RISK FACTORS IN CONSTRUCTION PROJECTS CASH-FLOW ANALYSIS

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Abstract

This study presents a new methodology for net cash flow prediction. This methodology depends on applying risk factors that affect the cash flow process. The probabilistic S curves are used as an alternative of the Standard S curve and the traditional method that neglect the effect of risk and uncertainties. These risk factors have been determined through a questionnaire survey. This survey was conducted among the main three parties in construction industry contractors, consultants and owners. Two hundreds questionnaires were sent to these organization, only 60 responses were received within the accepted range of questionnaire response from 20-30%. Through this survey, the most important cash flow risk factors were clearly identified. A simulation programs were used for generating the probabilistic S curves. A MS excel macro was used for a probabilistic cash in prediction. Probabilistic S curves provide a probability distribution of required cost and time to finish the project for any selected point at the project. The probabilistic cash flow prediction enables the users to accurately determine the project cash flow position.

Keywords: Cash flow - risk factors - probabilistic – analysis – Construction management

1. Introduction

Financial Management has long been recognized as an important tool in construction industry. However, the construction industry suffers the largest rate of insolvency of any sector of the economy. Companies fail because of poor financial management, especially inadequate attention to cash flow forecasting. It is common consensus that cash flow management and liquidity are key elements in the survival of contractor [23]. Therefore, many companies forecast and project expenditures to manage their finances.

Unfortunately construction project cash-flow is mainly affected by many uncertain but predictable factors.

Uncertainty in information affects decision making. For example, in structured finance transactions, the different counterparties involved perceive risks with differing levels of comfort. For many risk factors in such transactions, such as legal and regulatory risks, historical and numerical records are missing so that actuarial approaches fall short in resembling and modeling transaction-specific risks. Information on such risks is often vague, subjective, and uncertain. However, a confined number of experts that have intimate knowledge and some opinion on these risk factors may exist [29]. The uncertainty and ambiguity are caused not only by project-related problems but also by the economic and technological factors.

Heretofore it has been indicated the serious importance of the cash-flow prediction for construction contractors. A reliable cash-flow prediction can help to accurately identify the expected project financial requirement. So that, decision can be made at a suitable time regarding the potential sources of this finance.

Through the literature survey, it was noticed that the majority cash-flow prediction models have been based on standard cash flow S-curves, developed using the traditional manual approach, mathematical and statistical models. Many of these models failed to consider and analyses the risk factors such as changes in the design or specifications, contract conditions pertaining to cash in flow, interim valuations and certificates and construction programming issues such as inclement weather responsible for the considerable variations in the modeled cash flow profiles.

Hence, it is safe to say that a reliable cash-flow prediction should take into consideration the effect of these risk factors. This was demonstrated by the development of a series of typical S-curves by many researchers [18].

Kaka and Price [18] in developing a model for cash flow forecasting identified other risk factors affecting cash flow profiles to include estimating error, tendering strategies, and cost and duration variances. The identified risk factors have been reported to affect cash flow profiles as well as significantly impacting on the modeling of cash flow. However the perception of the contractors to the likelihood of the risk factors occurring in different project types and of varying scope and duration is yet to be investigated.

2. Research scope and Objective

The objective of this paper is the development of a probabilistic net cash flow model with the effect of the risk factors among the construction industry.
At first a questionnaire survey was distributed among the construction industry to determine the most important risk factors with their impact and frequency.

Then the second stage is to implement the risk factors in the designed model which consist of three stages as illustrated in Fig 1

First stage planning and scheduling using primavera p6 (commercial software), second stage is the implementation of the most important risk factors through the tested project , this stage was done by primavera risk analysis (commercial software) and the outcome is the probabilistic cash out. The last stage is the modeling and the production of the probabilistic cash in, net cash flow and the finance cost. This stage was made through a designed Microsoft Excel macro sheet. The designed model was validated through a real project with the comparison of the model outcomes and the actual data.

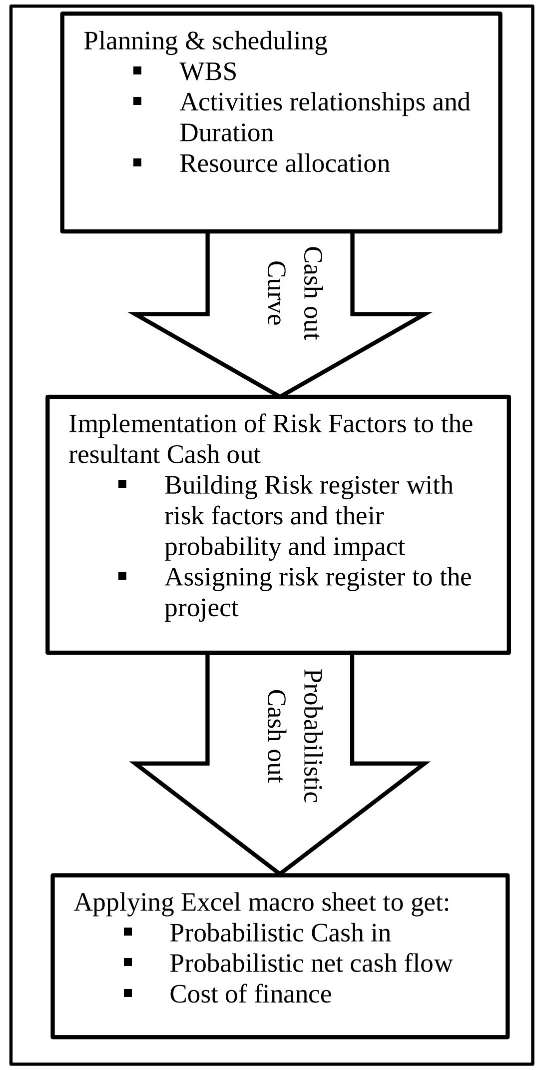

Fig.1. Risk model stages

3. A Review of Previous Cash Flow Models

In the absence of an ideal net cash flow curve, previous researchers have used ideal value curves to produce net cash flow profiles. The method defines the cash-in curve as the value curve minus any retention held, with an allowance for time lag. Similarly, the cost curve is derived from the earnings curve using specified lags and percentages of earnings.

The possibility of building an ideal value curve based on historic data has been the subject of a considerable amount of research [9, 28, 10, 15]. Although these approaches have gained general acceptance, they have not been without criticism. Hardy [14] found that there was no close correlation between the figures given for 25 projects considered, even when the projects were similar. Oliver [25] analyzed projects collected from three construction companies. He concluded that, although the number of projects analyzed was statistically small, construction projects are individually unique and follow such diverse routes that value curves based on historical data are not capable of providing the accuracy required for individual contract control.

Other researchers thought that value curves were unique to single contracts, and therefore should be estimated for each project. Allsop [3] linked a cash flow model to an estimating program which already existed at Loughborough University of Technology. The program used the estimated cost and estimated value with the contract schedules to calculate the cash flow of the project.

Studies on the accuracy of models based on ideal value curves are in conflict. The feasibility of building ideal value curves for different project types is questionable. There is evidence that single curves cannot be fitted accurately through even one type of project. Kenley [20] studied the variability of net cash flow profiles by collecting the cash-out and cash-in data from 26 commercial and industrial projects. The goodness of fit was reasonably accurate and 26 net cash flow profiles were produced. Comparisons between the results indicated that there was a wide degree of variation between the profiles of individual projects.

From another point of view, some researches have concentrated on the method of 'weighted mean delays' in order to develop a method for modeling individual construction project net cash flows. This method involves applying systematic delays to a cash inflow profile, in order to reckon the outflow profile. The balance between the two is the net cash flow.

Peterman [26] proposed an early model utilizing standard delays, and this was followed by Ashley and Teicholz [4] and McCaffer [22]. McCaffer refined the approach using forecast income schedules based on network analysis. These models did not use standard sigmoid (S) curves as their base

The systematic delay method used by McCaffer [22], relied on the hypothesis that the value curve can be modeled by the use of standard curves, and that the cash-in curve and cash-out curve can be modeled by the application of delay factors to the value curve. McCaffer used a method of weighted mean delays to derive the component curves from the standard value set at the commencement of this procedure. McCaffer's procedure is similar to that used by Ashley and Teicholz who defined the cash-in curve as the earnings minus held retention, with allowance for lag. Similarly the cost curve was derived from the earnings curve using specified lags and percentages of earnings.

Both the ideal reference curve and weighted mean delay models have limitations, one being that they use methods which yield consistent results regardless of the selection of originating curves. There is a large degree of variability between individual project net cash flows; therefore it is necessary to develop a model capable of adjusting to a wide range of variable profiles. Such a model is unlikely to use polynomial regression of net cash flow data, as 'the regression analysis has failed to produce a convincing explanation of cash flow differences' [24]. Hence further research must return to the work of Jepson [17] who suggested that 'generating' or 'component' curves (the inflow and outflow profiles) must be used to derive individual project net cash flows.

Several approaches to the analysis have been used and they may all be characterized as nomothetic, in that they attempted to discover general laws and principles across categorized or non-categorized groups of construction projects, with the purpose of a-priori prediction of cash flows. In contrast an idiographic methodology; the search for specific laws pertaining to individual projects.

Individual variation between projects is caused by a multiplicity of factors, the great majority of which can neither be isolated in sample data, nor predicted in future projects. Some existing cash flow models hold that generally two factors, date and project type, are sufficient to derive an ideal construction project cash flow curve. Such convenient divisions ignore the complex interaction between such influences as economic and political climate, managerial structure and actions, union relations and personality conflicts. Many of these factors have been perceived to be important in related studies such as cost, time and quality performance of building projects [16] and therefore models which ignore all these factors in cash flow research must be questioned.

The majority of previous studies use historical data or Standard curve models, based on historic data which have been extensively used in cash flow research mentioned above. Although these approaches have gained general acceptance, they have not been without criticism. Hardy [14] found that there was no close similarity between the ogives for 25 projects considered, even when the projects were within one category. This implicit support for an idiographic methodology was subsequently ignored, despite the problems which some researchers found in supporting their models.

Russell kenley and owen d. Wilson [19] take Consideration of the idiographic-nomothetic debate led to that the natural science methodology was inappropriate for unique phenomena such as construction projects due to a multiplicity of factors and influences effect project cash flows, many of which are unquantifiable and have differential impact.

It is therefore contended that an idiographic methodology is more appropriate to the study of construction project cash flows, than is a nomothetic methodology, and a nomothetic methodology can only be supported if a significant similarity can be shown to exist within groups. The experimental hypothesis is that there is substantial variation between projects.

In Their models it was noticed that the projects examined have yielded individual profiles, which support Hardy's [14] contention that no close similarities exist between projects. It is their belief that group models are both functionally as well as conceptually in error.

4. Risk Factors and Probabilistic Cost and Duration Estimating

Many models have been developed to assist contractors and clients in their cash flow forecasting. The majority of these have been based on standard cash flow S-curves, developed using the traditional manual approach, mathematical and statistical models.

Many of these models failed to consider and analyses the factors responsible for the considerable variations in the modeled cash flow profiles.

These factors can be grouped in some categories, these included size of construction firms, building types, procurement options, client types, project duration and project value. Most of the models neglect the effect of these factors on the activity causing the cost and duration variability and consider the cash flow profile as deterministic value.

As with all variability in activity cost and duration due to expected and unexpected changes upon the project various phases, Probabilistic estimation is needed. Recently, commercial computer programs have been developed with the specific purpose of probabilistic estimating [e.g., Monte Carlo and @RISK for Project. These simulation applications are capable of developing integrated probabilistic cost and duration estimating performance CPM calculations in order to find the early and late event times for each activity. If, in each iteration values of cost are found for each time increment, a possible S-curve can be generated. The final graph will have a representation similar to that shown in Fig.2, where the envelope of completion cost and duration values includes the end point of each simulated S-curve [5].

Barraza [8] represent a graphical representation for probabilistic forecasting Based on progress-based S curve. Progress-based S curves are defined as plots of cumulative budget and planned duration against project progress Barraza [7] Performance monitoring using PB-S curves is equivalent to the use of the EVS, however it has the advantage of representing the three units required to follow integrated performance: cost, time, and work (progress). Using a simulation approach and the PB-S curves representation, different possible total cost and project durations may be evaluated. Thus, for each simulation iteration, a possible PB-S curve can be plotted. Barraza [6] defined the resulting set of PB-S curves as stochastic S curves (SS curves).

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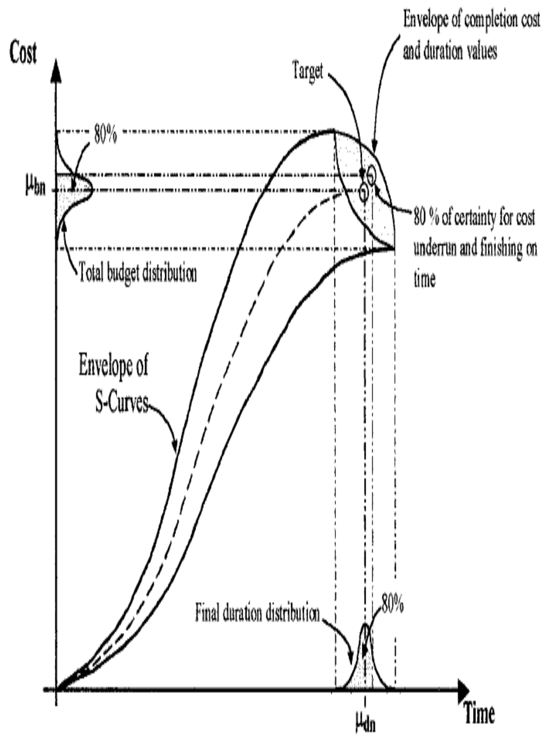

Fig.2. Cost and schedule probabilistic estimating [7]

A total of 60 organization returned their questionnaires duly completed. This represents a 30% response rate which is typical of the norm of 20-30% response rate in most questionnaire survey of the construction industry [2].

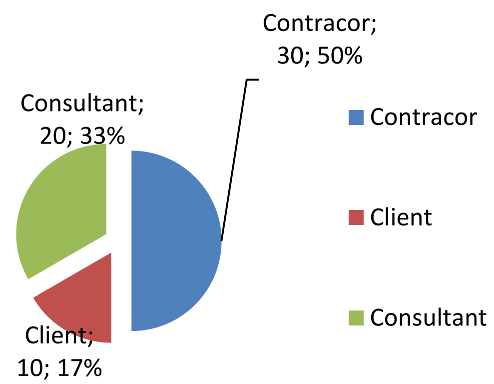

Fig. 3.work classification of questionnaire respondents according to party

5. Data collection

In order to assess the perception of contractors, clients and consultants to the risk factors involved in modeling cash flow forecast, a structured questionnaire was designed. This was based on an in-depth literature review of risk factors responsible for variation in cash flow profile and the authors' general knowledge of the factors. The questionnaire was administered through a postal survey, online survey and interviews to 200 organizations.

The questionnaire listed 27 risk factors derived from literature as potentially affecting cash flow forecasting. Respondents were then asked to provide opinion regarding each factor impact and frequency. The scoring was done on a Five-point Likert-type scale. The highest likelihood of a risk factor occurring and frequency was assigned a score of 5 The Least likelihood of a risk factor occurring and frequency was assigned a score of 1.

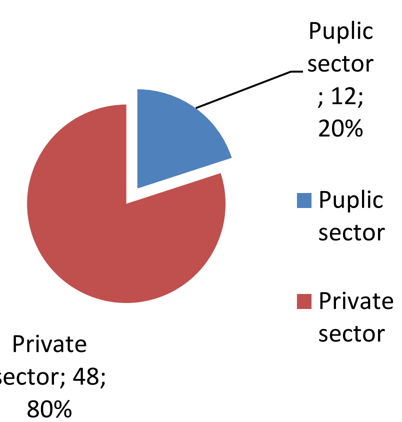

Fig.4. Work categorization with respect to Sector

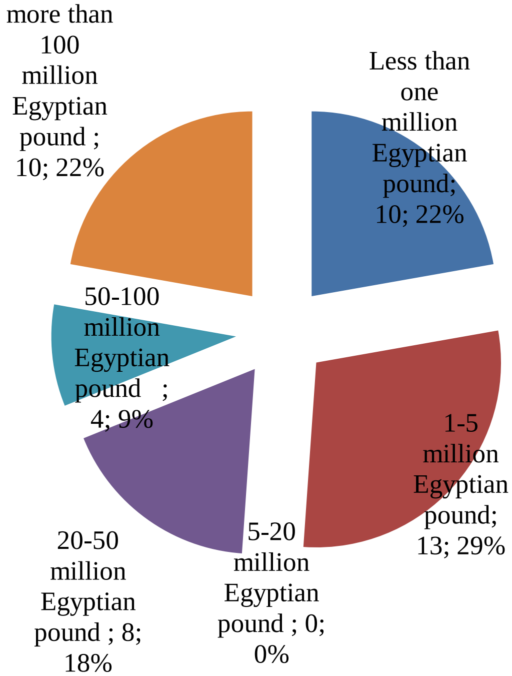

Fig.5. Annual work load for each organization

Figure 3 represent the classification of the 60 respondents according to work part. A careful inspection to the figure clearly shows that respondents consist of 30 contractors and 20 consultants and 10 owners. It is obvious that owners are the least participant to respond to the survey from our interviews.

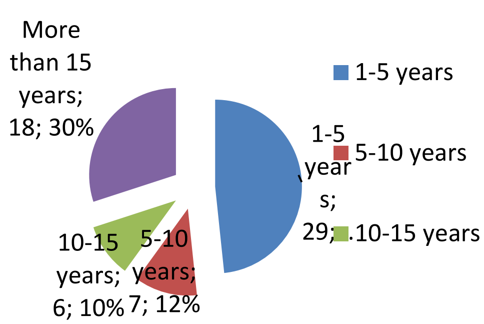

Fig.6. Previous experience in construction industry

That's because they did not understand the survey due to the non-construction knowledge or they aren't interested in the survey and seeing that the whole issue without any advantage and useless. Another reason that they all don't know the most of our risk factors in the survey and not familiar with. From the other side contractor was the most helpful and the most participant in the survey and that's why they know the problem, familiar with it and with all the risk factors in the survey and they are the most affected party .

Figure (3), (4), (5), (6) illustrate the distribution of respondents with respect to work categorization, Average annual work load and previous experience in construction industry respectively.

Figure.3. represents the work categorization with respect to the three main parties. It shows the the highly response of the contractors category as they are familiar with the issue of the questionnaire and because they are more targeted in the survey as mentioned before. While the client category comes at the end with 17 % due to the majority of the clients were not familiar with the issue and the factors and bothering to apply the survey.

Figure.4.illustrate the work categorization with respect to sector property. It shows that high difference between the public sector and private sector participation. That is due to difference between the number of public and private organizations. Other reason that the ease of access and response of the employers in the private sector than others in the public sector.

Figure.5. illustrates the average annual work load and it has respondents in each category except one category 5– 20 million Egyptian pounds. Figure.6. illustrates the previous experience in construction that the respondent has. It's obvious that almost half of the participants in the category of 1-5 years' experience. The reason that the high response of those participants.

6. Data analysis and results

Table 1 represents the Ranking of selected risk factors affecting net cash flow using work categorization grouping. From Table 2 we see the ranking of the risk factors with the respect to work categorization. For an example the factor "level of inflation" has an approximately agreement from the three parties where it ranked 14th overall while it ranked 13th, 15th and 15th for contractor, consultant and Owner respectively. "Changes in interest rates" has a totally agreement where it ranked 27th overall while it ranked 27th, 27th and 27th for contractor, consultant and owner respectively. On the other side factors as "material delay" ranked 7th overall while it ranked 14th, 8th and 10th for contractor, consultant and owner respectively. It's obvious that the judging differs from party to party and depends on factor and how this party familiar with and how it affect from their point of view. Thereafter, it was supposed to decide which of the 27 factors to be taken into consideration in the calculation of the net cash flow.

The score obtained for each factor shown in Table 1 were summed and divided by the number of factors to determine the average importance index (AI) of the factors. Then, the importance factor of each factor was compared with the average importance index. Factors with percentages more than or equal to the average percentage were considered as important factors, while the others were excluded. The average importance index is determined as follows:

AI=(57+53+51+50+49+47+46+45+44+43+42+41 +40+39+39+38+36+33+32+32+ 32+31+31+30+28+26+22) / 27 = 39.2 %

Therefore, factors with percentage more than or equal 39.2% were qualified. Table 2 shows the most important factors that were taken into consideration.

Two commercial software will be used, which are used in the construction industry "primavera p6 professional p6.1" and "primavera risk analysis". The first one used as a planning and scheduling tool while the second is used as a risk management tool. The first software provides the planner with simple data entry of the activities; dependencies, relationships, duration…etc. The software performs CPM calculations on the project as well as representing the project schedule in bar chart and network diagrams. The second software allows modeling more complex calculation using VBA (Visual basic in application) by implementing the risk factors on the cash out only so we will not be able to implement the risk factors upon the cash in profile. As a result that software will not process the cash in profile anther software was used to do so. Microsoft Excel was used to complete our modeling system outputs by generating Cash in, net cash flow and overdraft profiles.

The implementation mechanism consists of Three stages(Fig 7), the first stage is the planning and scheduling which is performed by one of the planning programs as primavera p6, Microsoft project 2010 and etc. (in this research we used primavera p6 for its wide commercial use). The second stage is the implementation of risk factors to the cash out. This stage performed by using any risk analysis simulation program as primavera risk analysis, @risk, Monte Carlo and etc. to get probabilistic cash flow. In this research primavera risk analysis was used for the highly used in the industry, the highly skilled and powerful software and finally it's more compatible with the primavera p6.the third stage is an excel-macro sheet to get probabilistic cash in and net cash flow and the cost of finance.

7. The proposed model

The implementation mechanism consists of three stages, the first stage is the planning and scheduling which is performed by primavera p6 for its wide commercial use. The second stage is the implementation of risk factors to the cash out. This stage performed by using primavera risk analysis to get probabilistic cash flow. The third stage is an excel-macro sheet to get probabilistic cash in and net cash flow and the cost of finance.

The first stage inputs are activities and their dependencies, relationships, duration and resources with their costs to get the project total duration and cost as cash out S curve. The second stage is the implementation of the risk factors on the cash flow curve resultant from the previous stage to get the probabilistic cash out. In this stage we use the primavera risk analysis to simulate probabilistic cash flow as a result of applying risk factors on the cash flow S-curve. The first step in this stage to import the project files from primavera P6 with all its data. Then to build risk register of the classified risk factors that have been mentioned previously in the research with their impact and probability. These impact and probability comes from the average of corresponding of the questionnaire responses in Table 3.

In the designed macro sheet the inputs are the probabilistic cash out data and the desirable percentage of markup, overheads, down payment and interest rate then these inputs goes throw the mathematical model equations in the macro sheet. The equations are illustrated below:

$Pt = Ct *(1+M)*(1-R)$…………..... (1)

Where,

Pt Cash in at time "t"

Ct Cash out at time "t"

M Markup percentage

R Retention Percentage

NSTCHt(1) = ∑ti=1 Ct - ∑t-1i=1 Pi … (2)

NSTCHt(2) = NSTCHt(1) - Pt … (3)

FCt = NSTCHt(1) * i

Where,

NSTCHt(1) Net cash flow at time "t", just before last payment

NSTCHt(2) Net cash flow at time "t", just after last payment

FCt Cost of finance at time "t"

After running the macro sheet designed with the previous mathematical model, the output data Probabilistic Cash in, Probabilistic net cash flow and Cost of finance are generated with a graphical representation.

Table 1: Qualified factors affecting the net cash flow

Factor	Total Score	Importance index
Agreeing interim valuations on site	171	57.0%
Receiving interim certificates	158.6	52.9%
Delays in payments from client	153	51.0%
Consultant's Instructions	149.8	49.9%
Provisions for phased handover	147.4	49.1%
Delay in agreeing variation	140.4	46.8%
Provision for fluctuation payments	137.2	45.7%
Delay in settling claims	133.8	44.6%
Extent of float in contract schedule	132.2	44.1%
Provision for interim certificate	129.4	43.1%
Material delay	125.2	41.7%
Retention	123	41.0%
Accidents & theft	119	39.7%
Estimating error	117.6	39.2%

Table 2: Ranking of risk factors affecting net cash flow using work categorization grouping

Factor	Overall%	Overall Rank	Contractor%	Contractor rank	Consultant%	Consultant rank	Owner %	owner Rank
Problems with the foundations	31.7%	19	27.9%	24	36.8%	17	33.2%	20
Listed buildings	31.0%	23	27.1%	25	40.2%	12	24.4%	26
Archaeological remains	26.1%	26	27.1%	26	22.6%	26	30.0%	24
Inclement weather	29.9%	24	31.5%	19	27.8%	23	29.2%	25
Accidents & theft	39.7%	13	39.6%	11	38.8%	13	41.6%	11
Extent of float in contract schedule	44.1%	9	41.2%	9	41.6%	11	57.6%	3
Receiving interim certificates	52.9%	2	59.7%	1	45.8%	7	46.4%	9
Retention	41.0%	12	39.3%	12	36.8%	16	54.4%	4
Delays in payments from client	51.0%	3	47.3%	6	53.0%	4	58.0%	2
Provision for fluctuation payments	45.7%	7	36.9%	15	57.4%	2	48.8%	8
Changes in currency exchange rates	37.8%	16	40.9%	10	34.6%	19	34.8%	19
Strikes	36.3%	17	29.6%	20	38.6%	14	52.0%	6
Level of inflation	38.8%	15	38.9%	13	38.2%	15	39.6%	15
Changes in interest rates	22.4%	27	23.2%	27	22.0%	27	20.8%	27

Estimating error	39.2%	14	35.1%	17	35.2%	18	59.6%	1
Penalty due to the violation of Authority regulation and rules	31.4%	22	29.1%	22	30.2%	21	40.8%	12
Provision for interim certificate	43.1%	10	47.6%	5	42.4%	10	31.2%	23
Material delay	41.7%	11	38.3%	14	44.6%	8	46.4%	10
Error in execution & rework	31.7%	20	34.1%	18	26.2%	24	35.6%	17
Equipment breakdown	33.1%	18	35.9%	16	28.8%	22	33.2%	21
Bankruptcy of subcontractor	27.9%	25	29.6%	21	22.8%	25	33.2%	22
Tender unbalancing	31.5%	21	29.1%	23	30.6%	20	40.8%	13
Consultant's Instructions	49.9%	4	49.9%	4	57.4%	3	35.2%	18
Agreeing interim valuations on site	57.0%	1	54.27%	2	62.80%	1	53.60%	5
Delay in agreeing variation	46.8%	6	46.93%	7	44.40%	9	51.20%	7
Delay in settling claims	44.6%	8	42.00%	8	50.60%	5	40.40%	14
Provisions for phased handover	49.1%	5	51.73%	3	50.20%	6	39.20%	16

8. Example Project

In order to examine the proposed system and test its capabilities to model probabilistic cash flow an example project consist of eleven activities was used.
This project “educational building” consists of 5 typical floors, each contains 4 classrooms and an auditorium, and it is constructed as steel structure to get the benefits of this structure as: salvage value, long spans, and quick installation, easy for further replacement in contrary of concrete structures.
The building was designed as a steel structure with slabs of corrugated sheets covered
The project has been worked out with primavera p6 at the first stage and was found to have an estimated cost of 2,921,242 EGP and with duration of 180 days or 6 months.

The second stage started with exporting project data to primavera risk analysis and start with building risk register for the project. Risk register uses the previously risk factors with their corresponding probability and impact that has been previously determined based on the questionnaire survey.

It has to be noted that those risk factors that are expected to affect the project cash out were only used while other risk factors cannot be included

Then such risk factors were assigned to the corresponding activity. This process done by
Experience of the top management head or by a brain storming sessions with the management team. After that we run risk analysis with the desired no of iterations. The resultant data from the output of this software is probabilistic date with respect time and cost.

Table 3: Average probability and impact for selected risk factors

No	Factor	Frequency	Impact
1	Accidents & theft	2.78	3.13
2	Extent of float in contract schedule	3.03	3.45
3	Receiving interim certificates	3.38	3.72
4	Retention	3.32	2.82
5	Delays in payments from client	3.32	3.72
6	Provision for fluctuation payments	3.15	3.40
7	Estimating error	2.48	3.88
8	Provision for interim certificate	3.08	3.15
9	Material delay	2.8	3.62
10	Consultant’s Instructions	3.17	3.68
11	Agreeing interim valuations on site	3.48	3.75
12	Delay in agreeing variation	2.97	3.72
13	Delay in settling claims	3.05	3.43
14	Provisions for phased handover	3.28	3.63

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From Figure 9.Duration probability for 0%, 50 %, and 100% were 180, 287 and 355 days respectively while from Figure 8. Cost distribution for 0%, 50 %, and 100% were mean 2,921,242EP, 4,720,617EP and 6,926,010EP respectively. In each probability the cost and time have been met.

Figure 10.Represents the probabilistic cash out for the project with probability 0%, 50 %, 100% and mean 2,921,242EP, 4,720,617EP, 6,926,010EP and 4,752,947EP respectively with comparison with the deterministic value. From this figure it's obvious that the mean value of this Probabilistic cash out is in the same line with the deterministic value but with an increase in cost and time which really happen in the real life project.

This project has been executed and finished before this research so the final data of competition are available. The project has been worked out for 350 days and with cost 3,005,440. From the actual data it's clearly showed that the probabilistic data are more accurate that deterministic data (planned data).

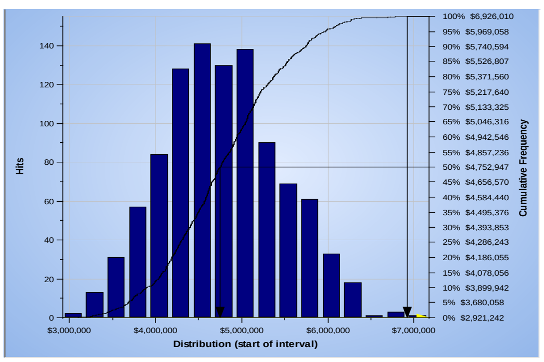

Figure.8. Cost probability distribution

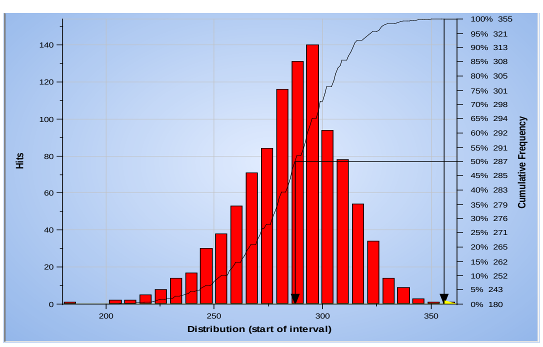

Figure.9. Duration probability distribution

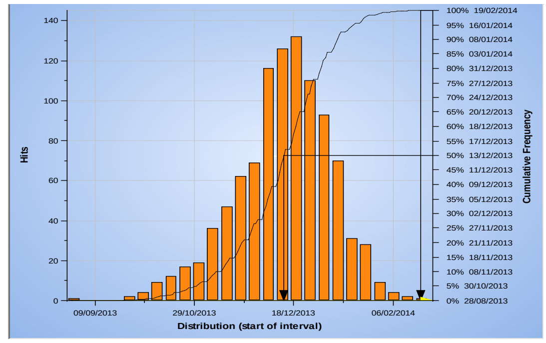

Figure.10. Finish date probability distribution.

The third and last stage of this system is the excel macro sheet which will calculate the cash in, net cash flows and the finance cost. We use excel as a tool of getting more outputs and for a graphical representation.

The input of this stage is the output from the previous stage, probabilistic cash out and some other variables as markup, interest value, down payment (if any) retention Value. From probabilistic cash out we get monthly cost then we apply the designed mathematical model mentioned before.

The mathematical model used to get cash in points to be able to sustain cash in graph so that we can calculate the net cash flow. The macro program was designed with allowance to calculate the overdraft values to get the finance cost if there is any external source of finance.

To calculate the cash in some assumption should be made the markup was taken 20%, retention 10% and down payment 10%.

Figures 12, 13 and 14 illustrate the graphical representation of outputs of the macro sheet with the corresponding probability 0%, 50 % and 100% respectively. Figures 15, 16 and 17 illustrate the probabilistic output for cash in, cash out and net cash flows with their graphical representation. From these figures the probabilistic data are available and it shows the envelop for each flow and the time for each one and the probability which enable a more than one choice for the decision maker and prepare a lot of scenarios for each case of probability.

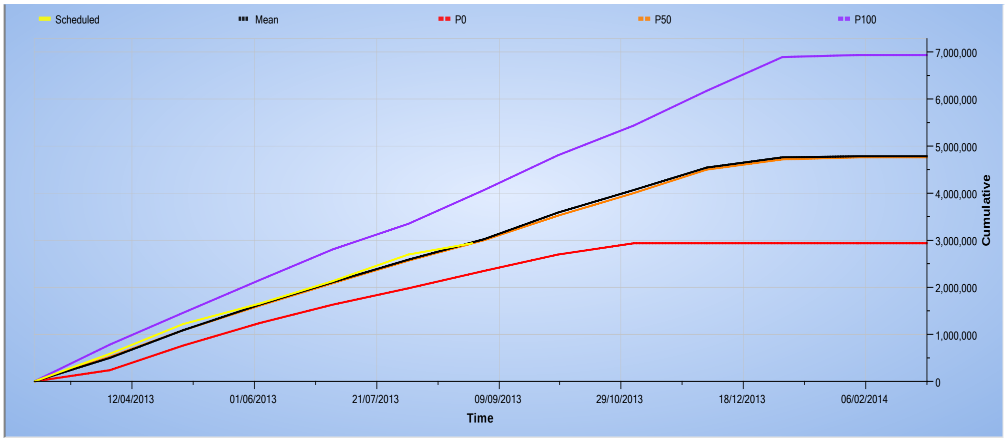

Figure.11. Probabilistic cash out

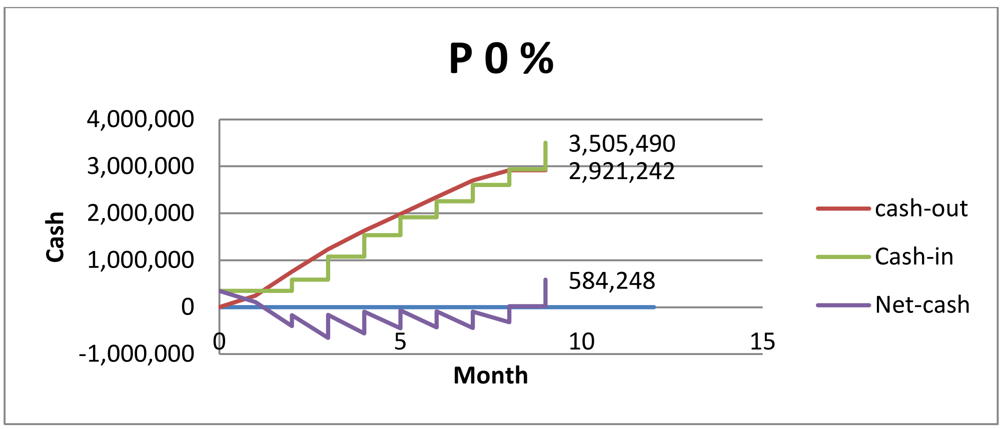

Figure.12. Cash flow For Probability 0%

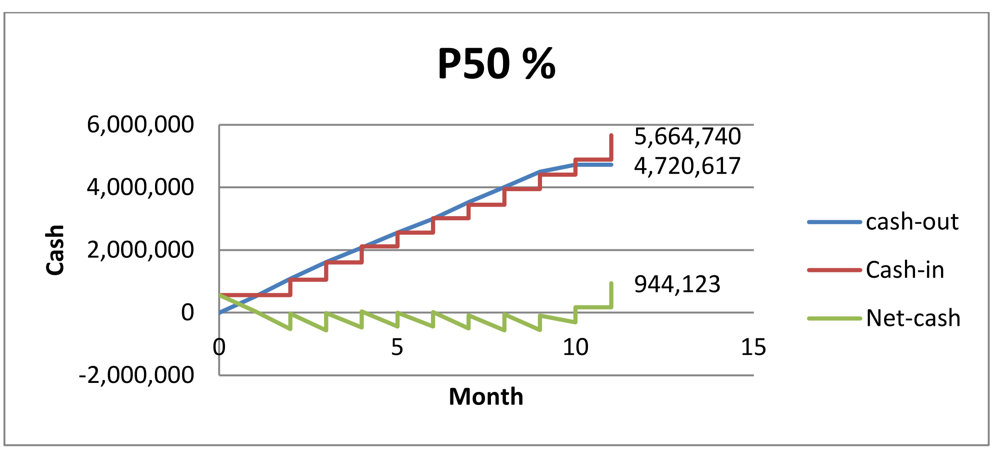

Figure.13. Cash flow for probability 50%

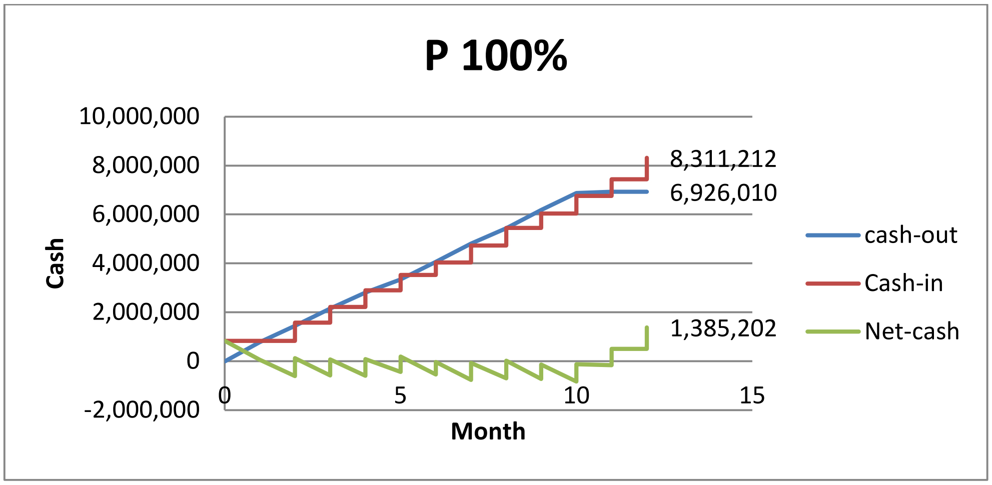

Figure.14. Cash flow for probability 100%

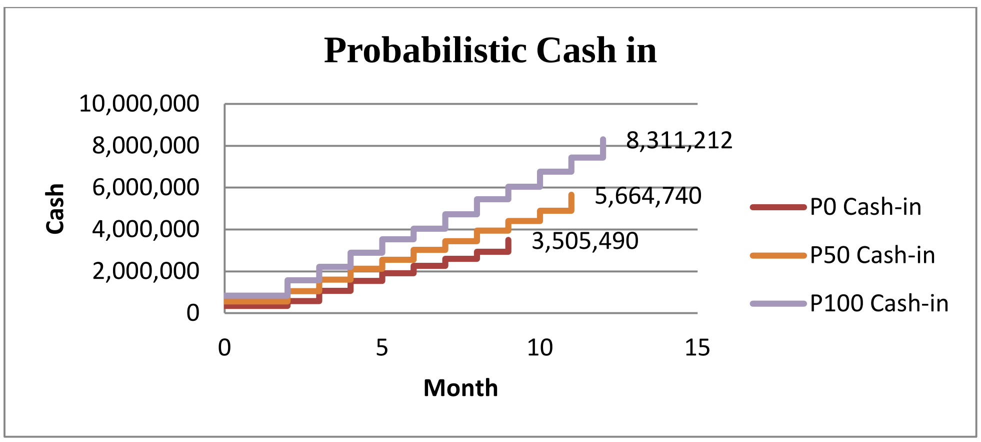

Figure.15. Probabilistic cash in

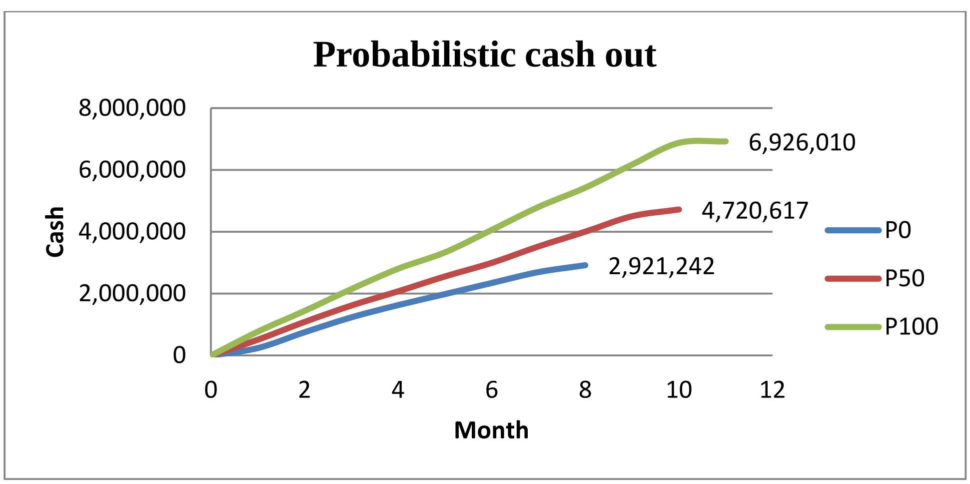

Figure.16 Probabilistic cash out

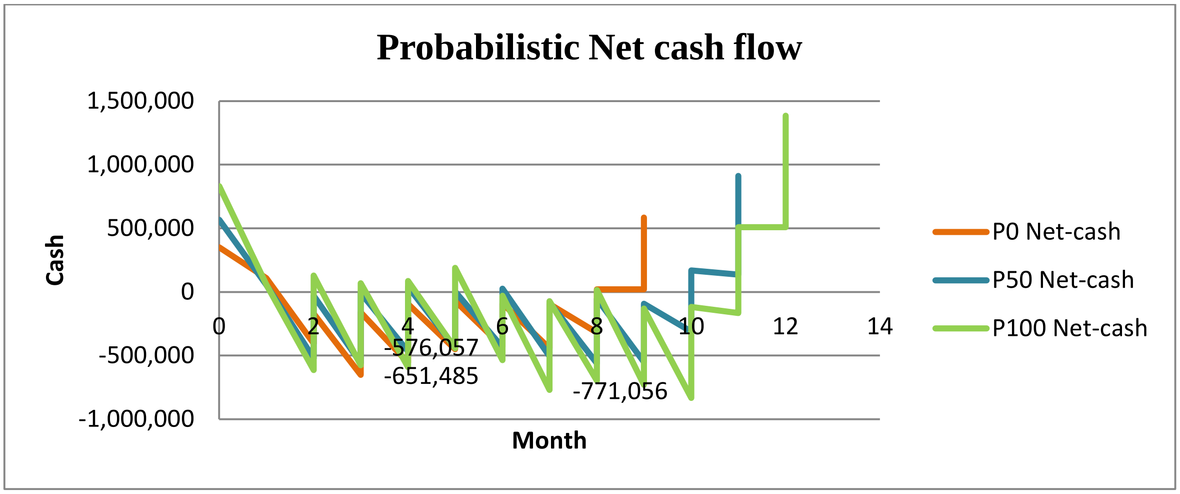

Figure.17. Probabilistic net cash flow

9. Conclusions

In this research, a cash flow risk model was developed. The developed model can be used to produce a probabilistic data for more accurate plan and evaluation. Some remarks were concluded and listed below:

- With the comparison between the actual and the output probabilistic data, it was noticed that with respect to the duration it a perfect fit but in the case of the cost the difference between the actual and deterministic is a small.
- In some cases as the real life case study it might be used more than three single cash flow to build probabilistic cash flow so a higher number of single cash flows will be used.
- Probabilistic cash flows is more accurate than deterministic one and it can be used by decision maker to evaluate the projects with a higher level of accuracy.
- Probabilistic cash flows present a lot of scenarios of what cash flow would be.

10. Recommendations and Future Work

The Proposed model can be implemented to different construction projects effectively. It can aid the decision maker with an accurate cost and time data.

The presented model in this research could be improved considering the following points:

- Integrate the risk factors on the cash inflow as some of the studied risk factors have a higher effect on it and it will provide a highly detailed cash flow.

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