for profit and income earning, value engineering is more efficient.

Keywords: value engineering, quality, designing, construction projects, AHP

1- Introduction

Construction quality is very effective on constructions' values. The employers are always trying to increase the value of construction using improvement in designing. There are two methods for this work. First employing consultant for designing and second is designing numerous items using value engineering. According to Society of American Value Engineering, value engineering is a systematic method with specific techniques that identifies the function of product or service and creates financial value for that so that the function is done with the least cost and with maintaining reliability and desired quality. In another word it can be said that value engineering is an organized value for analyzing the performance of systems, equipment, services and institutions in order to achieve real performance with the least expenditure in project's lifetime so that it is compatible with concerned quality and security. Value engineering is a very important method for optimal use of allocated budget. In most of the times for satisfying customers as well as increasing the quality of project, the employers use several plans therefore considering value engineering which is effective on three factors of cost, time and quality, the selection should be done among plans. It is tried in this research to select the plan with engineering approach in designing phase. In most of performed researches in the field of value engineering the concentration has been on industries and the criteria of evaluating in the industries of construction have been less paid attention. In another word the developed criteria have been always in relation with production industries. Based on this there have been created a research gap in the field of identifying and using the criteria of evaluating according to value engineering attitude in construction industries. Considering this important issue, some criteria of

evaluating construction plans can be referred as unknown aspect of this research. The goal of this research is identifying these criteria based on value engineering approach.

2- Theoretical principles and research background
2-1- Value engineering

Value engineering is an organized attempt which is done with the goal of investigating and analyzing all activities of a plan (the time of forming initial thought till designing and performing step and then installation and implementation) and has been known as one of the most efficient and important economic methods in the area of engineering activities. Value engineering in the framework of project management in addition to noticing all details of the plan, doesn't consider any part of work certain. The goal of value engineering is spending less time for achieving exploitation step without adding the costs or reducing the quality of work. Continuous increase in operating costs and increasing development of technology have obliged eliminating that part of costs which don't have any role in promoting the quality and are also unnecessary in terms of execution. Using value engineering in administrative projects considering the complexity of works especially in large administrative plans can turn to unquestioning tools of management in cost control. This method is targeted to remove or modify whatever causes imposing unnecessary costs without hurting main and basic functions of the plan. In another word value engineering is a set including several technical methods which through revision and analyzing work components will be enable to administer the plan completely with the least cost and time. Plan cost in this topic not only includes designing and administrative costs but also it contains ownership costs including exploitation, repairing and maintaining consumption costs in plan's lifetime. The methods of value engineering can cause modifying and promoting the processes of industrial production and doing new designs in each step of a project. Unlike what the common is in production industries and a modification method can be always used in next step of producing a specific good as well, in construction projects that each construct has special conditions, the limits of using a modification method of value engineering are only for that project, furthermore savings potential costs of a construction project will also be very different in its different steps. Despite using value engineering method in all steps of an administrative project, its most advantages will be obtained when is used in the initial steps of planning and designing. Innovation and applied aspects of value engineering differentiates this method from common and traditional methods of reducing costs. Traditional methods of reducing the costs mainly follow past experiences, attitudes and habits that have been repetitive and there is no creativity in them, vice versa value engineering discusses information, identifying problematic areas, suggestion and developing methods and innovative plans, training new thoughts and comprehensive integrated views that are supposed to be recommended.

Since 1961 that Laurens Miles defined value analysis as a creative and organized attitude to identify and eliminate unnecessary costs in the book of technical methods of analyzing value engineering till 1995 that Saksena and Krishnan published the book of value engineering in project management, value engineering was stabled as an accepted technical method in designing and administrative activities in most of the countries so that many involved in operational activities especially designers, contractors and employers got familiar with value engineering technical methods and concepts.

2-2 Literature review

Pourali (2003) in a research investigated value engineering and its function in civil projects. Value engineering is a process that is concentrated on improving the function of a product in terms of quality, time and expanding function range without increasing costs. Mainly in selecting projects for value engineering execution, total expected savings should be more than 10 times the cost of studies. Therefore the projects with low initial costs cannot be appropriate subject value engineering studies. Because of high costs of construction projects, studies and performing value engineering is very important in these projects. Each year, a big proportion of country's income is spent on constructionand national plans, reducing the cost and time of administrating plans in three steps of studying, designing and administrating to maintain and even improve their quality using value management cause optimum use of country's limited resources and early return of investment.

Sebt (2006) in an article investigated the way of using value engineering system in hospital projects of the Ministry of Health and Medical Education and proposing appropriate solutions. Treatment problem is considered as one of the important problems of today societies. On the other hand with the advancement of science and human knowledge the complexity of this discussion is increasing so that in recent years the economy of health and treatment has been discussed seriously in the world. On the other hand hospital is the most important institution of health and treatment as important arm of proposing health services and the first level of health services referral with specific responsibilities and territories. In another word the main place for each kind of charges for treatment including research, hospitalization and treatment is hospital. Therefore this research is an attempt in order to propose appropriate solutions for improving, speeding and valorizing hospital projects focusing on using value engineering technique.

Tohidi (2011) in a research investigated the position of value engineering in managing construction projects. Value engineering is an efficient technique for improving the value of project. Using value engineering, construction project life cycle costs (construction costs, exploitation and depreciation) will be decreased. Value engineering is an organized and function-oriented solution for controlling the costs that create savings or it improves the value of product without sacrificing the quality of function and its benefits, this product can be a work or project. Value engineering provides the possibility of improvement and designing in a creative field using value evaluation function analysis techniques. Main core of value engineering is analyzing function. In fact function analyzing and the way of facing problems is the distinctive point of value engineering approach from other management approaches that are used for reducing the costs, value engineering has a sensitive role in achieving permanent and promoting goals and creates a required field for coordination and relationship. In another word it causes to manage two aspects of variables and costs that is obvious requirement of sustainable profitability.

Cheah and Ting (2005) in an article named "evaluating the performance of value engineering in construction projects in South East Asia" stated that the function of value engineering in construction projects is very effective and in fact this effectiveness has made many people to look for using this approach in construction projects all over the world. They state in their research this approach is less used in South East Asia that the most important reason is lack of familiarity and information in the field of value engineering.

Chen et al (2010) in an article (2010) named "investigating the total performance of value engineering" investigated and evaluated value engineering workshops in construction projects. They state in their research that the success of value engineering workshops depends on different factors. In this research they analyze these factors. In their research, they used AHP approach for analyzing extracted data from questionnaires of value engineering elites.

Zhang et al (2009) in an article named "developing a system of knowledge management for value engineering operations in construction industry" developed a system of knowledge management for value engineering operations in construction industry. In their knowledge management system, creative problem solving tools have been used that can be utilized in the process of value management.

Atabay and Galipogullari (2013) in an article investigated the function of value engineering in construction projects. It is mentioned in this research that controlling the cost has been always of the most important existing sections inmanaging projects.In this research, the function of value engineering in controlling costs in construction projects has been investigated. The results of this research showed that the function of value engineering in Turkey has caused 6 percent reduction of financial costs and 17 percent reduction of projects' ending time that shows high efficiency of this approach in controlling cost and time.

3- Research Methodology

Collected data should be analyzed. For this, the reliability of questionnaire is first measured by Cronbach's alpha then using one way t-test, the criteria whose the mean of score is more than 5 in Likert scale are selected. These are criteria that are more important according to elites. Now in the second step, these criteria are measured for evaluating the plans. In this step using introduced case study, the information of project designers are collected and using existing methods in multi-criteria decision making, the plans are compared to be able to analyze the way of selected criteria performance. Current research is applied one and tries to investigate the function of value engineering using statistical analysis in the phase of designing residential buildings, mass housing projects.

3-1-Researchmethodology based on collecting data
Collecting data in this research has been done through reviewing some accomplished researches in the past. In order to this, library studies and data extraction by scientific articles databases were used. Methodology based on collecting data is survey type.

3-2- Explaining the method and the tools of collecting data
Considering the study of research history, the researcher must use library method for reviewing local or foreign literature. Also in order to collect research data, field method will be used. The method of collecting data is field one and important tools of this important issue is questionnaire. Collecting data tool is a questionnaire with 5 degree Likert scale related to research variables. Questionnaire's validity will be measured through survey of professors and experts in relevant industry and its reliability will be measured by Cronbach's alpha and SPSS software.

3-3- Statistical population and sample size
Statistical population of this research includes experts in the field of architecture and civil engineering. Collecting data out of whole this statistical population is impossible therefore Cochran formula is used for determining sample size.

3-4- Investigating the reliability of the questionnaire
Statistical population of this research includes experts in the field of architecture and civil engineering. Collecting data out of whole this statistical population is impossible therefore Cochran formula is used for determining sample size.

For calculating the size of sample, Cochran formula is used:

$$ n = \frac{\dfrac{z^2 pq}{d^2}}{1 + \dfrac{1}{N}\left(\dfrac{z^2 pq}{d^2} - 1\right)} $$

In formula above usually, the maximum permitted error (d) equivalent 0.1, confidence coefficient t=0.1, 96.90 or z and the values of p and q also equivalent 0.5 and population size has been considered as N. the value of P is considered as 0.5 because if P=0.5 n will find its maximum amount and this causes the sample to be adequately big (Sarmad et al, 2009).

Cronbach's alpha coefficient is used for measuring the rate of one-dimensionality of the attitudes, opinions. In fact we want to see to what extent the impression of respondents from questions have been the same. The base of this coefficient is on scales. Scale is a set of numbers which are allocated to people, things or behaviors in order to quantitate qualities. The most common scale which is used in social researches is Likert scale. In Likert scale the basis is on same weight of the items. So that each one of items a set of scores are given (e.g. from 1-5 for 5 item Likert scale) that the total scores for each individual of item represents his/her tendency.

3-5- The method of analyzing data

In this research, first library studies in the field of value engineering and designing criteria and the method of evaluating items are done then using interview and questionnaire an index of evaluation criteria is determined. In next step it is tried to evaluate these criteria through value engineering approach to confirm the functionality of these criteria in engineering studies then an evaluating method of designing items based on designed criteria is done that in this step, Teacher Construction Company Information is used. Evaluationmethod in this research is AHP (Analytical Hierarchy Process).

3-6- Hierarchical analysis approach

Decision making is one of the most important characteristics of human and each person during day and night make many decisions, some of these decisions aren't that much important and some other ones are very important. Whatever the responsibilities and authorities of human are more the decision making will be more important. Since making correct decision can affect personal and social life of human significantly, a strong technique that can help human in this field is tangibly necessary.

One of the most efficient of these techniques is Analytical Hierarchy Process (AHP) that was first discussed by Tomas L.Saaty in 1970. This technique is based on pair comparisons and gives managers the possibility of investigating different scenarios. Because of simple nature and meanwhile comprehensiveness, AHP has been always welcomed by managers and different users. On the other hand during past 20 years, it has drawn attention from scientific circles. This technique provides formulating problem hierarchal and also considering different quantitative and qualitative criteria possible in the problem.

This process interfere different options in decision making and has the possibility of analyzing sensitivity on criteria and sub-criteria. Moreover it is based on pair comparisons that facilitate judgments and calculations.

It also shows the compatibility or incompatibility of decision that can be an excellent advantage of this technique in multi-criteria decision making.

A theory based on utility function can be stated by exchanging goals from habits and stating habits as mathematics for explaining decision maker's behaviors to set decisions considering his preferences.

4- Results
4-1- Descriptive analysis

Inthis section, the situation of respondents including gender, age, education and their work experience are summarized in tables 1 to 4.

Table 1: Frequency distribution of respondents by gender

Percentage	Abundance	Gender
91%	168	Male
9%	17	Female
100%	185	Total

Table 2: Frequency distribution of respondents by age

Age	Abundance	Percentage
20-30 years	51	28%
31-40 years	72	39%
Above 40 years	62	33%
Total	185	100%

Table 3: Frequency distribution of respondents by education

Percentage	Abundance	Education
31%	57	Diploma and Associate
47%	86	Bachelor
22%	42	Master and above

100%	185	Total

Table 4: Frequency distribution of respondents by work experience

Work Experience	Count	Percentage
Under 5 years	25	145
5 - 10 years	42	23%
10 - 15 years	49	27%
15 - 20 years	37	20%
Above 20 years	32	16%
Total	185	100%

4-2 Inferential statistics
Obtained results from research inferential statistics include:
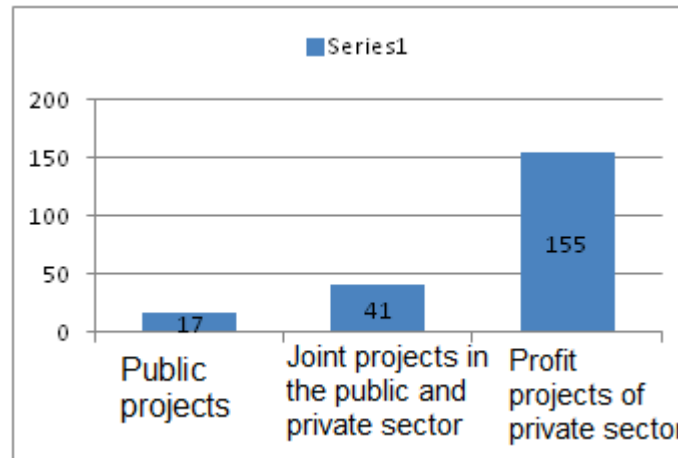- **The efficiency of value engineering in various projects**

Diagram 1- The efficiency of value engineering in various projects
- **The importance of value engineering studies in different sections of project designing**
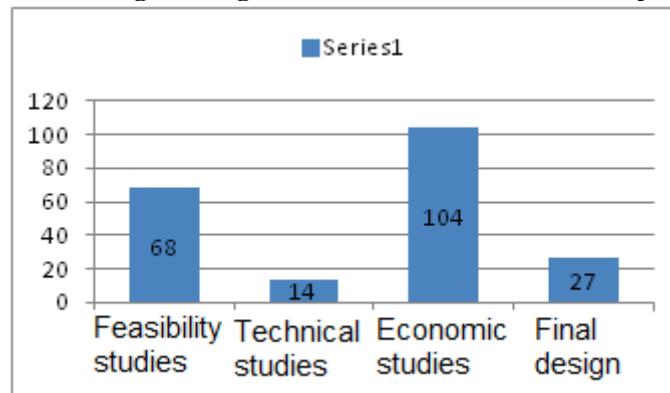
Diagram 2- The importance of value engineering studies in different sections of project designing
4-3 Analyzing the items
Analyzing items will be investigated in this section. In order to this, descriptive statistic analysis was used. To achieve the goal above, first items contained in the questionnaire are evaluated by SPSS software that obtained results are shown in Tables5 to 16.
Items that are designed based on value engineering effect are respectively:
1. Using value engineering causes saving in energy.

Table 5- The frequency of item no 1

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	2	4	1.9	1.9	1.9
	3	36	16.9	16.9	18.8
Valid	4	82	38.5	38.5	57.3
	5	91	42.7	42.7	100.0
	Total	213	100.0	100.0	

2. Value engineering causes increasing plan efficiency.

Table 6- The frequency of item no 2

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	3	30	14.1	14.1	14.1
	4	96	45.1	45.1	59.2
Valid	5	87	40.8	40.8	100.0
	Total	213	100.0	100.0	

3. Value engineering causes increasing safety.

Table 7- The frequency of item no 3

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	2	3	1.4	1.4	1.4
	3	45	21.1	21.1	22.5
Valid	4	69	32.4	32.4	54.9
	5	96	45.1	45.1	100.0
	Total	213	100.0	100.0	

4. Value engineering causes increasing the administration of plan.

Table 8- The frequency of item no 4

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	2	3	1.4	1.4	1.4
	3	51	23.9	23.9	25.4
Valid	4	96	45.1	45.1	70.4
	5	63	29.6	29.6	100.0
	Total	213	100.0	100.0	

5. Value engineering causes decreasing costs.

Table 9- The frequency of item no 5

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
Valid	1	3	1.4	1.4	1.4
	2	6	2.8	2.8	4.2
	3	48	22.5	22.5	26.8
	4	81	38.0	38.0	64.8
	5	75	35.2	35.2	100.0
	Total	213	100.0	100.0	

6. Value engineering causes increasing capital return.

Table 10- The frequency of item no 6

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
Valid	1	6	2.8	2.8	2.8
	2	6	2.8	2.8	5.6
	3	36	16.9	16.9	22.5
	4	60	28.2	28.2	50.7
	5	105	49.3	49.3	100.0
	Total	213	100.0	100.0	

7. Value engineering causes increasing the efficiency of land use.

Table 11- The frequency of item no 7

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
Valid	1	3	1.4	1.4	1.4
	2	6	2.8	2.8	4.2
	3	48	22.5	22.5	26.8
	4	90	42.3	42.3	69.0
	5	66	31.0	31.0	100.0
	Total	213	100.0	100.0	

8. Value engineering causes increasing the efficiency of human resources.

Table 12- The frequency of item no 8

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
Valid	1	3	1.4	1.4	1.4
	2	6	2.8	2.8	4.2

3	36	16.9	16.9	21.1
4	102	47.9	47.9	69.0
5	66	31.0	31.0	100.0
Total	213	100.0	100.0	

9. Value engineering causes creating specific goals in designing phase.

Table 13- The frequency of item no 9

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	1	6	2.8	2.8	2.8
	2	6	2.8	2.8	5.6
Valid	3	45	21.1	21.1	26.8
	4	63	29.6	29.6	56.3
	5	93	43.7	43.7	100.0
	Total	213	100.0	100.0	

10. Value engineering causes creating accurate timing in project plan

Table 14- The frequency of item no 10

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	1	3	1.4	1.4	1.4
	3	60	28.2	28.2	29.6
Valid	4	78	36.6	36.6	66.2
	5	72	33.8	33.8	100.0
	Total	213	100.0	100.0	

11. Value engineering causes creating a compiled program for designing.

Table 15- The frequency of item no 11

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	2	15	7.0	7.0	7.0
	3	39	18.3	18.3	25.4
Valid	4	99	46.5	46.5	71.8
	5	60	28.2	28.2	100.0
	Total	213	100.0	100.0	

12. Value engineering provides the possibility of analyzing the plans economically.
Table 16- The frequency of item no 12

	Options	Abundance	Frequency percentage	Valid Percentage	Cumulative percentage
	2	15	7.0	7.0	7.0
	3	51	23.9	23.9	31.0
Valid	4	87	40.8	40.8	71.8
	5	60	28.2	28.2	100.0
	Total	213	100.0	100.0	

As following considering the accomplished analysis on items, indicator and efficient criteria of value engineering are determined. Due to this the items which have allocated more mean to themselves in evaluating and investigating above are selected as superior criteria and the rest of research will go on based on these criteria. These criteria are in fact the most important that can be used for comparing the plans according to value engineering.

Five items with the highest mean are selected here, as the criteria for decision making.

Criteria with the highest mean are as follows:

1. Value engineering causes increasing plan efficiency.
2. Value engineering causes reducing the costs.
3. Value engineering causes increasing capital return.
4. Value engineering causes creating a compiled program for designing.
5. Value engineering causes increasing meet of employer's needs.

Criteria of plans evaluation are as follows:

Plan efficiency (c1)

Less costs (c2)

The rate of more capital returns (c3)

The existence of compiled efficiency program (c4)

Meeting employer's demands (c5)

4-4 Determining the criteria weights

The weights of criteria should be determined in this section. This important issue has been done based on special vector method using pair comparison matrix.

The results of this model have been stated based on EXPERT CHOICE software as following. Pair comparisons have been extracted through calculating the mean of director, technical managers and specialists with over 10 years of experience ideas in Teacher Construction Company. Pair comparison matrix for criteria is as follows:

Table 17: Pair comparison matrix for criteria

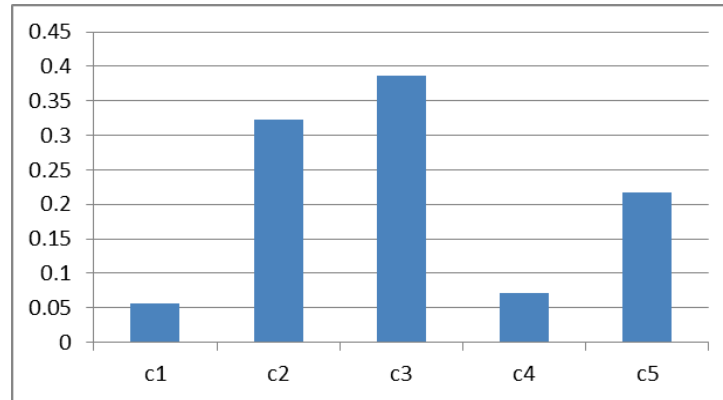|	c1	c2	c3	c4	c5
c1	7	1	1	5	3
c2	3	1	1	5	2
c3	1	1	3	3	3
c4	3	$\frac{1}{5}$	$\frac{1}{5}$	1	$\frac{1}{5}$
c5	1	$\frac{1}{3}$	$\frac{1}{7}$	$\frac{1}{3}$	$\frac{1}{4}$

Diagram 3- The value of criteria's weights

As it is clear out of these criteria's weights determination, two criteria of capital return rate and less costs are more important criteria than other ones and have been respectively the most important ones according to the idea of decision makers with relatively weights of 0.387 and 0.329.

Now, a pair comparison is done for each one of criteria for all 8 projects of the study that as result we have 5 pair comparison matrix. Projects under study are:

Ardebil Yademan (p1): This project is located in a land area of 507 square meters in Naft-e- Shomali Street of Tehran

Setayesh (p2): This project is built in a land area of 21320 and total infrastructure of 111.333 square meters in 35 floors

Meraj (p3): This project is located in a land area of3779 in Niayesh highway.

Parsian (p4): Based on the license, this project contains 3 residential units and 2 administrative units of 197 square meters that warehouse, parking, elevator and lobby have also been considered.

Negin Shahriar (p5): This project is located in land area of 3567 square meters in Tehranpars which is the form of 34 unit residential complex in 13 floors.

Negin Tehranpars (p6): Business tower of Negin Tehranpars is with 22.988 sqm with Land area of 3.532 square meters.

Kimia complex (p7): The project of Kimia complex located in Ardebil can be administrated with area of 1.897 and the total area of 22.775 square meters on 12 floors in 211 housing-business units.

Negin Sabalan (p8): This project is located in Ardebil, Sina town, next to the Telecommunication organization in a land area of 2589 square meters.

4-5- Calculating compatibility rate

Through comparing the obtained results with permitted compatibility rate of 0.1 it can be observed that in all cases the rates of compatibility are in permitted zones. If compatibility rate is more than permitted limit, the ultimate results of analyzing by EXPERT CHOICE are unreliable and the survey will have to be done again.
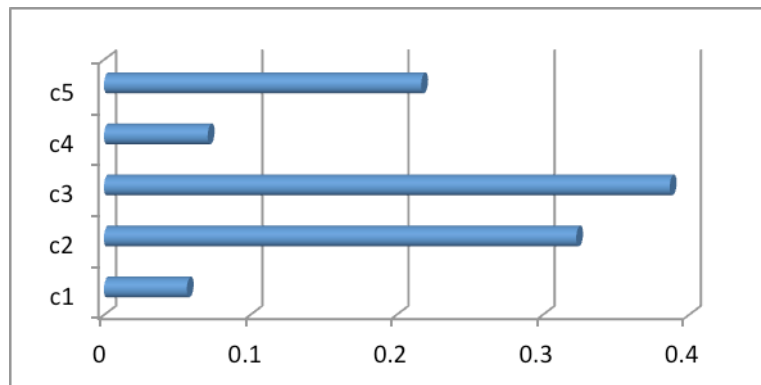

Diagram 4- The relative weight of value engineering evaluation criteria in all projects

5- Conclusion

In this research first using research history, the criteria of performance evaluation were proposed for investigating the plan of project. These criteria included a wide range. In this research evaluation of criteria, whose importance level was evaluated in the form of questionnaire, was based on concerned value engineering. The items of questionnaire included plan efficiency, sustainable architecture, capital return, reducing the costs and so on. A sample of questionnaire has been shown in appendix.

The size of the sample was calculated considering Cochran's formula and based on that =, the questionnaires were distributed among the elites in the field of designing and construction. The criteria were selected that have allocated the highest mean in analysis.

So the five criteria below were determined:

Plan efficiency (c1)

Less costs (c2)

The rate of more capital returns (c3)

The existence of compiled efficiency program (c4)

Meeting employer's demands (c5)

As it can be seen above, value engineering attitude can be severely seen in selecting the cases above. Selected criteria represent financial importance of projects and project qualitative importance. These factors (financial importance and qualitative importance) are exactly the basis of value engineering that in fact include meeting the need of customer the least expensively and the most profitability. Four criteria of c1-c2-c3-c5 are financially and criterion c4 shows the existence of work program that of course the existence of such this program causes doing project activities in specific framework and as result causes meeting the principle of economic saving in project and maintaining the quality level of what employer wants.

Introduced criteria can be as evaluation criteria in construction projects according to value engineering attitude. Based on this as the research was being done, 8 projects in Teacher Construction Company were evaluated. Introducing these 8 projects was done. For each one of five criteria above there was a pair comparison for determining the excellence of each project toward the other ones are proposed. As following the importance of criteria was determined by special vector that showed the importance of costs reduction and capital return according to contractors. The results of ranking 8 projects have been also proposed completely based on EXPERT CHOICE software output.

The results obtained from this research included the response of questions below:

1. In designing phase of which civil project, value engineering is more functional?

According to the results of this research and considering the ideas of elites, in profit construction projects that are more looking for profit and earning, value engineering is more important. In fact using value engineering is less efficient in public projects but it can still cause reducing the costs.

2. What part of value engineering will be more noticed in designing phase of construction projects?

Value engineering is very important according to the elites in phase of investigating and analyzing economically in designing projects.

3. What are designing items evaluation criteria?

The criteria for evaluating items include cases below:

Plan efficiency (c1)

Less costs (c2)

The rate of more capital returns (c3)

The existence of compiled efficiency program (c4)

Meeting employer's demands (c5)

4. Evaluation of plans done more for what purpose?

Considering weighting criteria, it can be concluded that financial criteria (reducing costs and capital return) are investigated. Considering the goals of companies for earning more income and profit, this important issue can be justified considering the philosophy of value engineering.

5. What are appropriate methods for evaluating the items?

Numerous methods can be proposed for evaluating the items. AHP approach has been used in this research that considering pair comparisons among different items, each criterion has a comprehensive and holistic approach to selecting superior items.

References
1. Atabay, S. Galipogullari, X. N. Application of value engineering in construction projects, Traffic and Transportation Engineering, 1 (2013) 39-48
2. Cheah, S.K., Ting, Appraisal of value engineering in construction in Southeast Asia, International Journal of Project Management,(2005).
3. Chen, P.Y. Chang, Y.H. Huang, Assessing the overall performance of value engineering workshops for construction projects, International Journal of Project Management, (2010).
4. Pourali E. "Value engineering and its role in development projects", Second Conference on Value Engineering of the country development projects, December 2000
5. Sebt, M. H., "Evaluation of the application of value engineering system in the hospital projects of Ministry of Health and Medical Education and providing appropriate solutions", 2006.
6. Tohidi, H. Review the benefits of using value engineering in information technology project management., The Journal of Computations and Materials in Civil Engineering 3,. (2011)
7. Zhang, X. Mao, S.M. About Risk, Developing a knowledge management system for improved value engineering practices in the construction industry, Automation in construction, (2009)

Appendix 1

Question number	Items	Disagree	Somewhat disagree	No idea	Somewhat Agree	Agree
1	Application of value engineering saves energy					
2	Value engineering makes increasing the plan efficiency					
3	Value engineering makes increasing the sustainable architecture					
4	Value engineering makes increasing the safety					
5	Value engineering makes increasing the beauty					
6	Value engineering makes increasing the possibility of project implementation					
7	Value engineering makesreduction in costs					
8	Value engineering makes increasing the investment return					
9	Value engineering makes increasing the efficiency of land use					
10	Value engineering makes increasing the human					

	resources efficiency					
11	Value engineering makes protection of the environment at the project site					
12	Value engineering makes meeting the employer demands					
13	Value engineering makes the creation of specific objectives in the design phase					
14	Value engineering makes the enhancement the experience and knowledge of the value engineering team					
15	Characteristics of the participants in value engineering groups impact on output					
16	Value engineering makes the exact timing in the project plan					
17	Value engineering makes creating compiled program for design					
18	Value engineering provides the analysis of the plans economically					