PORT –SAID ENGINEERING RESEARCH JOURNAL
Faculty of Engineering –port said university
Volume 19 No. 1 March2015 pp:11 : 20

Value Engineering Study of Low-Cost Governmental Housing Projects in Egypt

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Abstract:

Value Engineering (VE) techniques are usually implemented in construction industry to determine the project required function with lowest overall cost and/or increased performance which indicates highest possible value.
In the present study, the concept of Value Engineering was discussed; its job plan and the effective implementation of its procedures through a case study were presented. VE study is applied to the first phase of a national low-cost housing project in Port- Said Governorate, Egypt. The study comprised of three stages: First stage is to investigate on VE merits and possibility of application in such projects via a questionnaire to collect such data from specialist's respondents. Second stage focusing on the analysis of the applied phases of Value Engineering job plan in order to reduce the estimated cost and/or increase project performance. Third is to propose a computer model for recommendation phase in order to calculate the total potential savings and the percentage of savings in an organized systematic way similar to physical VE studies.
As a result of the present study, applying five phases of the VE job plan to the first phase of a national low-cost housing project in Port Said Governorate and replacement of selected items, led to a potential cost saving of nearly 44%.
As a result of the present questionnaire, nearly 85% of questionnaire respondents did not use VE techniques in their construction projects in Egypt. Others stated that these techniques were applied on less than 10% of projects in their organizations. 92% of respondents stated that the lack of awareness of VE among the project parties was the main reason that delayed its wide spread in Egyptian construction industry.
Based on the present study, database software was developed in this research to calculate the total potential savings and the percentage of savings in any project via applying VE techniques.

Keywords: Value Engineering, Job Plan, Construction Projects, Housing project, VE Software.

1- INTRODUCTION

Value Engineering concept have been reported in many early publications [1-3] and commonly defined as a systematic process of review and analysis of a project, during the concept and design phases, by a multidiscipline teamwork not involved in the project to provide recommendations for:

1- Providing the needed functions safely, reliably, efficiently, and at the lowest overall cost.
2- Improving the value and quality of the project.
3- Reducing the time to complete the project [4].

Value Engineering has been recently widely used in the construction industry so that all the involved parties are attracted to reduce all the unnecessary costs without any sacrifice in function, target quality or safety [5-7]. Despite that the Value Engineering techniques are increasingly implemented in various industries in a systematic way [8, 9]; they were lately applied in construction industry in Egypt. VE studies may frequently save from 10% to 30% in total costs for a project and may have a profound effect on its ultimate design. It is obvious that, the application of these techniques on governmental housing projects in Egypt is a great tool to save money, time and improve the quality [10 - 12].

2- RESEARCH SIGNIFICANCE

The main objective of the study reported in this paper is to identify the practical reality of the application of VE techniques on governmental housing projects in Egypt through its

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implementation on the first phase of national low-cost housing project in Port Said Governorate.

To achieve the proposed objectives, the study investigated three main stages. The first stage was the data collection phase. The data in this research were collected through interviews with representatives of different involved parties, where the survey samples were composed of 123 specialists (34 consultants, 63 contractors, 20 owners and 6 project management specialists).

The third stage of the research was the design and development of the VE computer model in order to calculate the total potential savings and the percentage of savings in an organized and systematic way similar to that occurs in physical VE workshops.

3- VALUE ENGINEERING JOB PLAN

During any actual workshop portion of the VE study, the five principal or key steps of the Job Plan is followed as prescribed by SAVE International [13].

The VE Job Plan follows these five key steps:

1. Information Phase
2. Speculation (Creative) Phase
3. Evaluation (Analysis) Phase
4. Development Phase (Value Management Proposals)
5. Presentation Phase (Report/Oral Presentation)

The details of these five key steps are described as follows:

1. Information Phase:

At the beginning of the VE Study, it is important to:

- Understand the background and decisions that have influenced the development of the design through a formal design presentation by the design consultants.
- Analyze the key functional issues governing the project. The functions of any facility or system are the controlling elements in the overall VE approach. This procedure forces the participants to think in terms of function, and the cost and impacts associated with that function.
- Define Owner's objectives and key criteria governing the project.
- Determine Owner's definition of Value.

2. Speculation (Creative) Phase:

This step in the VE study involves the listing of creative ideas.

- The VE team thinks of as many ways as possible to provide the necessary function within the project areas at Life-Cycle Cost which represent improved value to the client.
- Judgment of the ideas is prohibited.
- The VE team is looking for quantity and association of ideas, which will be screened in the next phase of the study.
- Many of the ideas brought forth in the creative phase are a result of work done in the function analysis. This list may include ideas that can be further evaluated and used in the design.

3. Evaluation (Analysis) Phase:

In this phase of the project, the VE team, together with the Client and/or Users,

- Defines the criteria to be used for evaluation.
- Analyzes and judges the ideas resulting from the creativity session. Ideas found to be impractical or not worthy of additional study are discarded. Those ideas that represent the greatest potential for cost savings and value improvement are developed further. A weighted evaluation is applied in some cases to account for impacts other than costs (such as schedule impacts, aesthetics, etc.).

4. Development Phase:

During the development phase of the VE study, many of the ideas are expanded into workable solutions. The development consists of:

- Description of the recommended design change.
- Descriptive evaluation of the advantages and disadvantages of the proposed recommendation.
- Cost comparison and LCC calculations.
- Each recommendation is presented with a brief narrative to compare the original design method to the proposed change.
- Sketches and design calculations, where appropriate, are also included in this part of the study.

5. Presentation Phase:

The last phase of the VE Study is the presentation of the recommendations in the form of a written report. A briefing/oral presentation of results is made to the Client and Users, as well as the design team representatives. The recommendations, the rationale that went into the development of each proposal and a summary of key cost impacts are presented at that time so that a decision can be made as to which VE proposals will be accepted for implementation and incorporation into the design documents.

In addition to the monetary benefits, a VE workshop provides a valuable opportunity for key project participants to come together, then step aside and view the project from a different perspective. The VE process therefore produces the following benefits:

- Opportunity to explore all possible alternatives
- Forces project participants to address "value" and "function"
- Helps clarify project objectives
- Identifies and prioritizes Client's value objectives
- Implements accepted proposals into design
- Provides feedback on results of the study [14].

4. QUESTIONNAIRE

Questionnaire was designed to collect information and feedback which reflects the current practice and methodology in the Egyptian construction industry. Also, the questionnaire results reflect the effectiveness of current VE practice and methodology on the low-cost governmental housing project in Port-Said Governorate.

4.1 Methodology

Questionnaire was distributed to collect data from respondents related to Value Engineering methodology. However, there was inadequate awareness of current VE practice in the Egyptian construction industry. Therefore, it was suggested that activating search for information, i.e. person to person search, was required to collect those data.

4.2 Questionnaire Goals

There were four parts of the questionnaire consisting of 82 questions. Questionnaire was divided into 4 parts according to the main study sections. This reflected the research concerns about what were the obstacles that hindered Value Engineering from being an obligatory process in managing construction projects in Egypt till now. The unnecessary items are adding over costs to the low-cost housing projects in Egypt. The views of end users for governmental housing projects would also help the authorities to conduct Value Engineering on the low-cost governmental housing projects.

4.3 Sample Size Determination

Wood and Haber [15] defined the sampling as the process of selecting representative units of a population for a study in research investigation. The objective of the sampling is to provide a practical means of enabling the data collection and processing the components of the research to be carried out ensuring that the sample provides a good representation of the population (Fellowes and Liu [16]).

In present research work, the sample size was selected for observation and analysis randomly from each type of the target groups (owners, contractors, consultants and project management specialists for governmental housing projects).

Statistical equations were used in order to calculate the sample size for the different parties involved in the questionnaire. The following equations were used to determine the sample size of the unlimited population (Creative Research System, 2001): [17]

$$SS = \frac{Z^2 * P * (1 - P)}{C^2} \quad \text{..... (1)}$$

Where,

SS = Sample size

Z = value in Normal Distribution corresponding to confidence level (e.g. 1.96 for 95% confidence level)

P = percentage picking a choice, expressed as a decimal (0.50 used for sample size needed)

C = margin of error (8% considered in this study)

Correction for cases of Finite Population:

$$SSnew = \frac{SS}{1 + \frac{SS-1}{POP}} \quad \text{..... (2)}$$

Where, *pop* is the population

The application of these equations resulted in sizes of samples for the different parties involved in the questionnaire as given in the next section.

4.4 Data Collection

According to the Egyptian Federation for Construction & Building Contractors in January, 2014, there were 1745 Contractors classified to five grades as shown in Table (1) where as the number of consultant was 427 consultants, according to the Egyptian Syndicate of Engineers in January, 2014 (Civil and Architectural Consultants).

The second stage was the application of VE techniques to the first phase of a national low-cost governmental housing project in Port Said Governorate in order to reduce its estimated cost, save time required to complete the project and increase project performance.

Table (1) Contractors classification according to the Egyptian Fedration for Construction& Building Contractors [18]

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Contractors	168	137	195	488	757

The size of the sample was determined by using the pervious equations. Questionnaire parts (1), (2A) and (2B) were sent to a sample of 146 specialized firms in Egypt. A total 123 of consultants, contractors, owners and project management firms replied as shown in Table (2). Part (2C) of questionnaire was sent to a sample of 52 end users. A total 48 of end users replied as shown in Table (3). Part (1) of questionnaire was a general questionnaire about the application of VE techniques on construction projects in Egypt. Part (2A) of questionnaire was a specialized questionnaire for contract division staff about the usefulness of the application of Value Engineering techniques on the low-cost governmental housing projects in Egypt.. Part (2B) of questionnaire was a specialized questionnaire for technical staff and engineers about the usefulness of the application of Value Engineering techniques on the low-cost governmental housing projects in Egypt. Part (2C) of questionnaire was a specialized questionnaire for end users of governmental Housing projects about the usefulness of the application of Value Engineering techniques on low-cost housing projects in Egypt.

Interviews and questionnaire were used together to collect information from Consultants, Contractors, Owners and Project Management. While only questionnaire was used with the end users sample.

Table (2): Sample Size and respondents for questionnaire parts (1), (2A) and (2B)

Field	Sample Size	Respondents
Consultants	40	34
Contractors	75	63
Owners	24	20
Project Management firms	7	6
Total	146	123

Table (3): Sample Size and respondents for Questionnaire part (2C)

Field	Sample Size	Respondents
End Users	52	48

4.5 Results and discussion

(1) Most of questionnaire respondents (85%) did not use Value Engineering techniques in their construction projects in Egypt. Others stated that they applied these techniques on less than 10% of projects in their organizations.

(2) Nearly 63% of respondents stated that Infrastructure/Roadway projects were achieved the best cost reduction in Value Engineering studies.

(3) All respondents stated that function analysis and life cycle costing techniques were the most utilized techniques in Value Engineering studies.

(4) Preliminary design and pre-tender stages were the most implementation stages which achieved a good cost reduction in Value Engineering studies.

(5) Nearly 95% of respondents stated that Architectural items showed beneficial cost reduction in its "Value Engineering" study rather than other items.

(6) In general, Cost savings differ from a project to another when utilizing "Value Engineering" during the project study.
(7) Most of respondents (98%) stated that Value Engineering studies have to be a mandatory process and we have to set a specific law for enforcing the use of Value Engineering in construction projects in Egypt.
(8) Seventy four percent of respondents recommended issuing a binding law for conducting VE studies in governmental projects in Egypt. It must be issued for projects of total cost exceeding LE. 50 Million.
(9) VE teamwork should consist of a minimum of 5 persons. The essential team members are (Civil engineer- Architect engineer- Mechanical Engineer- Electrical Engineer- Pricing Engineer).This number is valid for housing projects. This number is valid only for housing projects.
(10) All respondents recommended to set up a department of VE at the Ministry of housing but VE studies could be conducted by a third party from the private sector. This would enrich the project with fresh views of a party not involved in the project by any means prior to the time of the VE and to also enhance the project with the experience of such private sector party in performing VE studies.
(11) Most of respondents (76%) agreed that the Ministry of Housing could supervise the construction of the project by itself through especially formed technical departments on governmental housing projects. Others reflected their choice of the private consultant offices due to possible existence of expertise and technical staff. This is different from full time supervision of consulting engineers, ensuring high quality with short duration as their duties concerned only with technical work.
(12) Less than 10% of the engineers who were working in the field of construction projects in Egypt had the knowledge and expertise of Value Engineering techniques.
(13) Most of respondents (92%) stated that the lack of awareness of VE among the project parties was the main reason leading to the rare implementation of the "VE" in the Egyptian construction projects. The other reasons were following other methods to reduce costs; VE techniques was not included in curricula of engineering faculties and institutes in Egypt until very recently, also because of preference of routines construction, and resistance of change and new technologies.
(14) All respondents recommended that Value Engineering techniques should be introduced in the curricula of engineering faculties and institutes in Egypt. They also recommended that graduated engineers should be trained on Value Engineering techniques in order to expand its use in construction projects in Egypt.

The present work still needs improvement to reduce subjective judgment due to the sensitivity of evaluated results.

5. CASE STUDY

In the current study, VE techniques were applied to the first phase of a national low-cost housing project in Port Said Governorate in order to reduce the estimated cost and increase performance which indicates highest possible value.

5.1 Data collection

The project was planned to be implemented over 24 months starting from 2013 to be handed to beneficiaries in 2015 and consisted of 46 residential Buildings. Each building consists of 60 apartments including ground floor, shops, Mezzanine floor, administrative offices, and ten residential floors with 6 apartments. The apartment net areas were ranging from 76 to 82 m2. The total floor area was 600 m2. The total number of residential units was 2760. The total area of all buildings was 29440 m^2 with parking areas 4446 m^2, street areas 10386 m^2 and open apace areas 36476 m^2. The project was designed by Consulting Engineers Center and awarded to 4 contractors companies. The total budget specified by the owner was 469,200,000 (Four hundred and sixty nine Million and two hundred thousand) Egyptian Pounds. The actual value of the award contract was 554,003,436 (Five hundred and fifty four Million and three thousand four hundred thirty six) Egyptian Pounds.

5.2 Determination of the study items

According to Pareto's Principle or the 80/20 Rule of the "vital few and trivial many", [19] the principle that 20 percent of something always are responsible for 80 percent of the results, simply focus on the 20% of what is important in a project and that way you will save a lot of money and time. The study investigated items that present the major cost of the project.

5.3 Recommended alternative items

As a result of the present study, applying five phases of the VE job plan to the first phase of a national low-cost housing project in Port- Said Governorate and replacement of selected items, led to a potential cost saving of nearly 44%, reduce the time to complete the project from 24 months to 18 months and improve the quality of the project.
Cost model and life cycle cost technique (L.C.C.) are used in the present study.

5.3.1 The following three main items were recommended in the present VE study in order to save nearly 36% of the actual value of the contract:

1- The system of foundations was raft foundation with thickness of 70 cm based on concrete piles with diameter of 600 mm and a length of 22 meters. The number of these piles was 255 per building. Information about system of foundation for the nearby buildings executed at the same conditions (type of soil and height of building) indicated system of foundation to be raft foundation with 120 cm thickness. All soil mechanics reports for this project were collected and investigated. Two reports of them showed that raft foundation with 120 cm thickness is a suitable and safe system. The attached calculation by the two reports showed that the amount of the expected settlement on the long term is within the permissible limits according to the Egyptian Code. Modifying the system of foundation to be raft foundation with thickness of 120 cm based on plain concrete with thickness of 50 cm. Raft foundation was optimal solution to transport loads from superstructure to soil. Cost saving which could be achieved from this suggestion was 142 Million and 422,624 LE (25.71% of total project cost). This suggestion will also save time.
2- Using the natural gas instead of solar energy for water heating system. Cost saving which could be achieved from this suggestion was 25 Million and 392,000 LE (4.58% of total project cost).
3- The method of offering and awarding for this contract was modified to be public tender instead of public negotiation. Cost saving which could be achieved from this suggestion was 31 Million and 913,556 LE (5.76% of total project cost).

5.3.2 The following items were recommended in the present VE study in order to save nearly 8% of the actual value of the contract:

1. Replacement of ceramic tiles by larger sizes installed only by the contractor while the owner could make a public tender between specialized ceramic factories to supply these ceramic tiles directly to the construction site of the project. Cost saving which could be achieved from this suggestion was 9 Million and 998,376 LE (1.80% of total project cost).
2. An item of general and legal Conditions was modified to state that the contractor was obligated to provide (one) specialist engineer with experience of not less than five years for every 6 Million pounds of annual work instead of every 2 Million pounds of annual work. The suggested numbers of implementation engineers were enough to execute work effectively. Cost saving which could be achieved from this suggestion was 7 Million and 948,800 LE (1.43% of total project cost).
3. Replacement of Sweden wood with local Mosky wood for doors. Cost saving which could be achieved from this suggestion was 5 Million and 396,904 LE (0.97% of total project cost).
4. Delete the item which stated that Supply, installation and testing of elevator with total load of 500 kg from the original bill of quantities then the owner (Ministry of housing) could make a public tender between specialized elevator companies to supply, install and test these elevators. Cost saving which could be achieved from this suggestion was 5 Million and 336,000 LE (0.96% of total project cost).
5. Delete the item of general and legal conditions which stated that the contractor was obligated to hire a consultant for periodic supervision on the project. The owner's consultant is responsible for controlling quality of the work. Cost saving which could be achieved from this suggestion was 3 Million and 456,000 LE (0.62% of total project cost).
6. Delete the item of general and legal conditions which stated that the contractor was obligated to submit to the owner two insurances against fire and theft equivalent to (50%) of the project value. There was an item stated that the Contractor was completely responsible for accidents of theft or fire for the duration of the contract until the initial handing-over of the project. This item was sufficient to protect the project from accidents of theft or fire. Cost saving which could be achieved from this suggestion was 3 Million and 456,000 LE (0.62% of total project cost).
7. The item for supplying intercom for service of 60 apartments, linked with the entrance of the building and the guard room was deleted. The mobile services were enough to introduce this service to residents. Cost saving which could be achieved from this suggestion was 1 Million and 840,092 LE (0.33% of total project cost).
8. The garbage rooms were removed then the openings of garbage ducts were closed by brick, plaster from one side and paints from the other side. There was no need for the cooling unit to garbage rooms. The items which stated that supply and installation of garbage doors and windows were deleted. Cost saving which could be achieved from this suggestion was 1 Million and 815,656 LE (0.33% of total project cost).
9. The diameter of water consumption gauge per unit was modified to be 20 mm instead of 1 inch. This modification was according to the specification used in Suez Canal

Authority in Port Said. Cost saving which could be achieved from this suggestion was 1 Million and 479,139 LE (0.27% of total project cost).

10. Modify the items of Supply, installation and testing of sanitary tools to read only installation and testing of these sanitary tools then the owner (Ministry of Housing) could make a public tender between specialized sanitary factories to supply these sanitary tools directly to the construction site of the project. Replacement of shower base by corner bathtub 120x120 cm. Cost saving which could be achieved from this suggestion was 1 Million and 440,720 LE (0.26% of total project cost).
11. Using of aluminum doors for kitchen balconies instead of iron doors. Cost saving which could be achieved from this suggestion was 1 Million and 038,600 LE (0.19% of total project cost).
12. The frames of aluminum doors and windows were recommended to be made from Mosky wood instead of Sweden wood. Cost saving which could be achieved from this suggestion was 1 Million and 053,216 LE (0.19% of total project cost).
13. Delete the item of Supply, installation and testing of fire fighting system from the original bill of quantities then the owner (Ministry of Housing) could make a public tender between specialized fire fighting companies to supply, install and test fire fighting items. Cost saving which could be achieved from this suggestion was 572,314 LE (0.10% of total project cost).
14. Supply and installation of insulation, plaster and paints for a height 60 cm from Ground level for outside façade instead of Hashemi stone cladding the building from outside. Cost saving which could be achieved from this suggestion was 496,800 LE (0.09% of total project cost).
15. Modifying the item of supply and installation of doors for escape stairs with size of 1.50 x 2.20 m fire resistant for 90 minutes to be fire resistant for 30 minutes. The suggested time was enough for all residents to be outside the building. Cost saving which could be achieved from this suggestion was 82,800 LE (0.01% of total project cost).
16. Replacement of oil paints for bathrooms and kitchens ceilings with plastic paints. This suggestion was to improve quality.

6. Computer Model Development and Validation

The proposed computer model was designed to improve the implementation of the VE techniques in the construction industry generally and in the governmental housing projects specifically. The input data in this software are the original items (Quantities, and unit costs), and the proposed items (Quantities, and unit costs). The output data are the cost of original items under study, the cost of proposed items under study; the potential savings and the percentage of savings. For the computer model to be an efficient and useful one, it should be user friendly to allow the user to move from a step to another smoothly and in an organized manner.The Value Engineering computer model proposed in this study is intended to be precise, accurate and user- friendly to facilitate the passage through VE recommendations step by step to calculate the percentage of savings in an organized systematic way similar to the physical Value Engineering workshops. The proposed computer model was developed to be flexible, as it allows users to edit any pre-entered information and/or modify the flow of data.

6.1 Computer Model Design

The characteristics of the computer model design were as follows:

1. Programming Language Used: C #.net (C SHARP.NET)
2. Database Engine Used: Structure Query Language (SQL) Server2008
3. Interface Design: Photo Shop C55
4. Programming Design: Visual Studio 2010.net

6.2 Database Engine Used

SQL server was chosen to be the database engine to be employed. SQL server is a database program that allows the user to store and manage large collections of information. It is provided with all tools the user might need to create an efficient and effective database. It is an excellent database that could be suitable for use in this research. The program provides a wide range of options to choose. It is also trying to be very friendly to the user by displaying a lot of help menus and windows for constructing the database very quickly. It is required by the business for several reasons:

1. It is easy and very simple to use.
2. It can store and manage large collections of information.
3. You can efficiently and accurately add, update, view and organize the information stored in a database.
4. You can instantly locate information of interest in any database.
5. You can also perform more advanced searches.
6. You can also perform calculations on the information in a database to help you make quick, accurate and informed decisions.
7. The following screens in Figures from 1 to 4 shows the model when it is applied to the first phase of a national low-cost housing project in Port-Said Governorate.

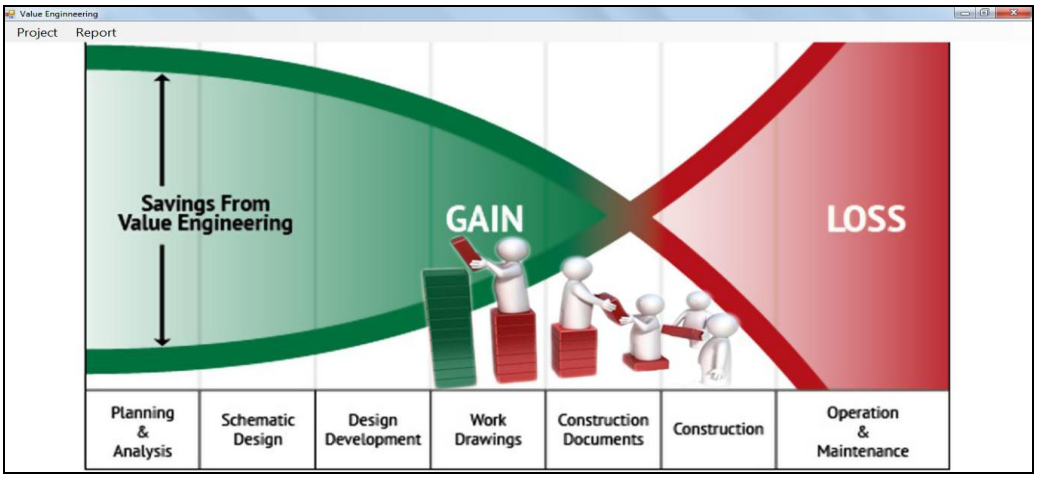


Figure (1) Main menu

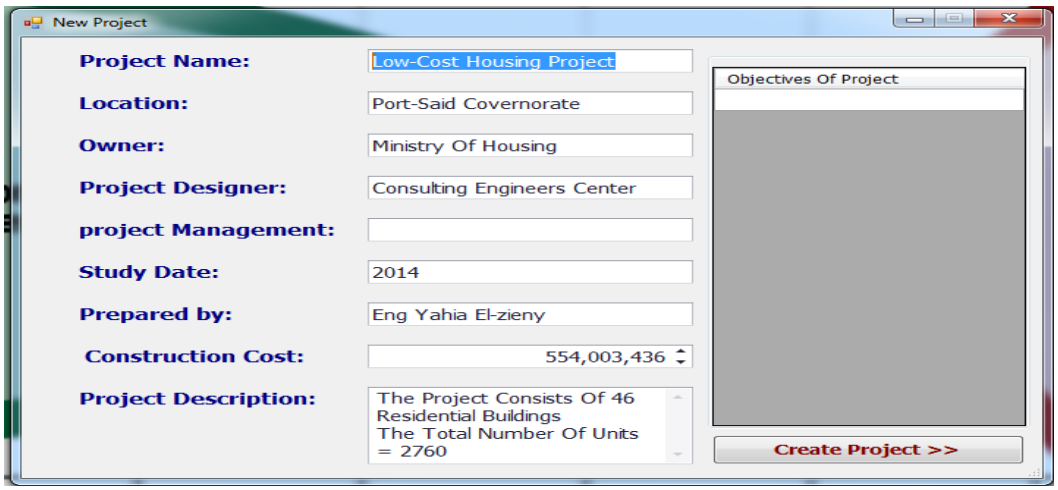


Figure (2) Screen of project details

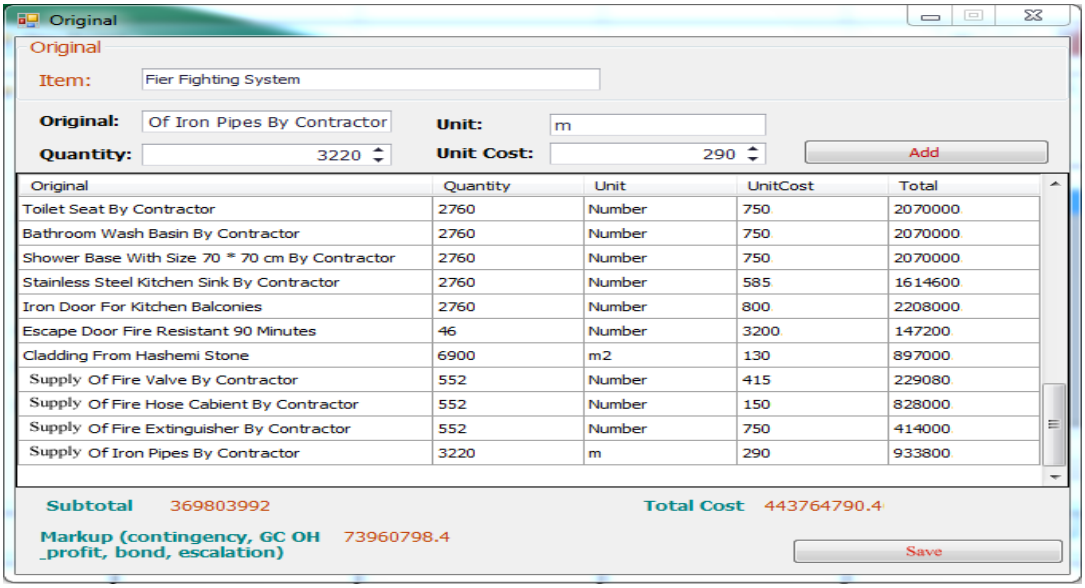
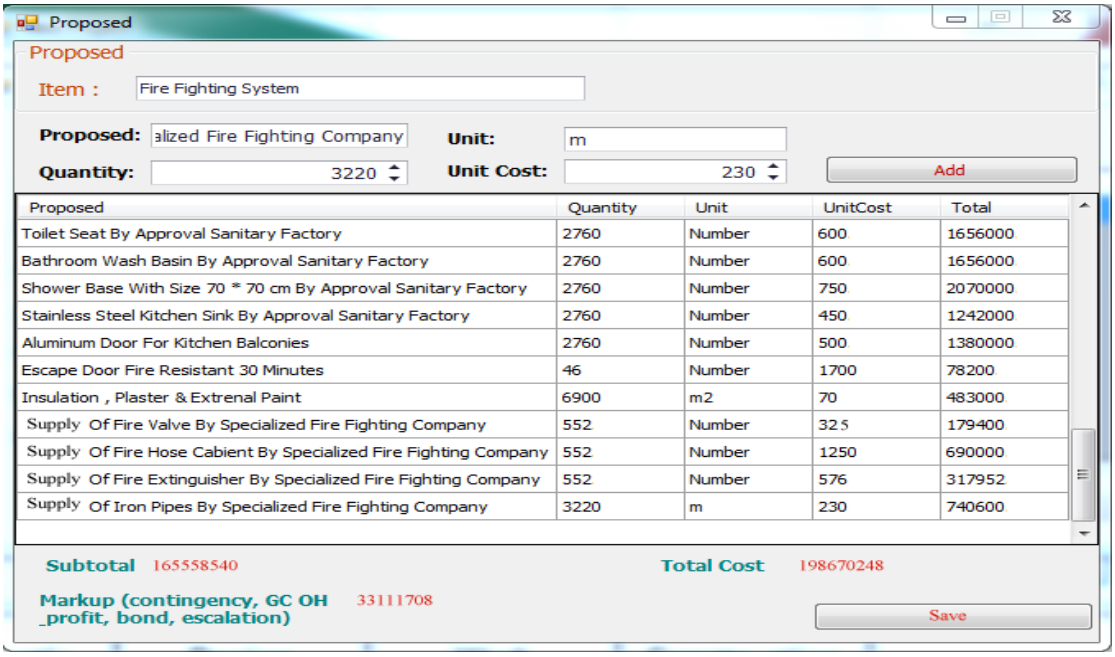


Figure (3) Last screen of adding original items



Proposed	Quantity	Unit	UnitCost	Total
Toilet Seat By Approval Sanitary Factory	2760	Number	600	1656000
Bathroom Wash Basin By Approval Sanitary Factory	2760	Number	600	1656000
Shower Base With Size 70 * 70 cm By Approval Sanitary Factory	2760	Number	750	2070000
Stainless Steel Kitchen Sink By Approval Sanitary Factory	2760	Number	450	1242000
Aluminum Door For Kitchen Balconies	2760	Number	500	1380000
Escape Door Fire Resistant 30 Minutes	46	Number	1700	78200
Insulation , Plaster & Extrenal Paint	6900	m2	70	483000
Supply Of Fire Valve By Specialized Fire Fighting Company	552	Number	325	179400
Supply Of Fire Hose Cabient By Specialized Fire Fighting Company	552	Number	1250	690000
Supply Of Fire Extinguisher By Specialized Fire Fighting Company	552	Number	576	317952
Supply Of Iron Pipes By Specialized Fire Fighting Company	3220	m	230	740600

Figure (4) Last screen of adding proposed items

Applying the software to the project under study by inputting the original items (Quantities, and unit costs), and the proposed items (Quantities, and unit costs).

The output report showed that:

The construction cost is 554,003,436 EGP.

The cost of original items under study is 443,764,790.40 EGP.

The cost of proposed items under study is 198,670,248 EGP.

The potential savings are 245,094,542.40 EGP.

The percentage of savings is 44.24% EGP.

These results matched the manual calculations of VE study on this project.

Report Form Project

Project Name	Project Construction Cost	Cost Of Original Items Studied	Cost Of Proposed Items Studied	Potential Savings	Percentage Of Savings
Infrastructure Saraya Bandar Resort	106976744	101212099.2	66408975.6	34803123.6	32.53
Low-Cost Housing Project	554003436	443764790.4	198670248.0	245094542.4	44.24
Oil Sector Complex Phase III	30750000	28470100.8	23770482.0	4699618.8	15.28

Figure (5) Screen showing the final report

7. Conclusions and Recommendations

The main conclusions of the present study are:

- It was necessarily important that "VE studies" had been begun from the feasibility study phase in order to be applied on the tendering documents such as (contract, legal and public conditions, special conditions and the method of project delivery).
- Rare implementation of VE techniques in the Egyptian construction projects are mainly due to the lack of awareness of Value Engineering among the project parties, following other methods to reduce cost, VE techniques was not included in curricula of engineering faculties and institutes in Egypt until very recently, also because of preference of routines construction, and resistance of change and new technologies.
- Applying VE techniques to the first phase of a national low-cost housing project in Port Said Governorate achieved cost savings estimated to (44.24%).This is a special case in which foundation represents high ratio in savings up to 25% but in other ordinary cases the percentage of savings may approximately reach 20%.
- Using the solar energy system for heating water in the governmental housing projects needs to be thoroughly studied prior to its implementation. This is essentially important to avoid failure as really happened before in former governmental housing projects in Port-Said Governorate.

- It is instantly and necessarily important to investigate the items that present the major value of the project to achieve the most potential savings according to Pareto's Principle.
- It is instantly and necessarily important to issue a binding law for conducting VE studies on future governmental housing projects in Egypt of total cost exceeding L.E. 50 Million.
- It is instantly important that VE must be integrated in the curricula of engineering institutions in Egypt.
- It is promptly important to train Egyptian engineers on VE techniques and how to use them during the different phases of construction projects in Egypt.
- All future design contracts for Egyptian governmental housing projects are recommended to include an item for providing VE Studies.
- It is highly important to establish a department of VE in the "Ministry of Housing". This department is suggested to be concerned with supervising VE studies conducted by a third party from the private sector.
- It's recommended not to add any item to contracts for governmental housing projects, which are considered part of the responsibilities of the contractor in accordance with the terms of the contract, as well as other general and legal conditions. Presences of such items add extra cost to the project.

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