DEVELOPMENT OF A VALUE ENGINEERING MANAGEMENT SYSTEM FOR CONSTRUCTION PROJECTS IN IRAQ

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ABSTRACT

The escalating cost of construction projects combined with the competitive nature of the construction industry requires the constant search for methods to increase the efficiency of such projects through the elimination of unnecessary costs while maintaining as well as improving levels of quality and performance desired.

Value Engineering (VE) offers an opportunity to achieve these goals, however, VE utilization by the construction industry in Iraq remains limited as hypothesized by the researchers. Hence, the reasons for this condition are worthy of investigation .Based on that, this research work has attempted to examine the current status of implementation of value engineering methodology within the Iraqi construction industries, well as pinpointing areas of weakness in applying VE.

The validity of the research hypothesis was tested by carrying out both an open and closed questionnaires, where a sample of Iraqi professional engineers working in both the public and private sectors have participated in responding to the questionnaires. Analysis of responses to the questionnaires has indicated the validity of the research hypothesis as well as identifying significant slips, which hinder the proper application of VE by the Iraqi construction industry. The researchers has proposed certain remedial actions to overcome these slips which have initiated the second major objective of the research work which entails the proposal of a "Value Engineering Management System" (VEMS) to facilitate the systematic application of VE methodology and techniques by the Iraqi engineers.

The evaluation process of the system by a number of experts has demonstrated approval and possibility of application in the field.

الخلاصة

ان الارتفاع المتزايد لكلف المشاريع الإنشائية مصحوبا بالطبيعة التنافسية للصناعة الإنشائية يتطلب البحث المستمر عن أساليب تزيد من كفاءة تلك المشاريع من خلال التخلص من الكلف غير الضرورية وفي الوقت نفسه المحافظة وتحسين مستويات النوعية والأداء المطلوب.

هندسة القيمة توفر أداة لتحقيق هذه الاهداف، حيث قد أثبتت نجاحها في أنحاء مختلفة من العالم. هذا النجاح كان من خلال تحقيق موفورات مالية ملموسة في الكلف التخمينية الأولية للمشاريع بدون التضحية بالنوعية او المعايير الموضوعة من قبل صاحب العمل. على الرغم من ذلك، فان توظيف هندسة القيمة في الصناعة الإنشائية في العراق لا يزال محدودا حيث الأسباب الكامنة وراء هذه الظاهرة تعتبر جديرة بالبحث.بناء على

ما تقدم، جاء هذا البحث ليقوم بدراسة واقع حال تطبيق منهجية هندسة القيمة في الصناعة الإنشائية في العراق وفقا لفرضية البحث التي قدمت من قبل الباحثين.

تم اختبار صلاحية فرضية البحث من خلال القيام باستبيان حقلي مفتوح أخر مغلق حيث تم اعتماد عينة من المهندسين العراقيين المختصين والعاملين في القطاعين العام والخاص ليشاركوا في الإجابة على الاستبيانين.

أن تحليل نتائج الاستبيانين قد أظهرت معوقات مهمة تحول دون التطبيق الصحيح لهندسة القيمة في الصناعة الإنشائية العراقية.

قام الباحث باقتراح عدد من الإجراءات العملية للتغلب على هذه المعوقات والتي مهدت إلى تحقيق الهدف الرئيسي الثاني للبحث آلا وهو اقتراح نظام أدارى لهندسة القيمة أطلق عليه اختصارا

مكن من خلاله التطبيق المنظم لمنهجية وتقنيات هندسة القيمة من قبل المهندس العراقي.VEMS

KEY WORDS
Construction Projects Management, Value Engineering,

INTRODUCTION

The Construction industry can be characterized as dynamic, complex, and highly competitive. Each project is composed of hundreds of items and a multitude of sophisticated systems and trades. The enormous number of available choices of materials and methods of implementation can be regarded as a challenge to construction managers, designers, and contractors in selecting the right method or material to be used in their projects. The cause of this challenge, stems from the fact that if a construction project is to be considered successful and efficient, it must perform its intended functions as required by the project owner at the lowest possible cost, which ultimately means selecting the right product at the right price.

Hence, there is always a growing need to explore new management techniques to augment the decision making process as far as selecting optimum design solutions and implementation methods in order to improve the value of the construction projects.

The concept of Value Engineering (VE) is gaining considerable attention throughout the construction industry in various parts of the world as a proven approach aiming not only at reducing the overall cost of construction projects, but further to enhance the functional performance through its creative solutions. The multiple techniques utilized in the practice of VE methodology enable decision-makers to explore new materials and methods in a way that increases the value and eliminates unnecessary costs.

HISTORICAL DEVELOPMENT OF VE:

VE developed during World War II in the United States. It began as a search for alternative product components, a shortage of which has developed as a result of the War (Palmer et al. 1996).

The General Electric (GE) Company undertook the initial development of VE. The person responsible for this development is Lawrence D. Miles, an electrical engineer with GE (Zimmerman 1982). The initial term used by GE was "Value Analysis". As the company experienced shortages in vital metals such as steel, aluminum, copper, Bronze, Nickel, and tin, it had to look for substitutes, keeping in mind that the function remains the same while the method of providing the function is different.

The company noticed that these substitutes resulted in substantial reductions in costs accompanied by an improvement in quality. GE decided to study this phenomenon, and Mr. Miles was assigned to this task in 1947. value analysis (VA) technique was accepted as a GE standard and gradually other

companies and government organizations adopted the new approach as a mean of reducing costs (O'Brian 1976). In 1954, the Navy Bureau of Ships, a division of the Department of Defense, established a value program. At this stage of the value method development, the US Navy due to a significant justification switched the terminology from value analysis to Value Engineering. The GE program selected an existing product that was being manufactured and analyzed it for unnecessary costs. The US Navy, on the other hand, felt it would be more prudent for their needs if they analyzed the engineering drawings before anything was built. Hence, the term value engineering was adopted since the approach will be applied at the design and engineering stage. Following the Navy's lead, the US army and Air Force also launched a VE program in their establishments.

VE, as applied to the construction industry, has been used since the late 1960's or early 1970's (Zimmerman 1982).The method was introduced by Alphonse J. Dell'Isola, into the US Navy Facilities engineering command in 1963, principally through the introduction of Department of Defense (DOD) VE incentive provisions in construction contracts (Dell'Isola 1982). This development came as a result of a directive issued in 1962 by the US secretary of Defense. This directive made the use of VE as a mandatory requirement according to the "Armed Services Procurement Regulation" (ASPR) for all procurements exceeding $100,000, and value program be included in certain contracts over $1 million. This requirement introduced VE to two of the largest construction agencies in the US, the army corps of engineers and the US Navy Bureau of Yards and Docks. The utilization of VE spread to other governmental departments (non military) in the United States. Some of these departments made it mandatory to include a VE clause in their design and engineering contracts. The introduction of VE into other countries outside the US came during the 1970's, a period much later than the inception of the idea in the late 1940's.In Japan, VE was introduced in 1970 through the auspices of the "Institute of Business and Management of Tokyo". In 1978, Italy began utilizing VE through a firm called "Chemint" of Milan. In Canada, "Bell" of Canada, and the "British Columbia Building Corporation" established a VE program in 1978, as did "Public works Canada" in 1980. (Dell'Isola 1982)

In the mid 1980's, Saudi Arabia founded a VE program in the "General Administration of Military Works" which is affiliated with the Defense and Aviation Ministry. Many VE studies were undertaken on different projects (Al-Owaid 1995).Egypt has undertaken VE studies in the early 1990s to evaluate Bridge construction systems (Bash et al.1991).

VE METHODOLOGY

The application of VE studies is implemented primarily through the utilization of a process termed the "Job Plan". The Job Plan is a systematic procedure for accomplishing all necessary tasks associated with a VE study.

O'Brian (O'Brian 1976) defines the Job Plan as the disciplined system which combines special technology of value analysis which other procedures and techniques to result in the complete analysis. The key features separating the Job Plan from other cost reduction techniques are functional analysis, use of creativity to develop and evaluate multiple alternatives, and the principle of maintaining the necessary quality to meet the user's need. (Macedo et al. 1978).

Adopting the organized and systematic approach of the VE Job Plan is the key to success in conducting a VE study. It allows the identification of unnecessary costs and seeks new and creative ways for performing the same function as the original part, process, or material. Different forms of the Job Plan are illustrated in **Table (1)**, which illustrates the variation in phases depending on the entity which authored the procedure.

General over view of Job Plans indicates that at a minimum, any Job Plan must be comprised of the following phases as perceived by the researchers:

1- Information phase.
2- Creative phase.
3- Analytical phase.

4- Evaluation and Development phase.
5- Recommendation phase.

Reasons for Using The Job Plan

There are distinctive reasons behind the application of the sequential steps in the Job Plan, which are unique to the VE approach and assist in maximizing its effectiveness (Zimmerman 1982).

- An organized approach. Following a Job Plan allows project studies to accomplish more in a short period of time, through restriction of study period within scheduled procedures.
- It forces a concise description of purpose. The Job Plan directs the study team to define requirements of project and to assess its true function.
- It concentrates on high cost areas. It allows the VE team to identify the concentration of cost, and to associate cost required to achieve a purpose.
- It forces people to think deeper than their normal habit solutions. The Job Plan directs and motivates people to make several comparisons and to analyze in detail how the total system works as well as the function of each part.
- Objective approach. The Job Plan allows objective look at the project, concentrating on the life-cycle costs of the facility. Participants in a VE study should avoid the tendency to disregard the step-by-step approach of the Job Plan which may result in the study degenerating into a design review. Design Reviews find obvious high cost saving with the tendency to overlook hidden high costs.
- Universal approach. The Job Plan is universal in its approach. It has been applied to manufacturing, system processes, construction projects, and software. In the construction field VE has shown excellent returns. Highways, bridges, waste water plants, chemical plants, power plants, buildings, transportation system, and other area have been value Engineered successfully.

VE TECHNIQUES

Major techniques utilized by VE specialists can be identified as follow:

1- Cost Modeling Technique.

The cost model can be considered as a technique to organize and distribute estimated cost into functional areas that can be easily defined and quantified. The main purpose of building a cost model is to ascertain project areas with abnormally high cost through the comparison of estimated costs with past historical costs of similar items.

2- Functional Analysis System Technique (FAST).

The purpose of FAST is to simplify the design, operation plan, procedure, or problem into identifiable functional parts thereby simplifying the problem. FAST is an effective, efficient method of getting good answers to three common sense, tough – minded management logic questions:" what is the problem?" "Why is a solution necessary?" "How can the solution be accomplished?"

3- Evaluation Matrix Technique.

Matrix Evaluation is used to augment the capability of evaluating value engineering recommendation where economic as well non – economic criteria should be considered. There are other parameters that should be considered in evaluating value engineering recommendations. Redesign costs, implementation time, performance, safety, aesthetics and owner – preferences are a few of the criteria's in the final judgment of ideas.

4- Life Cycle Costing Technique.

Life cycle costing can be defined as the systematic evaluation of alternative building designs and the comparison of their projected total owning, operating, and maintenance cost over the economic life of the proposed building (Macedo et al. 1978).

5-Delphi Technique.

Delphi technique is a simple concept that can be applied within a VE study. It is defined as "a method of obtaining consensus from a group of qualified individuals as a whole in first identifying then

evaluating of potential cost saving and design alternatives at early design stages in the absence of reliable cost data".

It should be mentioned that it is not necessary to utilize all the above techniques within the VE study. The expertise of the study team members and the importance of the item under study usually determine the technique or multiple techniques to be used in the study.

VALUE ENGINEERING STUDY PROCEDURES

Undertaking effective VE studies in order to realize the desired goal of reducing overall project cost while maintaining required performance and function is closely linked to the design phases of the construction project. Proper management of the VE study and related functions is key to its success. The development of a new facility goes through many phases starting from the point of the project idea inception until the project is commissioned and occupied by the intended users. The cost factor can be controlled effectively in the design phase of the project. **Fig. (1)** clearly illustrates the great influence of the role of Architect/Engineer in charge of design preparations on the overall cost of the project.

he benefits attained from VE application within the development process of a project varies with regard to the various phases of this process. The development of a new project goes through many phases from the time of its inception until it is usefully occupied and operated. To determine the most appropriate phase of VE application, it is necessary to review the various project development phases and the role of VE can contribute in achieving an optimum design solution as far as cost and function are concerned.

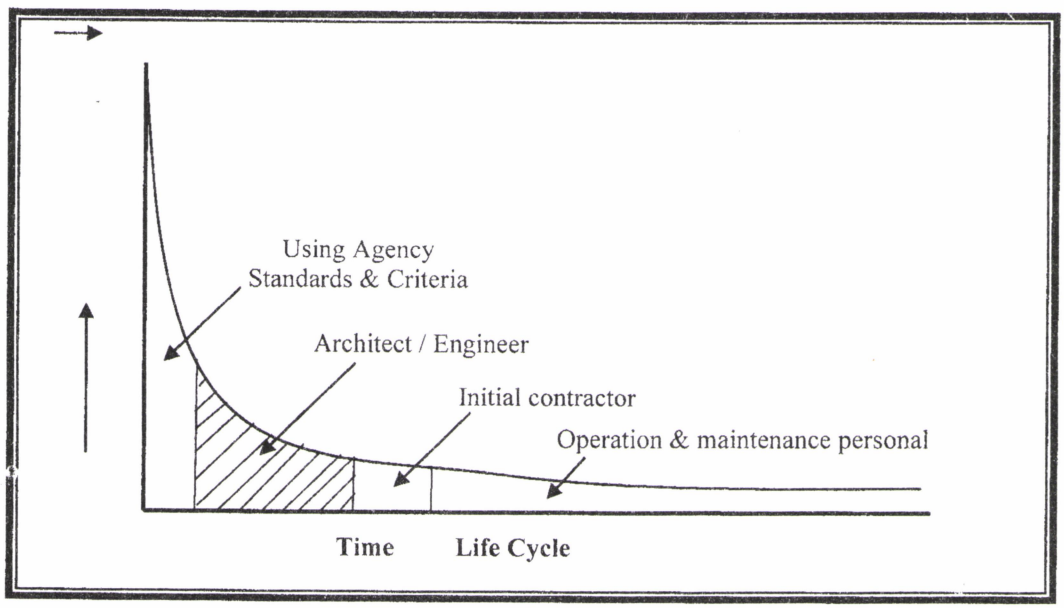

Fig. (1) Decision-Makers Influence on Cost.

Source: (Goldhaber 1977).

Table 1 Methodologies Adopted in VE Job Plans.

Source: (Al-Ansari 2000)

Source	Miles 1961	DOD 1963*	DOD 1968	Heller 1971	Mudge 1971	**GSA PBS 1972	Miles 1972	***PBS 1974	Macedo 1978	****US/ EPA 1982	Zimmerman 1982	Dell'Isola 1982	***** Save 1999
Methodology Phases	Preparation	Information	Preparation	Information	Area Selection	Preparation	Information	Information	Information	Information	Information	Information	Information
	Information	Alternatives Formulation	Information	Creative	Information	Information	Functional Analysis	Functional Analysis	Alternatives	Creative	Creative	Alternative	Creative
	Alternative Formulation	Analysis	Alternatives Formulation	Evaluation	Functional Analysis	Alternatives Formulation	Creative	Creative	Analytical	Investigation	Critique	Analytical	Evaluation
	Analysis	Development	Analytical	Study	Creative	Analysis	Critique	Analytical	Development	Recommendation	Development	Proposal	Development
	Program planning	Proposal Evaluation	Development	Documentation	Evaluation	Development	Development	Development	Proposal	Implementation	Recommendation	Final Report	Proposal Evaluation
	Program Implementation		Proposal	Implementation	Study	Proposal Evaluation		Presentation	Implementation Follow-up				
	Summary & Conclusion				Recommendation	Implementation		Implementation					
						Follow-up		Follow-up					

* DOD : US Department of Defense.

**GSA : U.S General Service Administration.

***PBS : U.S Public Building Service.

****US/EPA: United State Environmental Protection Agencies.

*****SAVE : Society of American Value Engineers.

New Projects development process involves six major phases:

1-Project conception phase.

Application of VE techniques at this phase is somehow limited due to the fact that the project is still a general concept with limited physical parameters established. In addition, facts and figures generated at this phase could not be classified as reliable due the numerous alterations expected to fit certain financial allocation

2-Project planning phase.

Value Engineering can have a significant impact during the planning phase and in conducting feasibility studies. Major impacts on the life-cycle cost of a facility are usually determined at this phase of the design process, where major decisions on the overall scope and magnitude of the project are made.

3-Project design phase.

Value Engineering can have a significant impact during the planning phase and in conducting feasibility studies. Major impacts on the life-cycle cost of a facility are usually determined at this phase of the design process, where major decisions on the overall scope and magnitude of the project are made. Initial VE study should be undertaken no later than the 30% of project designs completion. Cost and life cycle models whenever feasible should be established to serve as targets, and as basis for identifications of high potential savings areas (Barrie et al. 1977).

4-Bidding and construction phase.

VE contributions during the bidding and award stage by the owner could be through the proper selection of contracting method. The use of the constructing management approach in lieu of the general contractor method (public tendering) has proven to be more successful especially for major projects due to the fact that construction management adopts a parallel approach in the design and implementation of the project which enable proper selection of designers and contractors which leads to higher value for the project, and completion in the lowest cost and time possible (Bekr 1990).

5-Construction phase.

Benefit of VE decreases as the project moves toward it's advanced phases. The cost and time involved in redesigning the project or parts of a project act as a determent for any new ideas and methods to be introduced during the construction phase. Nevertheless, VE can play a significant part in the construction phase. Many owners recognize that construction contractors can contribute to cost savings by identifying potential areas of savings in construction materials and methods. The introduction of "Value Engineering Change Proposals" (VECP) clause to construction contracts allows the contractor to participate in the process of optimizing the project value (Dell'Isola 1982).

6-Commissioning phase.

The increase in cost of materials, equipment, energy, and labor highlights the importance of VE studies. Conducting proper life cycle costing studies during the initial phases of the design process will be rewarded with low operational and maintenance expenditure over the project's economic life, considering that the cost of operating certain facilities is several times higher than initial construction cost. Life cycle costing technique which is a product of VE takes into consideration the cost of money through economic analysis and the projection of inflationary trends as well as incorporating anticipated escalation factors in certain resources such as fuel or labor.

ADMINISTRATION OF VE STUDY

Undertaking a VE study involves several steps which take place in a systematic and sequential pattern in order to achieve the purpose intended for the study. There are certain tasks to be carried out starting from the pre-study phase which takes place prior to conducting the VE study, followed by the actual VE study activities, and finally the post study activities to conclude and follow-up on the study. **Fig. (2)** outlines the overall activities involved within the VE study.

It is important to point out that there are prime differences between design reviews conducted by the designer and design reviews conducted by the VE study team at the 40 hours workshops. Traditionally, engineering firms use design review committees to evaluate the project designs. However, the purpose is to ensure that the project functions properly according to the owner's requirements. On the other hand, the VE workshop has as its primary goal the reduction of the life-cycle costs of the project. The VE team directs its attention at specific precise design areas so as to generate alternatives that contribute in improving the value of the project.

VERIFICATION OF VE APPLICATION STATUSIN IRAQ

Following the review of major elements of VE and its related methodology and techniques, the researchers embarked on a field survey within the local engineering professionals. The main goal of this survey is to identify the status of the VE concept comprehension and extent of its acceptance and utilization by the Iraqi engineer through the project phases.

The tool of this survey took the form of:

Preliminary interviews and open questionnaire conducted with senior level engineers involved in the design and implementation of construction projects in Iraq.

Closed questionnaire distributed to engineers of various disciplines working in both the public and private sectors.

Preliminary Interviews & Open Questionnaire results

Initial indicators drawn by the researchers as a result of responses collected have shown a significant deference to the benefits of the VE concept and its contribution in enhancing the value of construction projects. There was consensus on most of the issues put forward with minor variation in answers on some of the issues.

Responses clearly indicate that the concept of VE is not applied in the process of evaluating construction projects at the design and implementation phase. As far as cost and function are concerned, the principle factor, which governs the construction project, is the owner preferences and alternatives are explored only when the proposed design exceeds the allocated budget.

This in principal deviates from the goals of VE of reducing the overall cost of the projects through removing unnecessary costs, the functional analysis, and life cycle costs considerations.

In addition, judgments used in selecting design solutions depend to a great extent on the personal experience of the engineer in charge, which is also not in accordance to the multi-disciplinary team approach advocated by the VE concept.

Exploring innovative and creative alternatives to materials and methods is somehow limited to resources available at the local market. This is partially due to the conditions experienced by the country as a result of the embargo, which inhibits the incorporation of more cost-effective alternatives to certain construction component.

There is a general agreement of the possibility of applying VE as a tool to enhance the value of construction projects; however, the interviewees cited factual obstacles to this goal which is the lack of experts and experience in applying this concept. Some respondents commented that VE is actually practiced in Iraq, but not in its systematic form, in addition, certain official directives promote the principles of VE in an indirect manner.

Majorities of respondents agree that the application of VE should not stop at the design phase, and that the contractor can play a role during the implementation phase to increase the value of the project and share in the savings resulting thereof.

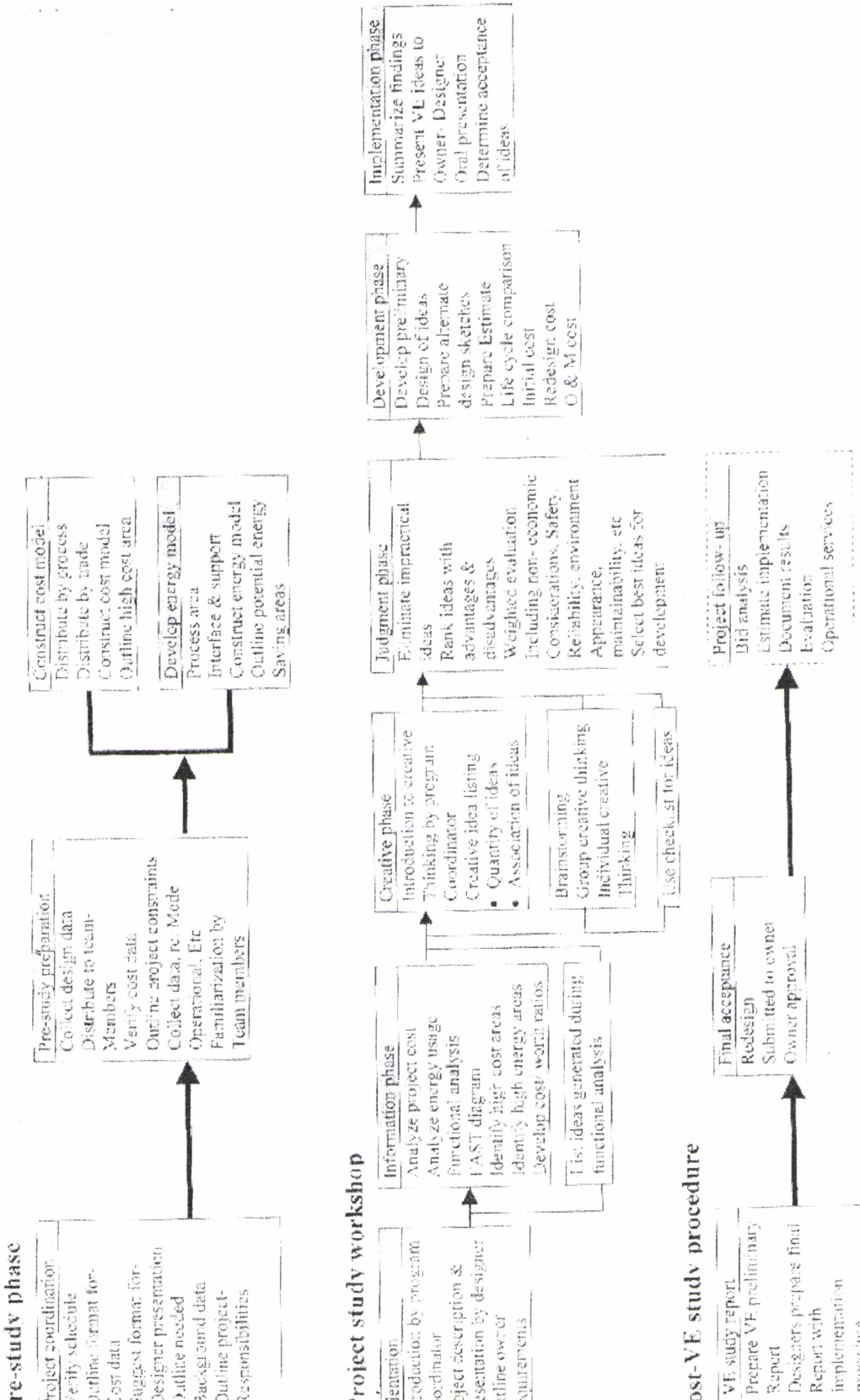

Fig. 2 Value Engineering Studies Task Flow Diagram.
Source (Zimmerman 1982)

Closed Questionnaire

Based on the initial conclusions and indications drawn from the preliminary interviews and open questionnaire, a more detailed closed questionnaire was conducted utilizing a wider sample of professional Iraqi engineers working in both the public and private sector. The sample covered engineers from various disciplines involved in the design and implementation of construction projects.

Table (2) illustrates the number of respondents and their assigned institutions. (7) Of the institutions is governmental organization where construction activities (design and/or implementations) form the majority of their functions. Engineering consulting establishments attached to universities were also covered in the Questionnaire From (Q.F.). In addition, a number of consultant engineers working in the private sector have participated in responding to the Q.F.

Table (2) Number of Respondents and Their Affiliation.

No	Institution	Number of respondents
1	National Center for Engineering Consultation/ Ministry of Housing and Construction	7
2	Al-Idrisi Center for Engineering Consultation/ Ministry of Housing and Construction	6
3	State Company for Industrial Design and Construction/Ministry of Industry and Minerals	8
4	General Commission for Roads and Bridges/ Ministry of Housing and Construction	5
5	Al-Furat State Company for Studies and Designs of Irrigation Projects/Ministry of Irrigation	5
6	Mayoralty of Baghdad/ Projects Directorate	5
7	Al-Fao Engineering General Company/Military Industrialization Commission	5
8	Universities Consulting Firms	5
9	Private Sector Establishments	6

Review of responses could lead to certain slips that were identified that present themselves as obstacles to the proper application of the VE methodology and techniques by the Iraqi construction sector. A summery of these slips is illustrated in **Table (3)**. This has led to the introduction of a "Value Engineering Management System (VEMS)" which will assist in improving the level of application, as well as providing certain remedial actions to overcome some of the obstacles mentioned.

VEMS FOR CONSTRUCTION ROJECTS

As a result of conclusions drawn from both the open and closed questionnaires, which clearly pointed out the fact that VE has not been practiced in Iraq by the construction industry, as well as the fact that there is a lack of adequate knowledge of methodology and techniques related to the VE concept, an integrated "Value Engineering Management System" (VEMS) proposed by the researchers to facilitate the implementation of VE. Certain slips were monitored in the application of the VE concept in Iraq and as discussed earlier. These slips were the motivation to formulate general as well as specific remedial actions in order to introduce the VE concept in a practical manner to the local construction industry. **Table (4)** outlines these remedial actions where some of these actions are within the control of the proposed VEMS, while others are within the control realm of other entities

involved in the implementation process of construction projects. Mandatory requirements to conduct VE studies could be introduced through special directives or legislations by concerned authorities. However, the decision to utilize VE studied to enhance the value of proposed projects should rest with the project owner.

Table (3) Identified Slips in the Application of VE by the Iraqi construction Sector.

No	Slips Identified
1	Limited numbers of engineers are acquainted with the VE concept or have participated in studies adopting its methodology.
2	Opinion that time and cost of VE studies can only be justified in construction projects that are characterized as strategic.
3	Inadequacy of current practices in formulating economic and technical feasibility studies at the decision phase.
4	Lack of appropriate legislations to implement VE.
5	VE is not utilized by A/E in the preliminary design stages.
6	VE is not utilized by A/E during advanced design stages.
7	Cost models are not built to compare between estimated cost and worth of construction items within the design.
8	No specified techniques are utilized to analyze the functionality of designs and link this analysis to cost and worth.
9	Evaluation matrix is occasionally used to compare various design alternatives.
10	Design process is dependent to a great extent on personal experience of A/E and in-house design reviews of such designs without seeking outside expertise.
11	No specific techniques are employed to calculate the total life cycle cost of projects.
12	Lack of qualified experts within the local engineering medium to properly execute VE studies.
13	Construction projects are subject to the preferences of the owner regardless of the cost factor.
14	Current Methods of project implementations do not promote exploring more efficient design alternatives.
15	Follow up on the success of design solutions during the commissioning phase is rarely carried out in order to compare projected maintenance and operational cost with actual figures

VEMS DESIGN OBJECTIVES

The proposed system is designed to fit within the process of implementing construction projects in Iraq, and as illustrated in **Fig. (2)** where the VEMS serves as crucial component in formulating a more efficient mechanism to implement such projects in accordance with the objectives of the Value Engineering approach.

The system incorporates several VE techniques to serve as a tool to identify optimal design solutions, and to augment the decision making process.

The techniques utilized are Functional Analysis, Evaluation Matrix, and Life Cycle Costing. The resulting output of the system is in line with the general objectives of VE, which aim at the elimination of unnecessary costs, and maximizing the project value.

Table (4) Proposed Remedial Actions to Slips in The Implementation of VE by The Iraqi Construction Industry.

Slips Identified	Remedial Actions
Opinion that time and cost of VE studies can only be justified in construction projects that are characterized as strategic	Introduction of minimum project value limits where VE studies are mandatory.
Lack of appropriate legislations to implement VE	Introduction of VECP clauses in construction contracts.
VE is not utilized by A/E in the preliminary design stages.	Initiation of VE studies at the 20-40 % of design completion.
VE is not utilized by A/E during advanced design stages	Initiation of VE studies at the 60-80 % of design completion.
Cost models are not built to compare between estimated cost and worth of construction items within the design.	Application of VEMS.
No specified techniques are utilized to analyze the functionality of designs and link this analysis to cost and worth	Application of VEMS
Evaluation matrix is occasionally used to compare various design alternatives.	Application of VEMS
Design process is dependent to a great extent on personal experience of A/E and in-house design reviews of such designs without seeking outside expertise.	Review of designs by outside consultants in conjunction with the utilization of VEMS as part of the evaluation process.
No specific techniques are employed to calculate the total life cycle cost of projects.	Application of VEMS
Lack of qualified experts within the local engineering medium to properly execute VE studies	Setting up seminars and workshops to train qualified engineers with the goal of attaining CVS status.
Construction projects are subject to the preferences of the owner regardless of the cost factor	Introduction of design criteria that link cost, worth, and function.
Current Methods of project implementations do mot promote exploring more efficient design alternatives.	Increased utilization of the construction management approach where CM acts as VE effort coordinator with A/E and Contractor
Follow up on the success of design solutions during the commissioning phase is rarely carried out in order to compare projected maintenance and operational cost with actual figures	Initiation of requirements to collect data with regard to maintenance and operational cost during commissioning phase to verify validity of selected design solutions. Data could be part of future VE studies and construction costs data bank.

This system represents the actual VE study workshop phase. There are pre and post study activities which should carried out in conjunctions with the outcome of the
Main features of VEMS were translated into a computerized form utilizing "Visual-FoxPro Ver. 7.0" programming language. Running the system requires a personal computer with Pentium II or higher performance processor, and a minimum of 64 MB of RAM (Random Access Memory). Flow chart to illustrate elements of the system is depicted in **Fig. (3)**.
The primary goal of this system is to provide a user friendly medium, which enables the systematic application of VE techniques. This goal is achieved through the following objectives:
Major VE techniques are to be presented in a simple and clear manner, which can be implemented by both experts and beginners. Delphi and FAST techniques were not incorporated into the system due to programming constraints.
Reports resulting from running the system can be adopted by decision-makers to evaluate proposed design solutions, choice of material or method of implementation.
Possibility of upgrading the system to accommodate new features, and link the system with external data bases to make use of available technical information
Ability to store VE studies conducted by the system to be used as a reference used in future projects containing information about cost, worth, and creative ideas which could be of benefit to designers and cost engineers.
The system can be used as an educational tool to introduce the concept of value engineering to the Iraqi engineer so as to improve acceptance and comprehension level of VE locally.

CONCLUSIONS

Major conclusions arrived at by the researchers as a result of the proceeding parts of this work can be abridged as follow:
The initial development of VE in the late 1940's and its later introduction into the construction industry in the early 1960's has introduced VE as a proven approach in improving the value of construction projects through the elimination of unnecessary costs and reducing overall cost without impairing required level of performance if not improve it. Figures published by a number of construction related organizations have shown significant savings and return on investment as a result of adopting VE as a tool to evaluate their projects.
- Local legislation and rules do not recognize VE as one of the tools to evaluate the efficiency of construction projects, nor as one of the approaches to be used in the economic and technical feasibility of projects.

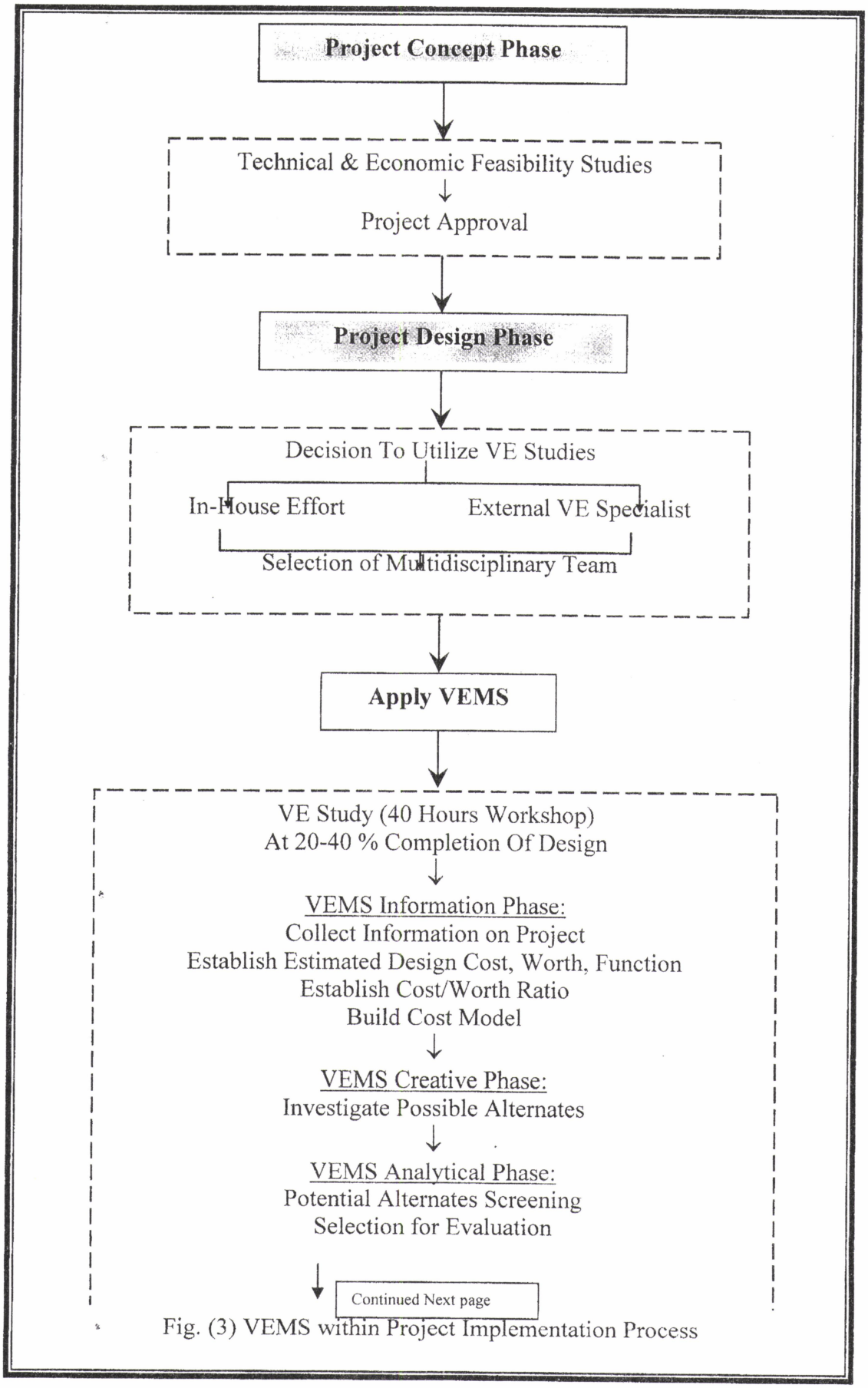

Fig. (3) VEMS within Project Implementation Process

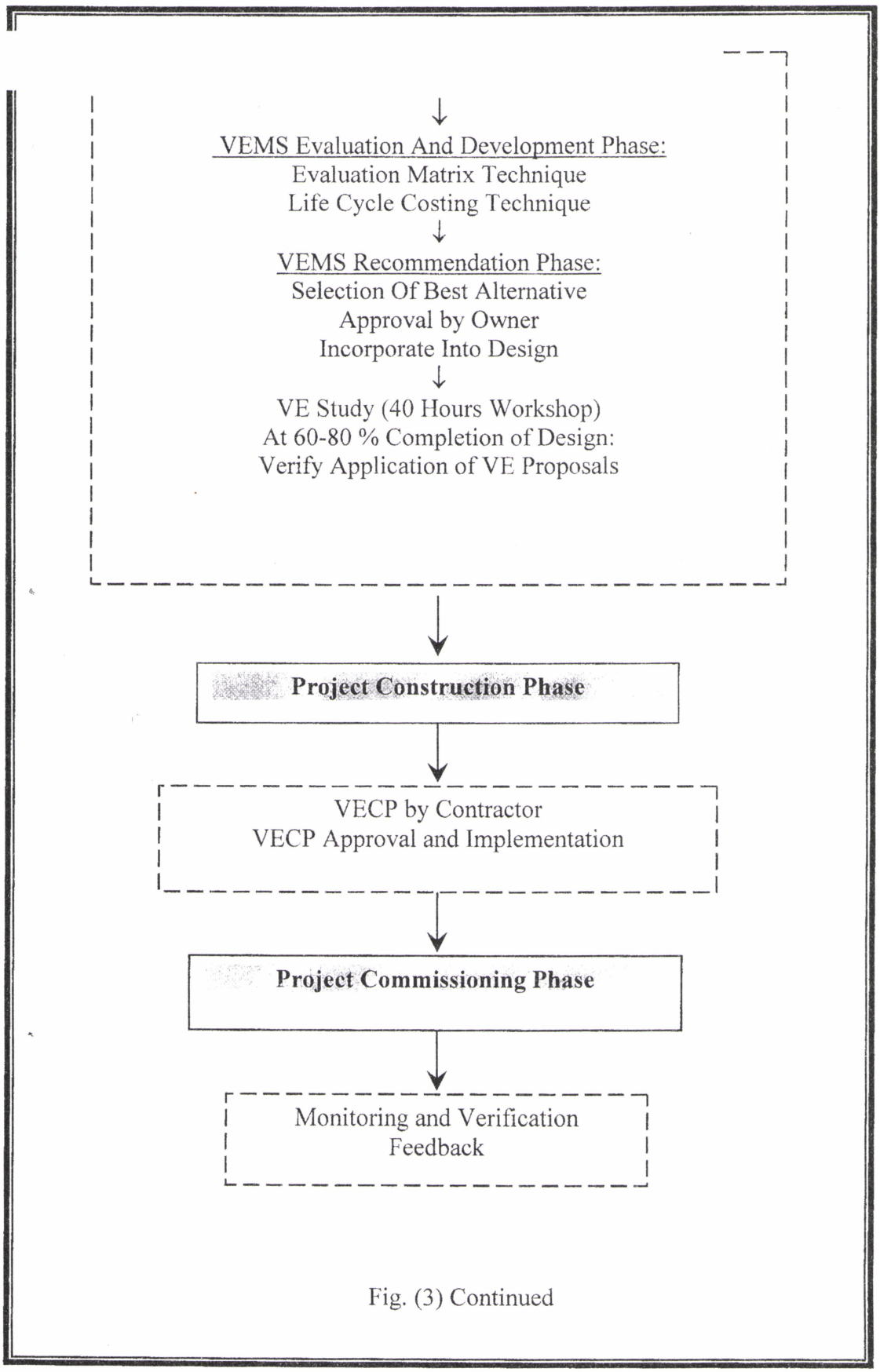

Fig. (3) Continued

- Preliminary interviews conducted at the start of the field work have indicated that the cost factor is not considered unless cost estimates exceed the project's budget.
- Paramount design criteria are the owner's preferences where the A/E role is to implement these preferences. Alternates to original design are only contemplated to reduce the cost estimates to fit the budget. This process translates in to cost cutting rather than improving value.
- As a result of the closed questionnaire undertaken, it was determined that only 66% of Iraqi engineers surveyed are acquainted with the term value Engineering, and only 22% have participated in studies adapting VE methodology. At any rate, almost all respondents agree to the importance of VE in improving the value of projects.
- Causes of lack of appreciation and comprehension of VE within the construction sector in Iraq were reported as a result of:

1- Lack of qualified experts in this field.
2- Insufficient exposure to other countries experience.
3- Cost and time required to carryout additional studies to formulate alternatives.
4- Projects are subject to the owner's preferences regardless of the cost factor.
5- Habitual and speedy methods of preparing design solutions do not allow for evaluation bench marks to review design proposals from cost and function point of view.

- The validity of the research hypothesis is both tested and proven through the information collected via the field work. Input received led to the development of VEMS which enable the systematic application of VE studies. 78% of the research sample has confirmed the need to introduce a computerized VE software as one of the means to catch up with the growing international recognition of VE as a tool to improve the value of construction projects.
- Evaluation of the developed VEMS by a number of engineers has demonstrated satisfactory approval levels with regard to practical benefits, clarity in goals, interaction between user and program, and input/output dialog.
- There is a general agreement on allowing the contractor to participate in the process of improving the value of construction projects during the implementation phase through the submitted of VECP (Value Engineering Change Proposals). However, the A/E should be instrumental in approving such proposals

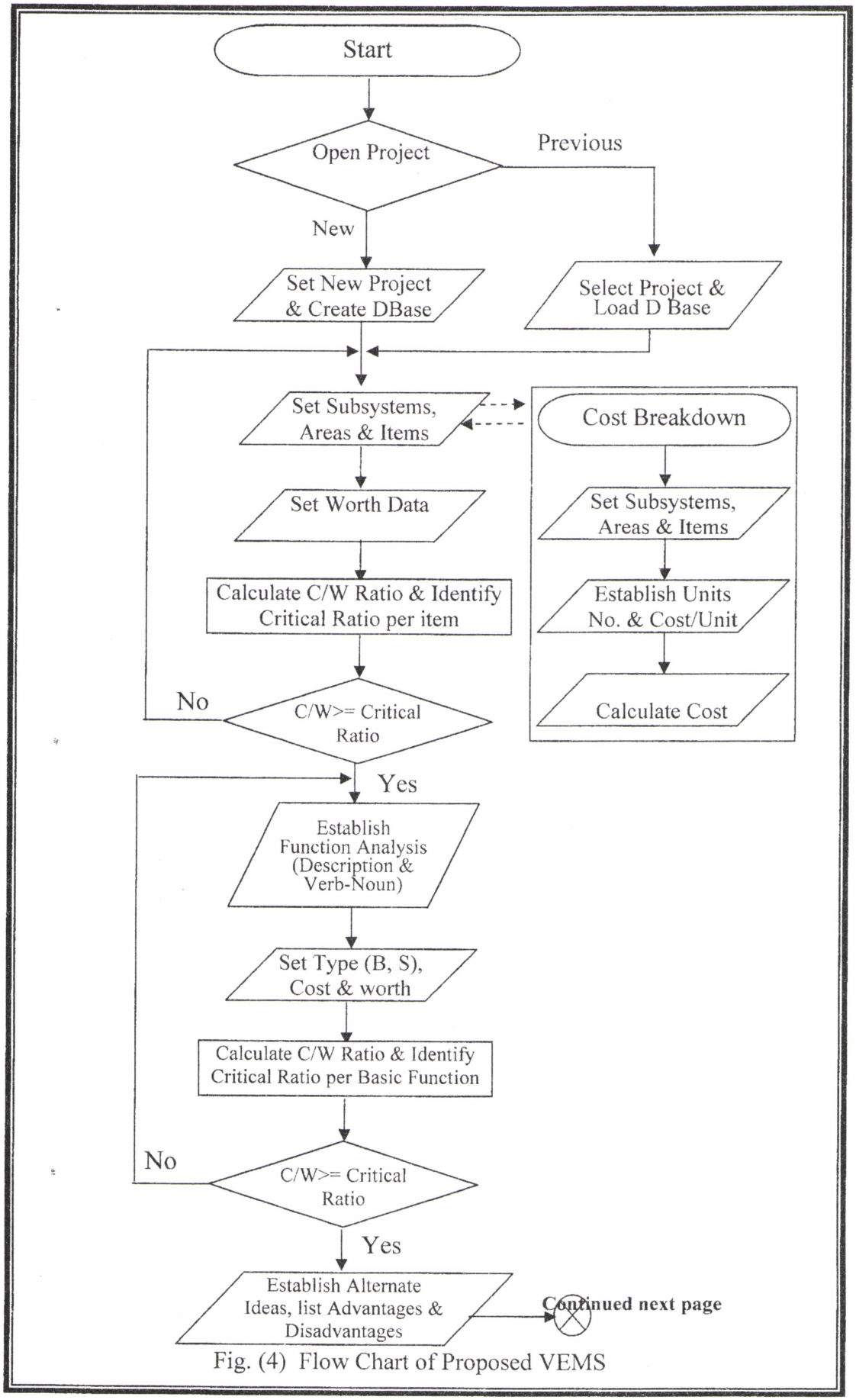

Fig. (4) Flow Chart of Proposed VEMS

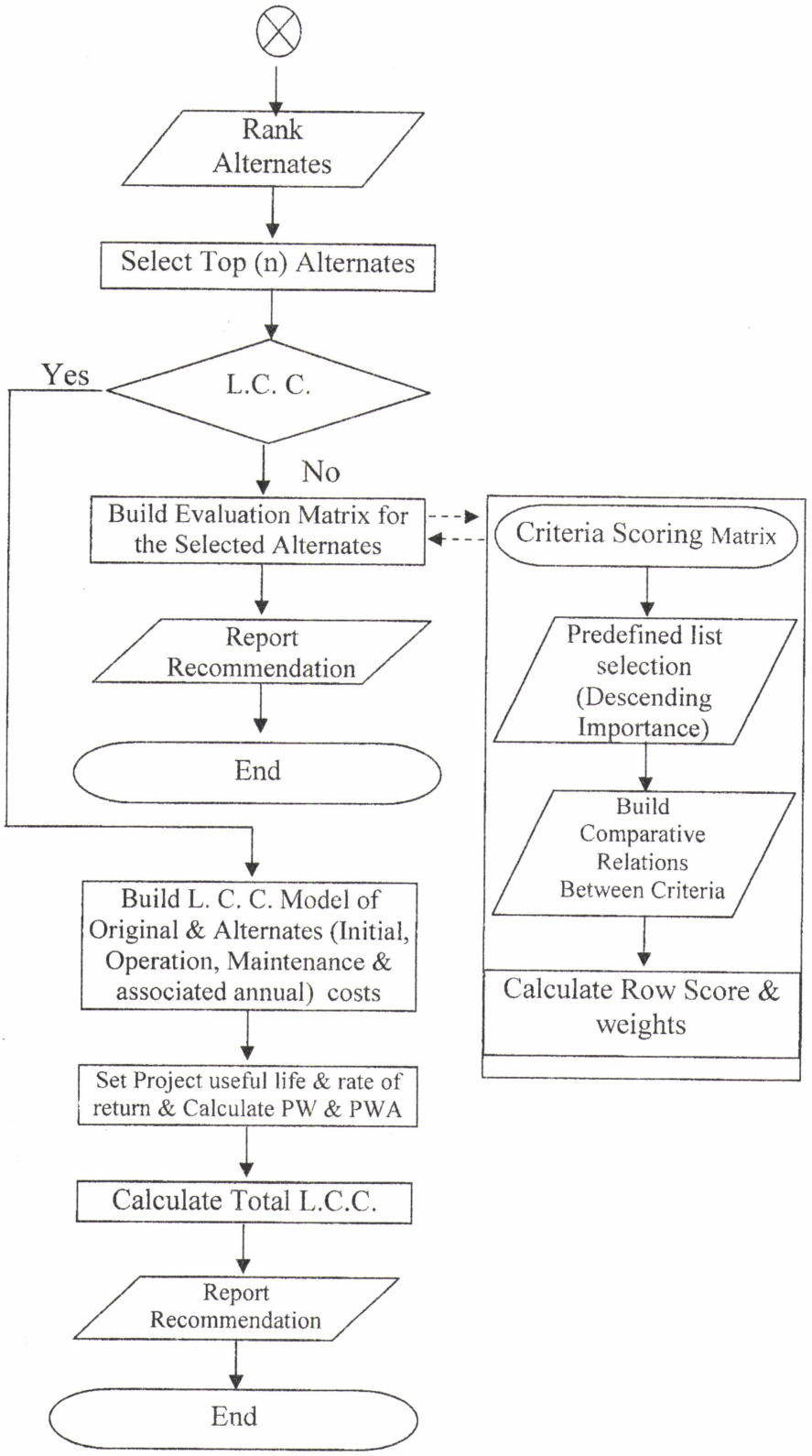

Fig. (4) continued

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