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A Stochastic Risk Management System for Construction Projects in Gaza Strip

نظام احتمالي لإدارة المخاطر في مشاريع التشييد في قطاع غزة

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Thesis

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Dedication

I dedicate this work, with sincere gratitude, to my mother and my father whom have sacrificed everything in their life for my brothers, sisters, and me so that we may have a better future, to my three children "Ahmad, Raghad, and Dalia", and to my wife who always encourages me to success.

Abstract

The construction industry has an important role in the economic activities in Gaza Strip. A construction project is associated with different levels of risk in terms of cost and duration. This research is aimed to develop a computer-based tool to help Palestinian contractors better manage risks in estimating the cost of building projects. This tool, in principle, provides users with an efficient mechanism that helps identify risks, estimate their costs, and propose possible ways that may help avoid or minimize these risks. Risk Cost Estimation and Management software (RCEM) is developed mainly based on categorizing construction key risk factors for each work group, determining their resulting consequences and proposing mitigation actions to prevent or mitigate risk effects.

The questionnaire is used as a tool to collect primary data related directly to this study. The researcher determined the main risk factors and their resulting consequences for each work category/group. The questionnaire's design allows respondents to scale freely their weights for the mentioned factors. It also allows them to give their own suggestions for new factors and add their relevant weights. Ninety eight copies of the questionnaire were distributed by direct contact to building contractors in Gaza Strip. Seventy five copies were answered which represents a good responding percentage.

The procedure followed in RCEM encourages disciplined estimating. It calculates the required contingency utilizing Monte Carlo Simulation technique. By using RCEM, the researcher hopes that contractors can estimate risk cost in more accurate way, which leads to a safer and more practical bid price of a project. It decreases the possibility of having a loss and increases of the possibility of having a reasonable profit. RCEM is designed using C# (C-Sharp) programming language. The software evaluators are generally satisfied with its performance. They indicated that it is suitable for use in the local estimating practice and they found many advantages that can be obtained by using it such as contributing in improvement of project planning, contributing in developing of bids pricing process in Gaza Strip, and helping in recognizing main risk factors and their resulting consequences for work categories. Recommendations for further studies are mentioned to give chance to enrich RCEM in the future.

الملخص

صناعة التشييد لها دور هام في النشاط الإقتصادي في قطاع غزة، و مشروع التشييد يحتوي على مستويات مختلفة من المخاطر فيما يتعلق بتكلفته و مدة تنفيذه.

يهدف هذا البحث إلى تطوير نظام محوسب لمساعدة المقاولين الفلسطينيين في عملية إدارة المخاطر بشكل أفضل من حيث توقع التكلفة لأي مشروع مباني. هذه الأداة و بشكل أساسي تزود مستخدميها بآلية فعالة تساهم في تعريف المخاطر و توقع تكاليفها بالإضافة إلى إقتراح طرق يمكن أن تساعدهم في تجنب هذه المخاطر أو تقليلها.

برنامج توقع و إدارة تكلفة المخاطر Risk Cost Estimation and Management Software (RCEM) تم تطويره بشكل أساسي بناء على تصنيف عوامل المخاطر الرئيسية لكل مجموعة عمل، و كذلك تحديد ما ينشأ عن هذه العوامل من نتائج، بالإضافة إلى إقتراح طرق للتعامل مع هذه المخاطر من أجل منع حدوث أضرارها أو التقليل من هذه الأضرار.

تم استخدام الإستبانة كأداة لتجميع المعلومات الأساسية التي لها علاقة مباشرة بهذا البحث. حيث حدد الباحث عوامل المخاطر الرئيسية و ما ينتج عنها لكل مجموعة عمل و تم تصميم الإستبانة على أساس أن يقوم المجيبون عليها بترتيب أوزان العوامل المذكورة بحرية، بالإضافة إلى أنها توفر لهم إمكانية أن يقوموا بإعطاء أي اقتراحات بإضافة أي عوامل جديدة وإضافة أوزانها.

لقد تم توزيع عدد ثمانية و تسعون نسخة عن الإستبانة المذكورة و بشكل مباشر لمقاولي الأبنية في قطاع غزة. عدد النسخ التي تمت الإجابة عليها هو خمسة و سبعون نسخة وهي تمثل نسبة استجابة جيدة.

إن طريقة عمل برنامج RCEM يشجع على انتاج تقدير تكلفة منضبط. انه يحتسب التكلفة الإحتياطية المطلوبة و ذلك باستخدام طريقة Monte Carlo Simulation.

يأمل الباحث أنه باستخدام برنامج RCEM سيتمكن المقاولون من تقدير تكلفة المخاطر بطريقة أكثر دقة مما سيؤدي إلى تحديد أسعار أكثر أماناً للمشروع و بطريقة عملية. و هذا يقلل من امكانية حدوث خسائر و يزيد من امكانية الوصول الى ربح معقول.

لقد تم تصميم برنامج RCEM باستخدام لغة البرمجة المعروفة بإسم (C-Sharp) C#. لقد أبدى مقيمو البرنامج رضاهم بشكل عام عن أدائه، و أشاروا إلى أنه مناسب للإستخدام المحلي في تقدير التكاليف، وقد وجدوا العديد من الفوائد التي يمكن الحصول عليها من استخدامه، مثل مساهمته في تحسين التخطيط للمشروع، و في تطوير طريقة تسعير العطاءات في قطاع غزة ، و المساعدة في التعرف على عوامل المخاطر الرئيسية و ما يمكن أن ينتج عنها لمجموعات الأعمال.

تم تحديد بعض التوصيات التي يمكن الأخذ بها في دراسات و أبحاث مستقبلية من أجل تطوير البرنامج و إثرائه.

Acknowledgment

It has been an honor and a privilege to me to work under the supervision of Dr. Kamalain Shaath. I wish to express my deepest and continuous sincere gratitude to him for his unlimited support, superb supervision and unfailing encouragement as his advice and recommendations were strongly valuable for the successful completion of this thesis.

I would like also to thank the rest of IUG construction management program staff: Prof. Adnan Enshassi, Prof. Rifaat Rostum and Dr. Mohammed Ziara.

I wish to thank all contractors in construction field whom I have interviewed to fill the questionnaires for their cooperation and valuable feed back which was obtained in our discussions.

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Chapter One
Introduction

1.1 General

Construction industry is one of the main industries that contributes in the local development process. It is considered as one of the most capital and labor intensive industries of the Palestinian economy. All construction projects are associated with different types and levels of risk and uncertainty, in terms of cost and duration, depending on project complexity, resources, market prices, location, political situation and many other factors. The amount of the uncertainty in the internal and external environments of a project is an important factor in determining whether there will be schedule and cost overruns in the project. Therefore, contractors need to be very cautious when starting a new project in order to minimize the possibility of the risk of running into any of the well-known pitfalls of the industry. Risk management must be taken into consideration especially in the bidding phase.

Risk management has rules and procedures that need to be adhered to in order to complete the project successfully. But, one often finds that local contractors do not take risk management into consideration, particularly the financial aspects. They usually enter into new projects based on construction cost alone. Hence they end up miscalculating the overall cost either intentionally or due to lack of know how. Also, most local project owners usually focus on the item's cost factor only while ignoring other factors, such as different types of risk and uncertainty associated with the project, which may affect the project goals. In other words, a local project owner may decide to take the lowest bid without even considering a deeper cost analysis of the items. However, the important question is, " how risk can be estimated, measured and managed?".

A contractor should recognize the concept of risk management and its techniques. Enshassi and Mayer (2001) note that knowledge of risk management amongst managers of most construction projects implemented in the Gaza strip is very low.

A contractor preparing a bid for a construction project should first recognize the sources of risk associated with such a project. This issue leads to evaluating the potential cost impacts of the risk on the project in order to prepare both of the mitigation actions and the proper bidding. By recognizing this issue, the contractor will be able to submit more competitive bids with sufficient safety margins.

When an invitation to bid is received by a contractor, the first decision to be taken by the contractor is to "bid or not to bid" on the new project. Alquier et al. (2000) point out that the most critical phase in the project life cycle is the bidding phase, where little information is available. Leopoulos et al. (2003) say that the scanty information during the bidding phase is a risk on its own.

The decision "bid or not to bid" depends on many factors. Alquier et al. (2000) mention that the right decision "bid or not to bid" primarily depends on a primary evaluation of contractor's capabilities in terms of strengths and weaknesses, which must be assessed depending on the light of project portfolio strategy, and some assumptions about competitors' behavior.

Once the decision to bid is taken, after the preliminary assessment of the risk factors, there are other decisions that must also be taken. One of the most important decisions is how to deal with risk. In other words, what strategies/ procedures ought to be followed by the contractor so as to deal with the anticipated risk.

Recognizing the risk management procedures, risk response plans and their need for control will allow for better assessment and forecasting of the risk magnitudes and their impact. Hence these allow for more effective measures being included in the preparation and bidding phase.

1.2 Problem definition

Time schedule and cost overruns are two of the main factors that might cause failure or stoppage of a project. There are different types of risks that influence the duration and cost of construction projects. Risk factors were categorized by many researchers in a number of different ways. For example, Barrie and Paulson (1992) point out that, such risks can be categorized into internal and external, predictable and unpredictable, and technical and non-technical. Another classification was done by Al-Bahar (1999) which categorized risk in construction project as follows: Acts of God, Physical, Financial and Economic, Political and Environmental, Design, and Construction related.

As such, this research work is geared towards the development of a system which can be used in assessing the risks associated with construction projects, categorizing these risks, and estimating the possible financial liabilities of such risks.

1.3 Research scope, aim and objectives

1.3.1 Scope

This research is focused on building projects in the Gaza Strip and it is limited to the contractors with a valid registration from the Palestinian Contractors Union (PCU) in this sector. The limitation extends to only include the union's first and second class contractors (out of five classes) and these are taken to represent the sample population of contactors in the Gaza Strip.

1.3.2 Aim

This research aims to investigate the risk associated with building projects and develop a computer-based tool to help Palestinian contractors better manage risks in estimating the cost of building projects. This tool should, in principle, provide users with an efficient mechanism that helps identify risks and determine possible ways that may help avoid or minimize these risks.

1.3.3 Objectives

The study is intended to achieve the following objectives:

1- Identify risks for building projects and categorize them.

2- Determine different strategies for managing (minimizing) these risks.

3- Develop a system to incorporate risk impact into the project cost estimate.

4- Computerize the suggested system.

5- Evaluate the system by examining it on real projects.

1.4 Outline methodology

First Stage: Literature review

Literature and previous research studies were reviewed to collect data about the construction project risk groups and its components in details, the factors affecting the project risks, the different strategies to deal with these risks and some computerized programs, models and techniques that have been developed to deal with risk.

Second stage: Field survey

Several meetings and discussions were held with experts in the construction field. Hence, a structured questionnaire were designed and then distributed by direct contact to building contractors in Gaza Strip. Statistical analysis for questionnaires is done by using Statistical Package for the Social Sciences (SPSS). Discussion is made for the obtained results.

Third stage: System formulation and evaluation

Depending on the previous two stages, a software model is developed using C# (C-Sharp) programming language. This System is evaluated by experienced people.

1.5 Thesis organization

Apart from this chapter there are other five chapters, as the following:

Chapters (2): It presents a literature review of the past research work efforts in the subject of risk identification and risk management in construction projects. The chapter also presents a review of different approaches to categorize project risks. In addition, there is a review of some models and techniques that have been developed to deal with risk.

Chapter (3): It presents the methodology adopted in this research including the questionnaire design, the method of analysis and information about the system development and evaluation.

Chapter (4): It presents the results of the questionnaire and covers the analysis of the surveyed results and discussion of these results.

Chapter (5): In this chapter, the developed system Risk Cost Estimation and Management Software (RCEM) is described in detail. The discussion includes concept, description, implementation, and evaluation.

Chapter (6): It presents conclusions, recommendations for parties involved in construction projects, and recommendations for further studies.

There are four Annexes which supplement these chapters. They are:

Annex 1: The questionnaire (In Arabic).

Annex 2: The questionnaire (English Version).

Annex 3: The developed system evaluation questionnaire (In Arabic).

Annex 4: The developed system evaluation questionnaire (English Version).

Chapter Two
Literature Review

2.1 Introduction

In the bidding phase, risk evaluation is a very important process to make a predictable safe price for the tender. Successful risk management will improve the probability of project success (in time, quality, and cost). Historical databases may help the process of risk management. Altug (2002) points that there are important benefits that may be gained from historical databases. These benefits are the managing of the risk checklists, creating information for estimations, and getting response strategies. The response strategies are planned to control the risk. In other words, the response strategies aim to avoid or reduce the negative impacts of the risks.

This chapter reviews the relevant literature regarding the subject of risk identification and risk management in construction projects. It also reviews some of the existing categories of risks, and some of the developed models.

2.2 Risk management

Risk is the possibility of loss, damage, or any other undesirable event during the course of implementation of a contract. Any project has some level of risk associated with it, which influences the project cost, time, quality and operational requirements. Alquier et al. (2000) point that one of the greatest factors, which improve the probability of project success, is the successful project risk management. The careful and rational consideration of the risk management can help a contractor compete and succeed.

Risk management may be defined as a process to control the level of risk and to mitigate its effects. The aim of risk management is to help project parties in avoiding effects of risk on contract profits.

Barrie and Paulson (1992) mentioned that insurance and bonding could cover some of the risks; others can be transferred to another party by the construction contract.

Enshassi and Mayer (2001) developed model that was adapted from some other references. The model places risk management in the context of project decision making, while considering the overlapping context of behavioral responses, organizational structure and technology. In this model, the context of project decision-making governs the established objectives and construction risk management. The processes of the model are: Risk identification, Risk analysis, Risk control and monitoring.

Flanagan (2002) says that, the risk management process as a system aims at identifying and quantifying all risks and uncertainties. Figure2-1 shows the risk management system and its sequences.

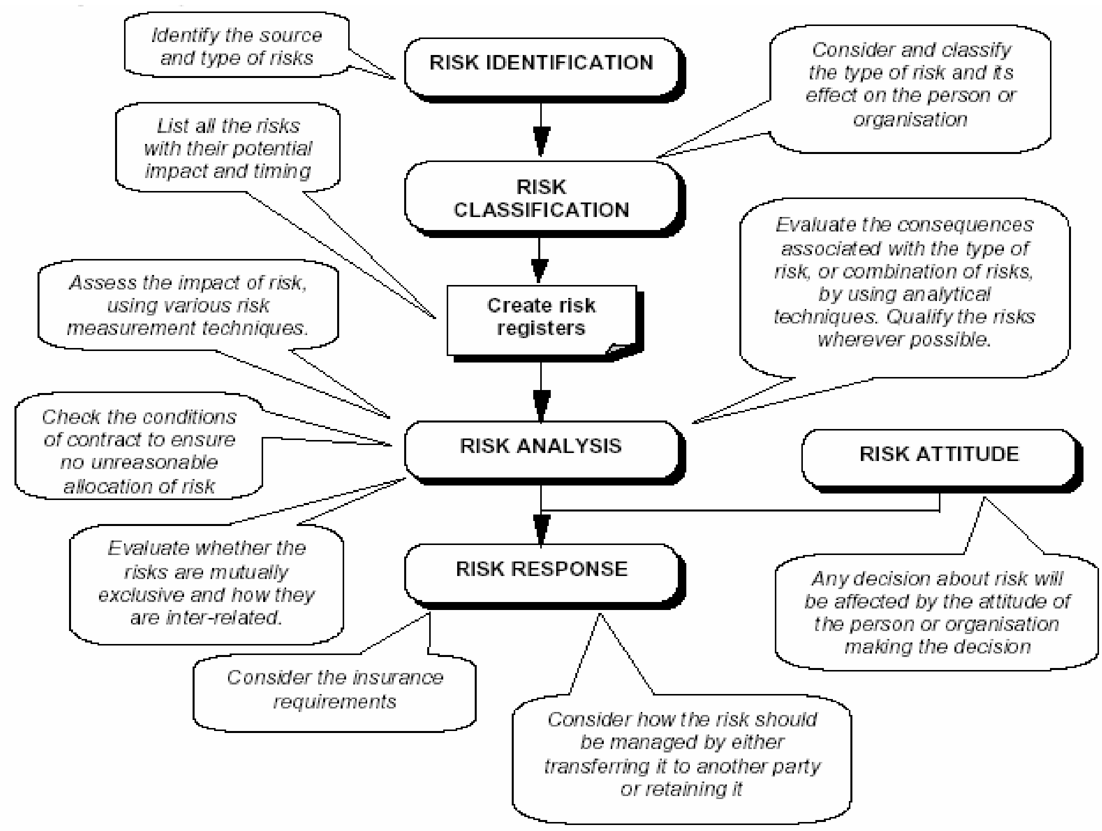

Figure (2-1): The risk management system (Flanagan, 2002)

Enshassi and Mayer (2001) conclude that there is a need to explore the categories of risks in Gaza strip in terms of nature of occurrence, impact and response alternatives. Also, attention should be given to the temporal characteristics of risk.

Risk management is the systematic process of identifying, analyzing, and responding to project risk. Ahmed et al. (2002) point that the said process consists of five stages as follows: -

-Identification; Estimation; Evaluation; Response and Monitoring.

The conceptual model, which is developed by Enshassi and Mayer (2001), divide the risk management process into four stages. These stages are; risk identification, risk analysis, risk response, and risk control and monitoring.

2.2.1 Risk identification

The risk identification process is probably the most important phase of risk management; it deals with the estimated events or things that can go wrong in the project. Numerous areas can cause construction project risks. Barrie and Paulson (1992) point that risks can be categorized into internal and external, predictable and unpredictable, and technical and non-technical factors.

Al-Bahar (1999) categorized risk in construction project as follows:

1) Acts of God: such as Flood, Earthquake, Landslide, Wind Damage and lightning.
2) Physical: such as damage to structure, damage to equipment, labor injuries, material and equipment fire and theft.
3) Financial and Economic: such as inflation, unavailability of funds from client, financial defaults of subcontractor.
4) Political and Environmental: such as changes in laws and regulations, war and civil disorder, expropriation, embargoes, requirements for payments and their approval, pollution and safety rules.
5) Design: such as incomplete design scope, defective design, errors and omissions, inadequate specifications, different site conditions.
6) Construction related: such as weather delays, labor dispute and strikes, labor productivity, different site conditions, defective work, design changes, equipment failure.

Kimamoto and Henley (1996) say that the generally accepted expression for risk is illustrated in the following equation:

$$Risk \equiv [(P_1, C_1),(P_2, C_2),\ldots,(P_x, C_x)] \text{ ....equation (2-1)}$$

Where:

P_x: is the occurrence probability of event x

C_x: is the occurrence consequences or outcomes of event x

It is noted from equation (2-1) that the risk can be measured by two factors which are the probability of an event occurrence and the consequences of that event.

2.2.2 Risk analysis

In this stage (which follows the risk identification), the probability of risks occurring in addition to possible impact of risks, must be studied and evaluated. Enshassi and Mayer (2001), cited AS/NZS 3931 (1995), say that the risk analysis is a process of identifying hazards and estimating the risk regarding individual or populations, property or environment by using the available information in a systematic manner.

In addition, the risk analysis process helps in determining the strategies or the procedures, which could be conducted in dealing with risks. Ahmed et al., (2002) mention that this process helps in making decisions with regard to classifying the risks under two classifications, which risks are retaining and which are transferring to other parties. Flanagan and Norman (1993) proposed a systematic 6-steps approach of risk analysis. These steps are as follows:

Step 1- All the various options should be considered

Step 2- Consider the risk attitude of the decision-maker

Step 3- Consider what risks have been identified, which are controllable and what the impact is likely to be

Step 4- Measurement, both quantitative and qualitative

Step 5- Interpretation of the results of the analysis and development of a strategy to deal with the risk

Step 6- Decide what risks to retain and what risks allocating to other parties.

They also highlight the techniques, which are available for risk analysis. These techniques are quantitative and qualitative. They mention that when a sufficient current data is available, then quantitative methods may give more objective results. While, the qualitative methods vary from person to person due to their response on the personal judgments and past experiences. The quantitative methods are preferred by most analysts (Ward and Chapman, 1997, Ahmed et al., 2002). Figure (2.2) illustrates the qualitative methods and the quantitative methods.

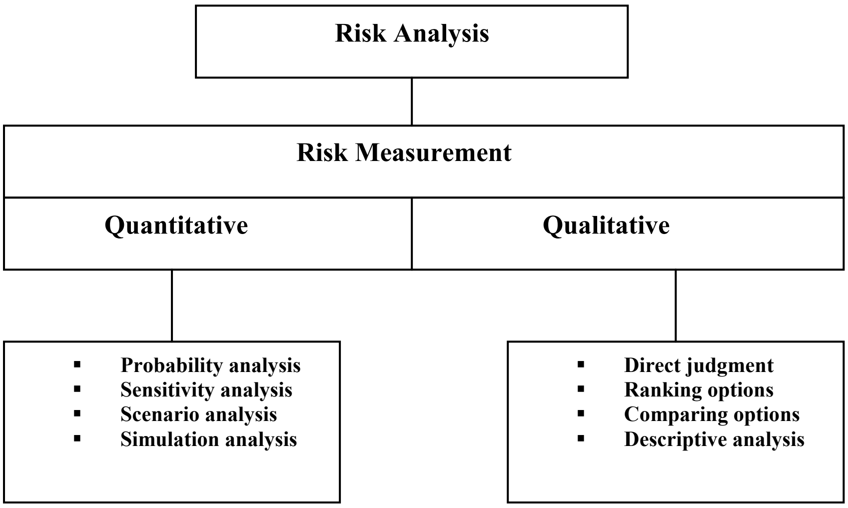

Figure (2-2): Various risk analysis techniques (Ward and Chapman, 1997)

2.2.3 Risk response

This stage deals with the strategies or the procedures that could be prepared by the contractor to deal with risks. The aim here is to help the contractor in avoiding or reducing the risks. RM641- topic 9, (2000), cited Standards Australia (1995), defined this process as the selection and implementation of appropriate options for dealing with risk.

So, when risks are identified and recognized by the contractor, he will prepare the responsive plans. Enshassi and Mayer (2001) mention that the aim of this stage is to minimize the risks, and to maximize the profit. They also mention that the response process can be conducted in five ways. These ways are; risk avoidance, risk reduction, risk retention, risk transfer and insurance. Also, RM641- topic 9, (2000) and Ahmed et al., (2002) mention that the basic ways are; avoidance, reduction, retention, and transfer.

2.2.3.1 Risk avoidance

This strategy involves the elimination of the causes of risk. Risk avoidance may involve adopting alternative methods of construction, using the exemption clauses in the contracts, or simply not bidding for the project. Risk avoidance strategy should be addressed whenever the level of risk is extreme.

Some references name this option as Risk elimination. RM641- topic 9, (2000) mention that there are various forms of risk avoidance, such as:

1) Eliminating a task.

2) Not entering into a new activity.
3) Undertaking a different course of action.

Some examples of this option are: bid non submittal by a contractor and non availability of project funding. There are numerous ways could be conducted to avoid risks. These ways are such as: tendering a very high bid; placing conditions on the bid; pre-contract negotiations as to which party takes certain risks; and not bidding on the high risk portion of the contract (Kelly, P.K., 1996).

But, risk avoidance decision must be taken carefully. RM641- topic 9, 2000 cited Standards Australia (1995) mention that risk avoidance may be wrongly adopted due to a risk adverse attitude and this may lead to:

1) Decisions to avoid risk regardless of the information available and costs repercussions.
2) Deferring decisions that the organization can not avoid.
3) Selecting an option because it represents a potential lower risk regardless of benefits.

2.2.3.2 Risk reduction

Risk may be reduced through making a control and through preventing a loss or reducing the chance of the loss that may occur. RM641- topic 9, (2000) presents two ways to reduce the risk, which are:

1) Reducing probability: to minimize the chance of the loss that may occur, for example, a fire- resistant construction to a fire loss minimizing. This approach should be conducted when the risks have a high probability of occurrence.
2) Reducing consequences: it talks about actions to be taken when the risk eventuates.

This approach is conducted to lower the severity of the risk event consequences.

Risk reduction strategy may sometimes require initial investment which should then reduce the likelihood of the expected risks (Powell, 1996).

2.2.3.3 Risk transfer

In this strategy, risk can be transferred to other parties such as the owner, suppliers, subcontractors, or an insurance firm. This can be achieved by adding specific clauses to the contract. Risk transfer involves transferring the risk to those who are more capable of maintaining control on the outcomes of the risks. When part of this risk is transferred and rest is retained, then this is known as risk sharing. This strategy is adopted when the risk exposure is beyond the control of one party and it is important that each party recognizes the magnitude of its fraction of the identified risk. Anderson (2001) mentions that a party who accept a risk, should bear a risk where:

1) He can control or avoid it.
2) He can insure it.
3) He gets the economic benefits of it.
4) It is efficient for him to bear it.
5) He incurs it, and there is no reason to transfer it from that party.

Pipattanapiwong (2004) cited Thompson and Perry (1992) declare that risk transfer can take two basic forms as follow:

Form 1: the property or activity responsible for the risk may be transferred. For example, the contractor can hire a subcontractor to work on a risky process.

Form 2: the property or activity may be retained, but the financial risk can be transferred. For example, the contractor can insure the work, or a part of it, which contain risk.

2.2.3.4 Risk retention

When none of the previously mentioned strategies is possible, risk retention is the only available strategy. This is the case for residual risks that can not be mitigated. These types of risks should be considered and monitored throughout the rest of the project's life for better control and risk management.

Bender and Ayyub (2001) mention that risk acceptance may be determined by the following ways:

1) Through a systematic process that may be project specific, based on general corporate, or governmental guidelines.
2) By the cost effectiveness of risk reduction or opportunity gained. This cost effectiveness is calculated as:

$$\text{Cost Effectiveness} = \frac{\Delta \text{Risk}}{\Delta \text{Cost}} \qquad \text{.................equation (2-2)}$$

Where:

ΔRisk: is the level of risk reduction.

∆Cost: is the monetary amount required to reduce risk

2.2.4 Risk control and monitoring

This phase is the final one of the risk management process. In this phase, the whole process of risk management must be monitored and reviewed to examine the targets set and contract strategies employed as a result of risk evaluation periodically, if the management plan remains appropriate, and if deviations would occur. If there are any deviations, corrective actions will be devised and evaluated (Enshassi and Mayer, 2001).

In addition, monitoring and review process should ensure that (RM641- topic 9, 2000):

1) Identified risks are still valid.
2) Any changes in the level of a risk is understood and communicated to those who need to know.
3) Implemented responses have been effective and lessons learned are captured.
4) Appropriateness of selected treatment strategies and, if failing, identify new treatments.
5) No other risks have materialized over time.

2.3 Construction bidding phase

In the beginning of the project life cycle, the knowledge about the project and its details are scarce. But the information and details are arising as the time spent and the project continues. In addition, decisions that are taken in the bidding phase are usually the ones that affect the project the most. Fig (2-3) illustrates that the importance of decisions and their effects are lesser as the project is continues (Bystrom and Pierre, 2003).

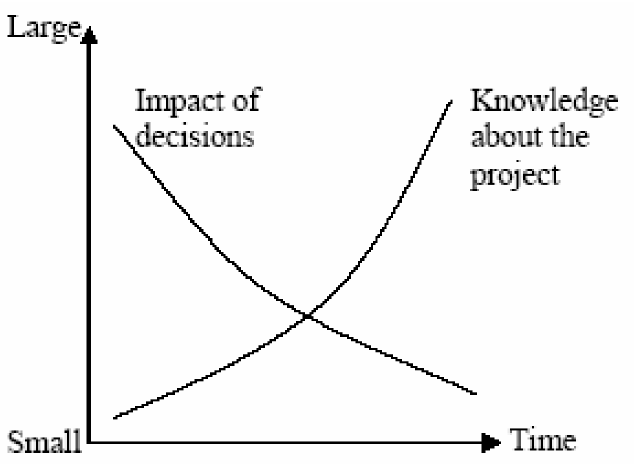

Figure 2-3): Conditions in projects (Bystrom& Pierre, 2003, based on Wenell, 2001 p. 48)

In this phase, there are some decisions that must be taken by the contractor; the first one is whether to bid on the project or not. There is number of elements that must be weighted by the contractor, such as: the type of the project, the difficulty of the work, the resources that are required, the bidding climate, the contractors need for work, probable competition, the owner, the duration of the project, and possible changes that may occur especially in the economic conditions (Wallwork, 1999). The bidding phase contains a high level of uncertainty, which affect both competitive factors, and parameters of cost/time/performance (Alquier et al., 2000). In addition, the contractor must consider some other important factors, such as: home office and field office that would be devoted to the project (Wallwork, 1999).

Leopoulos et al., (2003) mention that, by the integration and assessment of risks during the bidding phase, the results should be more accurate estimations and giving the opportunity of their integration, later, into the contract. They say that, they have presented and analyzed major number of projects of the Greek construction industry. The results strongly recommended that the 'strategy of risk management' should be integrated during the bidding process in order to achieve profitability projects. The main conclusion by them is that, even during the bidding phase, the additional costs that may arise can be foreseen.

Leopoulos et al., (2001) say that risk management is probably the most crucial factor of failure during the bid. It is acting as a double danger, affecting either the bid itself by losing the opportunity to win the auction, or the project if this is awarded to the organization

2.4 Risk management tools

The construction companies need tools to identify, analyze, qualify, allocate and response to risk. This part of the literature review introduces some tools that were developed to deal with risks.

2.4.1 Enshassi and Mayer risk model

Figure (2-4) shows the developed model. It places risk management in the context of project decision making, while considering the overlapping context of behavioral responses, organizational structure, and technology. In this model, the context of project decision-making governs the established objectives and construction risk management. The processes of the model are: risk identification, risk analysis, risk response and risk control and monitoring.

Also, the researchers mention that:

- This conceptual model provides an effective systematic framework for quantitatively identifying, analyzing, and responding to risk in construction projects.
- With this model, emphasis is placed on how to identify and manage risks before, rather than after, they materialize into losses or claims.
- The linkage between the processes of the model provides a closed-loop feedback to update the information in the system and to capture the information between these processes.
- To apply this model successfully, it is recommended that there must be a strong commitment by senior management towards project management. Also, the project manager and his staff must fully understand and be committed to the cost, time, and performance objectives at a sanctioned project.

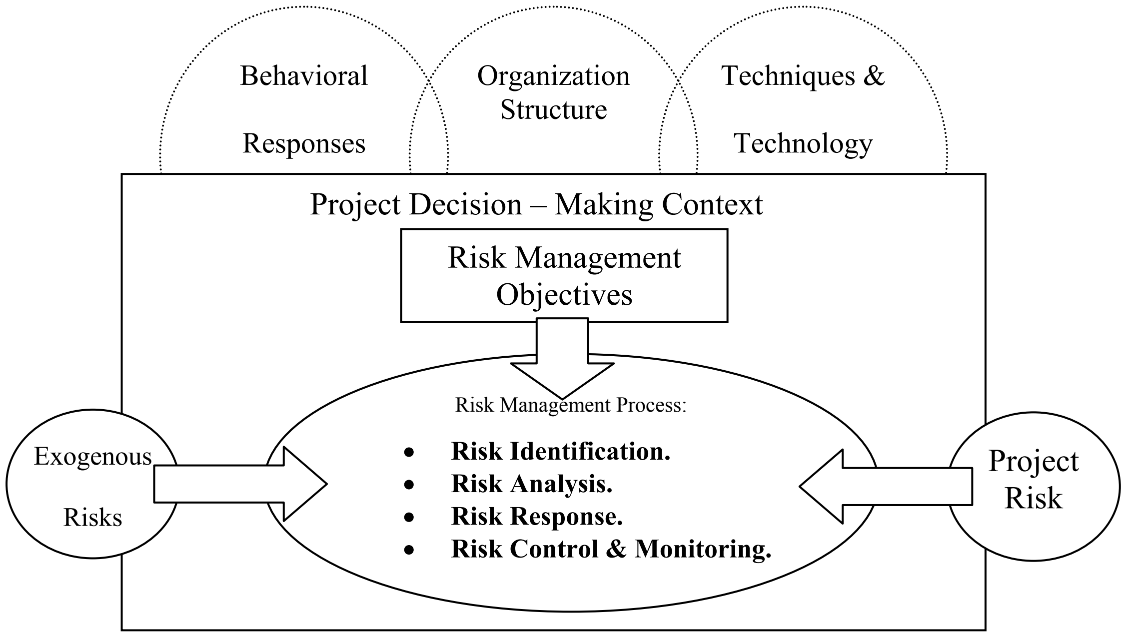

Figure (2-4): Conceptual model of construction risk management, (Enshassi & Mayer, 2001).

2.4.2 Texas risk management process

This process is introduced by the Department of Information Resources- Leadership for Texas Government Technology, in March, 2000. The purpose of this process is to be used by project teams to identify and handle the risks on their projects. The process may be used to:

- Provide information to the risk management work of the overall organization.
- Supply information to Quality Assurance Review activities.

Figure (2-5) illustrates a Graphical overview of the process.

The scope of this process contains three areas, as the following:

Area 1: Activities tailoring: Table (2-1) describes how risk management activities may be tailored for different types of projects.

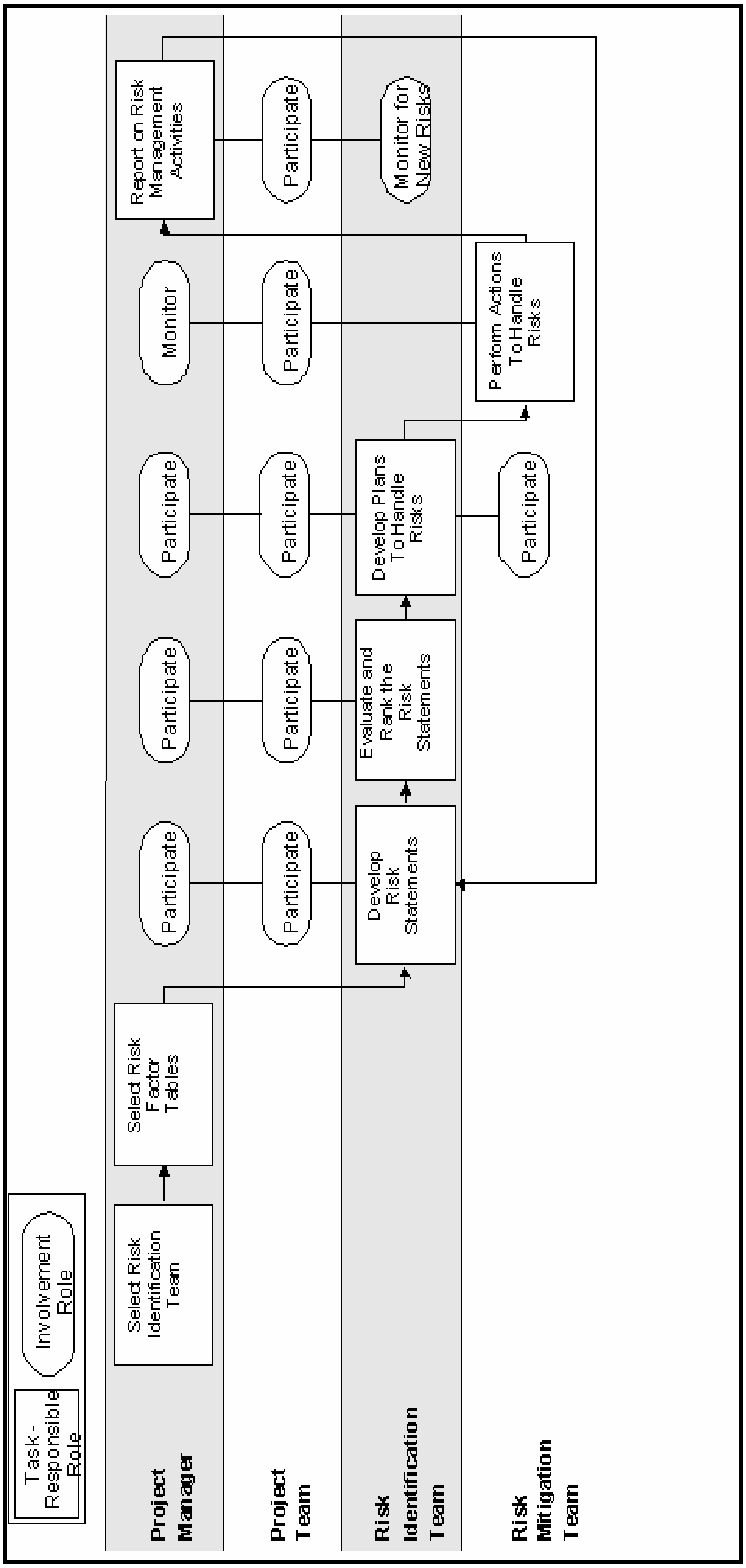

Figure (2-5): A graphical overview of the analyzing and managing project risk process

Table (2-1): How risk management activities may be tailored for different types of projects

Activity	Low Focus	Medium Focus	High Focus
Identify Risks	Use a list of categories of risks, or use a list of the key risks often encountered in the organization, to decide whether or not risks need to be handled	Follow the process described in this guideline at the start of the project	Follow the process described in this guideline at the start of the project and at each new phase
Analyze Risks	Review identified risks with a small team and determine how threatening they are to the project	Follow the process described in this guideline at the start of the project	Follow the process described in this guideline at the start of the project and at each new phase
Plan Risk Handling Actions	Include plans for the top 1 or 2 risks in the project work	Follow the process described in this guideline at the start of the project	Follow the process described in this guideline at the start of the project and at each new phase
Track and Control Risks	Monitor risk mitigation activities like other project actions	Monitor risk mitigation activities like other project actions; watch for additional risks to add to those handled	Monitor risk mitigation activities like other project actions; watch for additional risks to add to those handled

Area2: Roles tailoring: Table (2-2) describes how roles may be tailored for different types of projects.

Table (2-2): How roles may be tailored for different types of projects.

Role	Low Focus	Medium Focus	High Focus
Risk Identification Team	Only the project manager and team members	Project team and other stakeholders	Project team, representatives of all stakeholders and other organizations involved in the project
Risk Mitigation Team	Only the project manager and team members	Project team and members of management	Project team and any stakeholder or other organization which is well-equipped to help handle a given risk

Area 3: Deliverables tailoring: Table (2-3) describes how the deliverables may be tailored for different types of projects.

Table (2-3): How the deliverables may be tailored for different types of projects.

Activity Deliverable	Low Focus	Medium Focus	High Focus
Top N Risk Chart *	Usually fewer than five top risks	May have 6 to 10 top risks	May have more than 10 top risks. It is recommended those projects with more than 10 top risks are examined for restructuring to reduce the number of top risks. Alternatively, consider terminating the project
Mitigation Action Plan	One sentence action statements	Include actions in WBS	Include actions in WBS
Contingency Plan	Usually not needed	Short, narrative descriptions with rough cost and schedule estimates	Plan size and detail are related to investment levels.
Risk Status Report*	Informal, as part of status updates	Use one report for all risks being handled	Use one report for all risks being handled, with detailed item tracking for most threatening risks

It should be noted in the graphical overview of the process (Figure 2.5) that many of the activities are cyclical, or episodic, rather than tied to life cycle phase. The task or the responsibility of each team of the risk management process is illustrated in the Graph.

2.4.3 Alien Eyes Risk Model

This method is developed by Department of Building, School of Design and Environment, National University of Singapore, in the year of 2002. This method is introduced for companies working overseas, especially in developing countries. This research seeks to formulate a risk management strategy and framework for Singapore firms. The research team identified twenty-eight critical risks associated with international construction projects in developing countries. These risks were categorized into three hierarchy levels, which are; country, market and project. Then they were evaluated and ranked according to risks importance. Table (2-4) illustrates the categories, the levels and the risks evaluated.

Table (2-4): Risk Level Criticality

Risk Code	Risk and Risk Level	Risk Criticality (1….7)	Risk Rank	Risk Level Criticality (3rd Quartile)
Level I: Country Level				**4.95**
A1	Approval and Permit	5.85	1	
A2	Change in Law	5.28	2	
A3	Justice Reinforcement	5.28	2	
A4	Government Influence on Disputes	4.65	8	
A5	Corruption	4.80	6	
A6	Expropriation	4.52	15	
A7	Quota Allocation	4.13	19	
A8	Political Instability	4.95	4	
A9	Government Policies	4.65	8	
B1	Cultural Differences	3.50	25	
E1	Environmental Protection	3.43	27	
E2	Public Image	3.62	24	
G1	Force Majeure	4.03	22	
Level II: Market Level				**4.65**
B2	Human Resource	4.12	20	
B3	Local Partner's Credit worthiness	5.00	3	
B4	Corporate Fraud	4.60	11	
B5	Termination of Joint Venture (JV)	4.62	10	
C1	Foreign Exchange and Convertibility	4.52	15	
C2	Inflation and Interest Rates	4.72	7	
H1	Market Demand.	4.58	12	
H2	Competition	4.50	17	
Level III: Project Level				**4.55**
C3	Cost Overrun	4.95	4	
D1	Improper Design	4.53	14	
D2	Low Construction Productivity	4.12	20	
D3	Site Safety	4.02	23	
D4	Improper Quality Control	4.42	18	
D5	Improper Project Management	4.57	13	
F1	Intellectual Property Protection	3.50	25	

Table (2-5) shows the influence relationship among the risks in the three hierarchy levels.

Also, the research introduces practical mitigation measures, which have been collected and evaluated by the research team. The said method facilitates the categorizing of risks and representation of the influence relationship among risks at different hierarchy levels as well as the revelation of the mitigation sequence/priority of risks. In this section it can be recognized that some risk factors affect each other. This issue may contribute in categorizing risk factors.

Table (2-5): Risk Influence Matrix

		Country Level Risks												Market Level Risks							
		A1	A2 A3	A4	A5	A6	A7	A8	A9	G1	E1	E2	B1	B2	B3	B4	B5	C1	C2	H1	H2
Market Level Risks	B2		<						<			<	<								
	B3				<				<				<								
	B4		<	<	<								<								
	B5		<	<	<	<	<	<	<	<			<								
	C1		<				<	<	<	<											
	C2				<		<	<	<	<											
	H1									<											
	H2									<											
Project Level Risks	C3	◄	◄	◄		◄	◄	◄	◄	◄				←	←	←	←	←	←	←	
	D1		◄										◄	←							
	D2	◄							◄			◄	◄	←						←	←
	D3		◄		◄						◄			←							
	D4		◄		◄						◄		◄	←							
	D5		◄	◄	◄									←							
	F1		◄	◄	◄				◄			◄	◄	←	←	←		←			

Note: < Influence of Country Level Risks on Market Level Risks
◄ Influence of Country Level Risks on Project Level Risks
← Influence of Market level Risks on Project Level Risks
Refer to Table 1 for risk codes

2.4.4 Leopoulos method

Leopoulos et al. (2002) suggest a method, which aims to integrate risk management into the bidding process. This method presents a structured approach risk management strategy to be implemented during the bidding process. This method is presented to the proposed team (management team) to be able to take into account the risks involved in the process in first place and afterwards the risks that appear during the execution of the project.

Figure (2-6) illustrates the proposed process for the bidding phase, including the risk management parts. The researchers say that, by developing and controlling risk management during the bidding phase, the advantages are:

1- It enables the bidding manager to focus on the critical issues of the bid, and to enhance the probability of success.
2- Once the contract awarded, it helps the project manager to keep under control any adverse events, which may be anticipated.

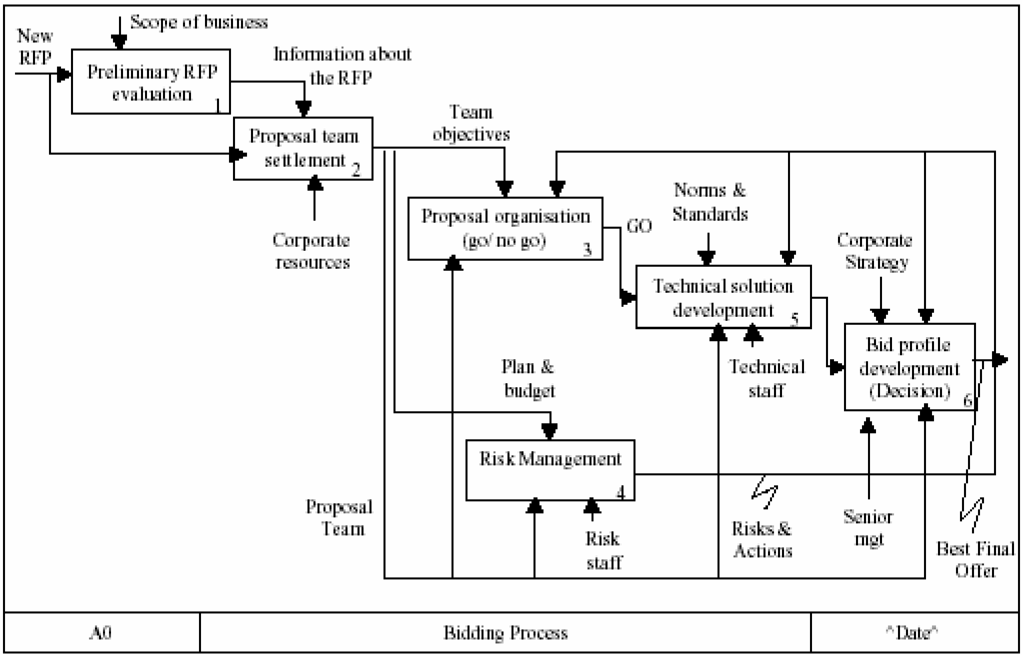

Figure (2-6): Proposed Bidding Process adapted from (Leopoulos et al., 2002)

2.4.5 Hall risk management support system

Hall et al. (2001) developed a spreadsheet- based software tool aiming at guiding the user through the stages of the risk management process. They mention that the benefit of using software is that large amounts of best practice guidance can be embedded in the tool, which links the guidance with each stage in the process.

The system facilitates the following:

1) Recording risks and risk management actions.
2) Focusing attention on the most important risks.
3) Clarifying risk ownership and responsibilities.
4) Providing a common format for risk communication throughout the supply chain.
5) Providing a convenient and traceable mechanism for revisiting risk assessments as a project proceeds.
6) Disseminating best practice through a comprehensive knowledge base and case studies.

The system provides one procedure in dealing with each risk factor. For example if there is a risk regarding the local disruption, the procedure is to instigate extensive traffic management plan. Also, if there is invalid/unapproved design, the procedure is to provide alternative design.

2.4.6 Simulation in risk analysis

Abd-El Said (2003), cited Touran (1992), says that traditionally, spreadsheet analysis tried to capture the uncertainty in one of three ways: point estimates, range estimates and what-if scenarios. In point estimates, commonly, the most likely values are used according to the mode for the uncertain value. In range estimates, three scenarios are typically calculated: the best case, the worst case and the most likely case. These types of estimates can show the range of outcomes only without the probability of any of these outcomes. In what-if scenarios, the calculation is based on the range estimates and calculates as many scenarios as possible, also without the probability of any of these scenarios.

To get results with their probability, spreadsheet simulation is used to generate random values for uncertain variables over and over to simulate a model. The most famous simulation model in this regard is Monte Carlo simulation. It was named after Monte Carlo, Monaco; where the primary attractions are casinos containing games of chance as roulette dice and slot machines, exhibit random behavior. The random behavior in games of chance is similar to how Monte Carlo simulation selects variable values at random to simulate a model, as the variables have a known range of values but an uncertain value for any particular time or event. This method has the advantage of allowing the analyst to account for relationships between input variables and providing the flexibility to investigate the effects of different modeling assumptions. The disadvantage for this method is correlation between project cost components as it is assumed that cost components are independent and change in one cost element do not affect any other components. This is inaccurate in typical construction projects; however, it is assumed that if the correlation between variables is sufficiently small, the assumption of independence does not create large errors. For every highly correlated cost item group, it can be combined into a single cost item such that all the remaining cost items can be considered independent. For each uncertain variable (especially critical cost elements), we can determine the potential variability distribution based on the conditions surrounding that variable. These lowest and highest estimates are far enough from the target estimate such that there is less than a 1% chance that the actual will be lower than the lowest estimate and less than a 1% chance that it will be higher than the highest estimate. A simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distribution for the uncertain variables and using those values for the cell. And finally, we get a set of a forecast outputs values with their probability**.**

A typical computer program based on the Monte Carlo simulation technique is Project Risk Analysis Program (PRA) version 2.1. This program was developed by Katmar software (www.katmarsoftware.com). It aims to enable the evaluation of capital risk on projects, and for the financial contingencies required to cover those risks to be calculated. The procedure followed in this program encouraging discipline estimating, and will calculate the required contingency according to Monte Carlo Simulation.

Figure (2-7) illustrates the data entry screen of the program, where the user must enter the items description of the project, the likely cost, low cost, high cost, Dist (the probability distribution models that are built into PRA are the triangular, normal and Lognormal distributions) and expected cost (Exp cost).

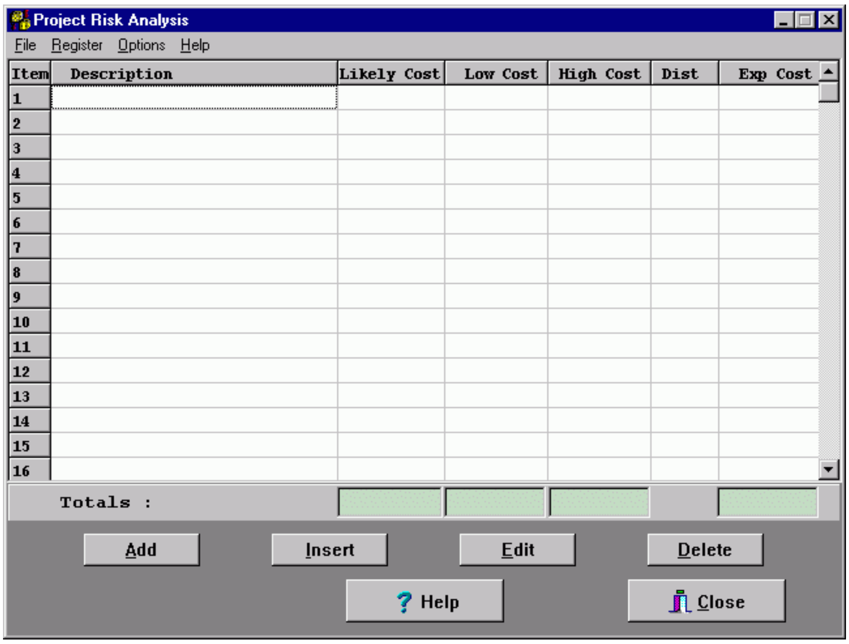

Figure 2-7): The Data Entry Screen

Figure (2-8) illustrates at a glance what the final project cost is most likely to be, and what the upper and lower limits are. This screen also shows a brief summary of the basic statistics.

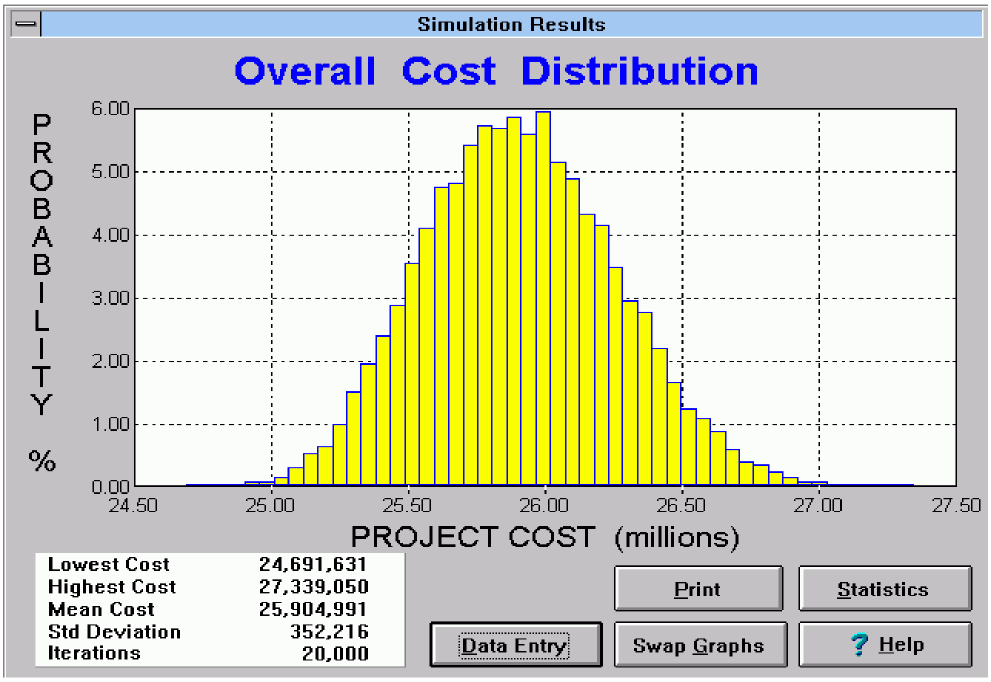

Figure (2-8): A Typical Histogram of Overall Cost Distribution

The user can show the same overall cost distribution in "S"-Curve format (Figure (2-9)) by clicking the Swap Graphs button.

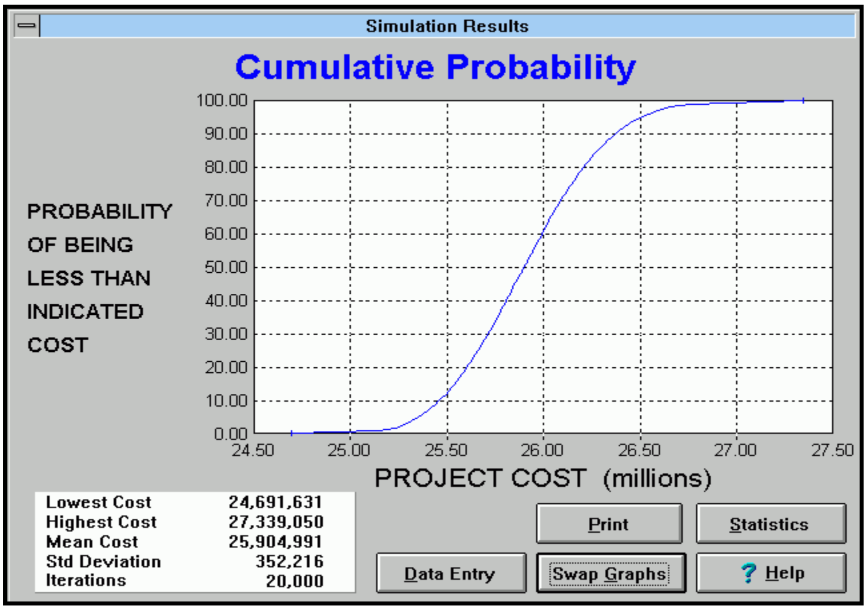

Figure (2-9): A Typical "S"-Curve of Overall Cost Distribution

2.5 Risk management in Gaza Strip

Contractors in Gaza Strip usually enter into new projects based on construction cost alone. Hence they end up miscalculating the overall cost either intentionally or due to lack of know how. Also, most local project owners usually focus on the item's cost factor only while ignoring other factors, such as different types of risk and uncertainty associated with the project, which may affect the project goals. In other words, a local project owner may decide to take the lowest bid without even considering a deeper cost analysis of the items. A contractor should recognize the concept of risk management and its techniques. As mentioned before, Enshassi and Mayer (2001) note that knowledge of risk management amongst managers of most construction projects implemented in the Gaza strip is very low.

Review of past conducted researches to study risk management aspects in Gaza Strip illustrated that there is a need for more research efforts in this regard. Also, there is no suitable and applicable software to be used by local contractors regarding detail of risk cost estimation and management. The mentioned tools in section 2.4 do not facilitate the recognizing of risk factors associated in different types of project works, their nature of occurrences, their anticipated results, and different ways or mitigation actions which could be conducted to mitigate or prevent risk effects.

To the best knowledge of the researcher, besides Enshassi and Mayer (2001) there is only one other research in the subject of risk management for construction projects in Gaza Strip which was conducted by Abu Mousa (2004). He determines a set of thirty-six risk factors subdivided into nine categories for the construction projects in Gaza strip. These categories are:

1) Physical: including occurrence of accidents and poor safety procedures, supplies of defective materials, and varied labor and equipment productivity.
2) Environmental: including acts of God, difficulty to access the site, adverse weather conditions, and differing site conditions.
3) Design: including defective design, not coordinated design, inaccurate quantities, lack of consistency between bill of quantities, drawings and specifications, and awarding the design to unqualified designer.
4) Logistics: including labor, material and equipment, scope of work defining, and accuracy of project program.

5) Financial: including inflation, delayed payment on contract, and financial failure.
6) Legal: including permits and regulations, labor disputes, third-party delays, and delayed dispute resolution.
7) Construction: including change order negotiations, quality of work and time constraints, changes in work, and actual quantities of work.
8) Political: including government acts, legislation, war threats, and blockade.
9) Management: including project complexity, organization and change management, coordination with sub-contractors, resource management, information and communication.

The researcher believes that the classification conducted by Abu-Mousa (2004) is not quite ready to be applied directly in cost estimation process. Accordingly, there is a need to make a new classification on the basis of limiting risk factors for each work group, the resulting consequences of each factor and the ways that could be followed to deal with each factor. This leads to better risk management and more accurate estimation of cost resulting from such risk factors occurrence.

Chapter Three

Research Methodology

3.1 Introduction

The preceding chapter illustrated in some detail the subject of risk identification and risk management in construction projects. Also, it presents a review of different approaches to categorize project risks and some models and techniques that have been developed to deal with risks. This chapter presents the data collection procedure adopted for this research. It also provides the information about research design, target population, survey samples and evaluation of the software.

3.2 Data Collection

As mentioned before, the first objective in this research is to identify risks for building projects in Gaza Strip, and categorize them. The second objective is to determine different strategies for managing (minimizing) these risks. The following methodology was followed to achieve these objectives:

1- Literature and previous research studies were reviewed to collect data about the construction project risk groups and its components in details, the factors affecting the project risks, and the different strategies to deal with these risks.

2- Several meetings and discussions were held with experts in the construction field about some actual cases and the key risk factors and resulting factors resulting from such key factors for various project works categories/groups.

3- Based on the information collected from the previous two steps, in the addition to the researcher own experience, he determines the relevant data needed for this study and hence decides upon the questions that must be contained within the questionnaire, which was conducted.

The third objective is to develop a stochastic model which would incorporate the risk impact in the process of cost estimating of construction projects.

The fourth objective is to computerize the suggested model. The main purpose of this model is to evaluate project risks. The procedure followed in the model encourages disciplined estimations, and will help calculate the required contingency according to a probabilistic technique, which is known as Monte Carlo Simulation.

The developed model is done by determining the cost of the main risk factors depending on the possible costs of the resulting consequences from such factors for works categories/groups. The developed model is proposed to be used in bidding phase where risks, impacts and mitigation actions are involved. The following methodology was followed to develop this model:

1- Determining the key work categories/groups of the building projects.
2- Depending on the questionnaire results, determining the main risk factors and the resulting consequences for each work category/group.
3- For each work category/group, determining the mitigation actions for each key risk factor.
4- Computerize the model which will calculate the total cost of the main risk factors as a result of the resulting consequences costs.

It is worth mentioning that the researcher determined the main risk factors and resulting consequences for each work category/group. And the proposed questionnaire's design allows respondents to scale freely their weights for related factors, consequences and mitigation actions.

The evaluation of the computerized system was done by experts. The researcher asked them to evaluate its overall functions as well as the friendliness of the program after they tried it. Figure 3.1 illustrates the methodology flow chart.

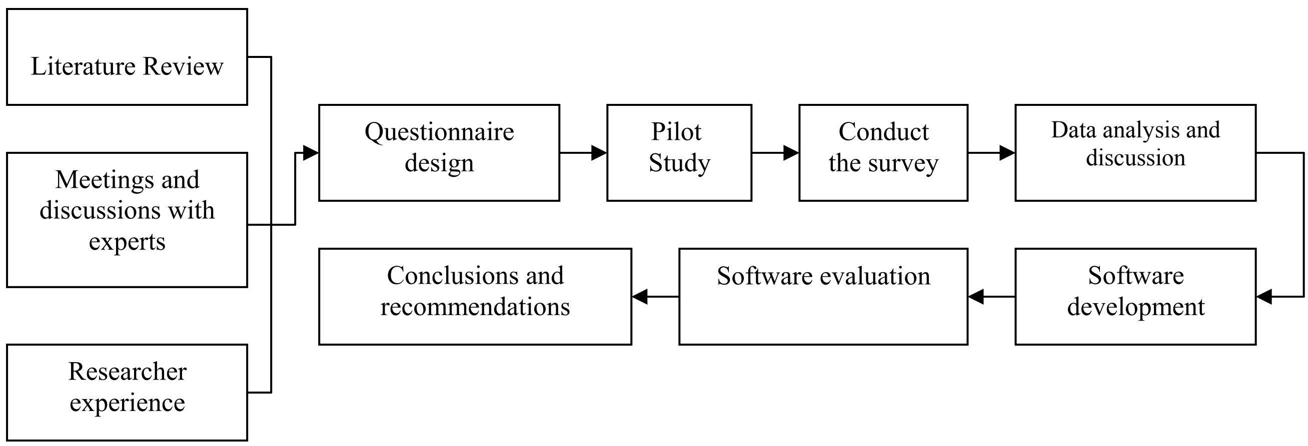

Figure (3-1): Methodology flow chart

3.3 Questionnaire for Study

The researcher has used the questionnaire as a tool to collect primary data related directly to his study. The questionnaire is a widely used data collection technique for conducting surveys. It is widely used for descriptive and analytical surveys in order to find out facts, opinions and views. It enhances confidentiality, supports internal and external validity, facilitates analysis, and saves resources (Naoum, 1998). The questionnaire was discussed with the supervisor and amended according to his advice. A pilot study was conducted to evaluate the questionnaire. To ensure obtaining complete and meaningful response to the questionnaire, interviews were conducted with respondents to explain the objective of each part of the questionnaire and to gain any relevant data regarding their answers.

The questionnaire consists of five parts as the following:

Part 1: Contractor organization Profile

Part 2: The way of dealing with risk

Part 3: Risk factors for different work types/categories.

Part 4: Main risk factors and resulting consequences for works categories.

Part 5: the ways which could be conducted to avoid or minimize risks (Mitigation Actions).

The questionnaire was developed in Arabic (Annex No. 1) to be more understandable by respondents. An English version was prepared (Annex No. 2) to help in documenting this research.

3.4 Methodology for Data Collection

In this study, descriptive and analytical analysis methods were used in order to study the risk management in construction projects in the Gaza Strip. The data collected from the questionnaire was recorded as answered by the sample members and was then analyzed using Statistical Package for Social Sciences (SPSS) program.

3.5 Survey Samples

Ninety eight copies of the questionnaire were distributed by direct contact to building contractors. Seventy five copies were answered represent a good percentage of response compared to similar cases. Eight questionnaires were excluded due to incorrect and incomplete answers.

3.6 Limitation of the research

As the building projects is the field of the researcher experience, and due to time limitation, this research is concerned mainly with building projects only and it did not take into account the other categories of construction industry. The research is limited to the contractors who have a valid PCU registration in September 2006 according to the PCU records.

Also, contractors of first class and second class in building projects represent the population of this study. Other classes were excluded as the researcher believes that their work is too limited to let them consider properly risk factors. This study is limited to the building contractors in Gaza Strip. The total population has been 109 companies. 56 of them is first class, and 53 of them is second class.

3.7 Pilot study

A pilot study was conducted to evaluate the questionnaire; the researcher distributed the questionnaire to a sample of 5 experienced persons. Generally speaking, it appeared that respondents had no difficulty in understanding the items or the instructions to complete the questionnaire. Minor modifications were done accordingly to the questionnaire.

3.8 Statistical Manipulation

To achieve the research goal, the researcher used the SPSS package for manipulating and analyzing the data. The statistical analysis for the questionnaire was done as the following:

- Defining and coding of variables.
- Summarizing the data on raw data sheet.
- Entering data.
- Cleaning data.

After that, the descriptive statistic method has been utilized. This method provides a general overview of the results. In this study, the results are presented in tabulation forms.

3.9 Developing and evaluation of the software

The results of this study show that the existing practices in risk management and risk cost estimating in construction projects are simple. Most contractors estimate and price their bids manually in the absence of a suitable model/tool for risk management and risk cost estimating. In other words, there is a weakness in dealing with risk. Also, as there are many details in the construction business, this enhanced the goal of this study to develop a computer-based tool to help Palestinian Contractors better manage risks in estimating cost of any given project. The software is developed to guide the contractor to deal with risks associated with construction projects in a systematic manner, which would also correspond with the general trend of computerization of most industries. The development process of the software, which is named RCEM, was based on some concluded ideas from the literature review related to risk management and its techniques and the experience of researcher in construction industry. In the beginning, the researcher tried to develop the software within Ms Excel environment. As he did not find it flexible enough to do some functions smoothly, he turned to C# (C- Sharp) programming language.

A test was conducted for the software after finishing the development process then it was discussed with the supervisor and some improvements were made accordingly. A structured questionnaire was used for software evaluation, to gain the opinions of experts about RCEM and its implementation. The evaluation questionnaire was designed in Arabic (see Annex 3) to be more understandable. English version was attached (see Annex 4). The questionnaire was discussed with the supervisor and amended according to his advice. The questionnaire consists of two sections to achieve the objectives of the software evaluations. The first section is addressed to the performance of RCEM indicators and the second section covers the respondents' comments about the software. Five first class contractors who are experts in building projects, in addition to one business development specialist were approached for evaluating the software. The researcher explained all steps for using and operating the system and how to read the results. He asked them to give their response to RCEM functions and its input-output relationships. They were asked to fill the questionnaire at the end of this process.

Chapter Four

Data Analysis and Discussion

4.1 Introduction

This study, conducted in the Gaza Strip, is to illustrate the building contractors' situation regarding to the risks; to determine the main risk factors and their consequences for each work category/group in building projects, and to determine different strategies/ways for managing (minimizing) these risks. The survey results are illustrated in this chapter.

4.2 Part 1 of the questionnaire: Contractor organization profile

This part investigates the characteristics of the sample regarding to position of the respondent, number of executed projects, experience of the organization in construction (years), and the value of executed projects in the last five years.

4.2.1 Position of the respondent

Table 4.1 shows that 28.4% of the sample respondents have a position as a director, 11.9% of the sample has a position as a deputy director, 34.3% of the sample has a position as a project manager, and 25.4% of the sample has a position as a site engineer. The variation of the respondents' positions is due to the difficulty in contacting the same person with the same position for all companies.

Table (4-1): The frequency and the percentages for position of the respondent

position of the respondent	Frequency	Percentage (%)
Director	19	28.4
Deputy Director	8	11.9
Project Manager	23	34.3
Site Engineer	17	25.4
Total	67	100.0

4.2.2 Number of executed projects in the last 5 years

Table 4.2 shows that 40.3% of contractors have executed from 11-20 projects in the last five years. And 20.9% of them have executed from 21-30 projects in the same period. This table indicates that most respondents generally executed a reasonable number of projects.

Table (4-2): Number of implemented projects

Number of executed projects in the last 5 years	Frequency	Percentage (%)
10 Projects or less	13	19.4
11-20 Projects	27	40.3
21-30 Projects	14	20.9
31- 40 Projects	5	7.5
More than 40 projects	8	11.9
Total	67	100.0

4.2.3 Experience of the organization in construction projects

Table 4.3 shows that 49.3% of respondents answered that they have been in construction business for more than 10 years. And only 6% of them answered that their organizations experiences are 3 years or less. This table indicates that respondents are generally mature in construction business.

Table (4-3): Experience of contractors in construction projects

Experience	Frequency	Percentage (%)
3 years or less	4	6.0
More than 3 years -5 years	9	13.4
More than 5 years -10 years	21	31.3
More than 10 years	33	49.3
Total	67	100.0

4.2.4 Work monetary volume in the last 5 years

Table 4.4 shows that in the last 5 years, 47.8% of respondents executed projects with a total volume from $1 million – less than $5 million. While only 9% of respondents executed projects with a total volume of $10 million or more.

Table (4-4): Work monetary volume in the last 5 years

Work volume (US $)	Frequency	Percentage (%)
Less than 500,000	7	10.4
500,000 – less than 1 million	14	20.9
1 million- less than 5 million	32	47.8
5 million – less than 10 million	8	11.9
10 million and more	6	9.0
Total	67	100.0

It can be concluded that most of the executed projects by respondents are of small size. This may be as a result of the unfavorable political and economical situation in Gaza Strip during AL-Aqssa Intifada.

4.3 Part 2 of the questionnaire: The way of dealing with risk

In the tables of this section, 4.3, the researcher considers the response classification for any item as follows:

- Very big if the weighted mean value is 90% or more.
- Big if the weighted mean value is from 70%- less than 90%
- Medium if the weighted mean value is from 50%- less than 70%
- Weak if the weighted mean value is less than 50%

4.3.1 Company's risk perception

According to the above mentioned classification, the weighted mean for all questions in table 4.5 lies between medium and big. It can be shown that the weighted mean of the fourth question (2.1.4) is big, where its value is 80.6%. This indicates that contractors have big consideration for the role of effective risk management in project success. The executed projects, in the last five years, are associated with a relatively high level of risks, where the relevant weighted mean is big (70.2%), which in turn, generally cause losses to contractors where the relevant weighted mean is medium (65.6%). Most contractors (with weighted mean of 70.2%) mentioned that they seriously take expected risk when pricing bids.

According to discussions held with contractors it can be concluded that a lot of them are not recognizing in depth risk management concepts, techniques and implementations, in addition to the absence of definite systems to analyze project risks and consequences. The absence of risk management training courses may give explanation to this issue.

Most contractors used computers in project management where the relevant weighted mean is big (82.6%). But the discussions with them illustrated that they did not use computers in risk management because they do not have suitable software or model to be used for this issue. Also, there is no commitment regarding the employment of special person or team for risk management by contractors, where the relevant weighted mean is medium (55.2%), and there is not enough interested contractors in giving training courses on risk management for their engineers, where the relevant weighted mean is medium (62.2%). This could be due to contractors' belief that it is an unnecessary expense, do not recognize the importance of such issues, and the engineering staff is not fully employed by most of contractors.

Table (4-5): Company's risk perception

No.	Description	V.Big %	Big %	Medium %	Weak %	V.Weak %	Weighted mean
2.1.1	What level of risk the company faced in the last 5 years?	16.4	34.3	34.3	13.4	1.5	70.2
2.1.2	What is the extent of losses caused by such risks?	10.4	28.4	44.8	11.9	4.5	65.6
2.1.3	How seriously does your company take expected risk when pricing of bids?	9.0	44.8	35.8	9.0	1.5	70.2
2.1.4	What is the extent of the company's level of conviction that effective risk management can result in success of the project?	36.4	36.4	21.2	6.1	0.0	80.6
2.1.5	What is the level of policies and strategies present in the company?	19.4	16.4	44.8	17.9	1.5	66.8
2.1.6	How far is the company interested in the skills and methods of risk management?	14.9	37.3	19.4	22.4	6.0	66.6
2.1.7	How far is the company committed to having especial person or team for risks management?	9.0	14.9	38.8	17.9	19.4	55.2
2.1.8	How far is the company interested in giving training courses on risk management for its engineers?	13.6	24.2	37.9	7.6	16.7	62.2
2.1.9	To What extent are computers used in project management by the company?	47.8	28.4	14.9	7.5	1.5	82.6

4.3.2 Company's risk strategies and policies

Table 4.6 illustrates that determining risks is the most used strategy with a weighted mean of 75.5%. On the other hand, the weighted mean of observing the risks and documentation solutions is 65.2%. This means that contractors need to put more effort in documenting risks. The researcher believes that this documentation helps building risk database that may be very useful in estimating future projects.

Table (4-6): Risk strategies and policies

No.	Strategies	level of use of the policies and/or strategies					
		V.Big %	Big %	Medium %	Weak %	V.Weak %	Weighted mean
2.2.1	Determining risks	19.7	47.0	25.8	6.1	1.5	75.5
2.2.2	Evaluating and analyzing risks	13.6	40.9	28.8	13.6	3.0	69.7
2.2.3	Dealing with risks/ controlling risks	15.2	37.9	33.3	10.6	3.0	70.3
2.2.4	Observing the risks & documentation solutions.	15.2	28.8	30.3	18.2	7.6	65.2

4.3.3 Risk attitudes

Table 4.7 shows that dealing with risks (minimizing risks) is the favorable choice for contractors, where the weighted mean of this choice is big (72.4%). The weighted mean of risk acceptance is medium (62.6%). This choice is taken when there is no other convenient alternative to accepting the risk. They may believe that this risk is expensive to avoid or to minimize, or it may not happen. The weighted mean of insuring against risks is 53.6% (medium), where most of local contracts include clauses which enforce contractors to ensure against some types of risks such as accidents. The discussions with contractors illustrated that the choice of avoidance by not bidding (with weighted mean of 52.6%) is conducted in cases such as the scanty of the available information about the project and the negative reputation of the owner. Also, the choice of partially transferring the risks to a subcontractor (with weighted mean of 51.8%) is conducted by giving some items or works to subcontractors in cases where the main contractor does not have the experience in these types of works and/or the project period is relatively small compared with its size.

The weighted mean of the choice of ignoring the risks is weak (46.8%) which is the lowest one. Contractors mentioned that this choice is conducted when risks is trivial and can be practically neglected.

Table (4-7): Risk attitudes

No.	Risk attitudes	The extent of use the choice					
		V.Big %	Big %	Medium %	Weak %	V.Weak %	Weighted mean
2.3.1	Ignoring the risks	1.5	7.5	31.3	43.3	16.4	46.8
2.3.2	Acceptance of risks	3.0	31.3	44.8	17.9	3.0	62.6
2.3.3	Dealing with risks (minimizing risks)	12.3	43.1	40.0	3.1	1.5	72.4
2.3.4	Partially transferring the risks to a subcontractor.	6.1	10.6	34.8	33.3	15.2	51.8
2.3.5	Insuring against risks	6.1	18.2	31.8	25.8	18.2	53.6
2.3.6	A voidance by not bidding	9.0	7.5	32.8	38.8	11.9	52.6

4.4 Part 3 of the questionnaire: Risk factors for different work types/categories

In section 4.4, the researcher considers the classification of the importance or the financial effect weighted mean value for each factor as follows;

- Big if the weighted mean value is 83% or more.
- Medium if the weighted mean value is from 50%- less than 83%
- Small if the weighted mean value is less than 50%

It is worth mentioning that risk factors were adopted from the previous research which was conducted by Abu Mousa (2004).

4.4.1 Excavation works

Table 4.8 shows that all weighted mean values are medium. This means that those factors are moderately considered risk factors in the excavation works. The table shows that the weighted mean value of the expectancy of the factor "actual quantities differ from the contract quantities" is 63.6%. It is relatively the most important factor. Also, the weighted mean of the financial effect of this factor is 63%. The highest value of the weighted mean value for financial effect is 72% for the factor of "unforeseen conditions".

Table (4-8): Expectancy and financial effect of excavation works risk factors

No.	Risk factors	Expectancy					Financial effect				
		Big %	Medium %	Small %	Nothing %	Weighted mean	Big %	Medium %	Small %	Nothing %	Weighted mean
3.1.1	Accidents	16.9	44.6	34.3	3.0	58.07	23.8	36.5	36.5	3.2	60.30
3.1.2	Adverse weather conditions	21.2	36.4	40.9	1.5	59.10	25.0	31.3	40.6	3.1	59.40
3.1.3	Defective design (incorrect)	15.2	59.1	19.1	6.1	60.97	31.3	37.5	26.6	4.7	65.17
3.1.4	Actual quantities differ from the contract quantities	24.2	48.5	21.2	6.1	63.60	25.0	45.3	23.4	6.3	63.00
3.1.5	Unforeseen conditions	21.2	36.4	34.8	7.6	57.07	40.3	38.7	17.7	3.2	72.00

4.4.2 Reinforced Concrete

Table 4.9 shows that the weighted mean values of the expectancy and the financial effect for all factors are medium except of "closure", "increasing of material prices" and "supplying defective materials". The expectancy and the financial effect weighted mean for "closure" and "increasing of material prices" are big. While the expectancy weighted mean of "supplies of defective materials" is small. It can be shown that "closure" factor is the most expected with weighted mean of 89.53%. Also, it has the highest financial effect weighted mean, which is 89.57%. This clearly shows that there is a high correlation between the expectancy and the financial effect of this factor. The expectancy weighted mean for "increasing of material prices" factor is 83.63%, and the weighted mean of the financial effect for this factor is 88.9%. The expectancy weighted mean of "supplying defective materials" factor is 46.27%, which means that other factors in the same table are more expected than this factor.

It is not surprising to have "closure" and "increasing of material prices" are the most expected factors and their financial effect is the highest. Many contractors suffered damages due to these factors during the last five years. The most important consequence of these factors is "project delay". It is also worth mentioning that "increasing of material prices" is expected to be a resulting consequence of "closure" occurrences for reinforced concrete works. The required materials and products are generally purchased by contractors or suppliers from outside the Gaza Strip. The prices that contractors pay for materials were fluctuating in unpredictably manner in the last five years.

Table (4-9): Expectancy and financial effect of risk factors of reinforced concrete works

No	Risk factors	Expectancy					Financial effect				
		Big %	Medium %	Small %	Nothing %	Weighted mean	Big %	Medium %	Small %	Nothing %	Weighted mean
3.2.1	Accidents	11.9	34.3	49.3	4.5	51.20	21.5	35.4	36.9	6.2	57.40
3.2.2	Adverse weather conditions	13.4	43.3	37.3	6.0	54.70	12.3	43.1	32.3	12.3	51.80
3.2.3	Defective design (incorrect)	13.6	62.1	19.7	4.5	61.57	28.1	50.0	17.2	4.7	67.17
3.2.4	Lower work quality due to time constraints	13.4	38.8	34.3	13.4	50.70	15.4	36.9	36.9	10.8	52.30
3.2.5	Closure	79.1	11.9	7.5	1.5	89.53	78.1	12.5	9.4	0.0	89.57
3.2.6	Supplying defective materials	16.4	25.4	38.8	19.4	46.27	27.7	38.5	15.4	18.5	58.50
3.2.7	Over auditing by supervision	26.9	55.2	16.4	1.5	69.17	32.8	45.3	20.3	1.6	69.77
3.2.8	Increasing of materials prices	62.7	26.9	9.0	1.5	83.63	76.2	15.9	6.3	1.6	88.90
3.2.9	Wage increases	25.8	31.8	34.8	7.6	58.60	28.1	34.4	25.0	12.5	59.37
3.2.10	Effective impact of changes in currency exchange rates	44.8	23.9	25.4	6.0	69.20	59.4	20.3	15.6	4.7	78.13

4.4.3 Block and Plaster works

Table 4.10 shows that the "closure" factor has a big expectancy with a weighted mean value of 86%. The financial effect weighted mean value of this factor is 88.73% (big) which is the highest weighted mean of financial effect in this table. On the other hand, the table shows that the least expected risk factor is "supplying defective materials" with weighted mean value of 41.8% (small), and its financial effect weighted mean value is 45.6% (small). So, this factor is the least expected factor in this table and its financial effect is the least one also. Discussions with some contractors illustrate that usually suppliers are the responsible parties regarding the defective materials, and they must compensate the contractor against any consequence damages. Also, in the last five years, the projects which are faced by such factor were scanty.

Table (4-10): Expectancy and financial effect of risk factors of block and plaster works

No.	Risk factors	Expectancy					Financial effect				
		Big %	Medium %	Small %	Nothing %	Weighted mean	Big %	Medium %	Small %	Nothing %	Weighted mean
3.3.1	Accidents	7.5	44.8	41.8	6.0	51.30	16.9	33.8	38.5	10.8	52.27
3.3.2	Supplying defective materials	7.5	32.8	37.3	22.4	41.80	12.3	33.8	32.3	21.5	45.60
3.3.3	Lower work quality due to time constraints	9.1	39.4	39.4	12.1	48.50	10.8	35.4	41.5	12.3	48.23
3.3.4	Closure	73.1	13.4	11.9	1.5	86.00	75.4	16.9	6.2	1.5	88.73
3.3.5	Over auditing by supervision	25.4	56.7	13.4	4.5	67.67	33.8	43.1	15.4	7.7	67.67
3.3.6	Increasing of materials prices	58.2	19.4	17.9	4.5	77.10	55.4	24.6	13.8	6.2	76.40
3.3.7	Wage increases	24.2	27.3	27.3	21.2	51.50	29.2	27.7	27.7	15.4	56.90

4.4.4 Tiling and granite works

Table 4.11 shows that the "closure" factor has a big expectancy with a weighted mean value of 83.1%. And this factor has a big financial effect with a weighted mean value of 84.63%. It is clear that there is a high correlation between the expectancy and the financial effect of this factor. Also, "increasing of material prices" has a big expectancy with a weighted mean value of 83.63%. This factor has a big financial effect with a weighted mean value of 88.9%. On the other hand, the expectancy of "supplying defective materials" is small where its weighted mean value is 44.2%. And it has a medium financial effect with a weighted mean value of 51.33%.

Table (4-11): Expectancy and financial effect of risk factors of tiling and granite works

No.	Risk factors	Expectancy					Financial effect				
		Big %	Medium %	Small %	Nothing %	Weighted mean	Big %	Medium %	Small %	Nothing %	Weighted mean
3.4.1	Supplying defective materials	10.4	34.3	32.8	22.4	44.20	15.4	38.5	30.8	15.4	51.33
3.4.2	Lower work quality due to time constraints	6.0	37.3	50.7	6.0	47.77	9.2	41.5	41.5	7.7	50.70
3.4.3	Approving material that surpass the expected	28.4	44.8	23.9	3.0	66.23	45.3	26.6	25.0	3.1	71.37
3.3.4	Closure	68.7	16.4	10.4	4.5	83.10	72.3	15.4	6.2	6.2	84.63
3.4.5	Over auditing by supervision	19.4	62.7	13.4	4.5	65.67	32.8	45.3	15.6	6.3	68.20
3.4.6	Increasing of materials prices	62.7	19.4	14.9	3.0	80.60	70.8	15.4	7.7	6.2	83.63
3.4.7	Wage increases	24.2	28.8	27.3	19.7	52.50	30.2	28.6	23.8	17.5	57.20

4.4.5 Aluminum works

Table 4.12 shows that the "closure" factor has a big expectancy with a weighted mean value of 82.87%. This factor also has a big financial effect with a weighted mean value of 90.8%. Similarly, "increasing of material prices" factor has a big expectancy with a weighted mean value of 81.77% and a big financial effect with a weighted mean value of 85.67%. On the other hand, the factor of "lower work quality due to time constraints" is the least expected (48.7%) and has the least financial effect (51.3%). It can be shown that the weighted means of the expectancy and the financial effect for other factors are medium. Contractors mentioned that they have appropriate ways in dealing with this factor such as increasing manpower. In addition to that, aluminum works are usually implemented in final phases of the project and does not affect other items of the works.

Table (4-12): Expectancy and financial effect of risk factors of the aluminum works

No.	Risk factors	Expectancy					Financial effect				
		Big %	Medium %	Small %	Nothing %	Weighted mean	Big %	Medium %	Small %	Nothing %	Weighted mean
3.5.1	Lower work quality due to time constraints	7.7	41.5	40.0	10.8	48.70	18.5	30.8	36.9	13.8	51.33
3.5.2	Closure	65.2	21.2	10.6	3.0	82.87	84.6	6.2	6.2	3.1	90.80
3.5.3	Over auditing by supervision	15.2	48.5	31.8	4.5	58.13	25.0	28.1	40.6	6.3	57.27
3.5.4	Increasing of materials prices	63.6	24.2	6.1	6.1	81.77	72.3	18.5	3.1	6.2	85.67
3.5.5	Wage increases	25.4	34.9	22.2	17.5	56.07	33.3	20.6	30.2	15.9	57.10
3.5.6	Effective impact of changes in currency exchange rates	40.9	24.2	27.3	7.6	66.13	49.2	23.1	18.5	9.2	70.77
3.5.7	Approving material that surpass the expected	30.3	33.3	21.2	15.2	59.57	44.6	24.6	21.6	9.2	68.20

4.4.6 Base-course and Asphalt works

Table 4.13 shows that the weighted means of the expectancy and the financial effect for both of "closure" and "increasing of material prices" factors are big. The weighted means of the expectancy for "closure" and "increasing of material prices" factors are 87.57% and 87.53% respectively. And the weighted means of the financial effect for these factors are 91.33% and 90.27% respectively. They are relatively the most expected factors and their financial effect weighted means are also the highest values. There is a high correlation between the expectancy and the financial effect weighted mean values for those factors.

The weighted means of the expectancy and the financial effect for other factors are almost medium.

It is worth mentioning that due to "closures", these works were affected exponentially due to price increases in the last five years.

Table (4-13): Expectancy and financial effect of risk factors of the base-course and asphalt works

No.	Risk factors	Expectancy					Financial effect				
		Big %	Medium %	Small %	Nothing %	Weighted mean	Big %	Medium %	Small %	Nothing %	Weighted mean
3.6.1	Adverse weather conditions	52.2	40.3	3.0	4.5	80.07	56.9	26.2	15.4	1.5	79.50
3.6.2	Defective design	24.2	53.2	19.7	3.0	66.23	30.8	47.7	20.0	1.5	69.27
3.6.3	Supplies of defective materials	18.5	46.2	23.1	12.3	57.00	31.3	46.9	14.1	7.8	67.27
3.6.4	Lower work quality due to time constraints	7.5	47.8	35.8	9.0	51.30	18.8	42.2	31.3	7.8	57.37
3.6.5	Over auditing by supervision	22.4	52.2	22.4	3.0	64.67	29.2	43.1	26.2	1.5	66.67
3.6.6	Closure	80.6	4.5	11.9	3.0	87.57	86.2	3.1	9.2	1.5	91.33
3.6.7	Increasing of materials prices	74.6	16.4	6.0	3.0	87.53	80.0	12.3	6.2	1.5	90.27
3.6.8	Wage increases	23.9	29.9	29.9	16.4	53.80	29.7	29.7	28.1	12.5	58.87

4.5 Part 4 of the questionnaire: Main risk factors and resulting consequences for works categories

The following tables in this section show the main risk factors for each work category as illustrated in part 3 of the questionnaire. These factors are set against the resulting consequences which result from each main risk factor.

The tables show the frequencies and the percentages for the resulting consequences of the main factors for each work group as expressed by respondents. The researcher considers (from his point of view) the resulting consequence has no significance if less than 20% of respondents mention that it is a sequence of the corresponding risk factor for the specific work category.

4.5.1 Accidents

According to the criterion specified earlier, the following are the significant resulting consequences for each work category. They are mentioned in descending order according to their frequencies as expressed by respondents.

For excavation works; injuries (100%), equipment damage (91%), work delay (85.1%), poor productivity (73.1%) and re-working (22.4%).

For reinforced concrete works; injuries (100%), poor productivity (100%), work delay (91%) equipment damage (55.2%), re-working (31.3%), increasing of material waste (22.4%) and legal disputes (20.9%).

For block and plaster works; work delay (100%), injuries (91%), poor productivity (91%), re-working (31.3%) and increasing of material waste (22.4%).

It is noticed that there is almost a consensus that injuries, work delay and poor productivity are direct resulting consequences of accidents for excavation, reinforced concrete and block and plaster works.

Table (4-14): Distribution of resulting consequences of accidents for excavation, reinforced concrete and block and plaster works

No.	Resulting consequences	Accidents					
		Excavation		Reinforced concrete		Block and plaster	
		frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	57	85.1	61	91.0	67	100.0
2	Equipment damage	61	91.0	37	55.2	6	9.0
3	injuries	67	100.0	67	100.0	61	91.0
4	poor Productivity	49	73.1	67	100.0	61	91.0
5	Legal disputes	6	9.0	14	20.9	6	9.0
6	Financial penalties	0	0.0	9	13.4	6	9.0
7	Increasing of material prices	0	0.0	0	0.0	8	11.9
8	Increasing of material waste	6	9.0	15	22.4	15	22.4
9	Re-working	15	22.4	21	31.3	21	31.3

4.5.2 Adverse weather conditions

The significant resulting consequences are:

For excavation works; work delay (100%) poor productivity (91%), reworking (26.9%), increasing of material prices (22.4%) and injuries (20.9%).

For reinforced concrete works; work delay (91%) and poor productivity (82.1%). None of respondents consider that equipment damage is a consequence factor of adverse weather conditions in the reinforced concrete works.

For block and plaster works; work delay (100%), poor productivity (91%) and financial penalties (22.4%). None of them consider that equipment damage is a consequence factor of adverse weather conditions in the block and plaster works.

For base-course and asphalt works; poor productivity (100%), work delay (88.1%), re-working (38.8%) and financial penalties (25.4%). None of respondents consider that equipment damage and injuries are resulting factors of adverse weather conditions in the base-course and asphalt works.

It is noticed that there is almost consensus that work delay and poor productivity are common resulting consequences of adverse weather conditions for excavation, reinforced concrete, block and plaster and base-course and asphalt works.

Table (4-15): Distribution of resulting consequences of adverse weather conditions for excavation, reinforced concrete, block and plaster and base-course and asphalt works

No.	Resulting consequences	Adverse weather conditions							
		Excavation		Reinforced concrete		Block and plaster		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	67	100.0	61	91.0	67	100.0	59	88.1
2	Equipment damage	12	17.9	0	0.0	0	0.0	0	0.0
3	injuries	14	20.9	6	9.0	6	9.0	0	0.0
4	poor Productivity	61	91.0	55	82.1	61	91.0	67	100.0
5	Legal disputes	0	0.0	0	0.0	0	0.0	8	11.9
6	Financial penalties	9	13.4	9	13.4	15	22.4	17	25.4
7	Increasing of material prices	15	22.4	9	13.4	9	13.4	9	13.4
8	Increasing of material waste	6	9.0	6	9.0	0	0.0	6	9.0
9	Re-working	18	26.9	12	17.9	6	9.0	26	38.8

4.5.3 Defective design

The significant resulting consequences are:

For excavation works; work delay (100%), legal disputes (100%), re-working (56.7%), poor productivity (47.8%), increasing of material prices (43.3%), increasing of material waste (26.9%) and injuries (20.9%).

For reinforced concrete works; work delay (100%), legal disputes (100%), poor productivity (47.8%), re-working (47.8%), increasing of material prices (43.3%) and increasing of material waste (26.9%).

For base-course and asphalt works; work delay (100%), legal disputes (79.1%), reworking (47.8%), increasing of material prices (43.3%) and poor productivity (29.9%).

It is noticed that there is a consensus amongst respondents that work delay is a direct resulting consequence of defective design for excavation, reinforced concrete and base-course and asphalt works. And there is almost a consensus that the legal disputes consequence is a direct resulting consequence of defective design for these works.

Table (4-16): Distribution of resulting consequences of defective design for excavation, reinforced concrete and base-course and asphalt works.

No.	Resulting consequences	Defective design					
		Excavation		Reinforced concrete		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	67	100.0	67	100.0	67	100.0
2	Equipment damage	0	0.0	0	0.0	0	0.0
3	injuries	14	20.9	0	0.0	0	0.0
4	Poor Productivity	32	47.8	32	47.8	20	29.9
5	Legal disputes	67	100.0	67	100.0	53	79.1
6	Financial penalties	0	0.0	0	0.0	0	0.0
7	Increasing of material prices	29	43.3	29	43.3	29	43.3
8	Increasing of material waste	18	26.9	18	26.9	12	17.9
9	Re-working	38	56.7	32	47.8	32	47.8

4.5.4 Actual quantities differ from the contract quantities

The significant resulting consequences are:

For excavation works; legal disputes (61.2%) and work delay (50.7%).

Table (4-17): Distribution of resulting consequences of actual quantities differ from the contract quantities for excavation works

No.	Resulting consequences	Actual quantities differ from the contract quantities	
		Excavation works	
		frequency	percentages
1	Work delay	34	50.7
2	Equipment damage	0	0.0
3	injuries	0	0.0
4	poor Productivity	12	17.9
5	Legal disputes	41	61.2
6	Financial penalties	0	0.0
7	Increasing of materials prices	6	9.0
8	Increasing of materials waste	12	17.9
9	Re-working	6	9.0

4.5.5 Unforeseen conditions

The significant resulting consequences are:

For excavation works; work delay (100%), legal disputes (38.8%), poor productivity (26.9%) and increasing of material waste (26.9%).

It is noticed that there is a consensus amongst respondents that work delay is a direct resulting consequence of unforeseen conditions for excavation works.

Table (4-18): Distribution of resulting consequences of unforeseen conditions for excavation works

No.	Resulting consequences	Unforeseen conditions Excavation works	
		frequency	percentages
1	Work delay	67	100.0
2	Equipment damage	6	9.0
3	injuries	12	17.9
4	poor Productivity	18	26.9
5	Legal disputes	26	38.8
6	Financial penalties	0	0.0
7	Increasing of material prices	6	9.0
8	Increasing of material waste	18	26.9
9	Re-working	12	17.9

4.5.6 Supplying defective materials

The significant resulting consequences are:

For reinforced concrete works; work delay (100%), financial penalties (70.1%), re-working (56.7%), legal disputes (49.3%), increasing of material prices (29.9%) and poor productivity (20.9%).

For block and plaster works; work delay (79.1%), financial penalties (70.1%), re-working (56.7%), legal disputes (49.3%) and poor productivity (29.9%).

For tiling and granite works; work delay (91%), financial penalties (70.1%), legal disputes (61.2%) and re-working (56.7%).

For base-course and asphalt works; work delay (79.1%), financial penalties (56.7%), legal disputes (49.3%) and re-working (47.8%).

It is noticed that most respondents show that work delay and financial penalties are the most expected resulting consequences of supplying defective materials for reinforced concrete, block and plaster, tiling and granite and base-course and asphalt works.

Table (4-19): Distribution of resulting consequences of supplying defective materials for reinforced concrete, block and plaster, tiling and granite and base-course and asphalt works

No.	Resulting consequences	Supplies of defective materials							
		Reinforced concrete		Block and plaster		Tiling and granite		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	67	100.0	53	79.1	61	91.0	53	79.1
2	Equipment damage	0	0.0	0	0.0	0	0.0	8	11.9
3	injuries	0	0.0	0	0.0	0	0.0	0	0.0
4	poor Productivity	14	20.9	20	29.9	12	17.9	12	17.9
5	Legal disputes	33	49.3	33	49.3	41	61.2	33	49.3
6	Financial penalties	47	70.1	47	70.1	47	70.1	38	56.7
7	Increasing of material prices	20	29.9	8	11.9	8	11.9	8	11.9
8	Increasing of material waste	6	9.0	6	9.0	6	9.0	6	9.0
9	Re-working	38	56.7	38	56.7	38	56.7	32	47.8

4.5.7 Lower work quality in presence of time constraints

The significant resulting consequences are:

For reinforced concrete works; financial penalties (73.1%), legal disputes (49.3%) and re-working (26.9%).

For block and plaster works; financial penalties (73.1%) legal disputes (49.3%), increasing of material waste (29.9%) and re-working (26.9%).

For tiling and granite works; financial penalties (73.1%) legal disputes (49.3%) and re-working (35.8%).

For aluminum works; financial penalties (68.7%) legal disputes (61.2%) and re-working (35.8%).

For base-course and asphalt works; financial penalties (77.6%), legal disputes (58.2%) and re-working (29.9%).

The results show that financial penalties and legal disputes are most expected as resulting consequences of lower work quality due to time constraints for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works.

Table (4-20): Distribution of resulting consequences of lower work quality due to time constraints for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works

No.	Resulting consequences	Lower work quality in presence of time constraints									
		Reinforced concrete		Block and plaster		Tiling and granite		Aluminum		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	Equipment damage	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	Injuries	0	0.0	0	0.0	8	11.9	0	0.0	0	0.0
4	Poor Productivity	8	11.9	8	11.9	0	0.0	0	0.0	0	0.0
5	Legal disputes	33	49.3	33	49.3	33	49.3	41	61.2	39	58.2
6	Financial penalties	49	73.1	49	73.1	49	73.1	46	68.7	52	77.6
7	Increasing of material prices	5	7.5	6	9	6	9	4	5.9	5	7.5
8	Increasing of material waste	12	17.9	20	29.9	6	9.0	5	7.5	6	9.0
9	Re-working	18	26.9	18	26.9	24	35.8	24	35.8	20	29.9

4.5.8 Closure

The significant resulting consequences are:

For reinforced concrete works; work delay (73.1%**),** increasing of material prices (73.1%), poor productivity (61.2%) and legal disputes (49.3%).

For block and plaster works; work delay (91%), increasing of material prices (91%), poor productivity (70.1%) and legal disputes (40.3%).

For tiling and granite works; work delay (100%), increasing of material prices (91%), poor productivity (61.2%) and legal disputes (49.3%).

For aluminum works; work delay (91%), increasing of material prices (82.1%), poor productivity (61.2%) and legal disputes (49.3%).

For base-course and asphalt works; work delay (100%), increasing of material prices (82.1%), poor productivity (61.2%) and legal disputes (49.3%).

It is noticed that there is almost consensus that work delay and increasing of material prices are common resulting consequences of closure for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works.

Table (4-21): Distribution of resulting consequences of closure for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works.

No.	Resulting consequences	Closure									
		Reinforced concrete		Block and plaster		Tiling and granite		Aluminum		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	49	73.1	61	91.0	67	100.0	61	91.0	67	100.0
2	Equipment damage	0	0	0	0.0	0	0.0	0	0.0	0	0.0
3	injuries	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	poor Productivity	41	61.2	47	70.1	41	61.2	41	61.2	41	61.2
5	Legal disputes	33	49.3	27	40.3	33	49.3	33	49.3	33	49.3
6	Financial penalties	6	9.0	0	0.0	0	0.0	0	0.0	0	0.0
7	Increasing of material prices	49	73.1	61	91.0	61	91.0	55	82.1	55	82.1
8	Increasing of material waste	6	9	12	17.9	8	11.9	12	17.9	12	17.9
9	Re-working	6	9	12	17.9	6	9.0	6	9.0	6	9.0

4.5.9 Effective impact of changes in currency exchange rates

The significant factors are:

For reinforced concrete works; legal disputes (65.7%) and increasing of material prices (59.7%).

For aluminum works; increasing of material prices (100%) and legal disputes (74.6%)

There is a consensus that increasing of material prices is a resulting consequence of effective impact of changes in currency exchange rates for aluminum works. On the other hand, there is a consensus that work delay, equipment damage, injuries and reworking are not expected as resulting consequences of effective impact of changes in currency exchange rates for reinforced and aluminum works.

Table (4-22): Distribution of resulting consequences of effective impact of changes in currency exchange rates for reinforced concrete and aluminum works

No.	Resulting consequences	Effective impact of changes in currency exchange rates			
		Reinforced concrete		Aluminum	
		frequency	percentages	frequency	percentages
1	Work delay	0	0.0	0	0.0
2	Equipment damage	0	0.0	0	0.0
3	injuries	0	0.0	0	0.0
4	Poor productivity	6	9.0	6	9.0
5	Legal disputes	44	65.7	50	74.6
6	Financial penalties	6	9.0	0	0.0
7	Increasing of material prices	40	59.7	67	100
8	Increasing of material waste	6	9	5	7.4
9	Re-working	0	0.0	0	0.0

4.5.10 Approved quality above the expected level of specifications

The significant resulting consequences are:

For tiling and granite works; increasing of material prices (68.7%), legal disputes (59.7%) and work delay (20.9%).

For aluminum works; increasing of materials prices (77.6%), legal disputes (59.7%) and work delay (20.9%).

These results show that legal disputes and increasing of material prices are more expected as resulting consequences of approved quality above the expected level of specifications for tiling & granite and aluminum works.

Table (4-23): Distribution of resulting consequences of approved quality above the expected level of specifications for tiling and granite and aluminum works

No.	Resulting consequences	Approved quality above the expected level of specifications			
		Tiling and granite		Aluminum	
		frequency	percentages	frequency	percentages
1	Work delay	14	20.9	14	20.9
2	Equipment damage	0	0.0	0	0.0
3	Injuries	0	0.0	6	9.0
4	Poor productivity	12	17.9	6	9.0
5	Legal disputes	40	59.7	40	59.7
6	Financial penalties	12	17.9	12	17.9
7	Increasing of material prices	46	68.7	52	77.6
8	Increasing of material waste	9	13.4	9	13.4
9	Re-working	0	0.0	0	0.0

4.5.11 Over-auditing by supervision

The significant resulting consequences are:

For reinforced concrete works; work delay (100%), legal disputes (73.1%), poor productivity (58.2%), re-working (35.8%) and increasing of material prices (34.3%).

For block and plaster works; work delay (100%), legal disputes (73.1%), poor productivity (58.2%), re-working (44.8%) and increasing of material prices (29. %).

For tiling and granite works; work delay (100%), legal disputes (64.2%), poor productivity (58.2%), re-working (35.8%) and increasing of material prices (20.9%).

For aluminum works; work delay (100%), legal disputes (64.2%), poor productivity (58.2%), re-working (35.8%) and increasing of material prices (34.3%).

For base-course and asphalt works; work delay (100%), legal disputes (64.2%), poor productivity (49.3%), re-working (38.8%) and increasing of material prices (32.8%).

The results show that work delay and legal disputes are more expected as resulting consequences of over-auditing by supervision for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works. It can be noticed that there is a consensus that work delay is expected as a resulting consequence of the factor for these works.

Table (4-24):Distribution of resulting consequences of over-auditing by supervision for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works

No.	Resulting consequences	Extra auditing by supervision									
		Reinforced concrete		Block and plaster		Tiling and granite		Aluminum		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	67	100.0	67	100.0	67	100.0	67	100.0	67	100.0
2	Equipment damage	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	Injuries	6	9.0	12	17.9	6	9.0	6	9.0	6	9.0
4	Poor Productivity	39	58.2	39	58.2	39	58.2	39	58.2	33	49.3
5	Legal disputes	49	73.1	49	73.1	43	64.2	43	64.2	43	64.2
6	Financial penalties	8	11.9	8	11.9	8	11.9	8	11.9	7	10.4
7	Increasing of material prices	23	34.3	20	29.9	14	20.9	23	34.3	22	32.8
8	Increasing of material waste	8	11.9	8	11.9	8	11.9	8	11.9	8	11.9
9	Re-working	24	35.8	30	44.8	24	35.8	24	35.8	26	38.8

4.5.12 Increasing of material prices

The significant factors are:

For reinforced concrete works; legal disputes (53.7%), work delay (43.3%) and poor productivity (34.3%).

For block and plaster works; legal disputes (44.8%), poor productivity (43.3%) and work delay (34.3%).

For tiling and granite works; legal disputes (44.8%), poor productivity (43.3%) and work delay (34.3%).

For aluminum works; legal disputes (44.8%), poor productivity (38.8%) and work delay (32.8%).

For base-course and asphalt works; work delay (43.3%), legal disputes (35.8%) and poor productivity (34.3%).

It is shown that legal disputes is more expected as a resulting consequence of increasing of material prices for reinforced concrete, block and plaster, tiling and granite and aluminum works.

Table 4-25): Distribution of resulting consequences of increasing of material prices for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works

No.	Resulting consequences	Increasing of material prices									
		Reinforced concrete		Block and plaster		Tiling and granite		Aluminum		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	29	43.3	23	34.3	23	34.3	22	32.8	29	43.3
2	Equipment damage	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	Injuries	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	Poor Productivity	23	34.3	29	43.3	29	43.3	26	38.8	23	34.3
5	Legal disputes	36	53.7	30	44.8	30	44.8	30	44.8	24	35.8
6	Financial penalties	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	Increasing of material prices	13	19.4	13	19.4	13	19.4	4	5.9	13	19.4
8	Increasing of material waste	9	13.4	9	13.4	9	13.4	10	14.9	7	10.4
9	Re-working	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

4.5.13 Wages increases

The significant resulting consequences are:

For reinforced concrete works; poor productivity (47.8%).

For block and plaster works; poor productivity (47.8%).

For tiling and granite works; poor productivity (47.8%).

For aluminum works; poor productivity (47.8%).

For base-course and asphalt works; poor productivity (38.8%).

It is shown that poor productivity is more expected as a resulting consequence of wages increases for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works.

Table (4-26): Distribution of resulting consequences of wages increases for reinforced concrete, block and plaster, tiling and granite, aluminum and base-course and asphalt works.

No.	Resulting consequences	Wages increases									
		Reinforced concrete		Block and plaster		Tiling and granite		Aluminum		Base-course and asphalt	
		frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages	frequency	percentages
1	Work delay	12	17.9	11	16.4	6	9.0	12	17.9	12	17.9
2	Equipment damage	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	Injuries	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	Poor Productivity	32	47.8	32	47.8	32	47.8	32	47.8	26	38.8
5	Legal disputes	12	17.9	11	16.4	12	17.9	12	17.9	12	17.9
6	Financial penalties	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	Increasing of material prices	5	7.4	5	7.4	6	8.9	4	5.9	5	7.4
8	Increasing of materials waste	9	13.4	9	13.4	8	11.9	9	13.4	9	13.4
9	Re-working	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

4.6 The concluded risk table for works categories:

Depending on the results of the previous two sections (4.3.2) and (4.3.3), Table 4.27 illustrates the main risk factors and the adopted resulting consequences for each work category.

For each resulting consequence corresponds to a work category, it is shown the ranking and the percentage of adoption as expressed by the respondents.

Table (4-27): Main risk factors and resulting consequences for works categories

No.	Main factors	Work Category \ Resulting Consequences	Work delay	Equipment damage	Injuries	Poor Productivity	Legal disputes	Financial penalties	Increasing of material prices	Increasing of material waste	Re-working
4.1	Accidents	Excavation	3 (85.1%)	2 (91%)	1(100%)	4 (73.1%)					5 (22.4%)
		Reinforced concrete	3 (91%)	4 (55.2%)	1(100%)	1 (100%)	7 (20.9%)			6 (22.4%)	5 (31.3%)
		Block and plaster	1 (100%)		2 (91%)	2 (91%)				5 (22.4%)	4 (31.3%)
4.2	Adverse weather conditions	Excavation	1 (100%)		5(20.9%)	2 (91%)			4 (22.4%)		3 (26.9%)
		Reinforced concrete	1 (91%)			2 (82.1%)					
		Block and plaster	1 (100%)			2 (91%)		3 (22.4%)			
		Base-course and asphalt	2 (100%)			1 (88.1%)		4 (25.4%)			3 (38.8)
4.3	Defective design (incorrect)	Excavation	1 (100%)		7 (20.9%)	4 (47.8%)	1 (100%)		5 (43.3%)	6 (26.9%)	3 (56.7%)
		Reinforced concrete	1 (100%)			3 (47.8%)	1 (100%)		5(43.3%)	6 (26.9%)	3 (47.8%)
		Base-course and asphalt	1 (100%)			5 (29.9%)	1 (79.1%)		4 (43.3%)		3 (47.8%)
4.4	Actual quantities differ from the contract quantities	Excavation	1 (61.2%)				2 (50.7%)				
4.5	Unforeseen conditions	Excavation	1 (100%)			3 (26.9%)	2 (38.8%)			3 (26.9%)	
4.6	Supplying defective materials	Reinforced concrete	1 (100%)			6 (20.9%)	4 (49.3%)	2 (70.1%)	5 (29.9%)		3 (56.7%)
		Block and plaster	1 (79.1%)			5 (29.9%)	4 (49.3%)	2 (70.1%)			3 (56.7%)
		Tiling and granite	1 (91%)				3 (61.2%)	2 (70.1%)			4 (56.7%)
		Base-course and asphalt	1 (79.1%)				3 (49.3%)	2 (56.7%)			4 (47.8%)
4.7	Lower work quality due to time constraints	Reinforced concrete					2 (49.3%)	1 (73.1%)			3 (26.9%)
		Block and plaster					2 (49.3%)	1 (73.1%)		3 (29.9%)	4 (26.9%)
		Tiling and granite					2 (49.3%)	1 (73.1%)			3 (35.8%)
		Aluminum					2 (61.2 %)	1 (68.7%)			3 (35.8%)
		Base-course and asphalt					2 (58.2)	1 (77.6%)			3 (29.9%)
4.8	closure	Reinforced concrete	1 (73.1%)			3 (61.2%)	4 (49.3%)		1 (73.1%)		
		Block and plaster	1 (91%)			3 (70.1%)	4 (40.3%)		1 (91%)		
		Tiling and granite	1 (100%)			3 (61.2%)	4 (49.3%)		2 (91%)		
		Aluminum	1 (91%)			3 (61.2%)	4 (49.3%)		2 (82.1%)		
		Base-course and asphalt	1 (100%)			3 (61.2%)	4 (49.3%)		2 (82.1%)		

Table 4.27 (cont.)

No.	Main factors	Resulting Consequences / Work Category	Work delay	Equipment damage	Injuries	Poor Productivity	Legal disputes	Financial penalties	Increasing of material prices	Increasing of material waste	Re-working
4.9	Effective impact of changes in currency exchange rates	Reinforced concrete					1 (65.7%)		2 (59.7%)		
		Aluminum					2 (74.6%)		1 (100%)		
4.10	Approved quality above the expected level of specifications	Tiling and granite	3 (20.9%)				2 (59.7%)		1 (68.7%)		
		Aluminum	3 (20.9%)				2 (59.7%)		1 (77.6%)		
4.11	Over auditing by supervision	Reinforced concrete	1 (100%)			3 (58.2%)	2 (73.1%)		5 (34.3%)		4 (35.8%)
		Block and plaster	1 (100%)			3 (58.2%)	2 (73.1%)		5 (29.9%)		4 (44.8%)
		Tiling and granite	1 (100%)			3 (58.2%)	2 (64.2%)		5 (20.9%)		4 (35.8%)
		Aluminum	1 (100%)			3 (58.2%)	2 (64.2%)		5 (34.3%)		4 (35.8%)
		Base-course and asphalt	1 (100%)			3 (49.3%)	2 (64.2%)		5 (32.8%)		4 (38.8%)
4.12	Increasing of materials prices	Reinforced concrete	2 (43.3%)			3 (34.3%)	1 (53.7%)				
		Block and plaster	3 (34.3%)			2 (43.3%)	1 (44.8%)				
		Tiling and granite	3 (34.3%)			2 (43.3%)	1 (44.8%)				
		Aluminum	3 (32.8%)			2 (38.8%)	1 (44.8%)				
		Base-course and asphalt	1 (43.3%)			3 (34.3%)	2 (35.8%)				
4.13	Wage increases	Reinforced concrete				1 (47.8%)					
		Block and plaster				1 (47.8%)					
		Tiling and granite				1 (47.8%)					
		Aluminum				1 (47.8%)					
		Base-course and asphalt				1 (38.8 %)					

4.7 Part five of the questionnaire: The ways which could be conducted to avoid or minimize risks (Mitigation Actions)

The following Table (4.28) illustrates the ways which could be conducted to avoid or minimize risks for works groups/categories as expressed by respondents. It is worth mentioning that the researcher has placed some samples/ways in the questionnaire regarding different factors (with bolded font). Respondents are free to indicate either they agree or do not agree with them. They are also encouraged to add their own suggestions. The table shows the percentages of agreeable respondents with each way. The researcher noticed that there are ways could be considered as preventive ways such as;

- Insuring against accidents.
- Increasing safety measures and tools.
- Assign the risk to the owner in the contract.
- Include allowance in tender for delay.
- Employ a designer engineer to review the design.
- Employ quantity surveyor.
- Assign the risk to the supplier.
- Subcontract a part of the work.
- Buy and store material.
- Have the company's money distributed in different currencies.
- Take the difference in price into consideration in the pricing phase.
- Undertake early enquiries.
- Daily documentation of events with supervisor.
- Employ a high professional project manager.
- Employ highly skilled manpower.

Other ways could be considered as mitigative ways such as;

- Increasing working hours
- Increasing manpower.
- Increasing equipment.
- Preparing a claim for time over run.
- Provide alternative designs.
- Increasing subcontract works as much as possible.
- Closer supervision to subordinates for minimizing abortive work.

Table (4-28): The ways which could be conducted to avoid or minimize risks

No.	Main factors	Work category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
5.1	**Accidents**	**Excavation**	**1- Increasing safety measures and tools. (100%)**	**2- Insuring against accidents. (100%)**	**3- Increasing manpower. (82%)**	**4- Increasing equipments. (82%)**
		Reinforced concrete	1- Increasing safety measures and tools. (100%)	2- Insuring against accidents. (82%)	3- Increasing manpower. (56.7%)	4-
		Block and plaster	1- Increasing safety measures and tools. (100%)	2- Insuring against accidents. (82%)	3- Increasing working hours. (77.6%)	4-
5.2	**Adverse weather conditions**	**Excavation**	**1- Increasing working hours. (100%)**	2- Increasing equipments. (48%)	3- Include allowance in Tender for delay. (27%)	4- Assign this risk to the owner in the contract. (10.5%)
		Reinforced concrete	1- Increasing working hours. (90%)	2- Increasing equipments. (42%)	3- Include allowance in Tender for delay. (27%)	4- Assign this risk to the owner in the contract. (10.5%)
		Block and plaster	1- Increasing working hours. (90%)	3- Increasing manpower. (49%)	3- Include allowance in Tender for delay. (27%)	4- Assign this risk to the owner in the contract. (10.5%)
		Base-course and asphalt	1- Increasing working hours. (90%)	2- Increasing equipments. (12%)	3- Include allowance in Tender for delay. (27%)	4- Assign this risk to the owner in the contract. (10.5%)
5.3	**Defective design**	**Excavation**	**1-Employ a designer engineer to review designs. (100%)**	2- Provide alternative designs. (73%)	3- Preparing a claim for time overrun and its consequences. (59.7%)	4- Assign this risk to the owner in the contract. (7.4%)
		Reinforced concrete	1-Employ a designer engineer to review designs. (90%)	2- Provide alternative designs. (68.6%)	3- Preparing a claim for time overrun and its consequences. (59.7%)	4- Assign this risk to the owner in the contract (7.4%)
		Base-course and asphalt	1-Employ a designer engineer to review designs. (90%)	2- Provide alternative designs. (56.7%)	3- Preparing a claim for time overrun and its consequences. (59.7%)	4- Assign this risk to the owner in the contract (7.4%)
5.4	**Actual quantities differ from the contract quantities**	**Excavation**	**1- Employ quantity surveyor. (100%)**	2-	3-	4-

Table 4.28 (cont.)

No.	Main factors	Work category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
5.5	**Unforeseen conditions**	**Excavation**	1- **Increasing subcontract works as much as possible. (100%)**	2- **Increasing insurance coverage**. **(100%)**	**3-** Daily documentation events with supervisor. (74.6%)	**4-** Assign this risk to the owner in the contract. (10.5%)
5.6	**Supplying defective materials**	**Reinforced concrete**	**1- Assign the risk to the supplier (100%)**	2- Increasing working hours. (90%)	3- Increasing equipments. (73%)	
		Block and plaster	1- Assign the risk to the supplier (100%)	2- Increasing working hours. (90%)	3- Increasing manpower. (77.6%)	
		Tiling and granite	1- Assign the risk to the supplier (100%)	2- Increasing working hours. (90%)	3- Increasing manpower. (77.6%)	
		Base-course and asphalt	1-Assign the risk to the supplier. (100%)	2- Increasing working hours. (90%)	3- Increasing manpower and/or equipments. (77.6%)	
5.7	**Lower work quality due to time constraints**	**Reinforced concrete**	**1- Subcontract a part of the work (100%)**	2- Increasing working hours (90%)	3- Increasing manpower and/or equipments. (90%)	.
		Block and plaster	1- Increasing working hours (100%)	2- Increasing manpower. (77.6%)	3- - Subcontract a part of the work. (59.7%)	
		Tiling and granite	1- Increasing working hours (100%)	2- Increasing manpower. (77.6%)	3- Subcontract a part of the work. (59.7%)	
		Aluminum	1- Subcontract a part of the work. (100%)	2- Increasing working hours. (26.8%)	3- Increasing manpower. (26.8%)	
		Base-course and asphalt	1- Subcontract a part of the work. (100%)	2- Increasing working hours. (77.6%)	3- Increasing manpower and/ or equipments. (59.7%)	
5.8	**Closure**	**Reinforced concrete**	**1- Buy and store materials. (100%)**	2- Increasing working hours, manpower and equipments. (90%)	3- Include allowance in Tender for delay and prices increasing. (7.4%)	4- Assign this risk to the owner in the contract. (7.4%)
		Block and plaster	1- Buy and store materials. (100%)	2- Increasing working hours, manpower and equipments. (90%)	3- Include allowance in Tender for delay and prices increasing. (7.4%)	4- Assign this risk to the owner in the contract. (7.4%)
		Tiling and granite	1- Buy and store materials. (100%)	2- Increasing working hours, manpower and equipments. (90%)	3- Include allowance in Tender for delay and prices increasing. (7.4%)	4- Assign this risk to the owner in the contract. (7.4%)
		Aluminum	1- Buy and store materials. (100%)	2- Increasing working hours, manpower and equipments. (90%)	3- Include allowance in Tender for delay and prices increasing. (7.4%)	4- Assign this risk to the owner in the contract. (7.4%)

Table 4.28 (cont.)

No.	Main factors	Work category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
		Base-course and asphalt	1- Increasing working hours, equipments and manpower. (90%)	2- Assign this risk to the owner in the contract. (7.4%)	3- Include allowance in Tender for delay and prices increasing. (7.4%)	4- Buy and store materials (2.98%)
5.9	**Effective impact of changes in currency exchange rates**	**Reinforced concrete**	1- **Have the company's money distributed in different currencies**. (89.5%)	2- Buy and store materials. (59.7%)	3- Subcontract a part of the work. (59.7%)	**4-** Assign this risk to the owner in the contract. (7.4%)
		Aluminum	1- Have the company's money distributed in different currencies. (89.5%)	2- Subcontract a part of the work. (89.5%)	3- Buy and store materials. (44.7%)	4- Assign this risk to the owner in the contract. (7.4%)
5.10	**Approved quality above the expected level of specifications**	**Tiling and granite**	**1- Undertake early enquiries (in the pricing phase). (100%)**	**2-Take the difference in price into consideration in the pricing phase. (67.1%)**		
		Aluminum	1- Undertake early enquiries (in the pricing phase). (100%)	2-Take the difference in price into consideration in the pricing phase. (67.1%)		
5.11	**Over auditing by supervision**	**Reinforced concrete**	**1- Increasing subcontract works as much as possible.** (100%)	**2- Closer supervision to subordinates for minimizing abortive work. (100%)**	3- Employ highly skilled manpower. (92.5%)	4- Employ a high professional project manager. (7.4%)
		Block and plaster	1- Closer supervision to subordinates for minimizing abortive work. (100%)	2- - Employ highly skilled manpower. (92.5%)	3- Increasing subcontract works. (14.9%)	4- Employ a high professional project manager. (7.4%)
		Tiling and granite	1- Closer supervision to subordinates for minimizing abortive work. (100%)	2- - Employ highly skilled manpower. (92.5%)	3- Increasing subcontract works. (14.9%)	4- Employ a high professional project manager. (7.4%)
		Aluminum	1- Closer supervision to subordinates for minimizing abortive work. (100%)	2- Employ highly skilled manpower. (92.5%)	3- Increasing subcontract works. (92.5%)	4- Employ a high professional project manager. (4.47%)

Table 4.28 (cont.)

No.	Main factors	Work category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
		Base-course and asphalt	1- Closer supervision to subordinates for minimizing abortive work. (100%)	2- Employ highly skilled manpower. (92.5%)	3- Increasing subcontract works. (92.5%)	4- Employ a high professional project manager. (4.47%)
5.12	**Increasing of materials prices**	**Reinforced concrete**	**1- Buy and store materials. (59.7%)**	2- Subcontract a part of the work. (92.5%)	3- Assign this risk to the owner in the contract (7.4%)	
		Block and plaster	**1- Buy and store materials. (100%)**	2- Subcontract a part of the work. (17.9%)	3- Assign this risk to the owner in the contract. (7.4%)	
		Tiling and granite	**1- Buy and store materials. (100%)**	2- Subcontract a part of the work. (17.9%)	3- Assign this risk to the owner in the contract (7.4%)	
		aluminum	**1- Buy and store materials. (100%)**	2- Subcontract a part of the work. (89.5%)	3- Assign this risk to the owner in the contract. (7.4%)	
		Base-course and asphalt	**1- Buy and store materials. (98.5%)**	2- Subcontract a part of the work. (89.5%)	3- Assign this risk to the owner in the contract. (7.4%)	
5.13	**Wage increases**	**Reinforced concrete**	1- Subcontract a part of the work. (29.8%)	2- Assign this risk to the owner in the contract. (4.47%)	3- Considering the increasing percentage of the item price due to this factor. (4.47%)	
		Block and plaster	1- Subcontract a part of the work. (29.8%)	2- Considering the increasing percentage of the item price due to this factor. (4.47%)	3- Assign this risk to the owner in the contract. (2.98%)	
		Tiling and granite	1- Subcontract a part of the work. (29.8%)	2- Considering the increasing percentage of the item price due to this factor. (4.47%)	3- Assign this risk to the owner in the contract. (2.98%)	
		Aluminum	1- Subcontract a part of the work. (29.8%)	2- Considering the increasing percentage of the item price due to this factor. (4.47%)	3- Assign this risk to the owner in the contract. (2.98%)	
		Base-course and asphalt	1- Subcontract a part of the work. (29.8%)	2- Considering the increasing percentage of the item price due to this factor. (4.47%)	3- Assign this risk to the owner in the contract. (2.98%)	

4.8 Conclusions

From the results obtained, analyzed, and discussed, the researcher concludes that:

1) Regarding the part of contractor organization profile:
    a. Respondents of the questionnaire are generally mature in construction business. 49.3% of them say that they have been in this field for more than 10 years.
    b. In the last five years, most of the executed projects by respondents are small size ones. This may be a result of the political and economical situation in Gaza Strip.

2) Regarding the part of the way of dealing with risk:
    a. Contractors have big consideration for the role of effective risk management in project success, where the relevant weighted mean value was 80.6%. It can be concluded that the situation in the local construction industry regarding risk management reflects a lack of systematic procedures to be followed by contractors.
    b. The executed projects are associated with a relatively high level of risk, where the relevant weighted mean value was 70.2%. This in turn, generally caused losses to contractors.
    c. There is no commitment regarding the employment of special person or team for risk management by contractors, and there is not enough interested contractors in giving training courses on risk management for their engineers. This could be due to contractors believing that it is unnecessary expense, they do not recognize the importance of such issues, and the engineering staff is not fully employed by most of contractors.
    d. Contractors with weighted mean value of 82.6% used computers in project management. But they did not use computers in risk management because they do not have suitable software or model to be used for this issue.
    e. Determining risk is the most used strategy by contractors in dealing with risk, where the relevant weighted mean is 75.5%.
    f. Contractors need to put more effort in documenting risks. Documentation is important for recording the identification, analysis,

and risk mitigation actions. And results for each risk factor leads for lessons to be gained, and actions to be taken if necessary.

g. Dealing with risk (minimizing risk) is the favorable choice for contractors, where the relevant weighted mean is big. Risk acceptance choice (its weighted mean is medium) is taken when there is no other convenient alternative where this risk is expensive to avoid or to minimize, or it may not happen. The choice of avoidance by not bidding (its weighted mean is medium) is conducted in cases such as the scanty of the available information about the project and the negative reputation of the owner. The choice of partially transferring the risks to a subcontractor (its weighted mean is medium) is conducted by giving some items of works to subcontractors in cases where the main contractor does not have the experience in these types of works and/or the project period is relatively small compared with its size. The choice of ignoring the risks, where its weighted mean is weak, is conducted when risks is trivial and can be practically neglected.

3) Regarding the part of risk factors for different work types/categories:

a. Closure is, in general, the most important risk factor in the last five years. In most cases, there is a high correlation between the expectancy and the financial effect of this factor.

b. Closure has a big effect on increasing of material prices, poor productivity and work delay due to material shortages for most of work categories. It is worth mentioning that the required materials and products are purchasing by contractors or suppliers from outside the Gaza Strip. The prices that contractors pay for materials were fluctuating in unpredictably manner in the last five years.

c. Each work category is associated with types and levels of risks.

4) Regarding the part of main risk factors and resulting consequences for work categories:

a. There are resulting consequences of each main risk factor for each work category.

b. There is almost a consensus amongst respondents that "work delay" is a resulting consequence of "accidents", "adverse weather conditions", "defective design", "actual quantities differ from the contract quantities", "unforeseen conditions", "supplying defective materials", "closure" and "over auditing by supervision" factors.

c. There is almost a consensus that "poor productivity" is a resulting consensus of "accidents", "adverse weather conditions", "closure", and "over auditing by supervision" factors.

d. There is almost a consensus that "injuries" is a resulting consequence of "accidents" factor.

e. There is almost a consensus that "legal disputes" is a resulting consequence of "defective design", "effective impact of changes in currency exchange rates" and "over auditing by supervision" factors.

f. There is almost a consensus that "increasing of material prices" is a resulting consequence of "closure", "effective impact of changes in currency exchange rates" and "approved quality above the expected level of specifications" factors.

5) Regarding the part of the ways which could be conducted to avoid or minimize risks:

a. Project manager experience is an important factor in dealing with project risk.

b. Contract is a very important item in risk management process as it is the source of all project risks allocation. It must be checked carefully to insure that the contract terms are generally fair.

c. There is almost a consensus that "increasing safety measures and tools", "insuring against accidents" and "increasing of manpower" are suitable ways in dealing with "accidents" factor.

d. There is almost a consensus that "increasing working hours" is a suitable way in dealing with "adverse weather conditions" factor.

e. There is almost a consensus that "employ a designer engineer to review designs", "provide alternative designs", and "preparing a claim for time overrun and its consequences" are suitable ways in dealing with "defective design" factor.

f. There is almost a consensus that "increasing subcontract works as much as possible", "increasing insurance coverage", and "daily documentation events with supervisor" are suitable ways in dealing with "unforeseen conditions" factor.

g. There is almost a consensus that "assign the risk to the supplier" and "increasing working hours" are suitable ways in dealing with "supplying defective materials" factor.

h. There is almost a consensus that "buy and store materials" is a suitable way in dealing with "closure" factor except for base-course and asphalt works. And "increasing working hours, manpower and equipments" is a suitable way in dealing with this factor.

i. There is almost a consensus that "have the company's money distributed in different currencies" is a suitable way in dealing with "effective impact of changes in currency exchange rates" factor.

j. There is almost a consensus that "undertake early enquiries (in the pricing phase)" and "take the difference in price into consideration in the pricing phase" are suitable ways in dealing with "approved quality above the expected level of specifications" factor.

k. There is almost a consensus that "closer supervision to subordinates for minimizing abortive work" and "employ highly skilled manpower" are suitable ways in dealing with "over auditing by supervision" factor.

l. There is almost a consensus that "buy and store materials" is a suitable way in dealing with "increasing of material prices" factor.

6) Risk checklist is a helpful tool in risk identification and evaluation. It is preferable for all construction companies to develop and periodically update its risk checklists for all project stages especially tender and construction stages.

7) A properly structured risk identification, analysis, and mitigation process can moderate the risks associated with construction projects.

8) Throughout the life of the project, the exposures should be re-evaluated so that timely control action can be taken and management attention can be refocused as necessary.

9) In risk cost estimation and management, there is a need for developing suitable computerized software to be used by contractors in Gaza Strip. Many benefits can be obtained from that such as:

   a. It helps in bidding in competitive and a suitable price
   b. It helps in improve project management process with regard to risks anticipation and mitigation.
   c. It contributes in building of a project database and in updating of database.
   d. It saves time and minimizes the efforts in cost estimation.
   e. It helps in recognizing of main risk factors, resulting consequences and mitigation ways/actions for work categories.

10) In this research, identifying the risk factors faced by construction industry is based on collecting information about construction risks and their resulting consequences and then corrective/mitigation ways may be done to prevent or mitigate the risk effects.

Chapter Five

Risk Cost Estimation and Management Software (RCEM)

5.1 Introduction:

In financial decisions, it is always helpful to have an objective measure of risk. The main reason for having measures of risk is to enable contractors to make better decisions especially in bidding and pricing phase. The pricing process can be simplified if a computerized estimating system is utilized. There has not, until recently, been a risk management tool suitable for Gaza Strip contractors to help them managing risk associated with cost estimating.

Risk Cost Estimation and Management Software (RCEM) aims at helping Palestinian contractors better manage risks in estimating cost of construction projects. This tool should, in principle, provide users with an efficient mechanism that helps identify risks and find possible ways to avoid or minimize these risks especially in the bid pricing phase. The developed model was built by determining the cost of the main risk factors depending on the possible costs of the resulting consequences from such factors for works categories/groups. Risk impacts and mitigation actions were considered in this tool. The procedure followed in RCEM encourages disciplined estimating, and calculates the required contingency according to the proven probabilistic method known as Monte Carlo Simulation. By using this tool, the researcher hopes that contractors can estimate risk cost in more accurate way, which leads to having more realistic and safe bid price of a project. This decreases the possibility of having loss and increases of the possibility of having a reasonable profit. RCEM was designed using C# (C-Sharp) programming language. This language is one of the powerful object-oriented programming languages developed by Microsoft. According to Microsoft, "C# is a modern, object-oriented language that enables programmers to quickly build a wide range of applications for the new Microsoft .NET platform, which provides tools and services that fully exploit both computing and communications." RCEM was designed to be flexible and easy to use. This chapter presents concepts, description, implementation and evaluation of RCEM.

5.2 Overview of RCEM

Figure 5.1 illustrates the overall schematic picture of RCEM which shows the interactive relationships between its different components. The work categories of a project are the initial input to RCEM. The output can be displayed in easy-to-read tabular and graphical formats that quickly and effectively give the estimator an overall appreciation of the risks.

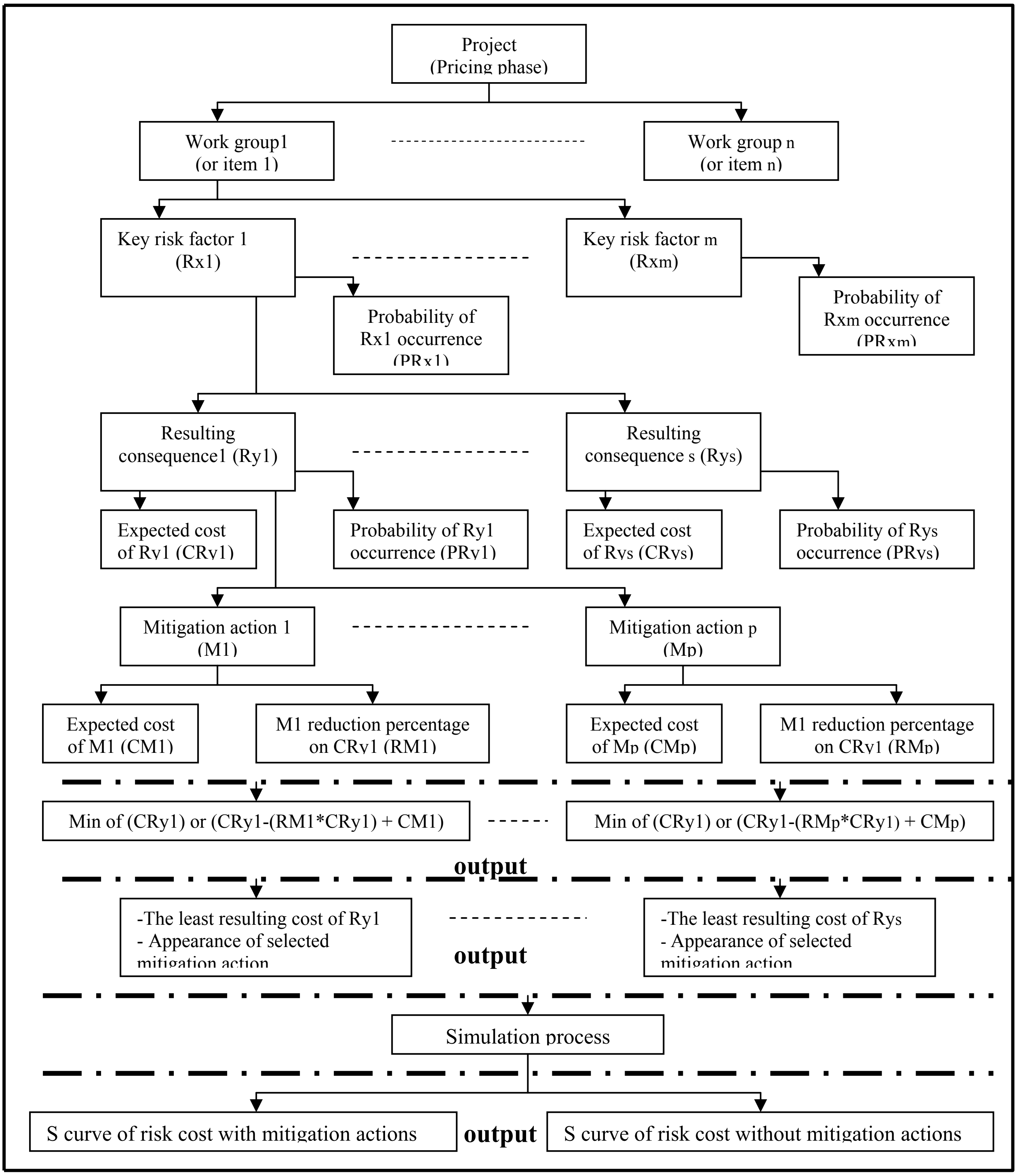

Figure (5-1): RCEM System

5.3 Program illustration

RCEM program must run under Win2000/XP with requirements of Internet Explorer 6 and .Net Framework library. The user runs the program by double clicking on its icon that is located typically in the RCEM folder (Figure 5.2)

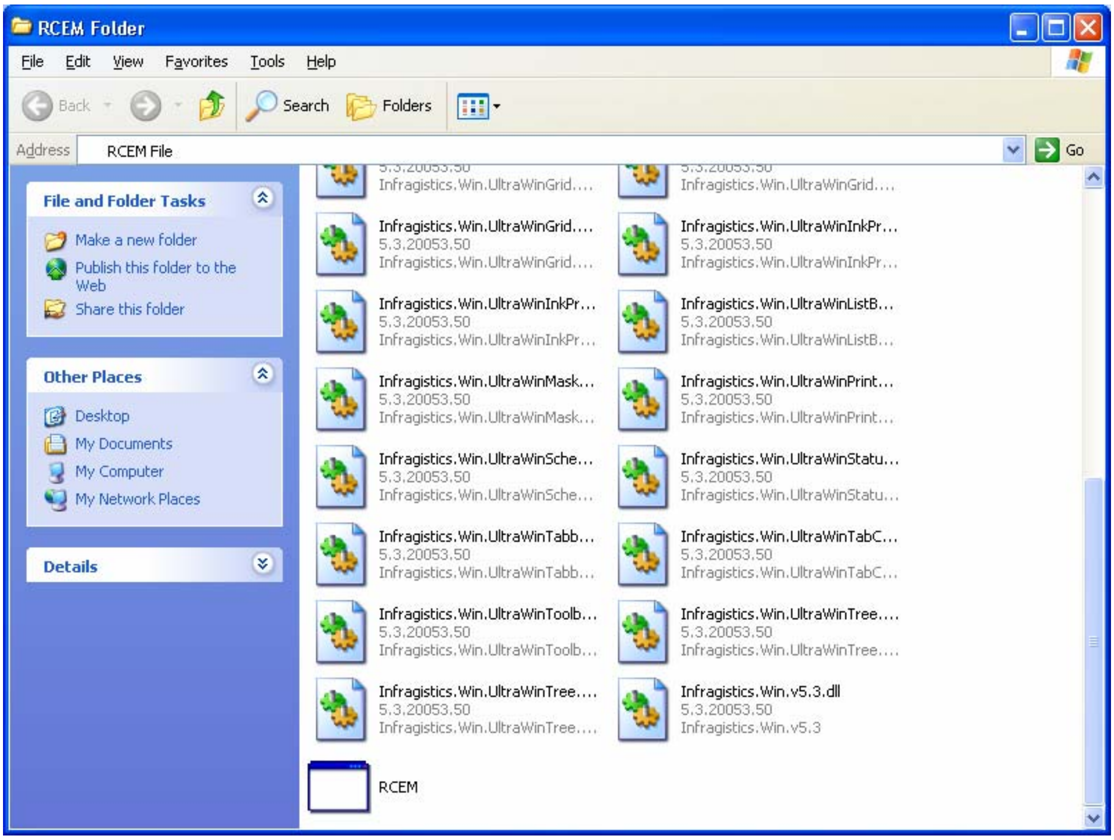

Figure (5-2): Entering to RCEM

RCEM begins with an introductory screen (Figure 5.3). By clicking on OK button, the main input screen will be displayed (see Figure5.4). The user can either enter new data at this screen or he/she can use existing project risk data from a disk file.

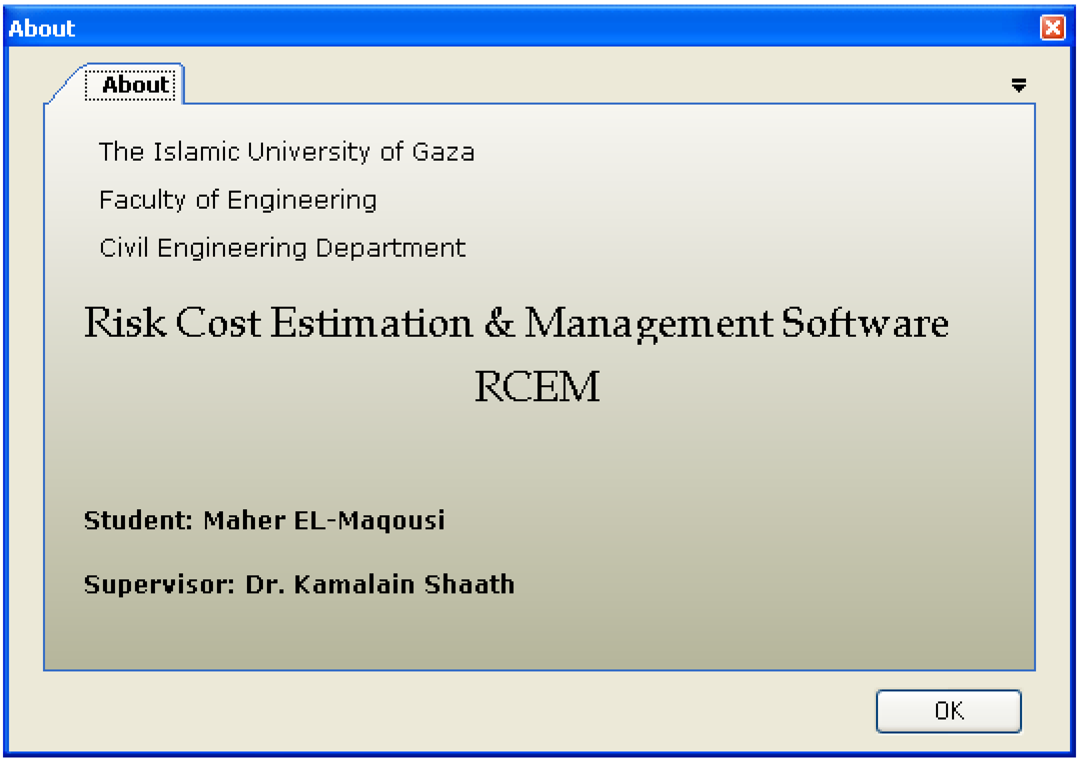

Figure (5-3): RCEM Interface

When the user finishes using RCEM, and he/she wants to return to Windows, he/she must click on the Close button in the top right corner of the screen.

The application consists of 6 tabs and they are:

5.3.1 First tab (Input items)

Figure (5.4) shows the first screen which has the main input screen that contains four columns. First column of the table (item) is for items entry, i.e. excavation works, reinforced concrete works, etc. Second column (Rx) is for main risk factors for each item. Third column (Ry) is for resulting consequences for each main risk factor. Fourth column (M) is for mitigation actions entry for each resulting consequence. Entry is done through combo box at the bottom of the screen. Add, modify, and delete facilities are also available at a convenient disposal of the user.

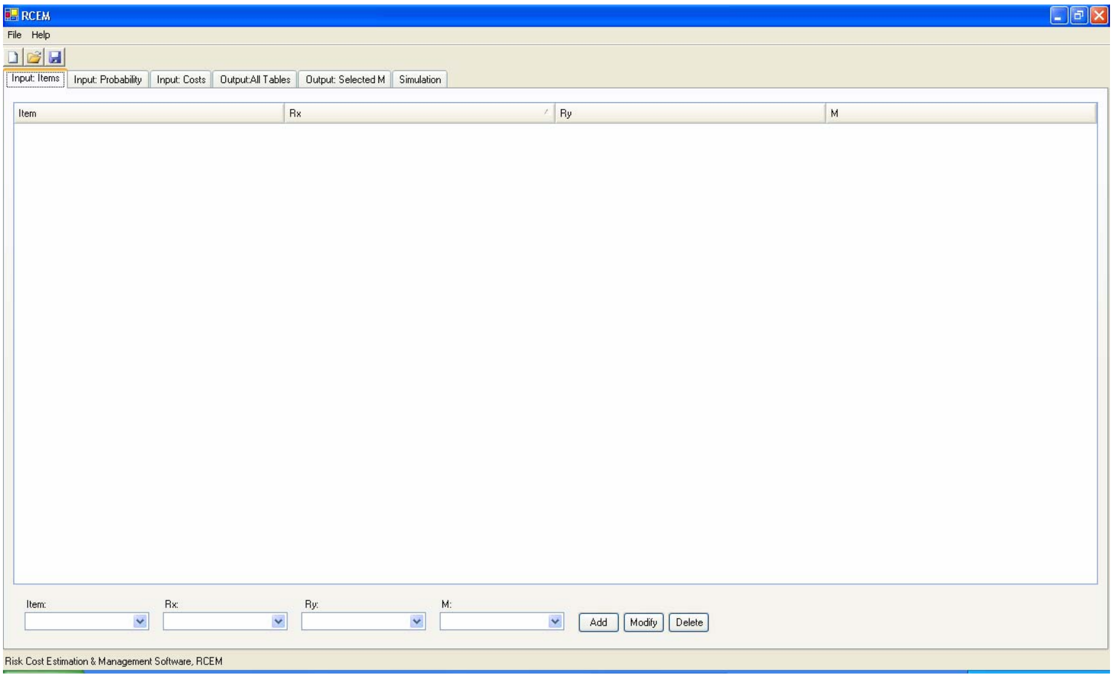

Figure 5-4): First tab of RCEM software (the main input screen)

5.3.2 Second tab (Input probability)

Figure (5.5) shows RCEM second tab with two tables. The first one is for entry of each main risk factor occurrence probability. The second is for entry of each resulting consequence occurrence probability and estimated cost of each consequence before using of any mitigation action.

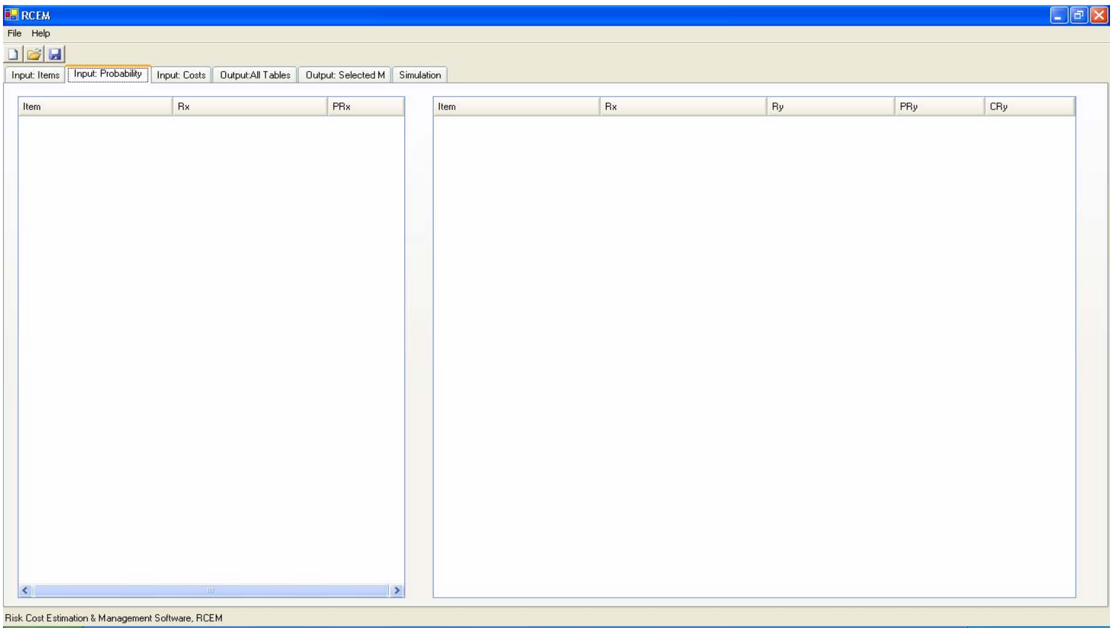

Figure (5-5): Second tab of RCEM software (Input probability)

5.3.3 Third tab (Input costs)

Figure (5.6) shows a screen with a table for entering estimated cost for each suggested mitigation action (CM). Also, for entering the expected reduction effect percentage of each mitigation action (RM) on the expected cost of the resulting consequence of main risk factor occurrence (CRy).

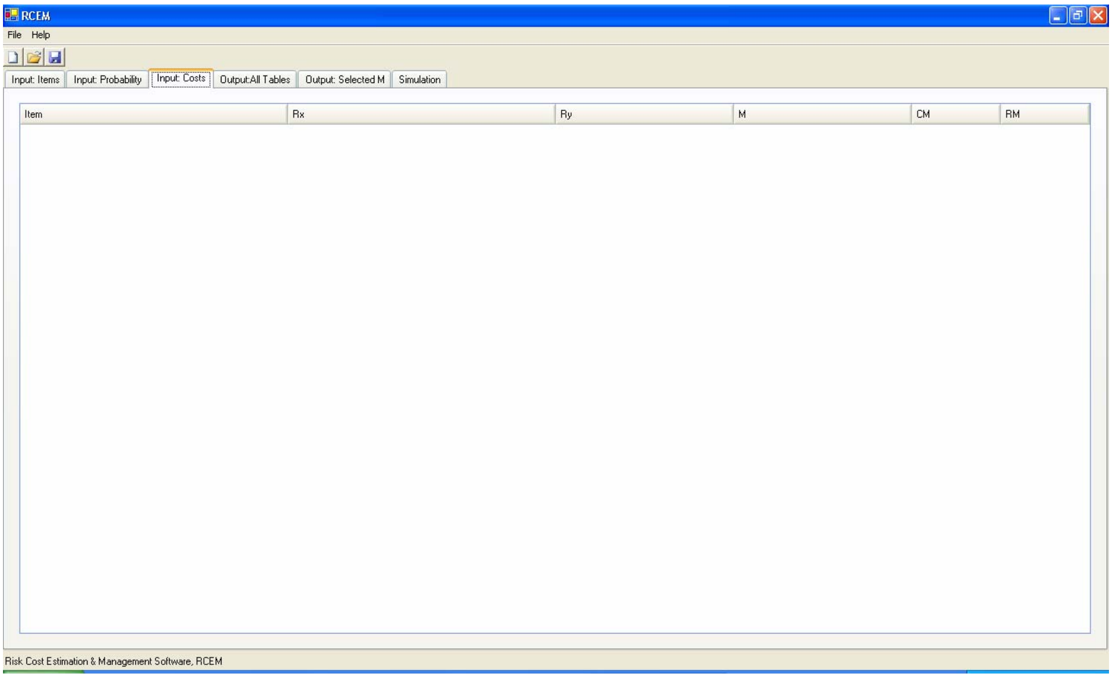

Figure (5-6): Third tab of RCEM software (Input costs)

5.3.4 Fourth tab (summary of previous tables)

Figure (5.7) illustrates a screen which shows a table that includes all entries in previous tabs.

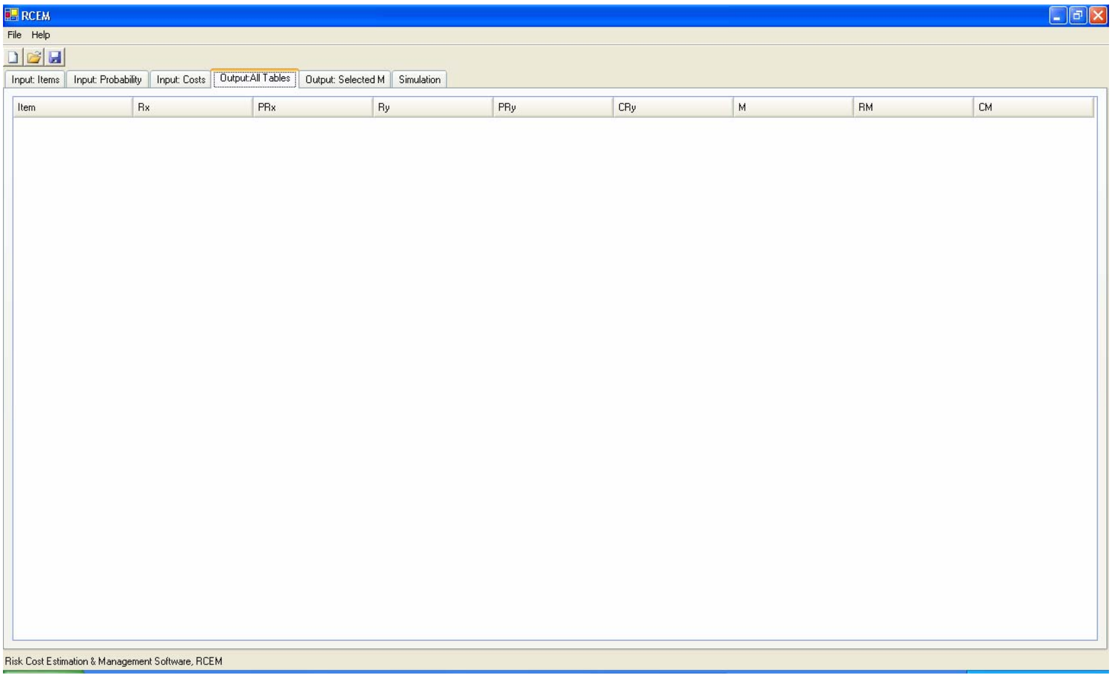

Figure (5-7): Fourth tab of RCEM software (summary of all tables)

5.3.5 Fifth tab (Output: selected M)

Once data is entered in the previous tables, RCEM starts processing this raw data according to the formula 5.1:

$$\min \begin{cases} CRy \\ \text{for} 1 \rightarrow p : \text{CRy} - (\text{RM}_p * \text{CRy}) + \text{CM}_p \end{cases} \qquad \text{……….formula 5.1}$$

Where:

CRy is the expected cost of the resulting consequence of main risk factor occurrence.

RM is the mitigation action reduction percentage on CRy.

CM is the expected cost of the proposed mitigation action.

p is number of mitigation actions.

The program calculates the result cost value for each resulting consequence. The operation is applied on all mitigation actions that are suggested to each resulting consequence. Finally the application chooses the least cost.

In the next table (Figure 5.8), the program defines the appropriate mitigation action for dealing with each resulting consequence, which leads to least cost (FCRy). If CRy value is less than the result of CRy – (RM* CRy) + CM, then there will be no specified mitigation action for that case, and the least cost will be the value of the mentioned CRy.

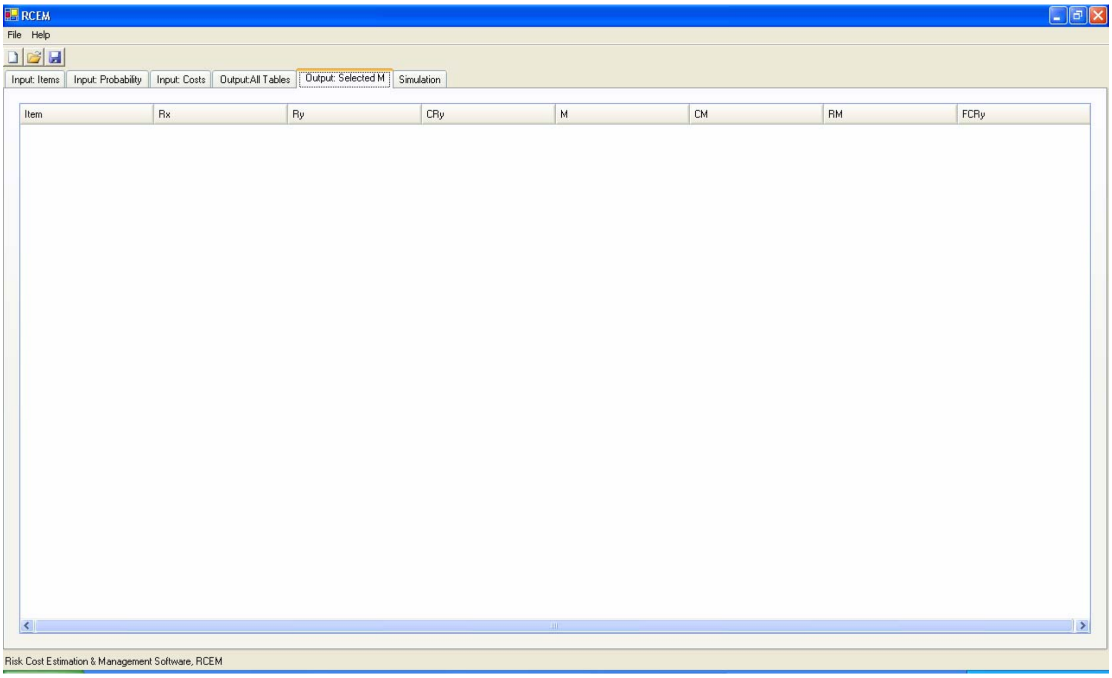

Figure (5-8): Fifth tab of RCEM software (Output: selected M)

5.3.6 Sixth tab (Simulation)

Figure (5.9) illustrates a screen which is designed for the simulation process. The user assigns number of iterations in the choosing combo box located under number of iterations label. Having a relatively high number of iterations is important in achieving the required confidence level in the running of a Monte Carlo simulation. The more iterations the user runs, the more reliable are the conclusions he/she draws. When the user is setting up a model, it is adequate to run only 500 to 1,000 iterations. He/she will see that the graphs in this case are rather irregular, but the results will not be very different from those with many more iterations. RCEM is very fast and it will run a very big number of iterations as the user wants, in a very little time. In RCEM the minimum number of iterations set by the researcher is 100 and the maximum is 50,000.

Clicking on start simulation button enables the start of simulation process. Then the X-Y chart appears. Two curves will be developed on the chart, one of them represents the resulting risk cost without using the mitigation actions, and the other represents the resulting risk cost using mitigation actions. The "S"- curve shows the probability of the cost being less than or equal to any particular project risk cost. This is termed the "cumulative probability" as it is the sum of all the probabilities up to the particular cost the user is looking at.

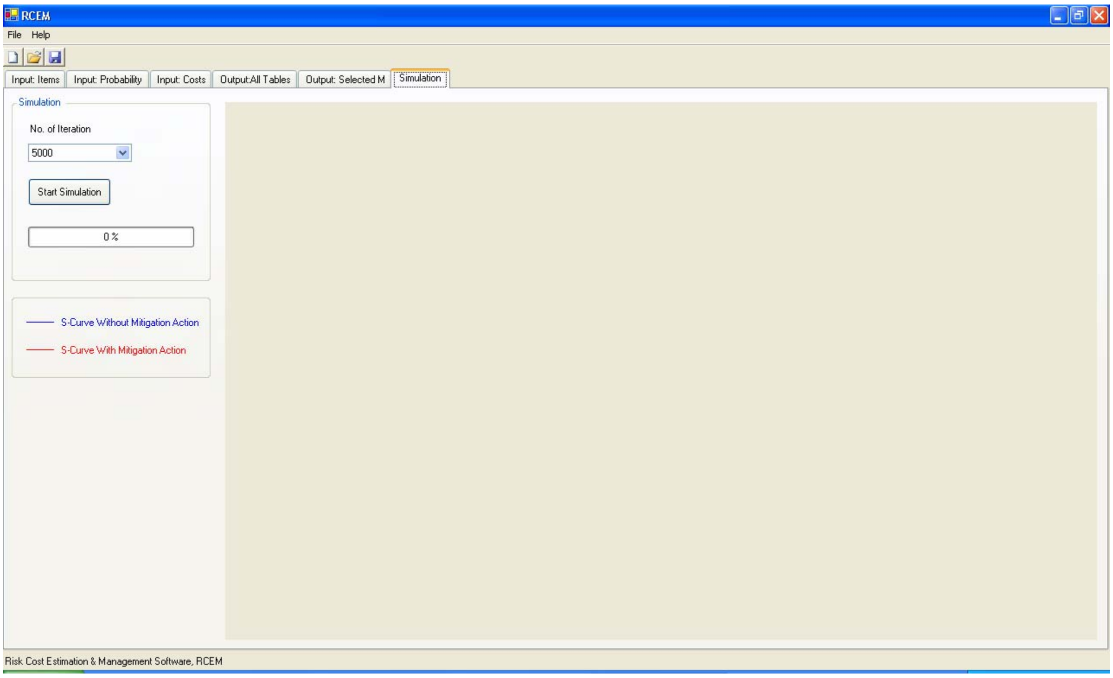

Figure 5-9): Sixth tab of RCEM software (Simulation)

Typical "S"-curves are shown in Figure (5.15). The form of the "S"-curve used here shows the cumulative probability of the project risk cost being less than the indicated cost. It therefore runs from zero percent probability at the lowest risk cost to 100% probability at the highest risk cost.

Simulation has been done according to the followings:

1. PRx is multiplied by PRy and the result is P
2. For each iteration, the program assigns a random number with a value between 0 and 1 which represents the occurrence or not of the resulting consequence.
3. This number is compared with P value.
4. If random number value is less than P, then the resulting consequence is expected, which means that the cost value of the resulting consequence is taken into consideration, otherwise, the resulting consequence is not expected to occur, and hence, its value is not calculated in the total risk value.

5. The researcher considered the resulting consequences as they are independent from each other.

It is worth mentioning that the theory of Monte Carlo simulation is based on random samples. Since each cost sample is random, the overall cost distribution that is generated is also random. If the user uses the same base cost data, every time he/she generates a new simulation he/she will get a slightly different answer.

5.3.7 Saving data to a disk

Once the user has entered the data for a new project, he/she can save it for a later use. This is done with the (File | Save) or the (File | Save As) commands on the main menu which are displayed on each screen.

The first time the user uses (File | Save) on new data, the program will open a dialog box asking him/her to specify the drive, directory and name for the file. The drive and directory are specified by default. The file name must be typed in the edit box on the bottom of the dialog box. The file name can be any legal Windows file name.

It must be noted that if the current data was loaded from a disk file, or if the user has already saved the data, the (File | Save) command immediately saves his/her data using the same filename that was used before. The old file on the disk is overwritten without asking the user to confirm the filename, and the old file cannot be retrieved. If the user wants to save the data in a different file, he/she must use the (File | Save As) command.

If the user has existing data that he/she wants to modify and save under a different name, or if he/she wants to save a copy of his/her file to a different directory, he/she must use the (File | Save As) command. This will give him/her a chance to specify the new drive, directory or filename before the file is saved to disk.

5.3.8 Reading existing files

Information that the user has previously entered and saved can be read back from disk into the program. To do this, he/she must use the (File | Open) command on the main menu which is displayed on the main screen. When he/she opens a file, it will over-write anything that is currently in memory. After he/she has invoked the (File | Open) command, a standard Windows dialog box will be opened. The dialog box will default to the current directory and will display all the Project Risk Analysis data files it finds there. Once the user has the correct directory displayed, he/she can scroll up and down with the window on the left of the dialog box until he/she finds the file he/she wants. When the user has located the required file, he must click on it and then click on the OK button, or simply double click on the name of the file. The file will then be loaded and displayed in the RCEM spreadsheets.

5.4 RCEM Implementation

The researcher finds that the best way to explain the system functions is by applying it on an example. In this example, the researcher used the results he got of the survey (in Chapter Four of this research) regarding to main risk factors and resulting consequences of work categories, in addition to the mitigation actions. This makes it easier for the researcher to explain and for the reader to understand. This example could be used by the user for any new project with modifying the related values. The user also, can modify, add, and delete any information in the tabs of the program to be suitable for any new project. In other words, the user can add, modify, or delete any value, item, mitigation action, main risk factor, resulting consequence, etc.

For simplification, the researcher considered only the resulting consequences that are greater than or equal to percentage of 50% (Table 4.28).

Figure 5.10 shows the first tab of the program. It includes the entries items, key risk factors (Rx), resulting consequences (Ry) and mitigation actions (M).

As shown, for example, the first item is aluminum works, the main risk factors of this item are "closure", "effective impact of changes in currency exchange rates", and "approved quality above the expected level of specifications". Also, the resulting consequences of "closure" (for example) are "increasing of material prices" and "work delay". For the resulting consequence of "work delay", there is only one proposed mitigation action.

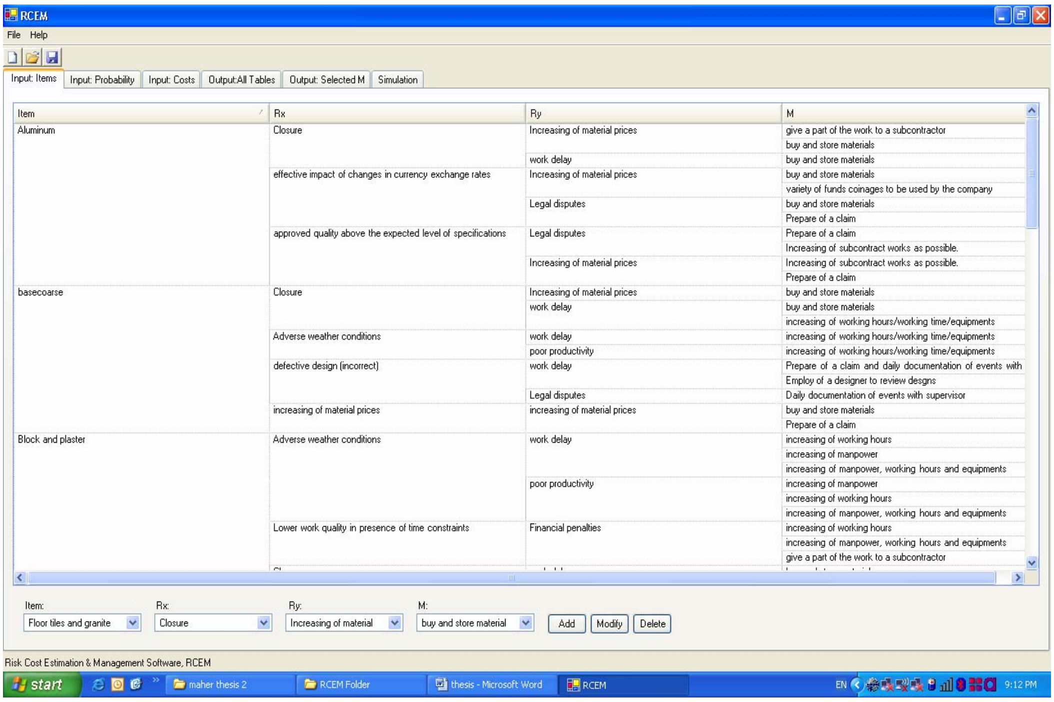

Figure 5-10): First tab with its entries

Figure 5.11 shows the second tab containing the entries of the previous tab. In this tab the user would enter the values of probability of each main risk factor occurrence (PRx), probability of each resulting consequence occurrence (PRy), and the expected cost of each consequence (CRy). The user can enter any value by clicking on its cell then type the number.

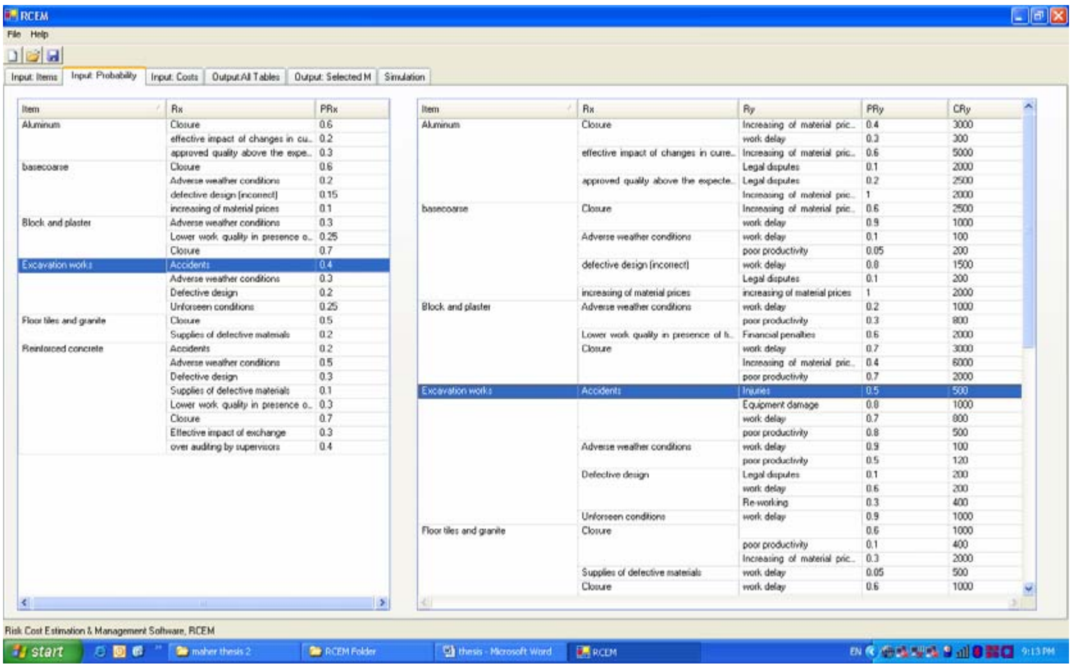

Figure (5-11): Second tab with its entries

Figure 5.12 shows the third tab containing the entries of the first tab. In this tab the user would enter the values of expected cost of each mitigation action (CM), and the mitigation action reduction percentage (RM) on CRy.

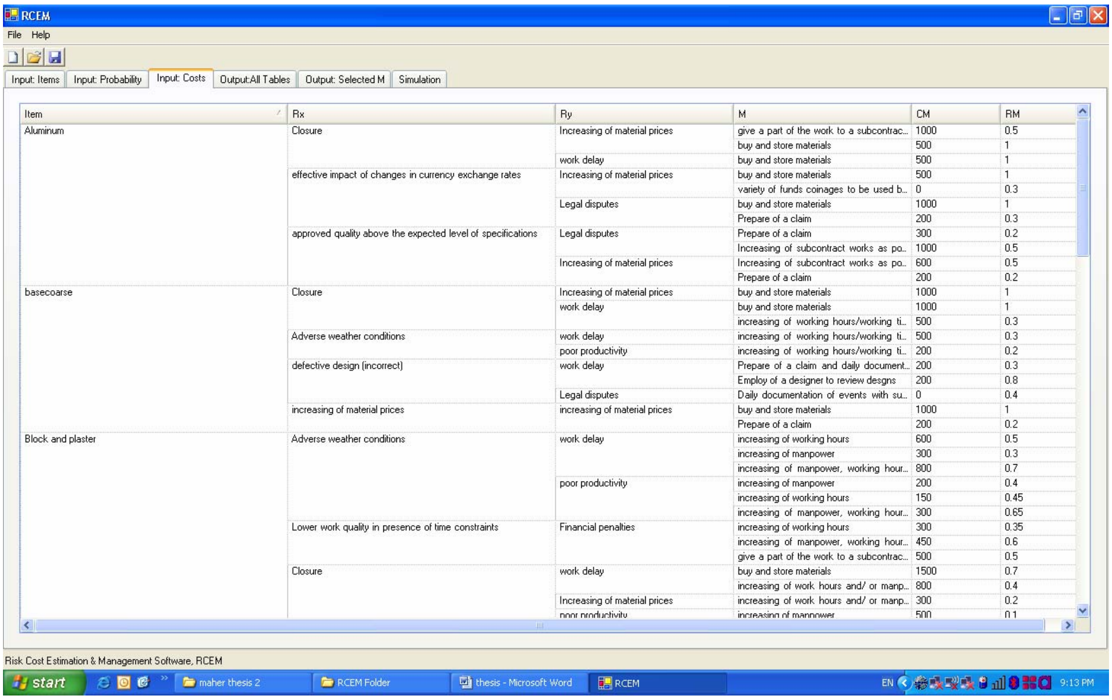

Figure (5-12): Third tab with its entries

Figure 5.13 shows the fourth tab containing all entries in the last tabs. In other words, this tab is the summary of the previous tabs.

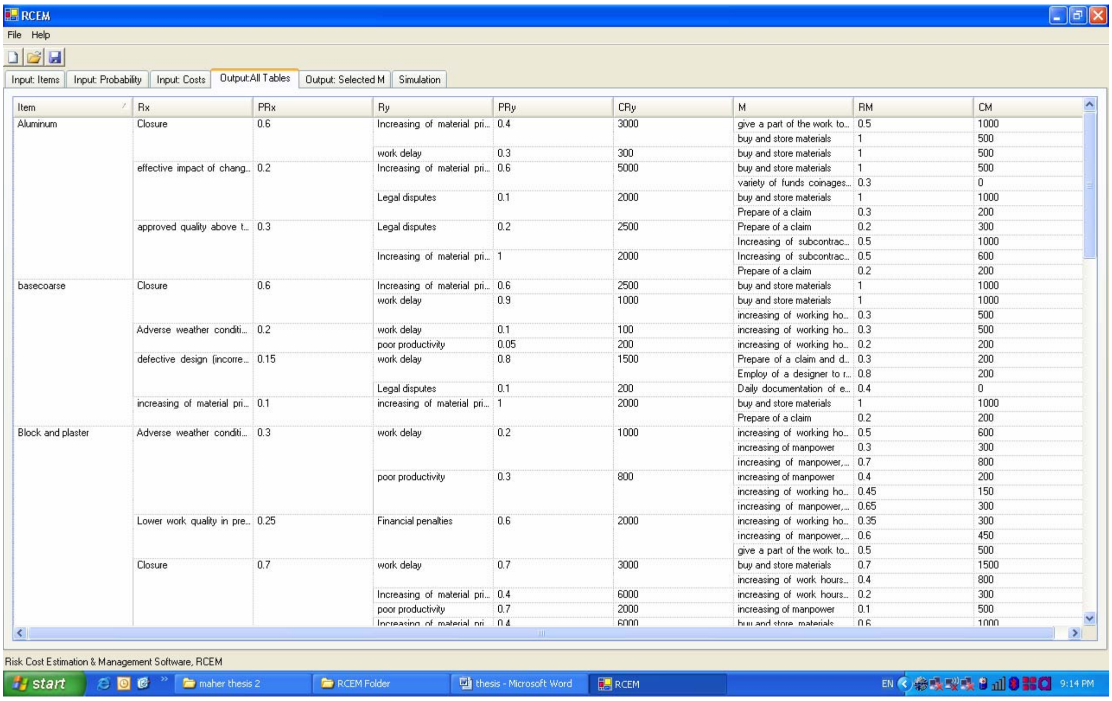

Figure (5-13): Fourth tab containing the summary of all previous tabs

Figure 5.14 shows the fifth tab containing all entries in the previous tabs. In addition, for each resulting consequence; the program illustrates the selected (appropriate) mitigation action, and the resulting final cost for each consequence (FCRy) according to formula 5.1.

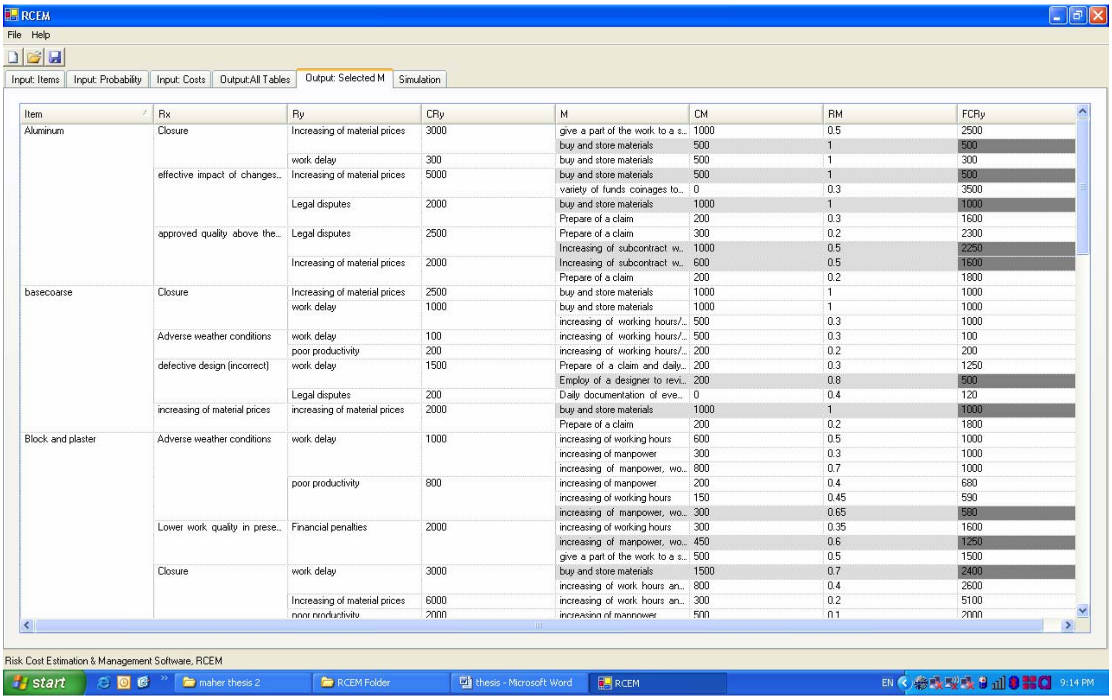

Figure (5-14): Fifth tab containing output results

Figure 5.15 shows the sixth tab, which is the final one. This figure illustrates the results of Monte Carlo simulation process. When the simulation has been completed the chart will automatically be displayed. As shown, the selected number of iterations is 10,000. The left curve demonstrates the results when using mitigation actions. The right curve demonstrates the results without considering mitigation actions. In each case, the user can see the cost of risk. Each "S"-curve shows the probability of the cost being less than or equal to any particular project risk cost. This is termed the Cumulative Probability as it is the sum of all the probabilities up to the particular cost the user is looking at.

The form of the "S"-curve used here shows the cumulative probability of the project risk cost being less than the indicated cost. It therefore runs from 0% probability at the lowest cost to 100% probability at the highest cost.

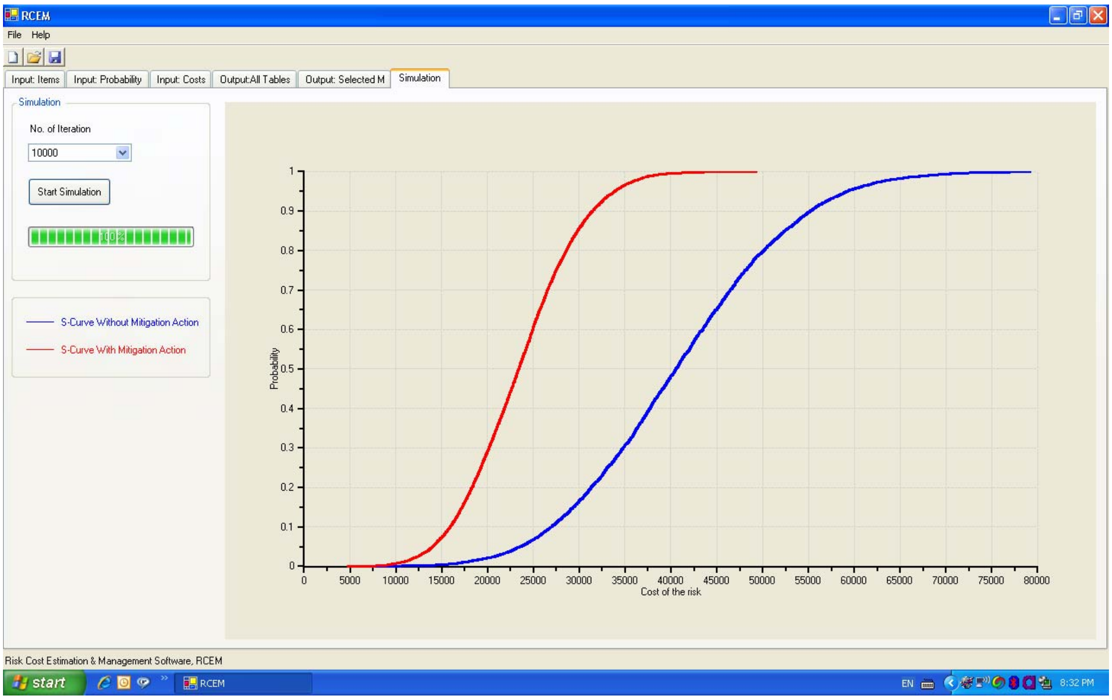

Figure (5-15): sixth tab containing simulation process results

It is worth mentioning the following notes:

1- In the tabs from first to fifth, if the user clicked on the heading cell of any column (items, Rx, Ry, etc), all values are arranged according to that cell.

2- If nothing appears in any cell, it means that its content like the one above it, and if the user clicked on the cell the content will appear.

3- By pointing the mouse at any heading cell (items, Rx, Ry, etc) the user gets its description.

4- If the user wants to use more than one mitigation action (M) for any resulting consequence (Ry), then he should combine them together to be handled as one. The user, in such case, should enter the estimated cost and the expected reduction effect percentage on the expected cost of the resulting consequence for this mitigation action (combined).

5.5 RCEM Evaluation

To evaluate RCEM the researcher introduced the system to experienced people and asked them to give their evaluation of its overall functions as well as the friendliness of the program after they tried it. Sargent (2000) mentions that this technique is called face validity and it can be used in determining if the logic in the conceptual model is correct and if a model's input-output relationships are reasonable. The researcher used this technique by asking five first class contractors who are experts in building projects, in addition to one business development specialist. He asked them to give their points of view in RCEM system and about its input-output relationships. The researcher explained all steps for using and operating the system and how to read the results especially the simulation process results. The researcher gave a copy of the evaluation questionnaire for each one of them to fill. The questionnaire is mainly designed to get a feedback about the RCEM system performance and benefits in addition to respondents' comments (see Annex 3).

5.5.1 RCEM performance

Table 5.1 shows the distribution of responses on RCEM performance. It can be shown that the evaluators were generally very satisfied with RCEM performance. They mentioned that it is a suitable and an efficient tool to be used by contractors. The results show that the overall weighted mean satisfaction of RCEM performance is (93.5%). This result is considered very high and excellent. This indicates that RCEM has a very good potential of acceptance to be used in order to enhance and improve construction industry and its management in Gaza Strip. According to respondents' opinion, there are many advantages that can be obtained by using RCEM, such as:

a. RCEM helps improve project management process during the implementation phase with regard to risks anticipation and mitigation
b. RCEM allows for higher dependency on computers in project management.
c. RCEM is more suitable for big size projects than small size ones.
d. RCEM contributes in determining a safe and a suitable price.
e. RCEM helps in recognizing of main risk factors and their resulting consequences for work categories.
f. RCEM is a persuasive and explanatory tool of price analysis submitted to the owner and consultant.
g. Results obtained can be readily and clearly read.
h. RCEM helps in bidding with a competitive and a suitable price.

5.5.2 Evaluators' comments and suggestions

Evaluators mentioned that RCEM is user friendly, specific, illustrative, and creative. It can be modified/updated easily and it is locally needed where it is the first software developed to deal with risk in Gaza Strip construction projects. They also mentioned that by using RCEM, the estimated cost of risk will be determined more scientifically by using formulas, charts, and facts. They recommended giving training courses for engineers and contractors to get familiar with it.

In addition, the business development specialist mentioned that software is excellent if used properly by contractors/business, companies/Banks/or other specialists. According to him, it can be developed further to include models/ templates for specific industries to serve other sectors.

One contractor said that it will be more useful if the system includes statistics information especially of the material prices increases and effective impact of changes in currency exchange rates in the last few years. The researcher suggests that further studies can be conducted to find a convenient way to link the system with relevant information from Palestinian Central Bureau of Statistics (its web site is www.pcbs.org).

One contractor advised for development another version in Arabic language. In fact, RCEM accepts information being entered in Arabic.

Table (5-1): RCEM performance as expressed by evaluators

No.	Techniques	No. of respondents					Weighted Mean %
		S. A	A	N	D	S. D	
1	RCEM contributes in improving of project planning	4	2				93
2	RCEM contributes in determining a safe and suitable price.	5	1				97
3	RCEM helps in bidding with a competitive and a suitable price.	4	2				93
4	RCEM contributes in development process of bids pricing in Gaza Strip.	4	2				93
5	RCEM helps in recognizing of main risk factors for work categories	5	1				97
6	RCEM helps in recognizing of consequences which could be resulted of main factors	5	1				97
7	RCEM helps improve project management process during the implementation phase with regard to risks anticipation and mitigation.	6					100
8	RCEM is suitable for all types of construction projects in Gaza Strip.	2	4				87
9	A persuasive and explanatory tool of price analysis submitted to owner and consultant.	5	1				97
10	RCEM contributes in building of a project database	2	4				87
11	RCEM contributes in updating of database	3	2	1			87
12	RCEM allows for higher dependency on computers in project management.	6					100
13	Simplicity in using RCEM	2	4				87
14	Simplicity in the way of updating the data.	5	1				97
15	Simplicity in updating the data by using RCEM	6					100
16	RCEM saves the time and minimizes the efforts in cost estimation	3	3				90
17	RCEM is flexible enough to all for each contractor's special circumstances and requirements	4	2				93
18	Results obtained can be readily and clearly read.	5	1				97
19	RCEM is a suitable for small size projects	1	4	1			80
20	RCEM is a suitable for big size projects	6					100
Average Mean %							93.5

(S.A= Strongly Agree, A= Agree, N= Neutral, D= Disagree, S.D= Strongly Disagree

Chapter Six

Conclusions and Recommendations

6.1 Introduction

The RCEM software has been developed to help Gaza Strip contractors in risk cost estimation. This will help them in prepare bids with safe and competitive prices. This chapter introduces the research conclusions and recommendations for contractors and other parties involved in construction projects to improve the local practices in risk and construction management. It also introduces recommendations for further studies.

6.2 Conclusions

1) Respondents of the questionnaire are generally mature in construction business. Most projects they executed are generally small size ones. This may be a result of the political and economical situation in Gaza Strip due to AL-Aqssa Intifada's effect on the construction field in the last few years.

2) The executed projects are associated with a relatively high level of risk. This in turn, generally caused losses to contractors.

3) In general, there is no commitment regarding the employment of special person or team for risk management by contractors, and there is not enough interested contractors in giving training courses on risk management for their engineers. Again as contractors are mostly small ones, it seems that they do not have the financial capability to invest in this field.

4) Contractors used computers in managing many aspects of projects. But they did not use computers in risk management because they may not have suitable software or models to be used for this regard.

5) Dealing with risk (minimizing risk) is the favorable choice for contractors. And determining risk is the most used strategy by contractors to achieve this.

6) Border Closure, in general, has been the most important and expected risk factor in the last five years. It has a big effect on increasing material prices,

poor productivity and work delay resulted mainly due to material shortages for most of work categories. In most cases, there is high correlation between the expectancy and the financial effect of risk factors.

7) In risk cost estimation and management, there is a need for a suitable tool or model to be used by contractors in Gaza Strip. RCEM is developed by the researcher to satisfy this need.

8) RCEM software development is mainly based on categorizing construction key risk factors for each work group, determining their consequences and proposing mitigation actions to prevent or mitigate the risk effects. RCEM evaluators showed that it has a very good potential of acceptance to be used in order to enhance and improve the construction industry in Gaza Strip.

9) RCEM evaluators are generally satisfied with the software performance. They indicated that it is suitable for use in the local estimating practice and there are many advantages that can be obtained from using it such as:
    a. It helps improve project management process during the implementation phase with regard to risks anticipation and mitigation.
    b. It allows for higher dependency on computers in project management.
    c. It is more suitable for big size projects than small size ones.
    d. It helps in recognizing main risk factors and their resulting consequences for work categories.
    e. It is a persuasive and explanatory tool of price analysis submitted to the owner and consultant.
    f. RCEM outputs are generally easy to understand and to deal with.
    g. RCEM helps in bidding to produce a competitive and a suitable price.

10) RCEM is the first software developed to deal with risk in Gaza Strip. By using it, the estimated cost of risk will be determined in a more scientific way.

6.3 Recommendations

1) As this study showed that most contractors gave little attention to the risk management process, contractors are advised to take care of this point and be

sure that the pricing team is risk sensitive and give enough effort to improve their capabilities.

2) Contractors need to put more effort in documenting risks. Documentation is important for recording the identification, analysis, and risk mitigation actions. Historical risk records will be helpful in pricing future projects. This saves time, money and trouble in the long term.

3) Offering courses in risk management is important for staff of all project parties, which help increasing their level of knowledge of the risk management processes, its techniques and its benefits. Contractors should recognize how to implement mitigation actions techniques such as how to share or transfer some risks by hiring specialized sub-contractors or asking for special insurance policies.

4) Contract documents are very important in the risk management process as they are the source of most project risks allocation. They must be checked carefully to insure that the contract terms are generally fair for all concerned.

5) The local construction industry parties are invited to have RCEM software and the like and use them in order to get more accurate estimate and to improve the construction management process.

6.4 Recommendations for further studies

1) Researchers are invited to do in depth investigation of key risk factors, consequences and mitigation actions for work groups in other fields of construction projects such as sewage, water supply and road projects. Results of such studies may then be incorporated as templates in the RCEM software.

2) Studies advised to be conducted to find a convenient way to link RCEM with relevant information from Palestinian Central Bureau of Statistics. It will be more useful if the system includes statistical information especially of the material prices increases and effective impact of changes in currency exchange rates.

3) RCEM software should be further developed by future research to make it possible for the user to choose a combination of mitigation actions, and have this option be compared with other options. This will enhance RCEM capability in determining the optimum solution.

4) RCEM, in addition to construction sector, can be developed further to include models/templates for specific industries to serve other sectors.

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Annex 1

The Questionnaire

بسم الله الرحمن الرحيم

الـجامـعة الإسـلامـية – غـزة
عـمـادة الـدراسـات الـعلـيـا
كلية الهنـدسـة – قسـم إدارة الـتشـيـيـد

استـبـيـان

إدارة المخاطر في مشاريع التشييد في قطاع غزة

الـباحـث: ماهر خضر المقوسي

المشرف: الدكتور كمالين شعث

بسم الله الرحمن الرحيم

استبيان للمقاولين في قطاع غزة

السلام عليكم ورحمة الله وبركاته وبعد،

أتقدم لكم بجزيل الشكر والامتنان لمساهمتكم بجزء من وقتكم للإجابة على هذه الاستبانة ، وألفت عناية حضراتكم إلى الملاحظات التالية:

1. إن هذا الاستبيان هو جزء من دراسة للأثر المالي لعناصر المخاطر الرئيسية على تسعير العطاءات من قبل المقاولين.
2. الدراسة هي البحث التكميلي لنيل شهادة الماجستير في إدارة التشييد في الجامعة الإسلامية بغزة، ويأمل الباحث أن تسهم الدراسة في تحسين أداء المقاولين في تنفيذ المشاريع و وضع نسبة ربح آمنة عند التسعير.
3. المعلومات التي ستساهمون بها هي لغرض البحث الدراسي، مع الالتزام التام بالمحافظة على سرية المعلومات الخاصة بكم.
4. يرجو الباحث أن تكون المعلومات دقيقة وصحيحة للوصول إلى النتائج المرجوة من هذا البحث.
5. مكونات الاستبيان:
   - معلومات عامة عن الشركة.
   - طريقة تعامل الشركة مع المخاطر.
   - عوامل المخاطر الرئيسية لأنواع الأعمال في المشروع.
   - عوامل المخاطر الرئيسية و العوامل التابعة لها (الناتجة عنها) لأنواع الأعمال في المشروع.
   - طرق تدارك آثار المخاطر المتوقعة أو منع حدوثها.
6. تقديرًا لكم على مشاركتكم في هذه الاستبانة فإن الباحث سيطلعكم إن شاء الله على نتائج الدراسة للاستفادة منها قدر الإمكان

مع الشكر الجزيل

الباحـــث: ماهر خضر المقوسي

المشرف: الدكتور كمالين شعث

<u>الجزء الأول : وصف الشركة</u>

1.1 المركز الإداري لمن يقوم بتعبئة الإستبانة :

- ☐ مدير الشركة
- ☐ نائب المدير
- ☐ مدير مشروع
- ☐ مهندس موقع

2.1 عدد المشاريع المنفذة خلال السنوات الخمس الماضية :

- ☐ 10 مشاريع فأقل
- ☐ من 11 إلى 20 مشروع
- ☐ من 21 إلى 30 مشروع
- ☐ من 31 إلى 40 مشروع
- ☐ أكثر من 40 مشروع

3.1 عدد سنوات خبرة المؤسسة في مجال الإنشاءات :

- ☐ ثلاث سنوات أو أقل
- ☐ أكثر من ثلاث سنوات إلى خمس سنوات
- ☐ أكثر من خمس سنوات إلى عشر سنوات
- ☐ أكثر من عشر سنوات

4.1 حجم العمل بالدولار خلال السنوات الخمس الماضية :

- ☐ 500,000 دولار فأقل
- ☐ أكثر من 500,000 إلى مليون دولار
- ☐ أكثرمن 1 إلى 5 مليون دولار
- ☐ أكثر من 5 إلى 10 مليون دولار
- ☐ أكثر من 10 مليون دولار

الجزء الثاني

طريقة تعامل الشركة مع المخاطر

1.2 - لكل سؤال من الأسئلة في الجدول التالي يرجى منكم تحديد الإجابة المتناسبة مع الحالة في شركتكم و ذلك بوضع علامة (√) في المربع الواقع أسفل الخيار الذي تحددونه مقابل كل سؤال.

الرقم	البيان	كبير جداً	كبير	متوسط	ضعيف	ضعيف جداً
1.1.2	- ما هو مستوى المخاطر التي واجهتها شركتكم في السنوات الخمس الماضية؟					
2.1.2	-ما هو مستوى الأضرار أو الخسائر الناتجة عن المخاطر التي واجهتها شركتكم خلال الخمس سنوات الماضية؟					
3.1.2	- ما مدى تعامل شركتكم مع المخاطر المتوقعة في الأعمال من حيث أخذها بعين الاعتبار عند تسعير العطاء؟					
4.1.2	- ما مدى اقتناع شركتكم بأن إدارة المخاطر بشكل فعال يمكن أن يؤدي إلى نجاح المشروع و تحقيق أهدافه؟					
5.1.2	- ما مدى وجود سياسات أو استراتيجيات لديكم لإدارة المخاطر؟					
6.1.2	- ما مدى اهتمام شركتكم بالتعرف على مهارات و طرق إدارة المخاطر؟					
7.1.2	ما مدى التزام شركتكم بتخصيص شخص أو فريق عمل معني بإدارة المخاطر؟					
8.1.2	- ما مدى اهتمام شركتكم بأن يحصل مهندسوها المعنيون على دورات للتعرف على تقنيات إدارة المخاطر؟					
9.1.2	- ما مدى اعتماد شركتكم على استخدام الحاسوب في إدارة المشاريع؟					

2.2 - يرجى تحديد درجة استخدام السياسات أو الاستراتيجيات المتبعة لديكم في إدارة المخاطر (إن وجدت) لتحقيق الهدف أو الأهداف الواردة في الجدول التالي:-

الرقم	الهدف من استخدام الاستراتيجيات/ السياسات	درجة استخدام السياسات/ الاستراتيجيات لتحقيق الهدف				
		كبير جداً	كبير	متوسط	ضعيف	ضعيف جداً
1.2.2	- تحديد المخاطر					
2.2.2	- تحليل المخاطر و تقييمها					
3.2.2	- معالجة المخاطر/ التعامل معها و ضبطها					
4.2.2	- مراقبة المخاطر و توثيق طرق التعامل معها					

3.2- في الجدول التالي يرجى منكم تحديد إلى أي مدى كانت شركتكم تلجأ إلى الخيارات المذكورة في الجدول عند التعامل مع المخاطر:

الرقم	الخيار المتبع في التعامل مع المخاطر	مدى لجوء الشركة لكل خيار في التعامل مع المخاطر				
		كبير جداً	كبير	متوسط	ضعيف	ضعيف جداً
1.3.2	- تجاهل المخاطر					
2.3.2	- قبول المخاطر كأمر واقع					
3.3.2	- التعامل مع المخاطر و ضبطها (تقليل المخاطر)					
4.3.2	- ترحيل المخاطر جزئياً بإعطاء البنود التي بها مخاطر لمقاول من الباطن.					
5.3.2	- ترحيل المخاطر كلياً (التأمين عليها).					
6.3.2	- تجنب المخاطر كلياً (عدم التقدم للمشروع)					

الجزء الثالث

عوامل المخاطر الرئيسية لأنواع الأعمال في المشاريع

فيما يلي تم تحديد عوامل المخاطر المتوقعة لبعض مجموعات بنود الأعمال في المشاريع ، يرجى توضيح مدى موافقتكم على وجود كل عامل في كل مجموعه، و كذلك يرجى تحديد درجة تأثيره الذي ينعكس مالياً من وجهة نظركم.
كما يرجى تحديد أي عوامل أخرى موجودة حسب رأيكم و لم يتم ذكرها مع تحديد مدى الموافقة على وجودها و درجة تأثيرها. و ذلك بالنسبة لكل نوع من أنواع الأعمال الواردة:

1.3--أعمال الحفر

الرقم	عوامل المخاطر	درجة موافقتكم على وجود العامل				درجة تأثير العامل (التأثير ينعكس ماديا)			
		كبيرة	متوسطة	صغيرة	لا يوجد	كبيرة	متوسطة	صغيرة	لا يوجد
1.1.3	وقوع حوادث								
2.1.3	أحوال جوية سيئة								
3.1.3	أخطاء التصميم								
4.1.3	الكميات الحقيقية تختلف عن العقد								
5.1.3	ظروف غير مرئية								
6.1.3									
7.1.3									

2.3- أعمال الخرسانة و حديد التسليح:

الرقم	عوامل المخاطر	درجة موافقتكم على وجود العامل				درجة تأثير العامل (التأثير ينعكس ماديا)			
		كبيرة	متوسطة	صغيرة	لا يوجد	كبيرة	متوسطة	صغيرة	لا يوجد
1.2.3	وقوع حوادث								
2.2.3	أحوال جوية سيئة								
3.2.3	أخطاء التصميم								
4.2.3	انخفاض مستوى جودة الأعمال لضيق الوقت المتاح								
5.2.3	الإغلاق و الحصار								
6.2.3	توريد مواد غير صالحة								
7.2.3	تدقيق زائد من قبل الإشراف								
8.2.3	غلاء المواد								
9.2.3	غلاء الأجور								
10.2.3	تغير مؤثر في أسعار صرف العملات								
11.2.3									
12.2.3									

3.3- أعمال بناء الطوب و أعمال القصارة:

الرقم	عوامل المخاطر	درجة موافقتكم على وجود العامل				درجة تأثير العامل (التأثير ينعكس ماديا)			
		كبيرة	متوسطة	صغيرة	لا يوجد	كبيرة	متوسطة	صغيرة	لا يوجد
1.3.3	وقوع حوادث								
2.3.3	توريد مواد غير صالحة								
3.3.3	انخفاض مستوى جودة الأعمال لضيق الوقت								
4.3.3	الاغلاق و الحصار								
5.3.3	تدقيق زائد من قبل الاشراف								
6.3.3	غلاء المواد								
7.3.3	غلاء الأجور								
8.3.3									
9.3.3									

4.3- أعمال البلاط و الرخام:

الرقم	عوامل المخاطر	درجة موافقتكم على وجود العامل				درجة تأثير العامل (التأثير ينعكس ماديا)			
		كبيرة	متوسطة	صغيرة	لا يوجد	كبيرة	متوسطة	صغيرة	لا يوجد
1.4.3	توريد مواد غير صالحة								
2.4.3	انخفاض مستوى جودة الأعمال لضيق الوقت								
3.4.3	اعتماد نوعية تفوق المتوقع								
4.4.3	الاغلاق و الحصار								
5.4.3	تدقيق زائد من قبل الإشراف								
6.4.3	غلاء المواد								
7.4.3	غلاء الأجور								
8.4.3									
9.4.3									

5.3- أعمال الألمنيوم:

الرقم	عوامل المخاطر	درجة موافقتكم على وجود العامل				درجة تأثير العامل (التأثير ينعكس ماديا)			
		كبيرة	متوسطة	صغيرة	لا يوجد	كبيرة	متوسطة	صغيرة	لا يوجد
1.5.3	انخفاض مستوى جودة الأعمال لضيق الوقت.								
2.5.3	الإغلاق و الحصار								
3.5.3	تدقيق زائد من قبل الإشراف								
4.5.3	غلاء المواد								
5.5.3	غلاء الأجور								
6.5.3	تغير مؤثر في سعر صرف العملات.								
7.5.3	اعتماد نوعية تفوق المتوقع								
8.5.3									
9.5.3									

6.3- أعمال طبقة الأساس (Base-course) و أعمال الإسفلت :

الرقم	عوامل المخاطر	درجة موافقتكم على وجود العامل				درجة تأثير العامل (التأثير ينعكس ماديا)			
		كبيرة	متوسطة	صغيرة	لا يوجد	كبيرة	متوسطة	صغيرة	لا يوجد
1.6.3	أحوال جوية سيئة								
2.6.3	التغيير في التصميم								
3.6.3	توريد مواد غير صالحة								
4.6.3	انخفاض مستوى جودة الأعمال لضيق الوقت								
5.6.3	تدقيق زائد من قبل الإشراف								
6.6.3	الإغلاق و الحصار.								
7.6.3	غلاء المواد								
8.6.3	غلاء الأجور								
9.6.3									
10.6.3									

الجزء الرابع

عوامل المخاطر الرئيسية و العوامل التابعة لها (الناتجة عنها) لمجموعات بنود الأعمال

في الجدول التالي تم تحديد عوامل المخاطر الرئيسية لمجموعات بنود الأعمال التي تم تحديدها في الجزء السابق ، بحيث تم ترتيب هذه العوامل في العمود الأول ، و في الصف الأول تم تحديد أهم العوامل التي يمكن أن يكون منها ما ينتج عن حدوث العوامل الرئيسية (أي يصبح عامل تابع أو ناتج يحدث كنتيجة لحدوث العامل الرئيسي).

فيرجى منكم تحديد العوامل التي يمكن أن تنتج عن كل عامل رئيسي بوضع علامة (√) في الخانة التي يتقاطع فيها الصف الذي يحتوي على العامل الرئيسي مع العمود الذي يحتوي على العامل الناتج .

كما يرجى إضافة أي عوامل رئيسية أو ناتجة ترون أنها مهمة و لم يتم ذكرها من قبل معد الاستبيان.

الرقم	العوامل الرئيسية	العوامل التابعة / نوع العمل	تأخر العمل	تضرر آليات	وقوع إصابات	تدني القدرة الانتاجية	ظهور خلافات	عمل خصومات على المقاول	غلاء الأسعار	زيادة الفاقد	إعادة الأعمال	....	....
1.4	وقوع حوادث	الحفر											
		الخرسانة و حديد التسليح											
		الطوب و القصارة											
2.4	أحوال جوية سيئة	الحفر											
		الخرسانة و حديد التسليح											
		الطوب و القصارة											
		طبقة الأساس و الإسفلت											
3.4	أخطاء التصميم	الحفر											
		الخرسانة و حديد التسليح											
		طبقة الأساس و الإسفلت											
4.4	الكميات الحقيقية تختلف عن العقد	الحفر											
5.4	ظروف غير مرئية	الحفر											
6.4	توريد مواد غير صالحة	الخرسانة و حديد التسليح											
		الطوب و القصارة											
		البلاط و الرخام											
		طبقة الأساس و الإسفلت											
7.4	انخفاض مستوى جودة الأعمال لضيق الوقت	الخرسانة و حديد التسليح											
		الطوب و القصارة											
		البلاط و الرخام											
		الألمنيوم											
		طبقة الأساس و الإسفلت											

الرقم	العوامل الرئيسية	العوامل التابعة / نوع العمل	تأخر العمل	تضرر آليات	وقوع إصابات	تدني القدرة الانتاجية	ظهور خلافات	عمل خصومات على المقاول	غلاء الأسعار	زيادة الفاقد	إعادة الأعمال	....	....
8.4	الإغلاق و الحصار	الخرسانة و حديد التسليح											
		الطوب و القصارة											
		البلاط و الرخام											
		الألمنيوم											
		طبقة الأساس و الإسفلت											
9.4	تغير كبير في أسعار صرف العملات	الخرسانة وحديد التسليح											
		الألمنيوم											
10.4	اعتماد نوعية تفوق المتوقع	البلاط و الرخام											
		الألمنيوم											
11.4	تدقيق زائد من قبل الإشراف	الخرسانة و حديد التسليح											
		الطوب و القصارة											
		البلاط و الرخام											
		الألمنيوم											
		طبقة الأساس و الإسفلت											
12.4	غلاء أسعار المواد	الخرسانة و حديد التسليح											
		الطوب و القصارة											
		البلاط و الرخام											
		الألمنيوم											
		طبقة الأساس و الإسفلت											
13.4	غلاء الأجور	الخرسانة و حديد التسليح											
		الطوب و القصارة											
		البلاط و الرخام											
		الألمنيوم											
		طبقة الأساس و الإسفلت											

الجزء الخامس

الإجراءات التي يمكن القيام بها لتقليل أثر المخاطر المتوقعة أو منع حدوثها

في الجدول التالي ، يرجى منكم تحديد أي إجراءات أو احتياطيات (بناء على خبرتكم العملية) يمكن عملها لمنع حدوث هذه المخاطر أو تقليل خطرها. فقد تم ترتيب العوامل في العمود الأول ، و تم تقسيم كل صف لكل عامل إلى خانات بحيث يتم تعبئتها من قبلكم بالإجراءات أو الاستراتيجيات التي يمكن اتخاذها لمنع أو تقليل أثر المخاطر.
و قد قام الباحث بتحديد بعض الاجراءات أو الاحتياطات لبعض العوامل لمجموعات أعمال مختلفة ، يرجى منكم تحديد فيما اذا كنتم توافقون على ما اذا كانت هذه الاجراءات أو الاحتياطات مناسبة أم لا.

	عوامل المخاطر	نوع العمل	الإجراءات/ الاستراتيجيات المناسبة لاتخاذها للحد من أثر كل عامل أو منع حدوثه (Mitigation Actions)				
1.5	**وقوع حوادث**	الحفر	1- زيادة احتياطات ووسائل السلامة	2--التأمين على الحوادث	3- زيادة العمالة	4-زيادة الآلات	5-
		الخرسانة و حديد التسليح	1-	2-	3-	4-	5-
		الطوب و القصارة	1-	2-	3-	4-	5-
2.5	**أحوال جوية سيئة**	الحفر	1-زيادة ساعات العمل	2-	3-	4-	5-
		الخرسانة و حديد التسليح	1-	2-	3-	4-	5-
		الطوب و القصارة	1-	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1-	2-	3-	4-	5-
3.5	**أخطاء التصميم**	الحفر	1-تعيين مهندس مختص لمراجعة التصميمات	2-	3-	4-	5-
		الخرسانة و حديد التسليح	1-	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1-	2-	3-	4-	5-
4.5	**الكميات الحقيقية تختلف عن العقد**	الحفر	1-تعيين حاسب كميات لتدقيق الكميات	2-	3-	4-	5-
5.5	**ظروف غير مرئية**	الحفر	1-زيادة العمالة و /أو الآليات	2-توثيق الأحداث بشكل يومي مع المشرف	3- زيادة أعمال الباطن ما أمكن	4-زيادة تغطية التأمين	5-
6.5	**توريد مواد غير صالحة**	الخرسانة و حديد التسليح	1-تحميل المورد مسئولية المواد و ما ينتج عنها	2-	3-	4-	5-
		بناء الطوب و القصارة	1-	2-	3-	4-	5-

	عوامل المخاطر	نوع العمل	الإجراءات/ الاستراتيجيات المناسبة لاتخاذها للحد من أثر كل عامل أو منع حدوثه (Mitigation Actions)				
		البلاط و الرخام	1-	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1-	2-	3-	4-	5-
7.5	**انخفاض مستوى جودة الأعمال لضيق الوقت**	الخرسانة و حديد التسليح	1-إعطاء جزء من الأعمال لمقاول الباطن	2-	3-	4-	5-
		الطوب و القصارة	1-	2-	3-	4-	5-
		البلاط و الرخام	1-	2-	3-	4-	5-
		طبقة الأساس و الغسفلت	1-	2-	3-	4-	5-
8.5	**الإغلاق و الحصار**	الخرسانة و حديد التسليح	1-شراء المواد و تشوينها	2-	3-	4-	5-
		بناء الطوب و القصارة	1-	2-	3-	4-	5-
		البلاط و الرخام	1-	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1-	2-	3-	4-	5-
		الألمنيوم	1-	2-	3-	4-	5-
9.5	**تغيير كبير في أسعار صرف العملات**	الخرسانة و حديد التسليح	1-توزيع السيولة الموجودة في الشركة على سلة عملات	2-	3-	4-	5-
		الألمنيوم	1-	2-	3-	4-	5-
10.5	**اعتماد نوعية تفوق المتوقع**	البلاط و الرخام	1-السؤال عن النوعية في الاجتماع التمهيدي.	2-الأخذ بالاعتبار فرق السعر بين المتوقع و بين أفضل نوعية عند التسعير.	3-	4-	5-
		الألمنيوم	1-	2-	3-	4-	5-
11.5	**تدقيق زائد من قبل الإشراف**	الخرسانة و حديد التسليح	1- زيادة أعمال الباطن ما أمكن	2- زيادة التدقيق الذاتي	3-	4-	5-
		بناء الطوب و القصارة	1-	2-	3-	4-	5-

	عوامل المخاطر	نوع العمل	الإجراءات/ الاستراتيجيات المناسبة لاتخاذها للحد من أثر كل عامل أو منع حدوثه (Mitigation Actions)				
		البلاط و الرخام	1-	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1-	2-	3-	4-	5-
12.5	زيادة أسعار المواد	الخرسانة و حديد التسليح	1- شراء أكبر قدر ممكن من المواد قبل العمل	2-	3-	4-	5-
		بناء الطوب و القصارة	1- شراء أكبر قدر ممكن من المواد قبل العمل	2-	3-	4-	5-
		البلاط و الرخام	1- شراء أكبر قدر ممكن من المواد قبل العمل	2-	3-	4-	5-
		الألمنيوم	1- شراء أكبر قدر ممكن من المواد قبل العمل	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1- شراء أكبر قدر ممكن من المواد قبل العمل	2-	3-	4-	5-
13.5	زيادة أسعار العمالة	الخرسانة و حديد التسليح	1-	2-	3-	4-	5-
		بناء الطوب و القصارة	1-	2-	3-	4-	5-
		البلاط و الرخام	1-	2-	3-	4-	5-
		الألمنيوم	1-	2-	3-	4-	5-
		طبقة الأساس و الإسفلت	1-	2-	3-	4-	5-

Annex 2

The Questionnaire (English Version)

بسم الله الرحمن الرحيم

Islamic University – Gaza

Deanery of Graduate Studies

Faculty of Engineering – Construction Management

Questionnaire

Risk Management in Construction Projects in Gaza Strip

Researcher: Maher K. EL-Maqousi

Supervised by: Dr. Kamalain Shaath

Part 1: Contractor organization Profile

1.1 position of the respondent:

- Director
- Deputy Director
- Project Manager
- Site Engineer

1.2 Number of executed projects in the last 5 years

- 10 Projects or less
- 11-20 Projects
- 21-30 Projects
- 31- 40 Projects
- More than 40 projects

1.3 Experience of the organization in construction (Years)

- 3 years or less
- More than 3 years -5 years
- More than 5 years -10 years
- More than 10 years

1.4 Work monetary volume in the last 5 years (USD)

- Less than $500000
- $500000 – less than $1 million
- $1 million- less than $5 million
- $5 million – less than $10 million
- More than $10 million

Part 2
The way of dealing with risk

2.1 Please, answer the following questions according to your company's case by ticking the (√) corresponding box.

No.	Description	v. Big	Big	Medium	weak	v. weak
2.1.1	What level of risk the company faced in the last 5 years?					
2.1.2	What is the extent of losses caused by such risks?					
2.1.3	How seriously does your company take expected risk when pricing the bids?					
2.1.4	What is the extent of the company's level of conviction that effective risk management can result in success of the project?					
2.1.5	What is the level of policies and strategies present in the company?					
2.1.6	How far is the company interested in the skills and methods of risk management?					
2.1.7	How far is the company committed to having especial person or team for risks management?					
2.1.8	How far is the company interested in giving training courses on risk management for its engineers?					
2.1.9	To What extent are computers used in project management by the company?					

2.2 Please, determine the level of use of the policies and/or strategies which are followed by your company in risk management to achieve the goal/ goals in the following table:

No.	Strategies	level of use of the policies and/or strategies				
		v. Big	Big	Medium	weak	v. weak
2.2.1	Determining risks					
2.2.2	Evaluating and analyzing risks					
2.2.3	Dealing with risks/ controlling risks					
2.2.4	Observing the risks & documentation solutions.					

2.3 Please, specify the extent of use of the choices mentioned when dealing with risks:

No.	Risk attitudes	The extent of use the choice				
		V.Big	Big	medium	Weak	v. weak
2.3.1	Ignoring the risks					
2.3.2	Acceptance of risks					
2.3.3	Dealing with risks (minimize risks)					
2.3.4	Partially transferring the risks to a subcontractor.					
2.3.5	insuring against risks					
2.3.6	A voidance by not bidding					

Part (3)

The following tables are for expected risk factors in certain categories of a project to be decided; please specify the level of acceptance with such analysis (existence of such factors). Also, determine its financial affect.

3.1 Excavation works

No.	Risk factors	Expectancy				Financial effect			
		Big	Medium	Small	Nothing	Big	Medium	Small	Nothing
3.1.1	Accidents								
3.1.2	Adverse weather conditions								
3.1.3	Defective design								
3.1.4	Actual quantities differ from the contract quantities								
3.1.5	Unforeseen conditions								
3.1.6									
3.1.7									

3.2 Reinforced concrete

No.	Risk factors	Expectancy				Financial effect			
		Big	Medium	Small	Nothing	Big	Medium	Small	Nothing
3.2.1	Accidents								
3.2.2	Adverse weather conditions								
3.2.3	Defective design								
3.2.4	Lower work quality due to time constraints								
3.2.5	Closure								
3.2.6	Supplying defective materials								
3.2.7	Over auditing by supervisors								
3.2.8	Increasing of materials prices								
3.2.9	Wage increases								
3.2.10	Effective impact of changes in currency exchange rates								
3.2.11									
3.2.12									

3.3 Block and Plaster works

No.	Risk factors	Expectancy				Financial effect			
		Big	Medium	Small	Nothing	Big	Medium	Small	Nothing
3.3.1	Accidents								
3.3.2	Supplying defective materials								
3.3.3	Lower work quality due to time constraints								
3.3.4	Closure								
3.3.5	Over auditing by supervisors								
3.3.6	Increasing of materials prices								
3.3.7	Wage increases								
3.3.8									
3.3.9									

3.4 Tiling and granite works

No.	Risk factors	Expectancy				Financial effect			
		Big	Medium	Small	Nothing	Big	Medium	Small	Nothing
3.4.1	Supplying defective materials								
3.4.2	Lower work quality due to time constraints								
3.4.3	Approving material that surpass the expected								
3.4.4	Closure								
3.4.5	Over auditing by supervisors								
3.4.6	Increasing of materials prices								
3.4.7	Wage increases								
3.4.8									
3.4.9									

3.5 Aluminum works

No.	Risk factors	Expectancy				Financial effect			
		Big	Medium	Small	Nothing	Big	Medium	Small	Nothing
3.5.1	Lower work quality due to time constraints								
3.5.2	Closure								
3.5.3	Over auditing by supervisors								
3.5.4	Increasing of materials prices								
3.5.5	Wage increases								
3.5.6	Effective impact of changes in currency exchange rates								
3.5.7	Approving material that surpass the expected								
3.5.8									
3.5.9									

3.6 Base-coarse and Asphalt works

No.	Risk factors	Expectancy				Financial effect			
		Big	Medium	Small	Nothing	Big	Medium	Small	Nothing
3.6.1	Adverse weather conditions								
3.6.2	Defective design								
3.6.3	Supplying defective materials								
3.6.4	Lower work quality due to time constraints								
3.6.5	Over auditing by supervisors								
3.6.6	Closure								
3.6.7	Increasing of materials prices								
3.6.8	Wage increases								
3.6.9									
3.6.10									

Part 4
Main risk factors and resulting consequences for work categories

Table below shows the main risk factors for each work category as decided in part 3. These factors are set against the resulting consequences which result from each main risk factor.
For each main risk factor, determine the resulting consequences for each work category, by marking the appropriate box.
If there is any other consequences, please specify.

No.	Main Factors	Resulting Consequences / Work Category	Work delay	Equipment damage	Injuries	Poor productivity	Legal disputes	Financial penalties	Increasing of materials prices	Increasing of material waste	Re-working
4.1	Accidents	Excavation									
		Reinforced concrete									
		Block and plaster									
4.2	Adverse weather conditions	Excavation									
		Reinforced concrete									
		Block and plaster									
		Base-course and asphalt									
4.3	Defective design	Excavation									
		Reinforced concrete									
		Base-course and asphalt									
4.4	Actual quantities differ from the contract quantities	Excavation									
4.5	Unforeseen conditions	Excavation									
4.6	Supplying defective materials	Reinforced concrete									
		Block and plaster									
		Tiling and granite									
		Base-course and asphalt									
4.7	Lower work quality due to time constraints	Reinforced concrete									
		Block and plaster									
		Tiling and granite									
		Aluminum									
		Base-course and asphalt									
4.8	Closure	Reinforced concrete									
		Block and plaster									
		Tiling and granite									
		Aluminum									

No.	Main Factors	Resulting Consequences / Work Category	Work delay	Equipment damage	Injuries	Poor productivity	Legal disputes	Financial penalties	Increasing of materials prices	Increasing of material waste	Re-working
		Base-course and asphalt									
4.9	Effective impact of changes in currency exchange rates	Reinforced concrete									
		Aluminum									
4.10	Approved quality above the expected level of specifications	Tiling and granite									
		Aluminum									
4.11	Over auditing by supervisors	Reinforced concrete									
		Block and plaster									
		Floor tiles and granite									
		Aluminum									
		Base-course and asphalt									
4.12	Increasing of materials prices	Reinforced concrete									
		Block and plaster									
		Floor tiles and granite									
		Aluminum									
		Base-course and asphalt									
4.13	Wage increasing	Reinforced concrete									
		Block and plaster									
		Tiling and granite									
		Aluminum									
		Base-course and asphalt									

Part 5

The ways which could be conducted to avoid or minimize risks

Table below shows the main risk factors for each work category as decided in part 3. Please specify the ways which could be conducted to avoid or minimize risks for each work group/category. The researcher has placed some samples/ways regarding different factors, please indicate either you agree or don't agree with each one.

No.	Main Factors	Work Category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
5.1	**Accidents**	**Excavation**	**1- Increasing safety measures and tools.**	**2- Insuring against accidents.**	**3- Increasing manpower.**	**4- Increasing equipments**
		Reinforced concrete	1-	2-	3-	4-
		Block and plaster	1-	2-	3-	4-
5.2	**Adverse weather conditions**	**Excavation**	**1- Increasing working hours.**	2-	3-	4-
		Reinforced concrete	1-	2-	3-	4-
		Block and plaster	1-	3-	3-	4-
		Base-course and asphalt	1-	2-	3-	4-
5.3	**Defective design**	**Excavation**	**1-Employ a designer engineer to review designs.**	2-	3-	4-
		Reinforced concrete	1-	2-	3-	4-
		Base-course and asphalt	1-	2-	3-	4-
5.4	**Actual quantities differ from the contract quantities**	**Excavation**	**1- Employ quantity surveyor.**	2-	3-	4-
5.5	**Unforeseen conditions**	**Excavation**	1- **Increasing subcontract works as much as possible.**	**2- Increasing insurance coverage**.	**3-**	**4-**
5.6	**Supplying defective materials**	**Reinforced concrete**	**1- Assign the risk to the supplier**	2-	3-	**4-**
		Block and plaster	1-	2-	3-	4-
		Tiling and granite	1-	2-	3-	4-
		Base-course and asphalt	1-	2-	3-	4-

No.	Main Factors	Work Category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
5.7	**Lower work quality due to time constraints**	**Reinforced concrete**	**1- Subcontract a part of the work**	2-	3-	4-
		Block and plaster	1-	2-	3-	4-
		Tiling and granite	1-	2-	3-	4-
		Aluminum	1-	2-	3-	**4-**
		Base-course and asphalt	1-	2-	3-	4-
5.8	**Closure**	**Reinforced concrete**	**1- Buy and store materials.**	2-	3-	4-
		Block and plaster	1-	2-	3-	4-
		Tiling and granite	1-	2-	3-	4-
		Aluminum	1-	2-	3-	4-
		Base-course and asphalt	1-	2-	3-	4-
5.9	**Effective impact of changes in currency exchange rates**	**Reinforced concrete**	1- **Have the company's money distributed in different currencies**.	2-	3-	**4-**
		Aluminum	1-	2-	3-	4-
5.10	**Approved quality above the expected level of specifications**	**Tiling and granite**	**1- Undertake early enquiries (in the pricing phase).**	**2-Take the difference in price into consideration in the pricing phase.**		**4-**
		Aluminum	1-	2-		4-
5.11	**Over auditing by supervision**	**Reinforced concrete**	**1- Increasing subcontract works as much as possible.**	**2- Close supervision to subordinates for minimizing abortive work.**	3-	4-
		Block and plaster	1-	2-	3-	4-

No.	Main Factors	Work Category	Ways which could be conducted to avoid or minimize risks (Mitigation Actions)			
		Tiling and granite	1-	2-	3-	4-
		Aluminum	1-	2-	3-	4-
		Base-course and asphalt	1-	2-	3-	4-
5.12	**Increasing of materials prices**	**Reinforced concrete**	**1- Buy and store materials.**	2-	3-	4-
		Block and plaster	**1- Buy and store materials.**	2-	3-	4-
		Tiling and granite	**1- Buy and store materials.**	2-	3-	4-
		Aluminum	**1- Buy and store materials.**	2-	3-	4-
		Base-course and asphalt	**1- Buy and store materials.**	2-	3-	4-
5.13	**Wage increases**	**Reinforced concrete**	1-	2-	3-	4-
		Block and plaster	1-	2-	3-	4-
		Tiling and granite	1-	2-	3-	4-
		Aluminum	1-	2-	3-	4-
		Base-course and asphalt	1-	2-	3-	4-

Annex 3

RCEM evaluation questionnaire

استبيان لتقييم "RCEM"

1- يرجى التكرم بالافادة برأيكم فيما يتعلق بالنقاط الواردة في الجدول التالي لغرض تقييم الفائدة من برنامج الحاسوب Risk Cost Estimation and Management Software :

الرقم	البيان	موافق جداً	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جداً
1	يساهم البرنامج في حسن التخطيط للمشروع					
2	يوفر الامكانية لتحديد أسعار آمنه مناسبة عند تسعير المشروع					
3	يساعد في تقديم عروض اسعار منافسة مناسبة					
4	يساعد في تطوير عملية تسعير العطاءات في قطاع غزة					
5	يساعد في فهم و ادراك عوامل المخاطر الرئيسية المتوقعة لبنود الأعمال المختلفة.					
6	يساهم في فهم و إدراك ما يمكن أن ينتج من عوامل مخاطر تابعة عن عوامل المخاطر الرئيسية					
7	يساعد في حسن إدارة المشروع في مرحلة التنفيذ من حيث توقع المخاطر و الاستعداد للتعامل معها بالطرق المناسبة					
8	ملائم لجميع أنواع مشاريع التشييد					
9	مقنع عند الإستعانه به من قبل المقاول في حالة الحاجة لتقديم تحليل اسعار للمالك أو الاستشاري					
10	يساهم في إنشاء قاعدة بيانات للمشروع					
11	يساهم في تحديث قاعدة بيانات المشروع					
12	يساهم في زيادة الإعتماد على الحاسوب في إدارة المشاريع					
13	سهل الإستعمال					
14	سهل من حيث طريقة تعديل البيانات					
15	يتم تحديث البيانات في البرنامج بسهولة					
16	يوفر الوقت و الجهد المبذول من قبل طاقم التسعير					
17	فيه مرونة لإستيعاب معطيات المقاول الخاصة					
18	يمكن قراءة النتائج منه بسهولة ووضوح					
19	مناسب للمشاريع الصغيرة					
20	مناسب للمشاريع الكبيرة					

2- يرجى إبداء أي ملاحظات أو انتقادات تجدونها من خلال استخدام البرنامج

3- يرجى تحديد أي مميزات لهذا البرنامج من وجهة نظركم

4- يرجى إبداء أي مقترحات يمكن إدخالها على البرنامج

Annex 4

RCEM evaluation questionnaire (English Version)

Questionnaire for RCEM evaluation

1- In order to evaluate RCEM, please give your opinions regarding the following points:

No.	Techniques	No. of respondents				
		S. A	A	N	D	S. D
1	RCEM contributes in improving of project planning					
2	RCEM contributes in determining a safe and suitable price.					
3	RCEM helps in bidding with a competitive and a suitable price.					
4	RCEM contributes in development process of bids pricing in Gaza Strip.					
5	RCEM helps in recognizing of main risk factors for work categories					
6	RCEM helps in recognizing of consequences which could be resulted of main factors					
7	RCEM helps improve project management process during the implementation phase with regard to risks anticipation and mitigation.					
8	RCEM is suitable for all types of construction projects in Gaza Strip.					
9	A persuasive and explanatory tool of price analysis submitted to owner and consultant.					
10	RCEM contributes in building of a project database					
11	RCEM contributes in updating of database					
12	RCEM allows for higher dependency on computers in project management.					
13	Simplicity in using RCEM					
14	Simplicity in the way of updating the data.					
15	Simplicity in updating the data by using RCEM					
16	RCEM saves the time and minimizes the efforts in cost estimation					
17	RCEM is flexible enough to all for each contractor's special circumstances and requirements					
18	Results obtained can be readily and clearly read.					
19	RCEM is a suitable for small size projects					
20	RCEM is a suitable for big size projects					

(S.A= Strongly Agree, A= Agree, N= Neutral, D= Disagree, S.D= Strongly Disagree

2- What are your comments about RCEM?

3- What are the merits of RCEM from your point of view?

4- If there are any suggestions that might contribute to RCEM development, please specify?