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The Role of Value Engineering in Reducing Stumbled Projects in Kuwait

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***Abstract*— This paper introduces the role of value engineering in reducing stumbled housing projects in Kuwait. The stumbled Public Authority for Housing Welfare Descriptive analytical approach was used in this research. The results show that the project's key success was realistic management planning: It provided all supporting tools for effectively applying the value engineering methodology. This study also declared that its benefit is limited despite the existence of a complete database for previous projects of the Public Authority for Housing Welfare. Based on the respondents' opinions, the application of value engineering at the beginning of any construction project has significant benefits to meet the project requirements, satisfy the owner's needs, and control the project's total costs.**

Keywords*— *Value Engineering; Stumbled; Construction Project

I. INTRODUCTION

Value management is an essential modern tool that analyzes three main project outcomes: efficiency of performance, quality of work, and production cost. It is used to overcome quality issues and save project time and cost [1]. Managerial issues or methods of managing the resources are the core of the development process; thus, successful management aims to enhance the managerial and technical issues, which started with quality checking. This has been extended to analyze the value and cost [2]. Many projects that are not well managed are susceptible to failure, although they are different in nature, size, and type. In these projects, it is necessary to identify the causes of the stumbling, analyze weaknesses, evaluate and monitor struggled progress, and then set the required precautions to elevate such problems [3]. The cost of stumbled project is estimated between 5% -20% of the contract's value [4].

Based on monthly reports from the Public Authority of Housing Welfare projects, a high percentage of project schedule delays caused housing projects to stumble. While most of these stumbled projects had clear requirements from the stakeholders, they have multiple causes of delay due to financial, schedule, and contractual problems [5].

II. BACKGROUND

Value engineering (VE) can improve the quality of projects by increasing their value, reducing their costs, and achieving the required specifications. Therefore, the project management team should employ the VE method to enhance project performance. This can be achieved by optimizing the use of resources, money, time, and effort [6].

The significance of value management has increased since it succeeded in fixing many administrative processes problems especially technical issues. The justifications underlying the increasing costs in administrative work will never end if there are different managers and systems [7].

III. DEFINITION OF VALUE ENGINEERING

In general, VE is defined as a creative and organized approach that can optimize the cost and the performance of their facilities or systems [8]. It is a proven management technique that was previously used as a systematic approach to get the best function balance between loss, ratability, and performance of their product or project management programs. It seeks to improve people's capability to promote progressive change by identifying and moving all unnecessary costs.

VE constitutes a function-based thinking system to identify and remove all unnecessary costs to keep or enhance the quality of any manufacture, construction, or service for each dollar spent [9].

A. Value Engineering Process

The VE process starts with the inception of the architect's idea according to the client's priorities and requirements. The VE process considers the clients' preferences to improve and optimize the final product to maximize the quality and reduce the total cost. This approach requires the involvement of all disciplines and client representatives when making decisions. It is necessary to include external parties to consider their requirements and ideas [10].

B. Methods of VE

Use The value engineering study's main objective is to identify new ideas that can enhance work value and reach the project's optimal quality level. Value engineering studies are developed in three stages: pre-study, VE workshop, and post-study. VE has qualities that analyze each phase and functionality. The pre-study stage confirms that all required documents are complete. The workshop stage consists of six phases: information phase; function analysis; speculation and creativity; evolution and judgment; development and reporting.; and presentation and implementation. The last step is to follow the recommendations [10]. The VE method according to the SAVE international organization consists of three stages [11].

VE analysis saves government agencies in the US and UK billions of dollars a year. Value analysis studies have been conducted for projects that included the US Federal Highway Administration and Federal-Aid Highway Program and saved the agency an average of 14.9 billion dollars over ten years between 2007 and 2016 representing 6% of the projects' estimated construction cost [12].

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C. *VE Support in Constrution Projects*

Value is a function of cost relative to the quality of construction projects. VE studies save time, money, and provide superior performance versus projects without these studies. Several studies in the literature suggest that the VE exercise is indeed a great system that should be implemented in every industry as much as possible [13]. VE plans to bring quantifiable value developments through price lessening and quality enhancing for the customer [14].

A recent paper from Nigeria [15] explored the stages of a VM workshop and derived the critical success factors of VM from previous research. They were identified as follows: multidisciplinary team mix of participants; VM workshop intervention into project development cycle; training/qualifications/competency of the VM facilitator; presence of decision-makers, client support, and active participation; job plan execution/implementation plan, and end user's participation. The study concluded that such VM's inclusion will benefit all construction projects once these factors are considered.

A study using principal component analysis to identify the main challenges hindering using VE in construction projects pinpointed five principal component groupings: 'VE team obstructions', 'VE study obstructions', 'VE implementation difficulties', 'conceptual problems', and 'developing economies obstructions'. These were the main categories where most main factors reside [16]. The construction industry generally acknowledges the necessity of effective application of value engineering to construction projects, and the findings indicate that VE is a very effective construction management tool [17]. Another study in Jakarta evaluated the slow adoption of VE in construction projects and reported that the main obstacles undermining such a process are limited understanding of VE government regulations and its benefits from project stakeholders [18]. The construction industry's critical barriers are inadequate facilitation of skills and training and difficulty in the involvement of decision-makers and other key partners in the VM workshop [19].

Based on literature analysis, the level of awareness about VE studies in the construction industries was average. Construction projects need more effort to maximize the awareness and applications of value management to enhance project outcomes. They can try and incorporate it into their work ethics for better productivity [20].

IV. Research Methodology

The research methodology has been designed (Figure (1)) to identify the most common causes that affect stumbled projects in Public Authority for Housing Welfare in Kuwait. The research method includes four consecutive steps: First, a literature review was done to identify the causes of stumbled projects with poor performance. One can then identify the effect of using VE to reduce the number of stumbled projects. The second step was to conduct a preliminary field survey with several project managers as well as technical and consulting engineers to benefit from their experience while adding, removing, or modifying proposed stumbled causes. The third step was to develop the final questionnaire to collect data from construction professionals as discussed previously. The fourth step is to analyze the received data and rank the most common reasons affecting stumbled housing projects in Kuwait.

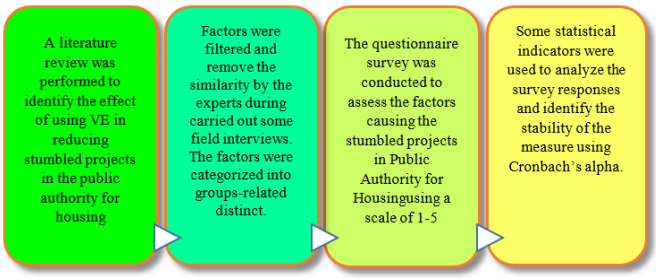

Fig. 1. The Research Methodology.

A. *Literature Review*

Our goal was to identify all factors related to the effect of value engineering on project performance. Based on previous studies, all factors were binned into six categories: planning, design, contract awarding, supervision performance, contractor performance, and VE.

B. *Field Interviews*

All factors resulted from the previous phase have been initially interviewed with construction experts to analyze all factors, removing unnecessary factors, adding other factors based on their experience, or modifying the current factors.

C. *Questionnaire Development*

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

1. Planning department status.
2. Design department status.
3. Contract awarding status.
4. Effect of supervision performance.
5. Effect of contractors' performance.
6. Effect of using value engineering.
7. Impact of VE on planning management performance.

The arithmetical averages and standard deviations of the study sample on all fields will be calculated based on a scale of 1 to 5 (where 1= strongly disagree, 2= disagree, 3=medium, 4=agree, and 5=strongly agree). The descriptive approach has been used to identify the real causes affecting stumbled housing projects in the Public Authority for Housing Welfare construction projects. Books, journals, and previous studies related to the research study were also used.

A final survey questionnaire was designed and distributed to the Public Authority for Housing Welfare in Kuwait to identify different factors affecting Kuwait's construction projects.

TABLE I.

UESTIONNAIRE

Field	Mean	Std. Dev.	Level
Available data from previous projects	3.78	1.07	High
Granting an adequate time for design	3.14	1.31	Moderate
The contracts awarded for the lowest price without considering the technical aspect	4.00	1.14	High
There is a lack of efficiency in some employees from the supervisory role	3.79	1.03	High
A VE department in the authority will lead to the successful implementation of value studies for the projects	4.28	0.72	High

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The analysis of the questionnaire shows that even though there is a database of old projects, they were not used. There was some lack of experience in developing the project schedule. Failure to give enough time to design contributes to the emergence of several problems during implementation. Awarding the lowest prices—regardless of the technical side—greatly contributes to the delay of projects. There is a weakness in the competence of some of the supervisory staff, which can lead to problems and delays. This problem is in addition to the lack of experience of some of the workers, poor materials, and poor technical capabilities of the contractor. These features all contribute to problems with the projects. Finally, the creation of a VE department in the organization will contribute to the successful application of value studies to projects.

TABLE II.

DEMOGRAPHIC RESULTS

Variable	Demographic Results		
	Level	*Number*	*Percentage*
Gender	Male	86	77.48%
	Female	25	22.52%

TABLE III.

COHORT BY QUALIFICATION

Variable	Demographic Results		
	Level	*Number*	*Percentage*
Education	Postgraduate	11	9.91%
	Bachelor	92	82.88%
	Lower than Bachelor	8	7.21%

TABLE IV.

COHORT BY EXPERIENCE

Variable	Demographic Results		
	Level	*Number*	*Percentage*
Years of Experience	Less than 5 years	7	6.31%
	From 5 to 10 years	23	20.72%
	From 11 to 15 years	35	31.53%
	From 16+ years	46	41.44%

TABLE V.

SAMPLE IN TERMS OF JOB VARIABLE

Variable	Demographic Results		
	Level	*Number*	*Percentage*
Job	Planning	12	10.81%
	Design	13	11.71%
	Supervision	53	47.75%
	Contractor	33	29.73%

TABLE VI.

COHORT BASED ON VE FAMILIARITY

Variable	Demographic Results		
	Level	*Number*	*Percentage*
VE	Familiar	99	89.19%
	Unfamiliar	12	10.81%

D. Data Collection

All factors resulted from the previous phase have been initially interviewed with construction experts to analyze all factors, removing unnecessary factors, adding other factors based on their experience, or modifying the current factors.

1) Study Population: The study was conducted on engineers and their assistants from the planning department, design management, and implementation management, as well as the contractor's engineers of the Public Authority for Housing Welfare in Kuwait. There were 277 members in the studied population.

2) Study Sample: There were 130 engineers (both male and female) and their assistants for the projects of the Public Authority for Housing Welfare in Kuwait selected. The questionnaire was distributed randomly to 130 experts; 111 completed questionnaires were received. Table 4.1 represents the demographic characteristics including gender, academic qualification, years of experience, and the respondents' job. Table II shows that respondents' categories where men are 77.48%, and women represent 22.52%. Table III shows that bachelor's degree holders have the highest percentage (82.88%) followed by higher education category (9.91%); those with less than a bachelor's degree is (7.21%). Table IV shows respondents based on experience (16 years and above at 41.44%). This suggests we will have reliable results because the respondents have good experiences in the field of the research study. According to Table V, supervisors had the highest response percentage (47.75%) followed by contractors (29.73%) and others. Table VI shows respondents familiar with VE (89.19%) while the percentage of unfamiliar with VE is (10.81%) indicating that the institution set the basic requirements for applying VE for their projects.

3) Data Validation: A survey sample was distributed to 20 respondents. The objective of this step was to verify the validity of the scale by calculating the correlation coefficient for all factors into each category with a total score shown in Table VII. It is clear from Table VII that most measurements in each category have a high degree of correlation with the total score ranging from 0.407 to 0.87 of the field. Most correlation coefficients were statistically significant below 0.01.

4) Stability of the Data: The measurement was applied to a survey sample of 20 respondents. The objectives were to verify the stability of the data via internal consistencysmethod using Cronbach's alpha and Table VIII. Table VIII shows that the stability values ranged between 0.85-0.92 and the total stability value (0.90). All of these values are sufficient and adequate to achieve the objectives of this research study.

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TABLE VII. C

CORRELATION COEFFICIENTS.

Planning		Design		Awarded		Supervise		Contractors		VE	
Item	R^2	Item	R^2	Item	R^2	Item	R^2	Item	R^2	Item	R^2
1	.792**	1	.728**	1	.724**	1	.711**	1	.407*	1	.713**
2	.837**	2	.750**	2	.701**	2	.763**	2	.443*	2	.817**
3	.715**	3	.855**	3	.819**	3	.616**	3	.741**	3	.875**
4	.778**	4	.765**	4	.622**	4	.543**	4	.519**	4	.754**
5	.668**	5	.773**	5	.769**	5	.741**	5	.507**	5	.788**
6	.558**	6	.641**	6	.596**	6	.707**	6	.681**	6	.748**
7	.861**	7	.682**	7	.861**	7	.742**	7	.516**	7	.804**
8	.716**			8	.727**	8	.827**	8	.554**	8	.686**
9	.764**					9	.758**	9	.566**	9	.845**
10	.624**					10	.666**	10	.563**		

[a] *statistically significant at 0.05

[b] **statistically significant at 0.01

$$s.d = \sqrt{\frac{\sum_i^n (xi - \bar{x})^2}{n-1}} \quad (1)$$

TABLE VIII. C

COEFFICIENTS OF STABILITY FOR CHRONBACH'S ALPHA

Chronbach's Alpha		
Category	***Items***	***Coefficient***
Planning Department Status	10	0.90
Design Department Status	7	0.86
Award System Status	8	0.88
Effects on Supervision Performance	10	0.88
Effects on contractors Performance effect	10	0.85
Effect of using VE	9	0.92
Total items	54	0.90

V. RESULTS AND DISCUSSION

The Statistical Package for Social Sciences (SPSS) was used in this research study to analyze the data collection based on the following goals.

1. To find the correlation coefficient between the categories' items and the total score of the category.
2. To find the measurement of the data stability using Cronbach's alpha.
3. To calculate the arithmetical averages of and standard deviations of the survey sample on all categories.
4. Regression analysis to verify the impact of VE on the effectiveness of the planning department.

The data from 111 respondents were analyzed, and the arithmetic mean was calculated for each factor according to Equation 1.

A. Planning Department Related Factors

The planning department is the first category, and it affects the overall VE process. Table IX shows that the database on previous projects in the authority has limited value. It is clear that the experience of developing the project schedule was insufficient and a lack of available data caused project problems. Poor quality in some projects is also due to poor planning.

TABLE IX.

PLANNING DEPARTMENT-RELATED FACTORS BY ARITHMETIC MEAN

Item	***Field***	***Mean***	***S.D.***	***Level***
6	Available data from previous projects	3.78	1.07	High
7	Lack of experience in estimating the project duration	3.69	1.20	High
10	Poor quality in some projects due to poor planning	3.61	1.25	Moderate
2	Site study was done before the project execution depending on the nature of the project	3.41	1.31	Moderate
5	Coordination between all departments related to the project	3.39	1.34	Moderate
3	The department sets the specification and rules carefully prior to starting the project	3.35	1.31	Moderate
9	A clear future vision during the planning stage	3.16	1.20	Moderate
8	A specified team of strategic planning to a housing plan	3.11	1.16	Moderate
4	Administration update specifications for the project	3.10	1.30	Moderate
1	The study considers all future problems	2.97	1.33	Moderate

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TABLE X.
DESIGN DEPARTMENT-RELATED FACTORS BY ARITHMETIC MEAN

Item	Field	Mean	S.D.	Level
4	Modifications made to contractual designs	3.83	0.85	High
2	The existence of unclear contractual drawings	3.80	1.15	High
6	A delay in approving any modifications to the design	3.71	1.11	High
3	Conflicts between contractual drawings	3.68	1.16	High
5	Errors in calculating the real quantities of the project items	3.61	1.06	Moderate
1	Granting an adequate time for design	3.14	1.31	Moderate
7	The designer is very familiar with the on-site implementation methods	2.76	1.31	Moderate

TABLE XI.
CONTRACTS AWARDING-RELATED FACTORS BY ARITHMETIC MEAN

Item	Field	Mean	S.D.	Level
5	The project timelines are not commensurate with the size of these projects. The time provided for the project is insufficient.	4.03	1.07	High
1	The contracts awarded for the lowest price do not consider the technical aspects.	4.00	1.14	High
3	Tendering several projects over a short period of time.	3.95	0.95	High
4	The same tender requirements and specifications are used for more than one project.	3.81	1.06	High
2	Budget valuation is carried out accurately before signing the contract	3.32	1.11	Moderate
8	Foundations for qualifying companies to enter tenders	3.31	1.30	Moderate
6	The authority shall estimate the prices of the project items accurately before the offer	3.07	1.16	Moderate
7	Companies that stumble in previous projects are excluded	2.81	1.45	Moderate

TABLE XII.
SUPERVISORY PERFORMANCE-RELATED FACTORS BY ARITHMETIC MEAN

Item	Field	Mean	S.D.	Level
1	There is a lack of efficiency in some employees from the perspective of the supervisor	3.79	1.03	High
5	A delay in resolving the issues between the parties of the project	3.76	0.91	High
2	Intransigence of some employees from the perspective of the supervisory	3.66	1.01	Moderate
4	The contractual terms and conditions are strictly followed	3.57	1.09	Moderate
6	A delay in approving the shop drawings	3.56	1.19	Moderate
3	Many variation orders take place during the construction project	3.53	1.09	Moderate
7	A delay in approving necessary materials during the construction stage.	3.38	1.08	Moderate
8	A delay in approving the laboratory tests for the project samples	3.14	1.10	Moderate
10	Penalties applied in a project	2.97	1.39	Moderate
9	The procedures for the termination of projects are applied to the stumbled companies	2.68	1.28	Moderate

TABLE XIII.
D
TABLE XIV.
CONTRACTOR PERFORMANCE-RELATED FACTORS BY ARITHMETIC MEAN

Item	Field	Mean	S.D.	Level
1	Lack of experience of some contractors' laborers	4.41	0.74	High
6	The weakness of financial capacities and technical potential of the contractor	4.33	0.94	High
2	A shortage and difficulty in providing laborers	4.15	0.78	High
8	Laborers' payment are delayed by some contractors.	3.87	0.93	High
3	A delay in the preparation of the shop drawings	3.74	1.05	High
7	The contractor faces difficulty in supplying some materials during the construction	3.59	1.01	Moderate
5	There are standards and criteria for measuring project performance	3.40	1.05	Moderate
4	Compatibility between construction project contract conditions	3.36	1.08	Moderate
10	Subcontractors are contracted without the consent of the owner	3.09	1.32	Moderate
9	The contractual schedule is followed	2.52	1.10	Moderate

C

B. Design Department Related Factors

This section discusses the design department category based on data received and its effectiveness on VE and project performance. This category included seven factors as shown in Table 5.2. According to data analysis, each factor's arithmetic mean was calculated based on all respondent's answers.

The results indicated several problems such as the rush in project design where corrections are made during execution causing delays. The lack of clarity includes some shop drawing.

C. Contracts Awarding Related Factors

The third category was about different factors related to awarded contract and their effect on VE and the project's overall performance. This category included eights factors (Table 5.3). According to data analysis, each factor's arithmetic mean was calculated based on all respondent's answers. The results indicated that contracts awarded based on the lowest prices regardless of the technical aspect contributed significantly to project stumbling.

TABLE XV.
APPLYING VALUE ENGINEERING ON AUTHORITY PROJECTS FACTORS RANKED ACCORDING TO ARITHMETIC MEAN

Item	Field	Mean	S.D.	Level
1	Training and qualifying of the workers in the field of the Authority enabled them to apply value studies Authority projects	4.30	0.75	High
2	A VE department in the Authority will lead to the successful implementation of value studies for the projects	4.28	0.72	High
3	The use of VE to analyze the project functions and their compliance with the requirements of the end-user increases the quality and performance of the project	4.24	0.68	High
4	VE contributed to the lowest prices of the project requirements, which increased the performance of the project	4.14	0.70	High
8	The design department will apply VE for all projects	4.13	0.73	High
5	Determination of the most appropriate methods for construction projects such as	4.09	0.72	High

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Item	Field	Mean	S.D.	Level
	operation and maintenance by applying VE studies to reduce the project costs			
6	VE factors will contribute to spending the rationalization in the Authority's projects	4.05	0.81	High
7	Encouraging companies to conduct value engineering studies would help to raise the quality of the projects	4.03	0.77	High
9	Applying VE will reduce project stumbling	3.93	0.92	High

TABLE XVI.
THE REGRESSION VARIANCE TEST RESULTS FOR VE IMPACT THE PLANNING MANAGEMENT EFFECTIVENESS

Variance	Squares Total Sum	DoF	Ave.	R	R^2	F	P
Regression	24.35	1	24.35				
Residuals	49.18	109	0.45	0.58	0.33	53.4	<0.001
Total	73.53	110					

TABLE XVII.
RESULTS OF THE SIGNIFICANT REGRESSION COEFFICIENT TEST TO PREDICT THE PLANNING DEPARTMENT'S EFFECTIVENESS IN USING VE.

Ind. Variable	Regression coefficient (Ω)	Value of Statistical test t	Significance Level
VE	0.78	7.35	<0.001

D. Supervisory Performance Related Factors

This section discusses the supervisory performance and its effect on the overall VE and performance of the project. This category included ten factors as shown in Table 5.4. According to data analysis, each factor's arithmetic mean was calculated based on all respondent's answers. The results indicated a lack of efficiency for some employees from the supervisory that contributed to construction project delays. Based on the expert opinions, the occurrence of many variation orders during the implementation stage was due to a lack of clarity in setting the project requirements' priorities.

E. Contractor Performance-Related Factors

Contract awarding is the fifth category and may affect the overall project performance. This category included ten factors (Table 5.5). The arithmetic mean was calculated for each factor based on all respondent's answers: The results indicated that contract awarding was based on the lowest prices regardless of the technical aspect and contributed significantly to project stumbling. Tendering several projects over a short time led to several problems such as a lack of resources leading to project delays.

F. VE-Related Factors

Applying VE is the sixth category and may affect the project performance for a housing project. This category included nine factors (Table 5.6). According to data analysis, each factor's arithmetic mean was calculated based on all respondent's answers. The results indicated that the VE department in the authority contributed to successful value studies for the projects. The training and qualification of the workers enabled them to apply value studies easily on Authority projects. Moreover, the Public Authority is currently encouraging more engineers to be involved in their projects.

1) Impact of applying value engineering on the effectiveness of planning management: The Table 5.7 indicated that there is a significant relationship between the independent variable and the dependent variable. The correlation coefficient value is 0.58, which reinforced the results of the calculated value F(53.98). This was statistically significant because the p-value was <0.01. The variance in the use of VE explains 33% of the variation in the planning department's effectiveness based on the value of the coefficient of determination. Table 5.8 shows the results of the regression coefficient. Table 5.8 shows the results of the t-test—the value of the regression coefficient using VE was statistically significant with a p-value of <0.001. The signal of the regression coefficient indicated that the relationship between VE and planning management is positive. VE leads to more efficient planning management. Hence, increasing VE with one unit increases the efficiency of planning management by 0.78 units.

VI. SUMMARY AND RECOMMENDATIONS

The The main objective of this paper was to determine the importance of applying VE studies for Kuwaiti housing projects. The survey results and analysis suggested that effective planning management in the Public Authority for Housing Welfare projects would benefit from VE methodologies. The study further showed that despite the existence of a database for past projects at the Public Authority for Housing Welfare, there were limited benefits. The quality of some projects was bad due to poor planning. The results also indicated some problems that occurred during implementation due to insufficient design time. Moreover, the study reveals that awarding according to the lowest prices regardless of the technical side contributes significantly to stalling projects. The study suggests that developing VE management systems in the Public Authority for Housing Welfare will contribute to the application of value studies successfully.

Suggestions should be applied in the Public Authority for Housing Welfare for successful application of value studies:

1. Training and qualifying employers in the field of VE.
2. Establishing VE management in organizations contributes to a successful application of value studies in projects.
3. Encourage companies to apply value studies and give companies that do VE special benefits.
4. The best time to apply VE is during the planning phase of the project.
5. Preparing specifications and conditions catered to Kuwait state projects.
6. Give adequate and appropriate time for designers.
7. It is essential to set standards and specifications for values set by a selected group of experts in VE.
8. Establishing good relationships and coordination between all parties involved in the project and achieve effective and continuous communication.

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9. Identifying and defining the special needs of the targeted group of the project.
10. Review the purchasing process and not rely only on the lowest price.

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