

Modeling To Calculate The Effect Of Cost Control On Risks In Construction Projects

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Abstract— Engineers often focus on cost control and budget reduction while ignoring the impact on increasing risk, this relation between cost control and risk analysis is very important, neglecting or overlooking this relation will negatively impact the project, the main focus of this study is to strongly demonstrate the relation between cost control and risk analysis, the main risk to be demonstrated is the problem of cost overrun, this is done by showing real-life cases where engineers ignored cost overrun in favor of reducing budget and cost control, after each case solutions and measures are defined to avoid these problems. A lot of real-life cases will be discussed where cost overrun was neglected in favor of cost reduction. Then solutions will be found for these cases and measures needed to avoid future cases will be defined. These situations happened in mega projects. Today technology and mobile software impacts the life. Another point to be investigated is developing new computer software to improve the cost control process with respect to risk analysis, in order to keep the project on budget to save it from any additional cost, the three focus points in the cost control process will be materials, labor and equipment, and all will be shown in the study, the software might have some limitations depending on available case studies, In order to save the budget of the project, the relation between cost control and risk analysis should be taken into consideration. The basis for this research originally started in real cases that happens daily in mega projects.

Index Terms— *Cost management, Cost Control, Risk, Cost overrun, Software, Wrong practices, Site problems*

1 INTRODUCTION

This paper demonstrates the effect of cost control on cost overrun on site according to real life situation, therefore the cost control and cost overrun will be introduced in general, the first part of the introduction will include the cost management process and cost control procedures, and the second part of the introduction will include the cost overrun, reasons of cost overrun and it's methods, and finally the statement of the problem and the aim of this thesis, these terms will be defined in order to compare what happened in real life and what should be happen.

Cost management is one of the processes that have effects on any project nowadays and it should be taken into consideration before starting any project. Cost management includes cost planning and cost control.

The cost control process comes after the cost planning. There are a lot of ways to control the cost, one of these ways is decreasing the cost for the site for a period of time, but how to control the cost without any mistakes.

The main aim for cost control is to identify and reduce business expenses to increase profits, in other meaning the main aim is to monitor expenditures and performance against progress of the projects to measure variance from the budget and the actual costs.

The budgeting process is the first thing to start with. Then the actual cost will be compared to the budget to get the financial situation of the business. If the actual costs are higher than the planned cost, so some actions shall be taken. According to IC-TAD (Institute of Construction Training and Development), there are several documents to control the cost, such as

- Unit cost sheet.
- Weekly statement of direct labor cost.
- Weekly statement of material cost
- Weekly statement of outputs of works or in other meaning the value of work.
- Monthly cost summary.

There is another item which is really important, and some of the engineers don't take it into consideration which is the Cost overrun.

Cost overrun in a simple way is defined as actual cost is more than the planning budget, it's also the unexpected costs due to many reasons such as inadequate estimation.

The problem of cost overrun in the construction field is one of the biggest problems that should be considered, and it's a worldwide problem, and cost overrun is a common problem between owner and contractors concerning the cost variation, Project success can be evaluated by meeting its technical performance as well as delivery on time and not to exceed the budget limits. In order to achieve project success project management must be done by managing the resources such as workers, machines, money, and materials. Delays and cost overrun occur due to mismanaging of the project.

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Some reasons for cost overrun are inaccurate project estimates, design errors, poor or not planning of change orders, Administration errors, and poor site management.

1.2 Problem statement

A lot of problems which happened in real life will be discussed later, but these problems happened due to some wrong corrective actions from the cost control, and weren't considered in the risk management plan, but the problem was that these actions lead to dismantling of the works and reworking again, which increases the cost and causes cost overrun, and as mentioned before the engineers often focus on cost control and budget reduction while ignoring the impact on increasing risks. The problems were due to some unforeseen conditions and specifications and both of them were not considered by the cost control.

1.3 Literature review

One of the aims of cost control is to construct at the cheapest possible costs consistent with the project objectives. Ultimately the decision of the manager that something should be done differently and the translation of that decision into practice are the actions to achieve control (Harris and McCaffer, 2002). [1]

Estimating and cost control (which include forecasting, estimating, budgeting, monitoring, and reporting) are the Costs include all processes which are employed to maintain financial control over the project, according to Nobe and Berryman (1996). [2]

In order to apply the cost control process, the right man for the right job must be selected, and the right equipment and tools for the right jobs must be selected, and also the right quality must be considered in the right quantity from the right source, this is according to Dharwadker (1985).[3].

According to Nida & Azhar (2008) [4], cost overrun is defined as exceeding the budgeted margin of the project, the construction industry has been facing issues concerning the cost overrun, which can be defined as not achieving the project objectives within the estimated budget, and this was according to Avots (1983).[5]

During the pre-contract stage of the project, most of the risks are not properly identified, assess the likelihood of its occurrence, assess its impacts on project performance, rather a **10% contingency** is added to the total project cost in order to accommodate the effect of unforeseen circumstances. In most cases, the 10% contingency is based on intuitive guesswork and this explains the attendant high cost overrun (Odenyinka, 2000).

The relation between time and cost is a very important aspect in the control of costs on site as any variation in time has automatic implication on cost (Chitkara, 2005). [6]

1.4 Aim of the paper

The main aim of this paper is to demonstrate the relation between cost control and risk analysis, this is done by showing real-life cases where engineers ignored risk analysis in favor of reducing budget and cost control, and then by showing real-life case studies and the effect of cost control on risks on site, software will be developed in order to solve some of the problems. The problems will be discussed in details and the problems will be discussed in order to clear that the risk management and cost control has a strong relation, and this relation must be considered in order to save the project from any additional costs.

1.5 limitations

The research focuses on the effect of cost control on risks in construction sites and is based on case studies in real life in construction sites in Egypt, the research was complemented by a study of construction projects in Cairo which are Mega Projects.

2 METHODOLOGY

The impact of wrong cost control on increasing the risks on site will be identified on this paper.

2.1 Questionnaire

A questionnaire has been prepared and distributed through many companies, to get the results of the way the companies dealing with these problems

2.1.1 Questionnaire Design

A questionnaire survey was designed based on the problems on the site. It was developed to get the opinion of the experienced respondents, a draft questionnaire was discussed with a supervisor who gave valuable advice. Finally, the final questionnaire was developed to collect the data, and it was accessible via hard copies which were distributed to the participants.

Part of the questionnaire was to gather information about the respondents such as their position and years of experience, the second part is the questions, for the first questionnaire, it was yes or no questions, but in order to make it simple, the questions were with scale from 1 to 5, the third part in the final questionnaire was two essay simple questions.

2.1.2 The participant's position

Contractors, owners, consultants, and sub-contractors will participate in the questionnaire, a lot of positions will participate in the questionnaire due to their experience as shown below

- Site engineer.
- Planning engineer.
- Cost control engineer and manager.
- Payment certificate manager.

- Quantity survey head section.
- Cost control consultant.
- Cost Control Engineer.
- Payment certificate senior engineer.

2.1.3 Measurement scale

Respondents in the second questionnaire were asked to answer the questions using a scale from 1 to 5 where each scale represented the following rating:

- 1 =Very Low
- 2 =Low
- 3 =Moderate
- 4 =High
- 5 =Very high

2.1.4 The respondents

The questionnaire survey sent to a large number of engineers with different positions, however, the returned responses were 110 responses.

For the questionnaire, the survey participants included all parties involved in the construction sector:

- Contractor (60 questionnaires).
- Consultant (15 questionnaires).
- Owner (35 questionnaires).

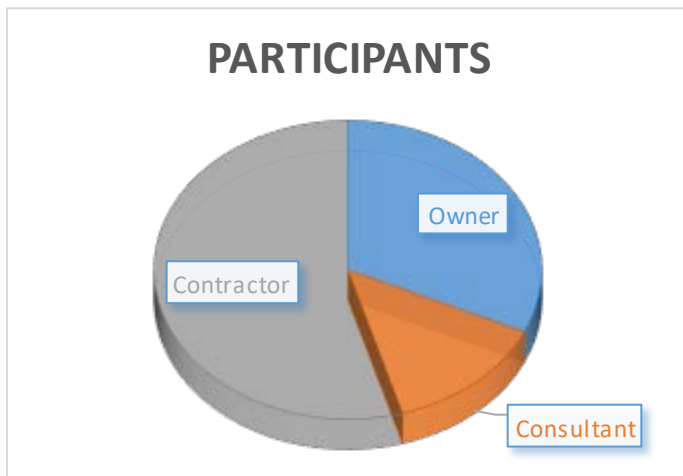


Chart -1: Participants

2.1.5 Analysis of the questionnaire

The following figure demonstrates the analysis and the response of the participants, so 45 % Considered the problem of safety plan as moderate, 55 % found that in favor of delivering on time, it's acceptable to ignore the quality, 55 % found that lack of skilled engineers has a moderate effect on project, 63.64 % found that using losses of mortar is not considered as a problem, and finally 28 % choose moderate for the problem of using less number of cement bags.

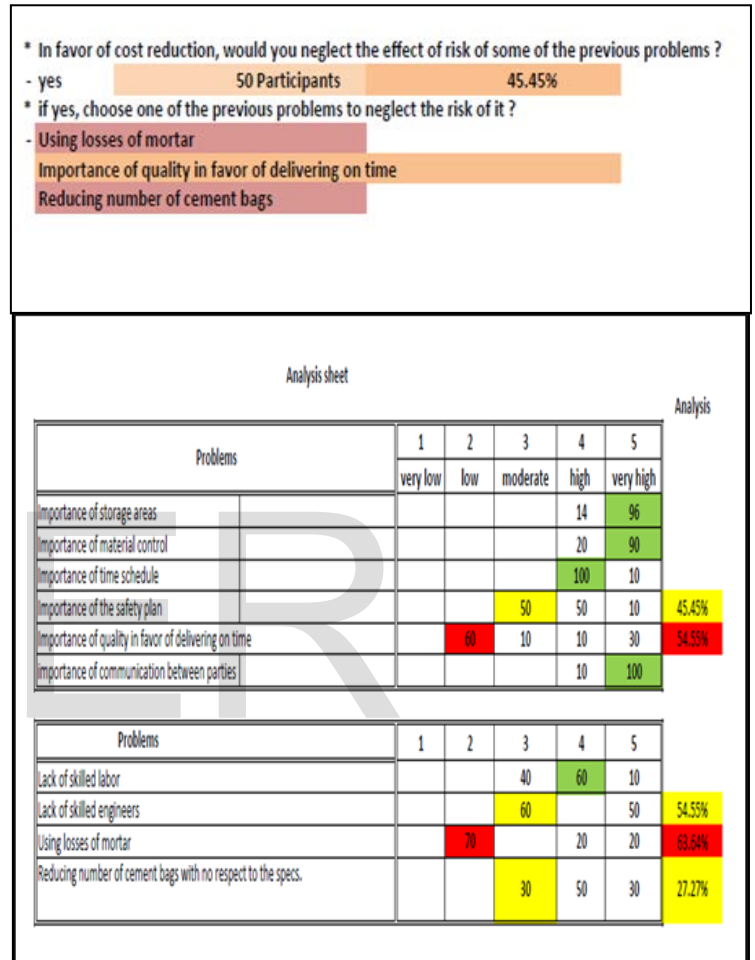


Figure 1-Analysis of the questionnaire

3 CASE STUDIES

The problems that happened in real life and which have been discussed are as follows

- The mortar
- The bad storage of materials
- The cost of life
- The problem of the crane
- The problem of protection of the finished works.
- Salaries (in-direct costs).

And also a lot of problems have been found according to other papers such as

- Tight project schedule
- Lack of skilled labor
- Using losses of mortar in the plastering process.
- Poor labor utilization.
- Decreasing the number of equipment.
- Decreasing tools for safety.



Figure 2- Cement problem

The effect of these problems on the cost of the project are for example as follows

- Failure of the plastering which will lead to maintenance which means higher costs.
- Delays which will lead to penalties.
- Huge cost to replace the damaged materials.
- Cost of life

Some of the risks that have been discovered are as follows

- Late submission of works.
- Failure of material storage.
- Poor quality of the work.



Figure 3- Lack of coordination problem

3.1 Converting problems into money

The most important part to realize the problem is to understand the effect of this problem on the cost. In the following part, the conversion of the problems into money will be shown. Not all the problems have been discussed but some of the problems which happened in real life. These problems are

- Cement problem.
- Lack of coordination between parties.
- Plastering.

The following figures are examples of failures on the site

3.1.1 Cement problem

The cost of bricks and sand are not included in this problem, the width of the wall was =1.56 m.

The main idea was to Save 5 cement bags for one wall and using 7 cement bags instead of 13 bags,

The cost of the cement bags = $5 * 50 = 250$ L.E

The Cost of workmanship per day = $120 + 120 + 90 + 90 = 420$ L.E

The construction for the wall took two working days, after the completion of the wall the quality control department refused to accept it, and the wall has been dismantled.

So the planned value to be saved was 250 L.E.

But what actually happened was that the actual cost exceeded this value as shown below:

Actual cost = $420 * 2 = 840$ L.E. for constructing the wall and = 840 L.E. For Re-constructing the wall

The planned value was supposed to be = 840 L.E.+ 650 L.E (cement) = 1490 L.E.

The planned value from the cost control perspective = $840 + 400 = 1240$ L.E.

The actual cost of work performed = $1240 + 840 + 650 = 2730$ L.E.

So there was a huge difference between the two values.

So if this problem was considered in the risk management plan with specific amount of money, so it means that the risk management plan was not good. Because this type of problems shouldn't be considered in the risk plan.

According to the previous numbers, the analysis for these numbers will be shown in the table below

Percentage of used quantity	Risk	Increasing cost by
53 % * quantity	100 %	83 %
60 % * quantity	75 %	62.6 %
70 % * quantity	56 %	47 %
80 % * quantity	37 %	31 %
90 % * quantity	18 %	15.6 %

Table 1- Problem results

The numbers in the previous table are according to the problems happened in the site, and it was based on linear equations in order to give warning to the engineers before making decisions like that.

3.1.2 Lack of coordination between parties

The problem was finishing the masonry works by one of the contractors before installing machines by another contractor due to lack of coordination, so the cost of dismantling the works will be demonstrated in details as shown below

The cost before dismantling

500 blocks = 3000 EGP, 15 cement bags = 15(40) = 600 EGP,

Workmanship = 6(150) = 900 EGP

Labor = 6(90) = 540 EGP, Total cost = 5040 EGP

Cost of dismantling

Workmanship = 4(150) = 600 EGP

Labor = 2(90) = 180 EGP

Cost of Rebuild

500 blocks = 3000 EGP, 15 cement bags = 15(40) = 600 EGP,

Workmanship = 6(150) = 900 EGP

Labor = 6(90) = 540 EGP, Total cost = 5040 EGP

So the planned value was supposed to be = 5040 EGP, and the actual cost was = 10860 EGP.

3.1.3 Plastering

The cost of sand is not included in this problem, and the problem was using losses of cement to save cement bags, the idea was to save 2 cement bags with 100 EGP. Using 10 bags instead of 12 bags, the planned value was supposed to be as follows:

$$P.V = 2(150) + (12)50 = 900 \text{ EGP}$$

P.V from cost control perspective = 800 EGP.

Cost of dismantling = 2(150) = 300 EGP

Cost of redoing = 2(150) = 300 EGP

Cost of Cement bags = 12(50) = 600 EGP

Actual cost from the site = 800+300+300+600 = 2000 L.E.

According to the previous numbers, the analysis for these numbers will be shown in the table below

Percentage of used quantity	Risk	Increasing cost by
83.3 % * quantity	100 %	122 %
85 % * quantity	89 %	109 %
87 % * quantity	77.8 %	94 %
89 % * quantity	65 %	80 %
90 % * quantity	59%	72 %
95 % * quantity	29%	36 %

Table 2- Problem results

The numbers in the previous table are according to the problems happened in the site, and it was based on linear equations in order to give warning to the engineers before making decisions like that, these percentages will be used to develop the application in order to give warning to the engineers before making wrong decisions which lead to cost overrun.

3.1.4 Salaries (In-direct cost)

The indirect cost is one of the big problems in the project, and it is not easy to control it, so this problem happened in one of the sites in Cairo, the planned value of the salaries wasn't as same as the actual value, this case will be shown in details, and due to poor controlling of the resources, this problem happened.

And as mentioned above, one of the important documents to control the cost is a weekly statement of direct labor cost, and the problem happened due to ignoring these statements. The time for the project was 1 year.

So the analysis of this problem is as follows

Departments	Planned (EGP)	Actual (EGP)	Variance
ادارة التنفيذ	3,168,828.40	3,284,654.40	EGP (115,826.00)
ادارة المشروع	1,096,848.00	1,096,848.00	0.00
المكتب الفني	576,482	576,482	0.00
ادارة الالكتروميكانيك	513,912	558,600	EGP (44,688.00)
ادارة الجودة	1,272,453	1,344,949	EGP (72,496.00)
ادارة التخطيط والمتابعة	243,000	243,000	0.00
ادارة المساحة	955,762	999,232	EGP (43,470.00)
ادارة المستخلصات	381,630	381,630	0.00
ادارة الأمن والسلامة	517,435	521,179	EGP (3,744.00)
ادارة التكاليف	89,114	89,114	0.00
الإدارية	516,846	541,269	EGP (24,423.00)
السكرتارية	162,540	162,540	0.00
Total	9,494,850	9,799,497	EGP (304,647.00)

Figure 4-Comparison between actual cost and planned value

The previous figure is a comparison between the planned values and actual values for different departments, considering that the planned

value was at the beginning of the project and the actual value was at the end of the project.

So the variance was 300,000 EGP approximately for 1-year project, so this problem must be considered and the salaries must be controlled very well by the cost control department.

The following figures are demonstrating the comparison between the planned values and the actual values and also demonstrating the variance between the two values

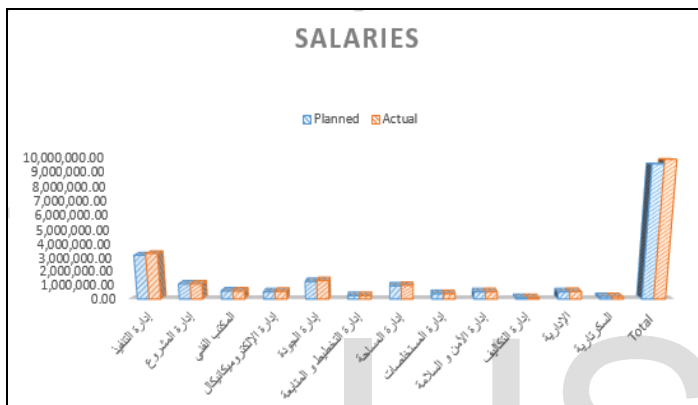


Figure 5-SALARIES

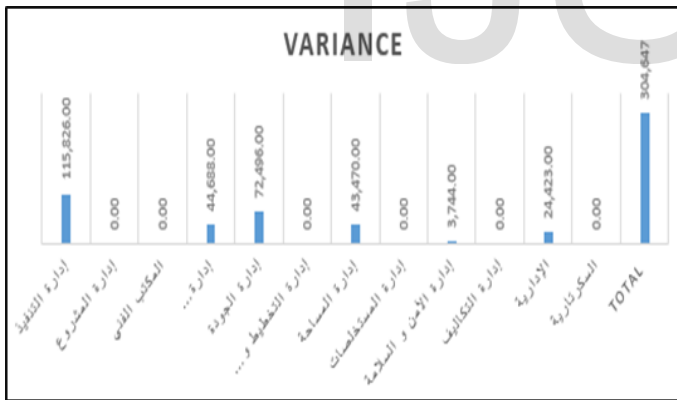


Figure 6-Actual vs. planned costs' variance

This problem was calculated using excel sheets and it was difficult to add this problem on the software due to the fact that it's a mobile application and it won't be logic to add problem such as the previous one on a mobile application.

4 SOFTWARE DEVELOPMENT

An application has been developed in order to help engineers, the function of this application was to calculate the number of bricks and number of cement bags used in masonry and plastering works.

The inputs for this application are as follows

- Height, width and thickness of the wall
- Height, width and thickness of the bricks.
- Number of bricks per cement bag.
- Number of plastering meters per cement bag.
- Cost of cement bag.
- Cost of the labor.

The outputs for this application are as follows

- Number of bricks.
- Number of cement bags.
- Total work area.
- Final report for bricks and plastering showing the probabilities of using fewer quantities and the resulted risk and the amount of expected escalation.

4.1 Final trial for the application

In the following figures the final trial will be shown by using the data of the problems

4.1.1 Bricks

- Adding dimensions of the wall.

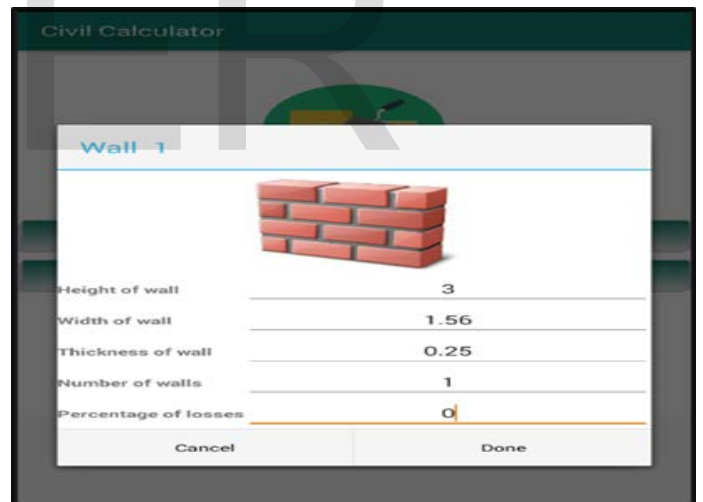


Figure 7- Wall dimensions

- Adding dimensions of the bricks.

Brick 1

Height of brick _____ 0.15

Width of brick _____ 0.2

Thickness of brick _____ 0.25

Bricks / Cement bags _____ 12

+ADD NEW BRICK INPUTS

SHOW RESULT

Figure 8-Bricks data

BRICKS
PLASTERING

TOTAL RESULT
PAINTING

FINAL REPORT

Bricks

Plastering

Figure 10-Final report

Bricks Cost inputs

Cement bag _____ 50

Number of labors _____ 2

Labor cost _____ 210

Working days _____ 2

SHOW REPORT RESULT

Figure 11- Cost inputs

The idle outputs will be calculated as shown in the figure below

Wall : 1

Area of wall : 4.68

Thickness of bricks : 0.25

Bricks for one wall : 156.0

Bricks for all walls : 156.0

Total of bricks with losses : 156.0

Total of cement bags : 13.0

Figure 9- Bricks' results

These outputs are the best, and in case of adding more cement bags, there will be no problem concerning the quantity, but there will be a problem if the quantity decreased, and the cost will be calculated in the application and also the risk.

By adding the cost of cement and workmanship using final report button and by choosing the bricks as shown in the figure below

Then by clicking on show report result button, the results will be shown as in the figure below

Final Report of Bricks

*The following cost is the most likely cost for the work, but in the following table you can find different probabilities of decreasing quantity of cement

Total cost = 1490.0

Quantity	Probabilities	Risk	Increasing cost by
6.89		100%	1236.7
7.8		75%	932.74
9.1		56%	700.3
10.4		37%	461.9
11.7		18%	232.44

Figure 12-Cost analysis

4.1.2 Plastering

For the final trial, the problem which happened on the site will be tested on the application.

By adding the dimensions of the wall as shown in the figure below

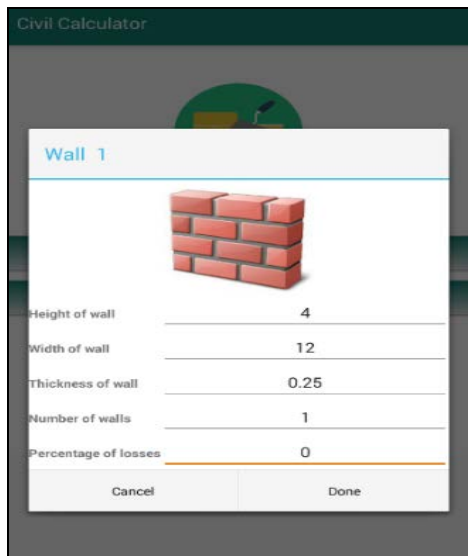


Figure 13-Plastering data

Then by adding the cost of cement and other data concerning the labor

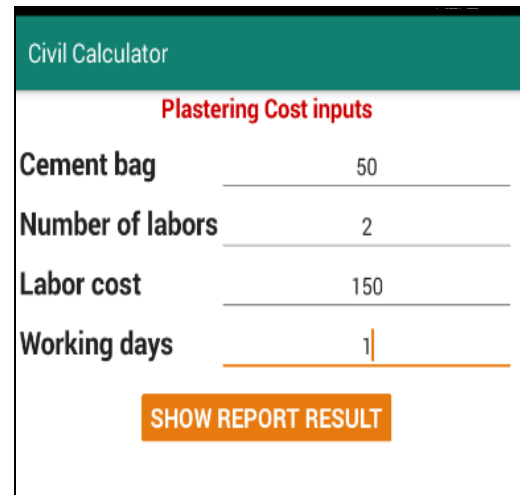


Figure 16- Cost inputs

Then by adding the number of meters per one cement bag as shown in the figure below

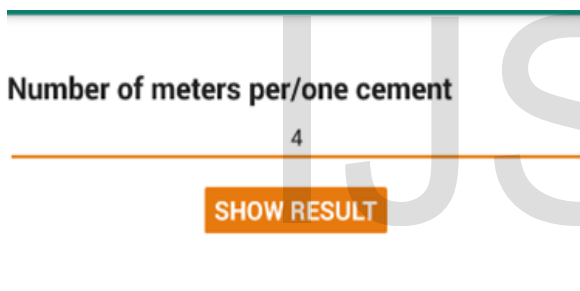


Figure 14- Cement data

Then by clicking on show report result button, the results will be shown as in the figure below

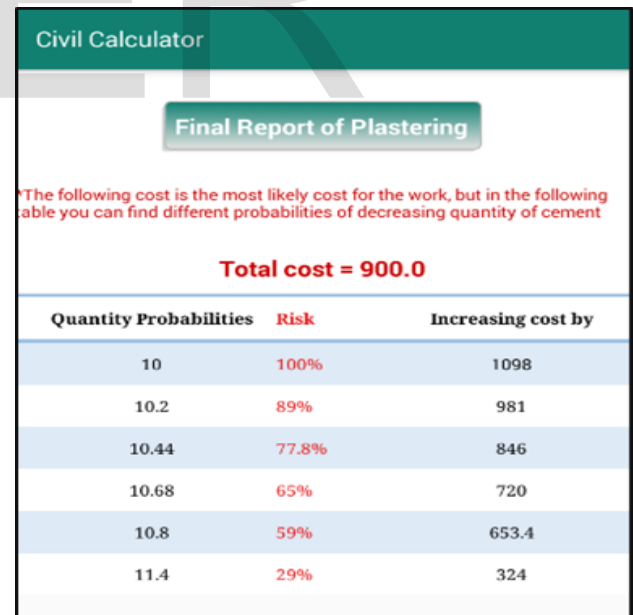


Figure 17- Cost analysis

The results are shown in the figure below

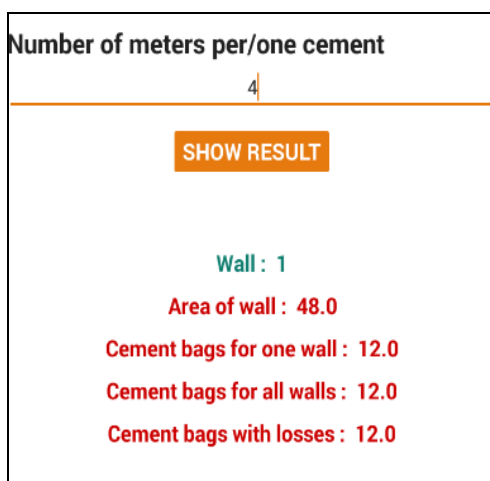


Figure 15-Plaster's results

The above-mentioned cost is in Egyptian pounds, so if the input is of different currency it should be taken into consideration.

4.1.3 Modifications

Some modifications have been added to the application in order to get more accuracy such as:

- Adding units and currency to the application.
- Separating the mortar into two things either cement or dry mix, because it was considered at the first trial that the dry mix is same as the cement, but actually, the rate of cement is totally different than the dry mix.
- Finally, adding the savings of the cement in case of no dismantling of the works.

The modifications of the final trial will be shown as follows

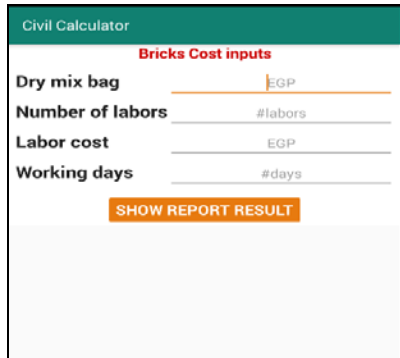


Figure 18- Units update



Figure 20- Units update

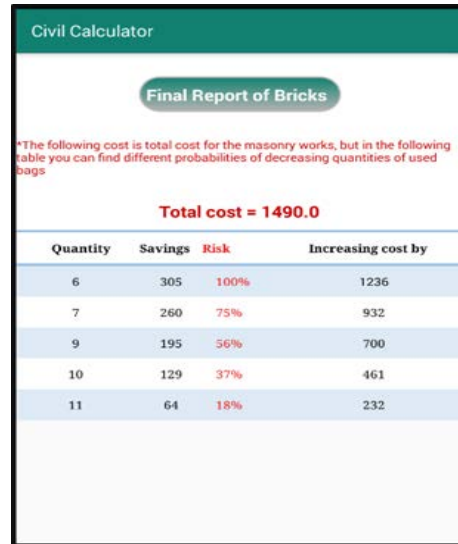


Figure 21- Savings

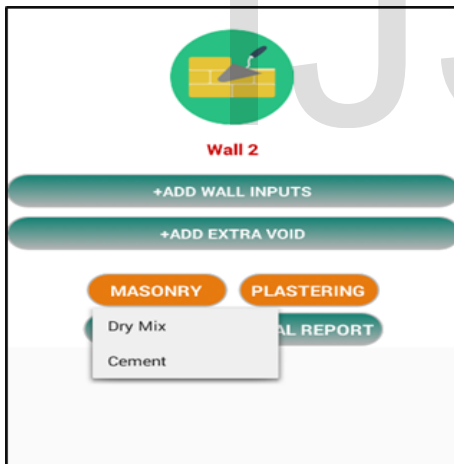


Figure 19- Mortar types

5 CONCLUSION

- Finally, Cost control is very important to keep the project on budget.
- In order to keep the project on budget, Cost control must be done in a perfect way.
- Some definitions of cost control and Cost overrun has been added in the introduction of the thesis, and this was to show the methods of cost control.
- In reality, these methods should be considered and also the content of this thesis should be considered in the cost control process and risk management.
- Many problems have been discussed in this thesis, these problems happened in real life.
- A questionnaire has been conducted and distributed through a lot of companies in order to analyze the way these companies dealt with the problems.
- The result of the questionnaire showed that a huge percentage of people agreed about accepting a lot of these problems in order to finish the project on time or faster.
- Also this paper included a part which shows the conversion of these problems into money.
- So an application has been developed in order to solve some of these problems or actually the cement problem which is the most important problem happened in different sites.

5.1 Summary

- The resulted risk should be considered, because it may have an effect on the total cost.
- The change in quantities will lead to increasing the risk and cost if the used quantity decreased.
- The change of quantities not only affect the cost but also it may affect the safety of people.
- In some cases, the increased risk lead to double the cost.
- Before decreasing the amount of money for any activity, the cost must be considered, and if it's included in the risk management plan, it must be checked again.

5.2 Future recommendations

- To apply this application to more activities and problems.
- To check these percentages and if there is any mistake, it should be replaced, because it was based on linear equations.
- To check this application before decreasing the cost for bricks and plastering.
- To add percentages of risk and cost for other activities if problems happened in other activities.
- To refer to the application even if the contingency of the project is huge.
- To change the design of the application if it's not suitable for users.

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REFERENCES

- [1]. Harris and McCaffer, (2002), Modern construction management, Black well science, OXFORD
- [2].Nobe, M. D., and Berryman, C. W. (1996). "Incorporating Reserve Fund Analysis into Graduate Construction Education", ASC proceeding of 32nd annual conference, Texas A&M Univer-

sity, College Station, Texas.

[3]. Dharwadker, P. P., 1996. Construction Management, 2nd Ed; Oxford & IBH Publishing Co. PVT.LTD New, Delhi. India.

[4]. Avots .I. (1983). Cost-relevance analysis for overrun control. International Journal of Project Management, 1, 142-148.

[5]. Nida & Azhar, Cost Overrun Factors in Construction Industry of Pakistan. First International Conference on Construction in Developing Countries, Advancing and Integrating Construction Education, Research & Practice, Karachi, Pakistan, August 2008.

[6]. Chitkara, K, K., 2005. Construction Project Management: Planning, Scheduling, and Controlling. Tata McGraw Hill Publishing Company Ltd.