Value Engineering in Construction Projects for Drainage and Stream way in Roads and Highways

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Abstract— **Collection of surface water along the roads drainages is very necessary and very important. Because, the criteria for the drainage and the main requirements of the design and disposal surface flow of traffic conditions may in fact, necessitate the formation of a sheet (film) on the basis of traffic flow and lack of drainage and its possibility to possess sufficient disposal speed under certain conditions. Design and implementation of surface water drainage system and sub-surface can be very dangerous for moving vehicles. Value engineering (VE) is a systematic method for reducing the time and cost of construction. The VE is the stable way to improve the quality of construction projects and production, to increase the efficiency and performance of the project. VE focuses on function analysis of research objects and strives to achieve the required function reliably at the lowest life cycle cost to gain the best integrated benefits. Approach: VE seeks optimizing and improving decision making to realize the optimal expenditure of owner funds while meeting required function at the lowest cycle cost. VE teamwork by involving construction, design and maintenance staff review the construction project features and look for ways to improve quality, control costs and time. Based on literature survey, combined VE and Drainage Engineering System (DES) or Surface Stream Way Drain (SSWD), can maximize profitability, efficiency and the best performance function available. In terms of DES, standards and criteria used in roads and highways are calculated to obtain clear and tangible results. In this study, based on VE it was provided a questionnaire to collect data, of course this stage started by pilot and actual study. Based on the first objective; 12 main factors of VE in construction projects for DES & SSWD were identified using factor analysis with SPSS Version 22. According to the second objective, the developed and enhanced framework were obtained. Finally based on the third objective, confirmation, acceptance and reliability of the developed framework an enhanced was assessed by interview with experts, constructors, consultants and project management involved in projects of main roads, highways and streets construction for drainage and surface stream way drain.**

Keywords- value engineering (VE), Construction Criteria, Drainage Engineering System and Surface Stream Way Drain (DES & SSWD

I. INTRODUCTION

Value Engineering (VE), is a systematic technique to reach a perfect value for all of the projects on product. This is a system utilized to detect approaches to minimize throw away, manage risks, control operations and find cost cutting procedures in the complete tasks in every project (Tohidi, 2011). The main aim of value engineering is to focus on cost saving, and other areas of a client needs during the performance of constructional projects such as building, dams, and transportation.

Value Engineering (VE) helps corporations to be more efficiently in handling initiatives both locally and also globally by cost steps and details; being useful and profitable; enhancing quality and value index; manage time well; enhance team working; optimized design and operation; using all resources efficiently; and methodical system for problematic projects and special projects.

Value Engineering (VE) is an inventive and also problem-solving soft application simultaneously, also it's a systematic framework to optimize values within a particular work through engineering process [1]. The profit of Value Engineering (VE) application tend to be superior realized from the project's goals, by getting much more worthy with investment along with the particular employers' desires, improve the characteristics from the challenges [2]. A VE program involves a several specific venture, course of action as well as merchandise to create a simple yet effective productive decision to comprehend within superior, produce ideas, as well as establish venture features [3]. It basically is afterwards introduced like a pitch carrying out the first endorsement point [4].

II. LITERATURE REVIEW

In this section evaluation of materials in addition to previous developed VE Tasks which have produced a comprehensive construction throughout VE Tasks have presented, also comprehensive construction over Value Engineering for Main Roads and Highways Construction are

offered within this phase. For further studies in the value engineering this study has focused on highway and main roads as two fields in construction projects that value engineering has been considered in order to fulfill the desirable requirements. Investigation in variety of VE application in Southeast Asia in order to find out which principle of VE is proper in industrial construction. The essential fact has been invoked by this research that the value engineering has constructive aspect in the construction projects [5]. Applying construction project management to improve the satisfactory degree in projects for clients with keeping the quality and framework of projects in Taiwan's CPM environment has been considered, also the beneficial source has been extracted for other CPM by this study[6]. Debating of VE principle in USA as essential outcome in constructive projects, meanwhile, other statements claim this approach is the customary concept for saving expenses. At last, the function analysis makes vital roles in construction projects[7]. The holistic review on the VE and the sustainable construction for finding the indication and association are between two approaches in the building projects. It has been concluded the sustainable construction is the inherent part of VE workshop with variation in performance for many different projects[8]. Identifying the best procedure by using the value engineering to establish the principles that shows the reliability , performance of the product, keeping the quality and adjusting the cost as substantial strategy in the workshops. This survey dedicated to the Procurement of Public Housing in the State of Kuwait by aiding the VE approaches[9]. Preparing the guidance to preserved the VE by federal department to improve the program, balance the costs, and elevate the quality by observing the appropriate policy from companies and agencies.

This study has been dedicated to executive office of the president United State of America Representing the VE model in the form of five-phases including the specific stages. In this paper the construction simulation technique has been used to minimize the different choices in terms of expenditures and time exclusively. The cyclic operation network has been employed in order to acquisition simulated data for establishing the framework in comparison with real situation[10]. Presenting the fuzzy logic approach for implementing the value engineering (VE) as Decision Support System (DSS) in case of divers and uncertain sources invoking the DSS leads to the precise model and decision by addressing the ranking for each process, finally the rank of each process for making the right and proper decision. This method has been implemented for tunneling industry [11]. It refers the value engineering as two concepts namely, Value Management (VM) and Value Analysis (VA). It plays the prominent roles in the Project Management Office (PMO).

This paper is contained the wall street crash in the 1930s that causes the manifestation of the governance desperate bid to contain agency problems; therefore, this sort of incident calls for havening extensive supervision on any contracts and manage the sources precisely [12]. Using effectively the value methodology in analysis of specific process is vital in linking the several constructive and manageable stages during the project. These stages could be included the time consideration, cost efficiency with observing the desirable quality as the

customers applying. The vertical value engineering could be mentioned as facility to enhance the project objectives [13].

Applying the fuzzy clustering framework in the highway VE for categorized prominent information has been considered. In this method the Case-Based Reasoning (CBR) model has cooperated with fuzzy model[14]. Employing VE strategy in the main road and highway projects that has been conducted by American agencies in the different state of united state based on some key factors such as policies, education and awareness, implementation, monitoring and future need has been discussed [15]. Searching for best ways to enhance the quality control cost and time in the construction project calls for studying the VE in order to motivate the constructional project's quality, cost schedule planning, cost parameters, also optimize design parameters. These all foregoing aims would be achieved by implementing the relevant model for VE for main road and highway projects [16].

Implementing the analytical method in Value Engineering of Main Road and Highway Construction that has been done in Iran by considering the cost and time reduction and increasing the quality has been studied. Furthermore, the beneficial point of this research is using the software R and linear regression method to show the privilege of the using VE in each stage of project stage [16]. Employing the VE for main roads and highways as constructional projects by focusing on the functional factors, in the other word the function analysis in evolving the function oriented instead of item oriented. Finally, it would be invoked that the function analysis effects on cost reduction [17]. Addressing the VE in the transportation project based on function analysis in order to decline cost and time and improving the quality of project in order to achieve the striking benefits. In VE all considerations have been included to find the optimal cost with meeting other vital project requirements. From 2000, the Value Engineering (VE) has been considered for designing constructions in Iran by Iranian Programing and Budget Organization (IPABO).

Soil, water and weather are the main parameters in contrast to the structures. But according the literature review has been less attention to the water effects (drainage and stream way) in highways and roads [18]. Many studies have been done on the main road construction projects by implementing value engineering (VE) including: cost management and reduction, quality improvement, resource optimization implementation, the detailed costs, improve teamwork, enhance the quality and quantity indicators, methodical system for particular projects and problematic projects. However, there is not any research from the view point of Value Engineering on the Surface Stream Way Drain (SSWD) and Drainage and runoff management very important after each rainfall. Surface water is one of the most polluted waters and is very noticeable environmentally. Therefore, this research focused on investigating the role of VE main road construction projects based on using the Surface Stream Way Drain (SSWD) after each rainfall in the main road on the Environmental health from the view point of Value Engineering in order to decreasing the air pollution and increasing the health of environment.

III.   THE OBJECTIVES OF THE RESEARCH

The following are the key objectives of this research work:

1)   To determine the VE existing criteria for drainage and stream flow at main roads construction

2)   To propose and develop an enhanced framework of VE based on runoff for main roads construction.

3)   To check the validity of VE enhanced framework for drainage engineering in main roads construction through a case study.

IV.   SCOPE OF THE STUDY

The study focused VE in drainage and stream way drain construction for main roads and highways. The provincial selected for this study (pilot and actual) is one of the most traffic provinces Tehran in north of Iran; figure 1 presented the located in the north of the country. Therefore, in terms of both investment and development is considered one of the most strategically important areas. This study is focused to twelve criteria includes; Construction Management (CM), Waste Materials(WM), Drainage Engineering & Surface Stream Way Drain (DE & SSWD), Materials (M), Aesthetic(A), Human Resource(HR), Environment(E), Quality(Q), Safety & Driving Risk(S&DR),Cost(C), Recycling(R) and Time(T).

In several parameters such as; aesthetic and environment and quality of structure focus to acceptable and comfortable for customer and users. In expert human resources part is tried to improvement of relationship between engineering and experts. In trouble-free Project Implementation our scope is to find a simple solution way. This research for drainage Surface Stream Way drain focuses to find technical solution ways. In time, cost and construction materials and waste materials, would be to the minimum possible, considered acceptable, Construction Management with all its components and other factors (mentioned above) could be effective on the value engineering.
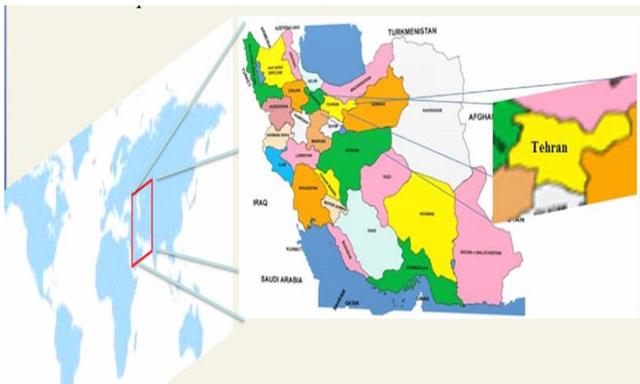

Figure 1 Tehran Province in the North of Iran

V.   DEFINITION OF TERMS

There are some businesses applying of value engineering techniques such as product process procedure system, service in business or economy activity including construction, governance, health care, industry and in other service sector. The focuses of value features are actually from the client point of view. Then value engineering is expert procedure of finding the most effective technique for the engineering is expert procedure of finding the most effective technique for the work. By focused on function, the maximum value from the party activity can be achieved the achieved with identification, processing and innovation of the work. There are some definitions about value engineering as follows:

•   According to Kelly and Graham (2006), Value Engineering is the process of making explicit the functional benefits a client requires form the whole or parts of a project at an appropriate cost during design and construction [19] The other definition of value engineering is identifying and reducing unnecessary cost method during design and construction of the project.

•   Value engineering is a systematic procedure aimed at achieving the required functions at least cost. In value engineering, the parties should realize the function required and condition all design alternatives must fulfill the same performance.

•   According to the Indian Value Engineering Society (INVEST), value engineering is a function oriented, systematic team approach and study to provide value in a product, system or service. This improvement is also focused on cost reduction; however, other important areas such as customer perceived quality and performance are also of paramount importance in the value equation.

According to the SAVE International (Society of American Value Engineering), Value Engineering is a systematic application of recognized techniques, which identify the monetary value for that function, and provide the necessary function reliability at lowest overall cost. Based on the definition of value engineering above, it can be summarized that value engineering is systematic techniques of procedures to get the best alternative or improvement design at lowest cost with the same quality and performance during the assign at on construction phase.

Some definitions about value engineering as follows:

1)   The functional benefits a client requires.

2)   A method to identify and reduce unnecessary actions. Improvement focused on cost reduction.

3)   A systematic procedure aimed at achieving the required functions at least cost.

4)   The SAVE International (Society of American Value Engineering), improvement design at lowest cost with the same quality.

VI. DEFINITION OF TERMS

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VII. STEPS AND LEVELS
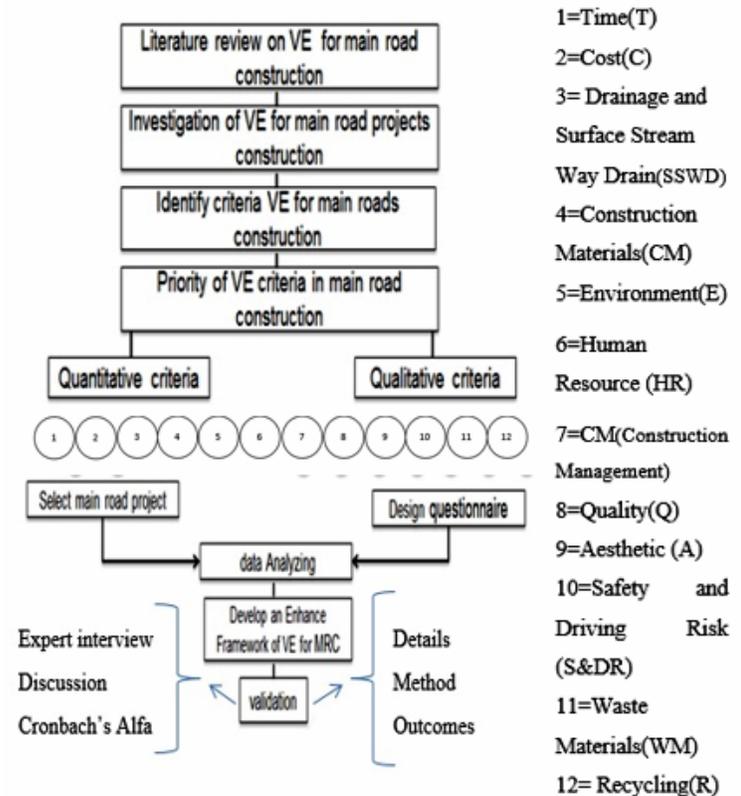
Below, the methodology of the work is presented:

Figure 2. Steps and levels for methodology

VIII. DATA COLLECTION AND ANALYSIS

Based on the first objective; "To determine the VE existing criteria for drainage and stream flow at main roads construction" 12 main factors of VE and DE & SSWD were identified after using factor analysis and one - way ANOVA with SPSS Version 22. According to the second objective; "To propose and develop an enhanced framework of VE based on runoff for main roads construction" the developed and enhanced framework were obtained. Finally based on the third objective; "To check the validity of VE enhanced framework for drainage engineering in main roads construction through a case study" confirmation, acceptance and reliability of the developed framework an enhanced was assessed by interview and discussion with experts, constructors, consultants and project management involved in projects of main roads, highways and streets construction for drainage and surface stream way drain.

In the present work, the pilot and actual studies were performed using 56 questions according to the existing VE criteria regarding to construction projects for DE and SSWD for highways, main roads and streets. To collect data, the prepared questionnaires were distributed between constructors, project managers and experts in Tehran. For pilot and actual

studies 70 and 450 questionnaires were distributed respectively. Finally, 190 respondents (30 for pilot and 160 for actual studies) returned filled up questionnaires, were collected.

A. Pilot study

The template is designed so that author affiliations are not SPSS reliability test for pilot study revealed that 46 out of 56 questions are statistically reliable the remaining 46 questions were used in the Cronbach's alpha as 0.802 (table 1), with 46 factors criteria total variance explained extraction method principal component analysis (table 2) and the main factors criteria in VE construction projects of main roads, highways and streets for DE & SSWD (figure 3). Therefore, the unreliable questions were corrected and 56 reliable questions were used in actual study.

Table1. Cronbach's alpha

Cronbach's Alpha	No. of Items
0.802	46

Table 2. Total Variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.357	18.168	18.168	8.357	18.168	18.168	5.112	11.113	11.113
2	5.948	12.930	31.098	5.948	12.930	31.098	4.866	10.579	21.692
3	5.075	11.032	42.130	5.075	11.032	42.130	4.139	8.997	30.689
4	4.554	9.901	52.030	4.554	9.901	52.030	3.991	8.675	39.364
5	3.829	8.324	60.355	3.829	8.324	60.355	3.656	7.949	47.313
6	3.733	8.116	68.471	3.733	8.116	68.471	3.595	7.816	55.129
7	2.828	6.148	74.619	2.828	6.148	74.619	3.369	7.323	62.452
8	2.451	5.329	79.948	2.451	5.329	79.948	3.149	6.845	69.296
9	2.265	4.923	84.871	2.265	4.923	84.871	3.108	6.757	76.054
10	1.539	3.346	88.217	1.539	3.346	88.217	2.903	6.310	82.364
11	1.334	2.900	91.117	1.334	2.900	91.117	2.819	6.128	88.491
12	1.025	2.228	93.346	1.025	2.228	93.346	2.233	4.854	93.346
13	.867	1.884	95.230						
14	.693	1.506	96.736						
15	.606	1.318	98.053						
16	.398	.864	98.918						
17	.188	.409	99.327						
18	.123	.268	99.595						
19	.095	.206	99.801						
20	.047	.102	99.903						
21	.021	.045	99.948						
22	.012	.025	99.973						
23	.011	.024	99.998						
24	.001	.002	100.000						
25	3.174E-16	6.899E-16	100.000						
26	2.653E-16	5.768E-16	100.000						
27	2.197E-16	4.777E-16	100.000						
28	2.050E-16	4.456E-16	100.000						
29	1.678E-16	3.648E-16	100.000						
30	1.483E-16	3.223E-16	100.000						
31	1.023E-16	2.223E-16	100.000						
32	6.133E-17	1.333E-16	100.000						
33	3.804E-17	8.269E-17	100.000						
34	3.022E-17	6.570E-17	100.000						
35	-5.318E-18	-1.156E-17	100.000						
36	-2.301E-17	-5.002E-17	100.000						
37	-3.478E-17	-7.561E-17	100.000						
38	-4.999E-17	-1.087E-16	100.000						
39	-7.657E-17	-1.665E-16	100.000						
40	-8.264E-17	-1.797E-16	100.000						
41	-9.778E-17	-2.126E-16	100.000						
42	-1.535E-16	-3.337E-16	100.000						
43	-1.971E-16	-4.284E-16	100.000						
44	-3.034E-16	-6.596E-16	100.000						
45	-3.494E-16	-7.596E-16	100.000						
46	-4.405E-16	-9.576E-16	100.000						

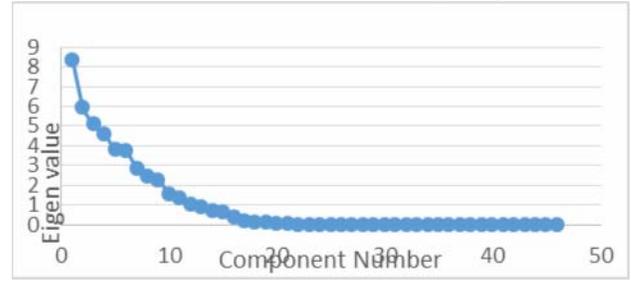Extraction Method: Principal Component Analysis.

Figure 3. The main factors Criteria in VE Construction Projects of Main Roads, Highways and Streets for DE & SSWD

B. Actual study

For actual study descriptive statistics can give only a picture of the studied population. However, it cannot express the relationship between variables and determine dependent variables. Therefore, this part tries to assess the hypotheses and the relations between variables using inferential statistics. Before any action, the most important action to be made is to select a proper statistical method fit to the study in order to implement statistical methods, to conduct statistical calculation, to perform appropriate examination and to have logic conclusions about hypotheses. In order to adopt statistical techniques, first of all it should be determined that whether the collected data have a normal distribution. If yes, parametric tests can be used for hypothesis examination purposes otherwise, non-parametric methods should be adopted. This study used Kolmogorov-Smirnov test to examine the normal distribute of data. This test assesses the normal distribution of data considering the following hypotheses (table 3). According to the obtained results, shown in above table (table 3), the significance level of components higher than error level is 0.05 implying the normal distribution of variables.

H0: the data are normally distributed

H1: data were not normally distributed.

Table 3. Normality and significance level

Factors	Significance Level	Error Value	Accept Hypothesis	Result
D & SSWD	0.207	0.05	H0	Normal
Time	0.052	0.05	H0	Normal
Cost	0.056	0.05	H0	Normal
Quality	0.087	0.05	H0	Normal
Aesthetic	0.121	0.05	H0	Normal
Human resource	0.111	0.05	H0	Normal
CM	0.365	0.05	H0	Normal
Environment	0.094	0.05	H0	Normal
Materials	0.283	0.05	H0	Normal
Safety & DR	0.074	0.05	H0	Normal
WM	0.054	0.05	H0	Normal
Recycling	0.345	0.05	H0	Normal

IX.   CONCLUSION

This study suggests 12 main factors for assessment of VE in DE and SSWD. Moreover, it represent a developed and enhanced framework for VE according to runoff for main road. However, the confirmation, acceptance and reliability of the developed framework an enhanced was assessed by interview and discussion with experts, constructors, consultants and project management involved in projects of main roads, highways and streets construction for drainage and surface stream way drain.

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