



Financial evaluation program for construction projects at the pre-investment phase in developing countries: A case study

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Abstract

The construction industry in the Middle East represents a significant part of the world's economy. Millions of dollars are spent each year on different construction projects. These projects normally pass through several phases starting from pre-investment phase, conception design phase and finally the construction and commissioning phases. Financial management is a creative organized approach with an objective to minimize financing risks. It focuses on financial evaluation as an important issue; in that it has long been an area of attention of construction practitioners and researchers.

This document represents a proposed program which is coded into a computer language designed to facilitate the financial evaluation process for construction projects at the pre-investment phase for a developing country. The results of this proposed program reveal that it is capable of giving investors pertinent financial information at the different stages of the project, particularly the construction field. The validity of the proposed model is tested using a case study.

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1. Introduction

During the last decade, the research on construction projects has expanded. This research has revealed that a construction project is most successful when it is operating within the technical specifications and is completed within the target time and budget. It must also be satisfying to the stakeholders. Unfortunately, due to many reasons, effective project performance is not commonplace in the construction industry, especially in developing countries (Nguyen et al., 2004).

This article focuses on the importance of early financial evaluation at the pre-investment phase of the construction projects. In spite of the fact that past research has revealed that

an early study of the pre-investment phase must be executed to dramatically influence the project's value production, as this phase has oftentimes been neglected in the Middle East.

The financial evaluation for construction projects can be considered as the last step in the feasibility study process, at the pre-investment phase. If the insight of the project's financial evaluation at the pre-investment phase improves, this will give a better understanding of the project value production and determine the project feasibility. The effectiveness of the feasibility study can determine the success of the project. Therefore, before undertaking project design and construction, the feasibility study is essential.

According to Wolfram et al. (2010), "a project's financial benefit is measured by its net present value (NPV), which is determined by discounting all arising cash flows to the start time of the project". Thus, we should not neglect any factors that can affect the financial evaluation of the construction

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projects at the pre-investment phase. In addition, any type of risk can be transferred to money value; this value can be involved in the project cash flow. As a result, the financial evaluation of the project will be affected and changed.

2. Literature review

The construction business, as any other business, is risky. However, construction projects are perceived to have more inherent risks due to the involvement of many contracting parties such as owners, designers, contractors, subcontractors, and suppliers. Construction projects are unique and built only once. They also involve a temporary project team that is assembled from different companies, countries, cultures, etc. Moreover, as the size and complexity of construction projects increase, the risk will also increase. In addition, the economic, political, social and cultural conditions where the project is to be undertaken will also affect the project. Project risks can be defined as an uncertain event or condition that can ultimately have a positive or negative effect on at least one of the project objectives, such as time, cost, scope, or quality. Also, [Patrick et al. \(2007\)](#) indicated that construction projects can be a complicated process, long lasting and affected by the environment. It can also be affected by financial intensity, dynamic organization structures such as organizational and technological complexity which can generate enormous risks. Therefore, professionals and scholars have been motivated to take extensive efforts to meet financial challenges. As a result, the following scholars have determined that there are many factors which contribute to the delay of the construction project: [Al-Moumani \(2000\)](#), [Assaf et al. \(1995\)](#), [Arditi et al. \(1985\)](#), [Baldwin and Manthei \(1971\)](#), [Chan and Kumaraswamy \(1995\)](#), [Dissanayaka and Kumaraswamy \(1999\)](#), [Hemanta et al. \(2012\)](#), [Mansfield et al. \(1994\)](#), [Sullivan and Harris \(1986\)](#), [Van et al. \(2009\)](#); cost overruns ([Assaf et al., 1995](#); [Dissanayaka and Kumaraswamy, 1999](#)), quality ([Arditi and Gunaydin, 1998](#)), safety ([Oglesby et al., 1989](#); [Sawacha et al., 1999](#)), and productivity ([Oglesby et al., 1989](#); [Sanders and Thomas, 1991](#)), etc. and problems in specific types of projects ([Chritamara and Ogunlana, 2001](#); [Ling and Bsy, 2002](#)). These studies usually focus on one or some certain specific aspects of project performance. [Weisheng et al. \(2011\)](#) applied the radio frequency identification (RFID) technology in the construction project management (CPM) for improving CPM goals such as time, quality, cost, safety, and environment. In addition, [Meng \(2012\)](#) revealed that relationship management has more effect on cost than on time and quality performance.

[Jaafari \(1990\)](#) stated that the future success of the selected strategy for the project implementation will be critically dependent on the effectiveness of the management of risks, including the allocation of the residual risks to appropriate recipients through correct structuring of the project. [Xu et al. \(2010\)](#) developed a fuzzy synthetic evaluation model for assessing the risk level of a particular critical risk group (CRG) and the overall risk level associated with public–private partnerships (PPP) projects in China. [Luo and Gao \(2011\)](#) applied the risk assessment model for BT construction engineering project financing. [Nieto-Morote and Ruz-Vila](#)

(2011) created a fuzzy approach to make a risk assessment for construction projects. [Caño \(1992\)](#) mentioned that risk identification, evaluation, strategies and basic procedures must be defined in the feasibility study, and the accuracy of the risk and profitability assessments depend on the process of constantly reviewing and updating the data as new and better data and feedback become available. In addition, the feasibility study is the project-objective's generator; it establishes the conditions that make the project workable (if the feasibility conditions are not compatible with the environment, the project must be abandoned). It also determines the functions that may be taken into account during the whole project life.

A feasibility study is defined as an evaluation or analysis of the potential impact of a proposed project or program. It is conducted to assist decision-makers in determining whether or not to implement a particular project or program. It is based on an extensive research on the current practices and the proposed project/program and its impact. It will contain extensive data related to financial and operational impacts and will include advantages and disadvantages of both the current situation and the proposed plan ([Urkiaga et al., 2006](#)). [Graham \(2006\)](#) indicated that the project client or the consultant will work out the project feasibility study traditionally by considering financial issues, such as return of investment, demand and supply in the market, and risk analysis on the market conditions. According to [Hutchinson \(2009\)](#) “it has been appreciated that the project feasibility study is one of the most easily misunderstood aspects in developing a project”. In addition, economic and financial viability is one of the most important aspects in a feasibility study ([Ali et al., 2001](#); [Avlonitis et al., 2002](#); [Chao and Hsiao, 2012](#); [Sipala et al., 2003](#); [Wang et al., 2012](#)). [Shen et al. \(2010\)](#) showed that economic performance is given the most concern in the current practice of the project feasibility study. The results also suggest the need for shifting the traditional approach of the project feasibility study to a new approach that embraces the principles of sustainable development. [Chiao Lin et al. \(2012\)](#) proposed a novel construction project progress forecasting approach which combines the gray dynamic prediction model and the residual modified model to forecast the current progress during the construction phase.

[Behrens and Hawranek \(1991\)](#) indicated that there are various methods of financial evaluations in the investment field. The first one is called “discounting methods”, including net present value and internal rate of return; the second one is called “simple methods”, including payback period and simple rate of return; the third one is called “financial evaluation under uncertainty” and this includes break even analysis and sensitivity analysis.

The net present value theory (NPV) can be considered as one of the famous methods which may be used for measuring the financial situation of construction projects. [Sobel et al. \(2009\)](#) argue that in addition to comparing several economical proposals, the NPV is an appropriate criterion which can be employed to plan the projects. [Coates and Kuhl \(2003\)](#) point out that simulation softwares such as SLAMII (based on Monte Carlo) can be used to estimate the NPV distribution. Using the mean and standard deviation of cash flows of different years

and considering their normal distribution, they simulate many random scenarios thereby estimating the NPV distribution. Another proactive approach is the real option approach proposed by Dixit and Pindyck (1994). In this approach, decision making about the economical projects consists of a flexible process. Each project is divided into several decision-making phases. After finishing each phase, entering certain information obtained from the market conditions (the discount rate and the amount of expenses and revenues), a new decision is made. When a decision is to be made, options which might occur for the life cycle of a project are taken into account and their effect on estimating the discount rate of the project and computing the NPV are considered (Payam and Vahideh, 2011). At any rate, a project cash flow was required to calculate the NPV. So, Thelmpson, 1979 defined cash flow as the difference between income and expenditure in any time period. Also, cash flow consists of the flows of cash into and out of a business (Needles et al., 1999); typical cash out flows on a construction project include interest, material, labor cost, etc., and cash inflows include various payments, such as bonuses. Numerous approaches have been developed for investigating cash flows in construction. For example, Barbosa and Pimentel (2001) constructed a linear programming model for cash flow management in the Brazilian construction industry. Chiu and Tsai (2002) developed a heuristic searching rule to gain a near-optimal solution and incorporated penalty and bonus into multi-project scheduling problem with a discounted cash flow. Chen et al. (2005) investigated the significance of payment conditions and assessed the cash flow model accuracy. Moreover, Park et al. (2005) adopted moving weights of cost categories in a variable budget while constructing a cash flow forecasting model, and applied realistic data to examine the model accuracy. Elazouni and Gab-Allah (2004) applied integer programming to establish a finance-based scheduling model for minimizing project duration, and presented project schedules with various credit limits. Elazouni and Metwally (2005) considered credit limit and scheduled a construction project using improved genetic algorithms for total profit maximization under different credit limit settings. Yeung et al. (2009) created a Partnering Performance Index (PPI), to evaluate the partnering performance of construction projects in an effective way within a very short period of time. There are many models which are created to facilitate the management process of construction projects, such as the models of Cheng et al. (2012), Guangshe et al. (2011), Kang et al. (2011), John et al. (2009), Malgorzata and Ozgur (2009), Maravas and Pantouvakis (2012), and Scherer and Schapke (2011).

3. Proposed system for financial evaluation

The life cycle of money, expenditures and revenues, for construction projects take long periods, possibly 10 years to achieve the planned target. That equates to a lot of changes related to the future events. So, the financial evaluation at the pre-investment phase is an important issue to light the way of the project's success. In general, previous research about cash flow of the construction projects by researchers and their efforts

have been diverted to the methods of reducing the failure items of projects concerned only with financial management of the project through the investment phase. Questionnaire results for 320 projects in the construction field in Egypt (the biggest country in the Middle East) revealed that a financial evaluation for only 4% of these projects was prepared at the pre-investment phase but the effect of time on the value of money was not included. About 1.72% of these projects applied the financial evaluation at the pre-investment phase but it took a lot of time to start the investment phase. Finally, the remaining ratio of these construction projects did not make a financial evaluation at the pre-investment phase. Accordingly, the number of construction projects in Egypt failed, were not completed, or completed with cost overruns and/or delays.

This study concerns the financial evaluation for construction projects at the pre-investment phase. Particularly, we spotlight the cash flow for all project life costs by creating a computerized program for investors in the construction field to help them decide and facilitate the financial evaluation process for construction projects at the pre-investment stage by calculating the NPV for all project proposals within a short time. Also, verifying the feasibility of each proposal takes into consideration the effect of time value of money during the project life cycle. In addition, the effect of down payment on the magnitude of the NPV was investigated. To provide in-depth discussions and understanding of the proposed model, a case study approach is adopted in this research.

3.1. The system layout

The proposed system is coded to be computerized by using Dot NET language (.NET), the user interface designed by Microsoft for access in Windows. The proposed system was created for dealing with all the cash in/out of the project during the project life cycle to improve the financial evaluation of construction projects. The construction projects were covered by three financial phases, as the project money phases, as shown in Fig. (1). Accordingly, the project financing can be divided into three time frames.

The pre-construction phase concerns the items related to cash out only because there is no cash in or revenues at this stage. These data can be summarized in the preliminary fees, such as the purchasing value of the project land, administrative fees, and feasibility study fee. The construction phase includes the two values of money, cash in and cash out, such as expected value for the project construction, administrative fees, and expected revenue. Accordingly, the value for each item should be saved at the proposed program database to calculate the NPV. The final stage, the post-construction phase, includes all the items related to cash in and any items of Cash Out, if found.

3.2. The system input

The proposed computer program is designed to enter all the project financial data required during the project life costing, including all phases of the project. These data include project name; project description; inflation rate (%); discount rate (%);

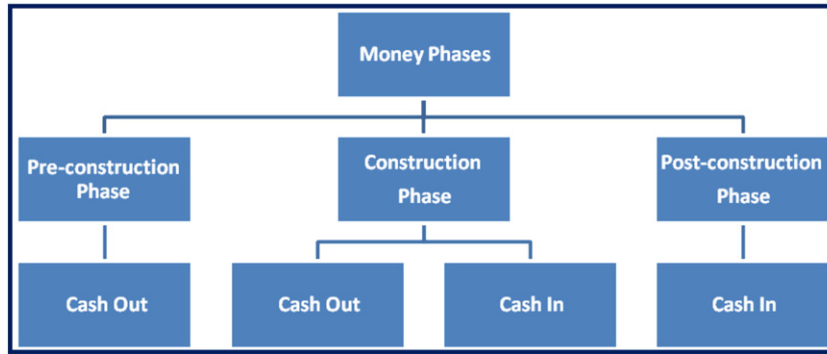


Fig. 1. Project money phases.

total area of the project; project start date (month and year); total land price; expected down payment (if any); expected price for construction/unit area; administrative fees (%); names of the proposed alternatives and its types; expected duration and start date for pre-investment, construction, and post-construction phases; expected area and expected selling price for each proposal.

3.3. The criteria of the proposed system

The net present value (NPV) of a project is defined as the value obtained by discounting, separately for each year, the difference of all cash outflows and inflows accruing throughout the life of a project at a fixed and pre-determined discount rate. This difference is discounted to the point at which the implementation of the projects is supposed to start. The NPV of the project can be calculated as follows:

$$NPV = NCF_1 + (NCF_2 * a_2) + (NCF_3 * a_3) + (NCF_4 * a_4) + \dots + (NCF_i * a_i) + \dots + (NCF_n * a_n)$$

$$a_i = \frac{1}{(1 + i_m)^n}$$

where NCF_i is the net cash flow of a project in months 1, 2, 3, ..., i , ..., n , and (a_i) is the discount factor in months 2, 3, ..., i , ..., n appropriate to the discount rate applied and (i_m) is the discount rate per month, calculated by the following equation:

$$i_m = (1 + i_y)^{1/M} - 1$$

where (i_y) is the discount rate per year and (M) is the number of payments per one year. See Table (1).

If the NPV is positive, the profitability of the investment is above the discount rate. If it is zero, the profitability is equal to the

discount rate. A project with a positive or zero NPV can thus be considered acceptable (Feasible). If the NPV is negative, the profitability is below the discount rate and the project should be dropped or rejected (Non-feasible). Accordingly, the NPV can be calculated per each month of the project life costing. An important decision of an investor is often not only the profitability of this investment, but also the answer to the question: how long does it take to get the money back including a certain minimum interest rate?

The minimum attractive rate of return (MARR) as specified by the top management in a private firm reflects the opportunity cost of the capital of the firm, the market interest rates for lending and borrowing, and the risks associated with investment opportunities. Regardless of how the MARR is determined by an organization, the MARR specified for the economic evaluation of the investment proposals is critically important in determining whether any investment proposal is worthwhile from the standpoint of the organization. In our case study, (i_y) represented the value of MARR.

3.4. The system output

The proposed system gives important information to the investors by indicating the feasibility of the project in a simple way within a short time and minimum cost. In addition, the output of the proposed system includes the net present value (NPV) for each proposal; maximum finance; the expected date to achieve MARR; project recommendations (Feasible or Non-feasible); constructed area percent; the exact date to get the money back; the relation between the down payment and the NPV; total cash in/out; expected construction price...etc.

4. Case study using the proposed program

Five proposals were prepared by consultant offices for building a multi-usage project in a specific area, including residential, administrative and commercial areas as shown in Table (2). The technical evaluation is prepared by professional teams in the construction field. Also, the financial evaluation will be required for these proposals. So, the new proposed program was applied to investigate this issue. The expected selling price per meter square at this location for residential 1, residential 2, administrative, commercial, and garage is 2100 LE, 8000 LE, 10,000 LE,

Table 1
The value of “M” and the corresponding value of “r”.

| Value of “M” | Time of payment | Formula equation for “r” |
|--------------|---------------------------------|--|
| 12 | Every month | $i_m = i_{\text{every month}} = (1 + i_y)^{1/12} - 1$ |
| 4 | Every 3 months | $i_{\text{every 3 months}} = (1 + i_y)^{1/4} - 1$ |
| 3 | Every 4 months | $i_{\text{every 4 months}} = (1 + i_y)^{1/3} - 1$ |
| 1 | Every 12 months = once per year | $i_{\text{every 12 months}} = (1 + i_y)^{1/1} - 1 = i_y$ |

Table 2
Areas for each proposal (case study).

| Items | Type | Unit | Proposal no. 1 | Proposal no. 2 | Proposal no. 3 | Proposal no. 4 | Proposal no. 5 |
|-------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Area | | | | | | | |
| 1 | Residential 1 | m ² | 22,800 | 25,000 | 15,552 | 7300 | 24,000 |
| 2 | Residential 2 | m ² | 15,200 | 16,000 | 10,368 | 4800 | 1600 |
| 3 | Commercial | m ² | 10,600 | 5500 | 4000 | 2000 | 4250 |
| 4 | Offices | m ² | 29,070 | 11,500 | 6250 | 4000 | 8900 |
| 5 | Garage | m ² | 7600 | 6000 | 5400 | 3200 | 4000 |

25,000 LE, and 2000 LE respectively. There are other data and assumptions which are required for our case study as follows:

- ✚ Currency unit=LE (note: 1.00 LE=\$0.167)
- ✚ Total project area=8900 m²
- ✚ Total land price=133,500,000 LE
- ✚ Expected construction cost per m²=1727 LE
- ✚ Discount rate=10% and inflation rate=4.55%
- ✚ The starting project date is October, 2008.
- ✚ The expected duration for the pre-investment phase = 12 months
- ✚ The expected time for the construction phase = 27 months.

4.1. Input data screens

All the previous data will be entered by the user into the proposed program screens as shown in Fig. (2). The main screen

includes all the items which are required to make calculations of the financial evaluation such as main data, reporting, charts, security, and help. The *Project screen* includes main principle data for the studied project such as: project name, total land area of project, total land price, expected cost for construction unit, inflation rate, discount rate, project starting date, value of down payment (if any), and description of the project location. The *Alternative screen* contains all the proposed alternatives names (consultant proposal no. 1, consultant proposal no. 2, consultant proposal no. 3, consultant proposal no. 4, and consultant proposal no. 5). The *Types screen* and *Item screen* help the user to enter the type of the project as shown in Table (2). The project type may be residential, commercial, offices, school ... etc. Also it may be a multipurpose project such as our case study; including residential (1) which refers to the economic units' type in its expected selling price. On the other side, residential type (2) refers to the market price in this region {selling price of residential type (2) is higher than the residential type (1)}. The *Project phase screen* is used to determine the duration for each phase and its initial date. The durations for the pre-construction and the construction are 12 and 27 months respectively in the case study; so the starting months will be 0, 12, and 39 for the pre-construction, the construction, and the post-construction respectively.

By using the *Item screen*, the user informs the program with the data that is required such as the project name, proposed alternatives, the type of this alternative, number of floors, and the expecting selling prices. After that the user saves this data by pressing the save icon at the left side of the Item screen. The



Fig. 2. Main opening screen for the proposed program.

previous step should be repeated per each alternative of the studied project. See Fig. (3).

The *Cash flow screen* helps the user to enter all values of the cash in/out per month in detail during the project life cycle taking into account the project phases, items, and the money values as shown in Fig. (4).

The proposed model gives two options for the user when entering the values of the cash in/out for the proposed project. The first option is entering the cash in/out in a detail (per month) if there is enough time to make the financial study. The second option is a quick financial study to get a trust result as soon as possible. The user should answer two questions in the second option to inform the program with the minimum required data. The questions are:

1. What is the start date of the cash flow item?
2. What is the duration (months) for this cash flow item?

Table (3) shows the starting date and start sequence for the cash flow and the duration, per each type.

In all cases, the user entered all data of the cash in/out in the previous screens depending on the required accuracy and the available time. The output appeared in the bottom of the Cash flow screen.

4.2. Resulting and output data screens

If one of the several project alternatives has to be chosen, the project with the largest NPV should be selected. This needs some refinement, since the NPV is only an indicator of the positive net cash flows or of the net benefits of a project. In cases where there are two or more alternatives, it is advisable to know how much investment will be required to generate these positive NPVs.

After running the proposed program, the magnitude of the NPV for each proposal was represented in the *Net present value screen* as shown in Fig. (5). The analysis revealed that proposal no. 1 is feasible and its NPV equals (110,111,063) LE. The message box will display “*Feasible project*”. On the other side, the magnitude of the NPV is negative for the other proposals. Accordingly, the message box will display “*Non-feasible project*”.

The output table at the bottom of the NPV screen shows the magnitude of the total NPV and cash in/out for each month during all phases of the project cycle. Also, these results can be transferred to an Excel file for printing. To do so, just press on the icon to the right side of this screen. In addition, the program model automatically transfers exactly per month all of the sequence numbers to the month name to determine the value of the cash in/out and its date. Also, the program

| Project | Alternative | Type | Area | Unit | Expecting Selling Price | No. of Floor |
|---------|-------------------------|---------------|-------|------|-------------------------|--------------|
| Alex V1 | Consultant No.1(Essa) | Residential 1 | 22500 | m2 | 2100 | 13 |
| Alex V1 | Consultant No.1(Essa) | Residential 2 | 15200 | m2 | 8000 | 13 |
| Alex V1 | Consultant No.1(Essa) | Commercial | 10600 | m2 | 25000 | 13 |
| Alex V1 | Consultant No.1(Essa) | Offices | 29070 | m2 | 10000 | 13 |
| Alex V1 | Consultant No.1(Essa) | Garage | 7600 | m2 | 2000 | 13 |
| Alex V1 | Consultant No.2(Raghb) | Residential 1 | 25000 | m2 | 2100 | 13 |
| Alex V1 | Consultant No.2(Raghb) | Residential 2 | 16000 | m2 | 8000 | 13 |
| Alex V1 | Consultant No.2(Raghb) | Commercial | 5500 | m2 | 25000 | 13 |
| Alex V1 | Consultant No.2(Raghb) | Offices | 11500 | m2 | 10000 | 13 |
| Alex V1 | Consultant No.2(Raghb) | Garage | 6000 | m2 | 2000 | 13 |
| Alex V1 | Consultant No.3(Balaha) | Residential 1 | 15552 | m2 | 2100 | 13 |
| Alex V1 | Consultant No.3(Balaha) | Residential 2 | 10368 | m2 | 8000 | 13 |
| Alex V1 | Consultant No.3(Balaha) | Commercial | 4000 | m2 | 25000 | 13 |
| Alex V1 | Consultant No.3(Balaha) | Offices | 6250 | m2 | 10000 | 13 |
| Alex V1 | Consultant No.3(Balaha) | Garage | 5400 | m2 | 2000 | 13 |
| Alex V1 | Consultant No.4(Na3eem) | Residential 1 | 7300 | m2 | 2100 | 13 |
| Alex V1 | Consultant No.4(Na3eem) | Residential 2 | 4500 | m2 | 8000 | 13 |
| Alex V1 | Consultant No.4(Na3eem) | Commercial | 2000 | m2 | 25000 | 13 |
| Alex V1 | Consultant No.4(Na3eem) | Offices | 4000 | m2 | 10000 | 13 |
| Alex V1 | Consultant No.4(Na3eem) | Garage | 3200 | m2 | 2000 | 13 |
| Alex V1 | Consultant No.5(Hakeem) | Residential 1 | 24000 | m2 | 2100 | 13 |
| Alex V1 | Consultant No.5(Hakeem) | Residential 2 | 1600 | m2 | 8000 | 13 |

Fig. 3. Main items screen.

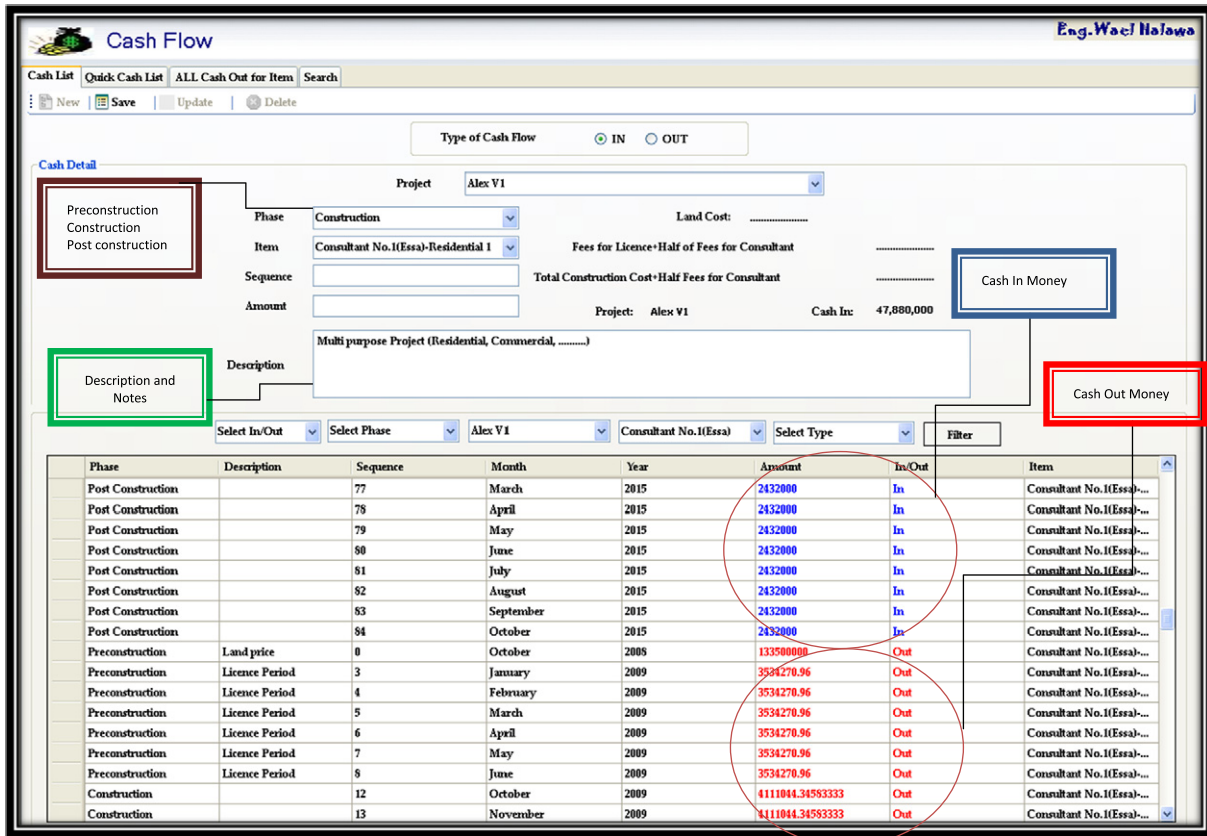


Fig. 4. Main cash in/out screen.

informs the investors with a variety of charts to facilitate the output results and represents the comparison among all proposed alternatives. These charts include information about the effect of the different percentages of down payment on the magnitude of the NPV; the NPV comparison for the proposed alternatives; the NPV for each month; and other charts to help the investor select the best proposed alternatives Fig. (6), such as the down payment NPV chart, representing the magnitude of the NPV per percent of the down payment. The results revealed that the magnitude of the NPV decreased when the down payment percent increased. The NPV for proposal no. 1 equals 110,111,063 LE, 109,224,562 LE, 108,338,061 LE, 107,451,560 LE, and 106,565,059 LE at down payment equals 0%, 5%, 10%, 15%, and 20% respectively. In addition, Fig. (7) represents the comparison among the NPVs for all proposed alternatives. It can be seen that the NPVs for proposal no. 1, proposal no. 2, proposal no. 3, proposal no. 4, and proposal no. 5 are 110,111,063 LE,

Table 3
Starting date and duration for each type.

| Type | Start sequence (starting month no.) | Number of months (duration) |
|---------------|-------------------------------------|-----------------------------|
| Residential 1 | 27 | 60 |
| Residential 2 | 35 | 50 |
| Commercial | 35 | 48 |
| Offices | 39 | 48 |
| Garage | 35 | 12 |

–4,847,697 LE, –49,408,116 LE, –89,425,875 LE, and –62,998,193 LE respectively. Also, the data can be represented in different formats by selecting the type of the chart such as (columns, pie, line...). Table (4) shows the difference between the results from our proposed program, where the time factor was included, and the traditional ways, which were collected from the consultants without taking into consideration the effect the time factor during the project life costing. The results of the proposed program are accurate and logical compared to the results of the older, traditional ways.

The data which was delivered from the proposed program revealed that the NPV for proposal no. 1 is 110,111,063 LE but it equals 437,676,778 LE in case the traditional evaluation ways are used. There was a difference of 327,565,715 LE between the two methods. It can be concluded that the traditional evaluation ways give inaccurate results for evaluating the construction projects.

The investors at the pre-investment phase for any project need to answer two important questions. The *first question* is “What is the value and time of maximum finance for his project?” The *second question* is “At what time does the project achieve the target MARR?” The proposed program is able to give the answer for these questions by selecting the chart of finance per month as shown in Fig. (8). The maximum finance for proposal no. 1 is –279,875,045 LE in August 2011 instead of –302,703,222 LE, which is the value of the total cash out as mentioned in Table 4. In addition, the investor will achieve his target MARR for this project in May 2013; this will happen in

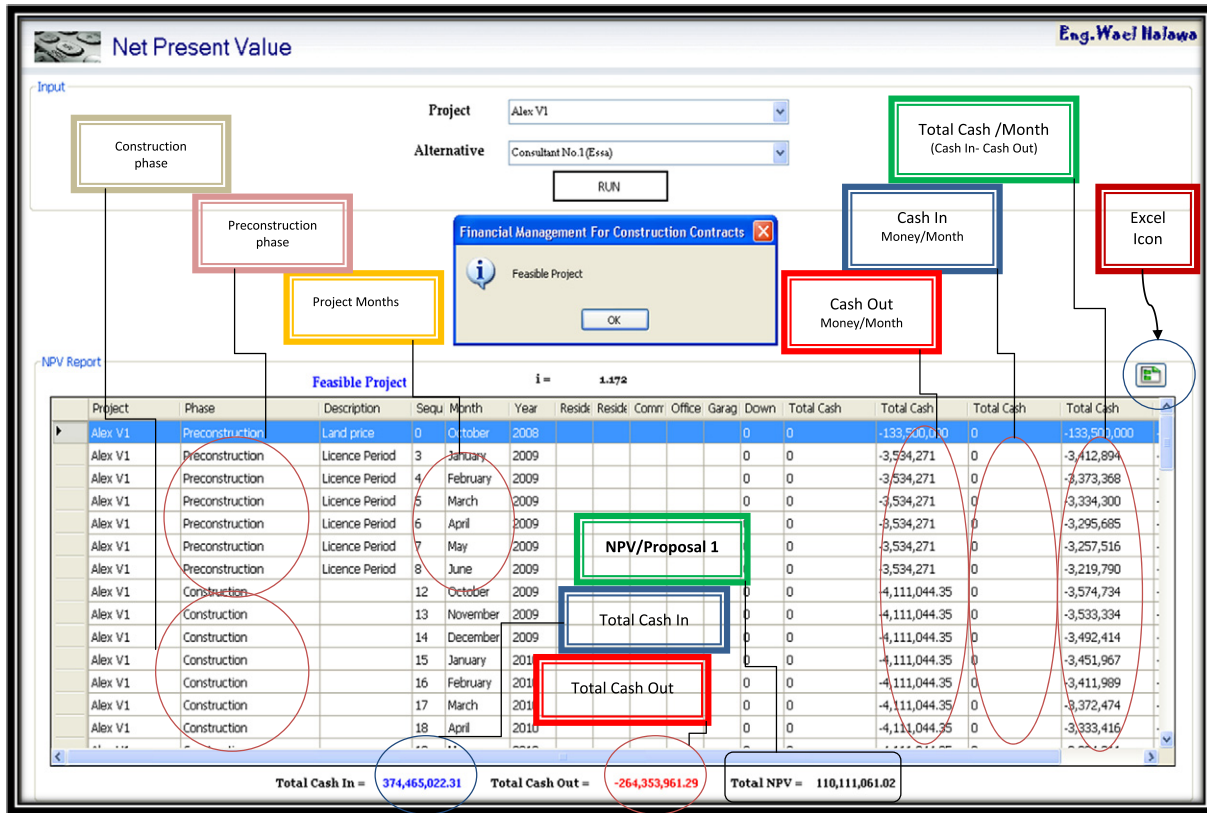


Fig. 5. Net present value screen.

the fifth year after exactly 54 months, so that, the investor would be able to make a good plan for his resources which are required to cover the maximum finance before starting the

project. The proposed model also provides the investors with important charts, such as the relation between the NPV and the construction price for each proposal; the magnitude of the cash

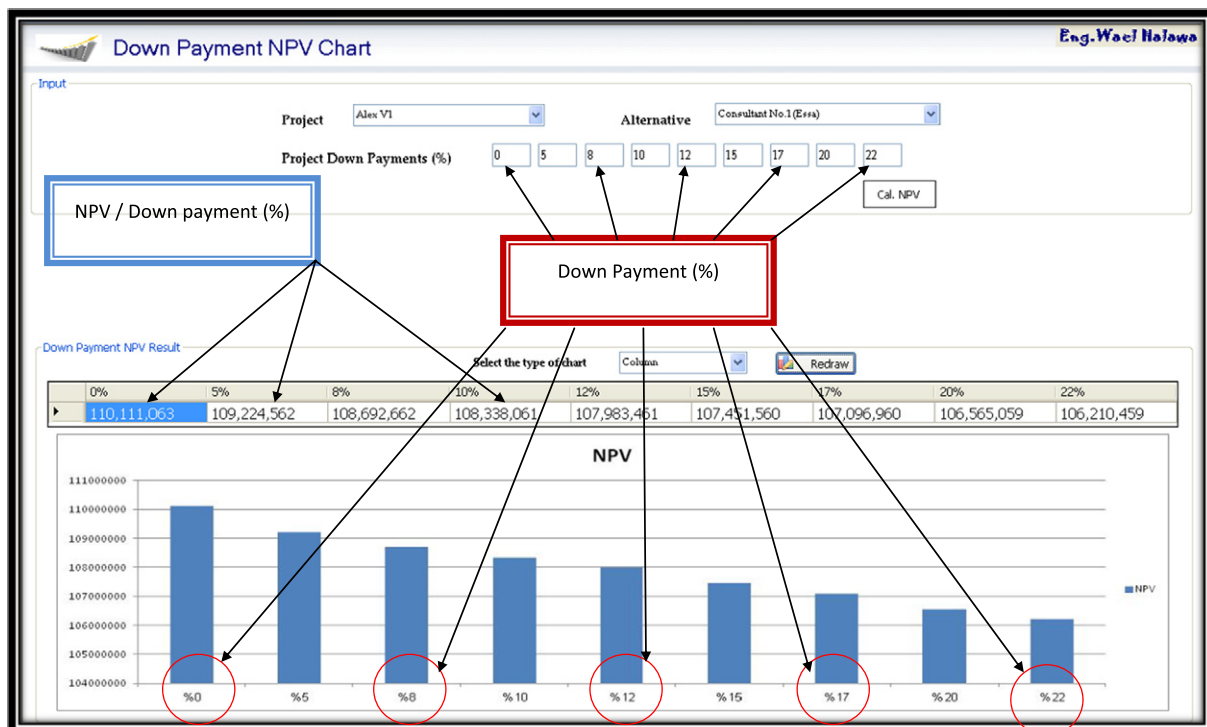


Fig. 6. NPV corresponding to different percentage of down payment.

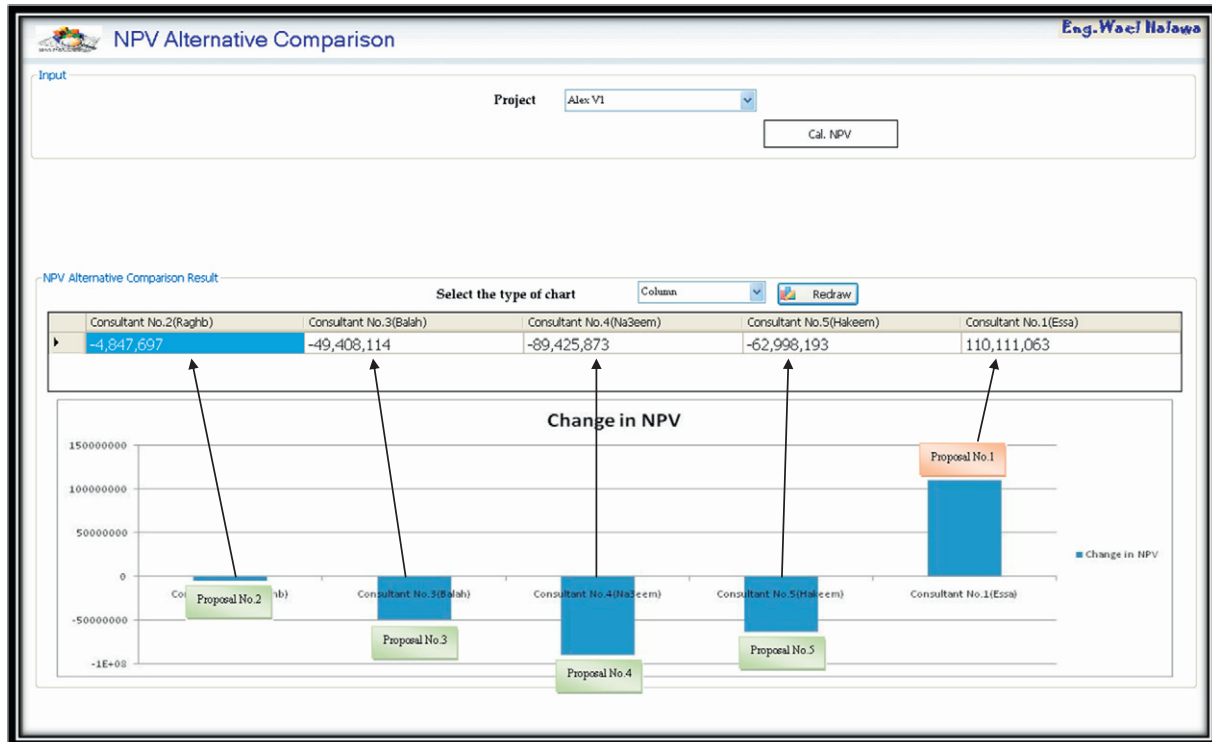


Fig. 7. Comparison among the NPV proposals (column chart).

in/out per month during all phases of the project life costing; and the cumulative cash in/out.

The previous screens are explained in detail in the *Help screen* of this program to make it easier for any user. The investor is able to make a financial evaluation and make an informed decision for the project because the program provided the supported results to indicate if the proposal is feasible or not and the corresponding NPV. Also, investors will be able to update the financial data related to the cash in/out at any time of the project life cycle to update the NPV and insure that the planned and actual paths of the project are almost the same.

5. Conclusion and future work

The computer software has benefited the construction field by providing financial information faster, thus allowing better financial management. Financial evaluation is an important issue at different stages of the construction industry. Accordingly, this study presented a proposed computerized program to

facilitate the financial evaluation system for the construction projects at the pre-investment phase. The life cycle costing of the construction projects may involve a long period (from 4 to 10 years) to achieve the target MARR. We can summarize the main tasks of this program in the following points:

1. The proposed system is coded to be computerized by using Dot NET language (.NET), the user interface designed by Microsoft for access in Windows. It was created for dealing with all cash in/out of the project during the project life cycle to improve the financial evaluation of the construction projects.
2. Facilitating the financial evaluation system by calculating the NPV for the construction projects at the pre-investment phase taking into account the effect of the time value of money. In other words, if the NPV is positive, the profitability of the investment is above MARR. If it is zero, the profitability is equal to MARR. A project with a positive or zero NPV can thus be considered acceptable and

Table 4
The comparison between the traditional ways and the proposed program.

| Proposal name | Total cash out | Total cash in | Traditional ways (cash in–cash out) | | Results from the model | |
|----------------|----------------|---------------|-------------------------------------|--------------|------------------------|--------------|
| | | | NPV | Decision | NPV | Decision |
| Proposal no. 1 | -302,703,222 | 740,380,000 | 437,676,778 | Feasible | 110,111,063 | Feasible |
| Proposal no. 2 | -260,496,672 | 445,000,000 | 184,503,328 | Feasible | -4,847,697 | Non-feasible |
| Proposal no. 3 | -215,988,307 | 288,903,200 | 72,914,893 | Feasible | -49,408,114 | Non-feasible |
| Proposal no. 4 | -175,766,079 | 150,130,000 | -25,363,079 | Non-feasible | -89,429,873 | Non-feasible |
| Proposal no. 5 | -218,329,808 | 266,450,000 | 48,120,192 | Feasible | -62,998,193 | Non-feasible |
| Comment | | | "No time factor" | | "With time factor" | |

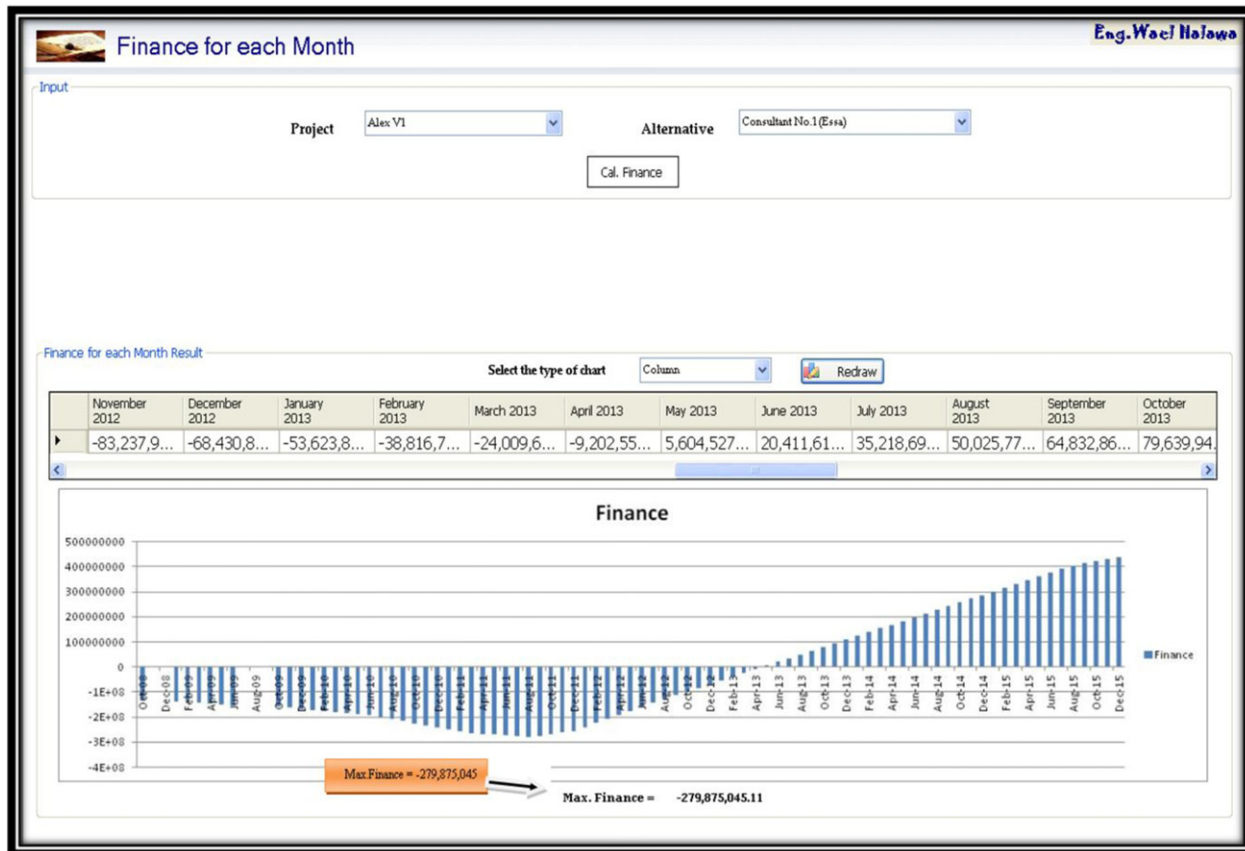


Fig. 8. Finance for each month screen.

- feasible. If the NPV is negative, the profitability is below MARR and the project should be dropped and considered to be non-feasible. The analysis discovered that proposal no. 1 is feasible and its NPV equals (110,111,063) LE. In addition, the message box will display “Feasible project”. On the other side, the magnitude of the NPV is negative for the other proposals.
- Ability to make a comparison among several proposals in a simplified way to select the best option. The results revealed that the NPVs for proposal no. 1, proposal no. 2, proposal no. 3, proposal no. 4, and proposal no. 5 are 110,111,063 LE, -4,847,697 LE, -49,408,116 LE, -89,425,875 LE, and -62,998,193 LE respectively.
 - Dealing with a large size of data, making it suitable for modifications several times within a short timeframe for large projects. In addition, it solves the problem of manual calculations. Also, the data can be represented in different formats by selecting the type of the chart such as (columns, pie, line...) and the results can be transferred to an Excel file for printing.
 - The proposed program optimizes the relation between the NPV and the down payment of the project. The NPV for proposal no. 1 equals 110,111,063 LE, 109,224,562 LE, 108,338,061 LE, 107,451,560 LE, and 106,565,059 LE at down payment equals 0%, 5%, 10%, 15%, and 20% respectively. Accordingly, the

- magnitude of the NPV decreased when the down payment percent increased.
- Informing the investors of the magnitude and the time of maximum finance of the project during the life cycle costing and at which time the project achieves the target MARR. The case study results showed that the maximum finance for proposal no. 1 is -279,875,045 LE in August 2011 instead of -302,703,222 LE. In addition, the investor will achieve his target MARR in May 2013; this will happen in the fifth year after exactly 54 months.
 - The data which was delivered from the proposed program revealed that the NPV for proposal no. 1 is 110,111,063 LE but it equals 437,676,778 LE in case the traditional evaluation ways are used. There was a difference of 327,565,715 LE between the two methods. It can be concluded that the traditional evaluation ways give inaccurate results for evaluating the construction projects.

Lastly, it should be noted that under the very unusual circumstances of the economic and financial crisis we are currently experiencing, the convenience of public spending would seem to be only of a very fleeting nature. Consequently, the need to ensure that this spending creates more value than it destroys must obviously remain a key priority. Accordingly, the

financial evaluation program can be considered as a guide for this spending during the whole project life.

This research is suitable for the pre-investment phase rather than the other phases. Future research will focus on informing this computer program with data from other planning, cost control programs (such as Primavera and Microsoft project), and accountant programs. These will enhance the application of financial management in the construction field and will create a good performance in project financing.

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