

CHAPTER ONE: Introduction

1.1 **Background :**

Construction, like all industries today, is looking to improve business efficiencies. However it faces unique challenges due to the complexity of construction projects. These complexities create greater risks for inefficiencies than those faced by other industries. Providing research into construction risk mitigation is particularly critical in order to help the industry become more successful in overcoming its challenges ⁽¹⁾.

Risk Management (RM) is a concept which is used in all industries, from IT related business, automobile or pharmaceutical industry, to the construction sector. Each industry has developed its own RM standards, but the general ideas of the concept usually remain the same regardless of the sector. According to the Project Management Institute (PMI) (2004), project risk management is one of the nine most critical parts of project commissioning. This indicates a strong relationship between managing risks and a project success. RM is described as the most difficult area within construction management ⁽²⁾.

Risk is an uncertain event or condition that, if it occurs, has an effect on at least one project objective. Objectives can include scope, schedule, cost, and quality. Risk is defined as any action or occurrence which will affect the achievement of project objectives ⁽³⁾.

One of the major roles undertaken by a project manager is the management of the risk of a project. However, this duty is particularly complex and inefficient if good risk management has not been done from the beginning of the project. An effective and efficient risk management approach requires a proper and systematic methodology and, more importantly, knowledge and experience

Risks and uncertainties inherent in the construction industry are more than any other industries. Many industries have become more proactive about using risk management techniques in project. However, with respect to the construction industry, the same is not used commonly. Risk is an integral component of any project. Risk is present in all projects irrespective of their size or sector. No project is totally free from risks. If risks are not properly analyzed and strategies are not trained to deal with them, the project is likely to lead to failures.

1.2 Project life cycle :

Each activity or process, regardless of the area of business domain, has a beginning and an end. Similar concepts are used in the engineering world to systemize projects over time. The term project life cycle is used as a management tool to improve a projects performance. The scope of life cycles differs among industries and diverse terminology with a various number of phases is used depending on the sectors. However, several terms are often used within one particular sector even though a number of phases can vary ⁽²¹⁾

Therefore, it is difficult to systemize and provide one common scope and definition of a project life cycle.

The various forms of PLC frameworks described in the literature are a result of variety of project types. For construction projects, for instance, the PLC model can consist of eight succeeding phases including pre-feasibility, feasibility, design, contract/procurement, implementation, commissioning, handover and operation ⁽²¹⁾ In contrast, other researchers present a four stage as the most widely used framework, where conceptualization, planning & Design , execution and closing are the main phases.

The same authors in another publication make a further division of each of the four phases into another number of stages and steps. Such fragmentation of the activities provides easier and more accurate potential risk identification and makes risk management processes more effective ⁽¹⁵⁾. Due to the variety of project types, PLC requires adjustments and an individual approach. A number of further stages within each phase should be adjusted to a particular project depending on its scope and structure. Since each project is unique, a framework used in one project can turn out to be completely inapplicable in another. Therefore the model, as the one proposed by should be used as an example and not as ready-made template.

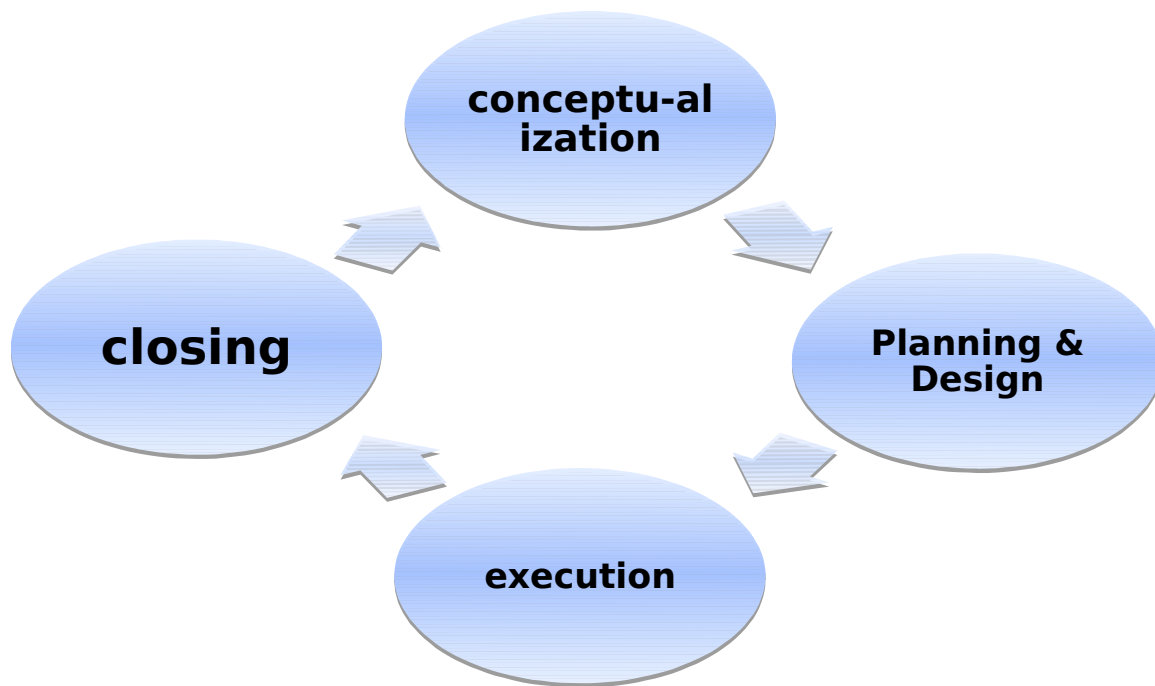


Figure 1.1 Project life cycle ⁽⁶⁾

1.2.1 Conceptualization Phase :

- During the first of these phases, the conceptualization phase, the project objective or need is identified; this can be a business problem or opportunity. An appropriate response to the need is documented with recommended solution options. A feasibility study is conducted to investigate whether each option addresses the project objective and a final recommended solution is determined. Issues of feasibility (“can we do the project?”) and justification (“should we do the project?”) are addressed.
- Once the recommended solution is approved, a project is initiated to deliver the approved solution and a project manager is appointed. The major deliverables and the participating work groups are identified, and the project team begins to take shape. Approval is then sought by the project manager to move onto the detailed planning phase.

1.2.2 Planning & Design Phase

- The next phase, the planning phase, is where the project solution is further developed in as much detail as possible and the steps necessary to meet the project's objective are planned. In this step, the designer identifies all of the work to be done. The project's tasks and resource requirements are identified, along with the strategy for producing them. This is also referred to as "scope management." A project plan is created outlining the activities, tasks, dependencies, and timeframes. The project manager coordinates the preparation of a project budget by providing cost estimates for the labor, equipment, and materials costs. The budget is used to monitor and control cost expenditures during project implementation.
- Once the project team has identified the work, prepared the schedule, and estimated the costs, the three fundamental components of the planning process are complete. This is an excellent time to identify and try to deal with anything that might pose a threat to the successful completion of the project. This is called risk management. In risk management, "high-threat" potential problems are identified along with the action that is to be taken on each high-threat potential problem, either to reduce the probability that the problem will occur or to reduce the impact on the project if it does occur. This is also a good time to identify all project stakeholders and establish a communication plan describing the information needed and the delivery method to be used to keep the stakeholders informed.
- Finally, you will want to document a quality plan, providing quality targets, assurance, and control measures, along with an acceptance plan, listing the criteria to be met to gain customer acceptance. At this point, the project would have been planned in detail and is ready to be executed

- **1.2.3. Implementation (Execution) Phase**

- During the third phase, the implementation phase, the project plan is put into motion and the work of the project is performed. It is important to maintain control and communicate as needed during implementation. Progress is continuously monitored and appropriate adjustments are made and recorded as variances from the original plan. In any project, a project manager spends most of the time in this step. During project implementation, people are carrying out the tasks, and progress information is being reported through regular team meetings. The project manager uses this information to maintain control over the direction of the project by comparing the progress reports with the project plan to measure the performance of the project activities and take corrective action as needed. The first course of action should always be to bring the project back on course (i.e., to return it to the original plan). If that cannot happen, the team should record variations from the original plan and record and publish modifications to the plan. Throughout this step, project sponsors and other key stakeholders should be kept informed of the project's status according to the agreed-on frequency and format of communication. The plan should be updated and published on a regular basis.
- Status reports should always emphasize the anticipated end point in terms of cost, schedule, and quality of deliverables. Each project deliverable produced should be reviewed for quality and measured against the acceptance criteria. Once all of the deliverables have been produced and the customer has accepted the final solution, the project is ready for closure.

- **1.2.4 Closing Phase**

During the final closure, or completion phase, the emphasis is on releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources, and communicating the closure of the project to all stakeholders. The last remaining step is to conduct lessons-learned studies to examine what went well and what didn't. Through this type of analysis, the wisdom of experience is transferred back to the project organization, which will help future project teams.

1.3 Research problem

The management of risks is a central issue in the planning and management of any venture. Construction industry is subject to more risk and uncertainty than many other industries. The process of taking a project from initial investment appraisal to completion and into use is a complex process. Construction industry in Sudan is suffering from the misunderstanding of risk management including risk identification, analysis and assessment, and that is why this research is important, where it will discover the risk factors in the construction industry in Sudan and determine the importance of each factors in terms of severity and allocation.

1.4 Justification of the study

Risk management became an essential mission of the construction industry projects. Taking into account that the construction industry is considered one of the most risky industries, it is important for the engineers to be aware of the negative consequences that might result from lack of risk

management, which in turn affect the submission of the project on the planned time. Considering the unstable financial status in Sudan, time factor plays an essential role since any delay in the project submission will affect its cost.

Unfortunately, only few researchers have participated in addressing the problem of risk factors affecting the construction industry projects in Sudan. Therefore, this study aims to identify these factors in order to mitigate the negative consequences.

1.5 Research questions

In order to achieve the purpose, the following research questions have been formulated to support the investigation:

- What are the risk factors affecting construction project in Sudan?
- What are the roles of the project parties-consultant & contractor- in managing project risks and mitigating its impacts?
- What are the risk preventive methods which could be used to avoid risk?
- Are there any local legislations or polices to mitigate risk impact?

1.6 Research objectives

This research sets sights on introducing the risk management in building projects from the engineers' perspectives and identifies key risk factors and their impacts on the projects.

1.6.1 General Objectives

- To increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project.

1.6.2 Specific Objectives

- To identify the risk factors that might face the construction projects and its impact.
- To assess engineers' awareness about managing risk factors before and through project implementation.
- To investigate the practices of risk management across project organization of Sudan construction companies.
- To allocate the roles of the project parties in managing different risk factors
- To identify the preventive and metegitave methods before and after project implementations in order to reduce the possible future risks and maximizing Profitability.

1.7 Hypothesis

In order to conduct this research, certain hypothesis was adopted such as:-

1. Problems are expected because of the lack of engineers' knowledge and practice about risk factors management.
2. Risk management leads to achieve high productivity and improve performance levels in construction companies.
3. Lack of legislation and policies are behind risk impact.
4. The short comings in playing contractual roles by the parties increase the probability of risk impact.

1.8 Research Importance and limitation

This research is considered to be of an important effect on the construction industry in Sudan. Being the cause is the current situation of the industry. Projects end up with disputes, conflicts between parties of the project, lack of quality and

creep in project duration due that increase in the total cost of the project thereby engineers should be more aware about practicing of risk management.

1.9 Research Methodology

The study was conducted through several phases' namely theoretical part, data collection, data analysis results and discussion, conclusions and recommendations. The theoretical part conducted in order to provide the literature overview about the construction project in general with the focus on the risk management and identifying risk factors and the relevant information from books, papers, previous researches and websites related. Data collection was collected by using a self-administer questionnaire which was distributed to the engineers in different firms.

Subsequently, chapter four showed results and discussion. Finally the final recommendations are drawn up in the conclusion section.

CHAPTER TWO: Literature Review

2.1 The nature of the construction industry

The nature of the construction projects makes the industry unique in that the manufacturing facility or plant must move to the construction site. There are many different descriptions of the construction industry, drawn from different specialist disciplines. This vagueness is compounded by the fact that the construction involves such a wide range of activity that the industry's external boundaries are also unclear ⁽⁴⁾. For example, the term "construction" can include the erection, repair, and demolition of things and diverse as houses, offices, shapes, dams,...etc. Construction is difficult to

Comprehend fully because the relationships between the parts are not always clear and the boundaries of the industry may be characterized as:

- It is fragmented
- It is sensitive to economic cycles
- There are extraordinary diversity of professions, specialists and suppliers
- It is largely affected by external environments. There is no other industry that requires the proper application of business practices much as construction industry. The many variables and complex relationships that exist

between variables that must be considered in the process of building a construction project necessitates sound business practices and decisions. The coordination and use of many types of labor skills, materials and equipment that are used to build a project require daily application of proper business practices (Adrian, 1975). The variable environment surrounding the construction project complicated decisions to be made concerning the use of labor, materials and equipment. ⁽⁴⁾.

2.2 The Size of the Construction Industry

There is no doubt that construction is a key activity in any economy, it influences and is influenced by the gross domestic product (GDP) of any nation ⁽³⁾. Construction industry is defined as a risky industry with uncertainties that management has to deal with. A variety of external and internal factors influencing the construction process are main reasons of this situation ⁽³⁾.

The construction industry is characterized by having many players of multiple disciplines who are brought together at various stages throughout a single project. Construction projects are complex and time-consuming undertakings. The structure must be designed in accordance with applicable codes and standards, culminating in working drawings and specifications that describe the work in sufficient details for its accomplishment in the field (Clough,1986). The construction projects have been divided into four main categories: residential construction, building construction, heavy engineering construction and industrial construction. ⁽⁴⁾

2.3 Construction industry in Sudan

The Sudanese construction sector is characterized by many small and large projects and high labor intensity; it is also highly dependent on public

regulations and public investments. The Sudanese construction industry also has a number of factories and material suppliers that provide building materials and specialist fittings. The scope of Sudanese construction industry is very wide, includes residential construction, building construction of commercial, irrigation, roads, tunnels, transportation, facility building, and heavy engineering construction refer to infrastructure construction and industrial construction. The construction sector is an important to the Sudan economy; the construction sector accounted for 3.2% of the country's GDP in 2009 and grew by about 10% in 2010 in nominal terms, according to the Central Bank of Sudan .⁽⁵⁾

2.4 Management in Construction

On the whole, construction contractors have been slow in applying proper management methods to the conduct of their business ⁽⁶⁾. Management in construction industry have been characterized as being weak, insufficient, nebulous, backward and slow to react to changing conditions. Nevertheless, in the overall picture, the construction industry is at or near the top in the annual rate of business failures and resulting liabilities ⁽⁶⁾ Explanations are given for why the construction has been slow in applying management procedures that have proven effective in other industries. The reasons are :

- Construction projects are unique
- Construction projects involve many skills largely non-repetitive in nature
- Projects are constructed under local conditions of weather, location, transportation and labor that are more or less beyond the contractor's control.
- Construction firms, in main, are small operations, with the management decisions being made by one or two persons ⁽⁶⁾
- There are special problems in construction
- The future cannot be forecasted
- Construction is a high-risk business ⁽⁴⁾.

2.5 The risk management

Risk management is very important for accomplishing any project and should be developed in the planning stage of the project. Many explanations and definitions of risks and risk management have been recently developed, and thus it is difficult to choose one which is always true. Each author provides his own perception of what risk means and how to manage it. The description depends on the profession, project and type of business ⁽⁴⁾. Risk management in general is a very broad subject and definitions of risk can therefore differ and be difficult to apply in all industries in general. For the purpose of this thesis one definition of risk and risk management will be chosen, in order to have a clear understanding of these concepts in construction industry. ⁽²⁾

2.5.1 Defining OF Risk

Risk can be defined as an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective. A risk has a cause and, if it occurs, a consequence ⁽⁷⁾. Events are said to be certain if the probability of their occurrence is 100% or totally uncertain if the probability of occurrence is 0%. In between these extremes the uncertainty varies quite widely. ⁽²⁾

The Project Management Institute (1996) introduced a simple definition for risk as a discrete occurrence that may affect the project for better or worse. In order to emphasize the major objectives of survey on risk management actions, risk has been defined as the probability of occurrence of some uncertain, unpredictable and even undesirable events that would change the prospects for the profitability on a given investment ⁽⁹⁾

- Risk exists when a decision is expressed in terms of range of possible outcomes and when known probabilities can be attached to the outcomes.
- Uncertainty exists when there is more than one possible outcome of a course of action but the probability of each outcome is unknown. ⁽²⁾

Risk and uncertainty are the two most often used concepts in the literature covering RM field. Although these terms are closely related, a number of authors differentiate between them ⁽⁴⁾. Also practitioners working with risk have difficulty in defining and distinguishing between these two. Often definitions of risk or uncertainty are tailored for the use of a particular project. To make it more systematized, a literature research was done. The findings of this search resulted in a number of definitions of risk and uncertainties. These have been compiled and are presented in Table (2.1) .

| Author: | Risk definition | Uncertainty definition |
|----------------------------|--|---|
| Winch (2002) | A stage where there is a lack of information, but by looking at past experience, it is easier to predict the future. Events where the outcome is known and expected. | Uncertainty is a part of the information required in order to take a decision. The required information consists of the amount of available information and uncertainty. The level of uncertainty will decrease the further a project is proceeding throughout the lifecycle. |
| Cleden (2009) | Risk is the statement of what may arise from that lack of knowledge. Risks are gaps in knowledge which we think constitute a threat to the project. | Uncertainty is the intangible measure of what we don't know. Uncertainty is what is left behind when all the risks have been identified. Uncertainty is gaps in our knowledge we may not |
| Smith <i>et al.</i> (2006) | Risks occur where there is some knowledge about the event. | There might be not enough information about the occurrence of an event, but we know that it might occur. |
| Webb (2003) | Risk is a situation in which he possesses some objectives information about what the | Uncertainty is a situation with an outcome about which |

| | | |
|----------------------------|--|----------------------------|
| | outcome might be. Risk exposure can be valued either positively or negatively. | a person has no knowledge. |
| Darnall and Preston (2010) | Risk is a possibility of loss or injury. | |

Table 2.1 Definitions of risk and uncertainty

All risk definitions compiled in Table (2.1) describes risk as a situation where lack of some aspect can cause a threat to the project. Lack of information and knowledge are those factors which are most commonly mentioned by all the authors as leading reasons for a failure. ⁽²⁾

A risk is defined as the potential for complications and problems with respect to the completion of a project and the achievement of a project goal and as an uncertain future event or condition with the occurrence rate of greater than 0% but less than 100% that has an effect on at least one of project objectives (*i.e.*, scope, schedule, cost, or quality, etc.). In addition, the impact or consequences of this future event must be unexpected or unplanned. It is well accepted that risk can be effectively managed to mitigate its' adverse impacts on project objectives, even if it is inevitable in all project undertakings. ⁽⁸⁾

2.5.2 Risks in Construction

The construction industry generally has a bad reputation for its work. The industry has a reputation for time and cost overruns. This bad reputation is due to many reasons. One of them is that the construction industry is one of riskiest of all business types

⁽⁶⁾.There are a number of risks which can be identified in the construction industry and which can be faced in each construction project regardless of its size and scope. Changes in design and scope along with time frames for project completion are the most common risks for the construction sector. The further in the process, changes in scope or design are implemented, the more additional resources, time and cost, those changes require. Project completion ahead of time may be as troublesome as delays in a schedule. Too quick completion may be a result of insufficient planning or design problems which in fact shorten the completion time but on the other hand lead to a low quality of final product and increased overall cost. Being behind schedule generates greater costs for both investors and contractors due to non-compliance with contracted works.⁽¹⁰⁾ And thus it is important to keep a balance in the concept of time-cost-quality trade off, which more widely is becoming an important issue for the construction sector⁽¹¹⁾ .Depending on the project scope, sources of risks will identify risk categories or risk factors for the construction sector which will be a subject of one of the next titles.

2.5.3 Sources of Risks

Checklist of risk drivers ⁽⁸⁾ :

- Commercial risk.
- Financial risk.
- Legal risks.
- Political risks.
- Social risks.
- Environmental risks.
- Communications risks.
- Geographical risks.

- Geotechnical risks.
- Construction risk

These sources of risk relate to project-specific and non-project-specific risks, as both these types of risk need to be considered when identifying the risks in a project or a process. The institution, assisted by the project team, need to define the boundaries of these sources and to break down these sources into detailed risk elements. This will allow a common understanding amongst those attempting to identify the risks in a project.

2.5.4 Typical Risks on a Construction Project

- Occurrence of accidents to operatives on site causing physical injury.
- Failure to complete within the stipulated design and construction time.
- Failure to obtain the expected outline planning, detailed planning or building code/regulation approvals within the time allowed in the design program.
- Unforeseen adverse ground conditions delaying the project.
- Unexpected rises for labor and materials.
- Force majeure.
- Failure to complete the project within the client's budget allowance.
- Loss of the contractor caused by the late production ⁽¹²⁾

It is important to distinguish the sources of risk from their effects. Ultimately, all risk encountered on a project is related to one or more of the following ⁽¹²⁾

- Failure to keep within the cost budget/forecast/estimate/tender.
- Failure to keep within the time stipulated for the approvals, design, construction and occupancy.
- Failure to meet the required technical standards for quality, functions, fitness for purpose, safety and environment preservation.

The effect of adverse events will be financial loss. The task of professional advisors, contractors and suppliers is to identify the discrete sources of risk which cause to failure occur, and to develop a risk management strategy that provides for the most appropriate organizations to carry that risk ⁽¹²⁾.

2.5.5 Risk Categories

Risk classification is an important step in the risk assessment process, as it attempts to structure the diverse risks that may affect a project. There are many approaches in literature for construction risk classification. ⁽³⁾

The obvious problem with categorizing risk, apart from the cultural Perceptions noted by the royal society report, is that there is a danger of confusing sources, causes, effects and fields of study for the risk domain. A source approach to risk categorizations is shown in Figure (2.1). It is proposed that the risks can be considered to six categories: financial and economic, political and environment, design, site construction, physical and Environmental factors.⁽¹³⁾ These Risk Factors modified according to factors existing in Sudan and has been adopted in this research.

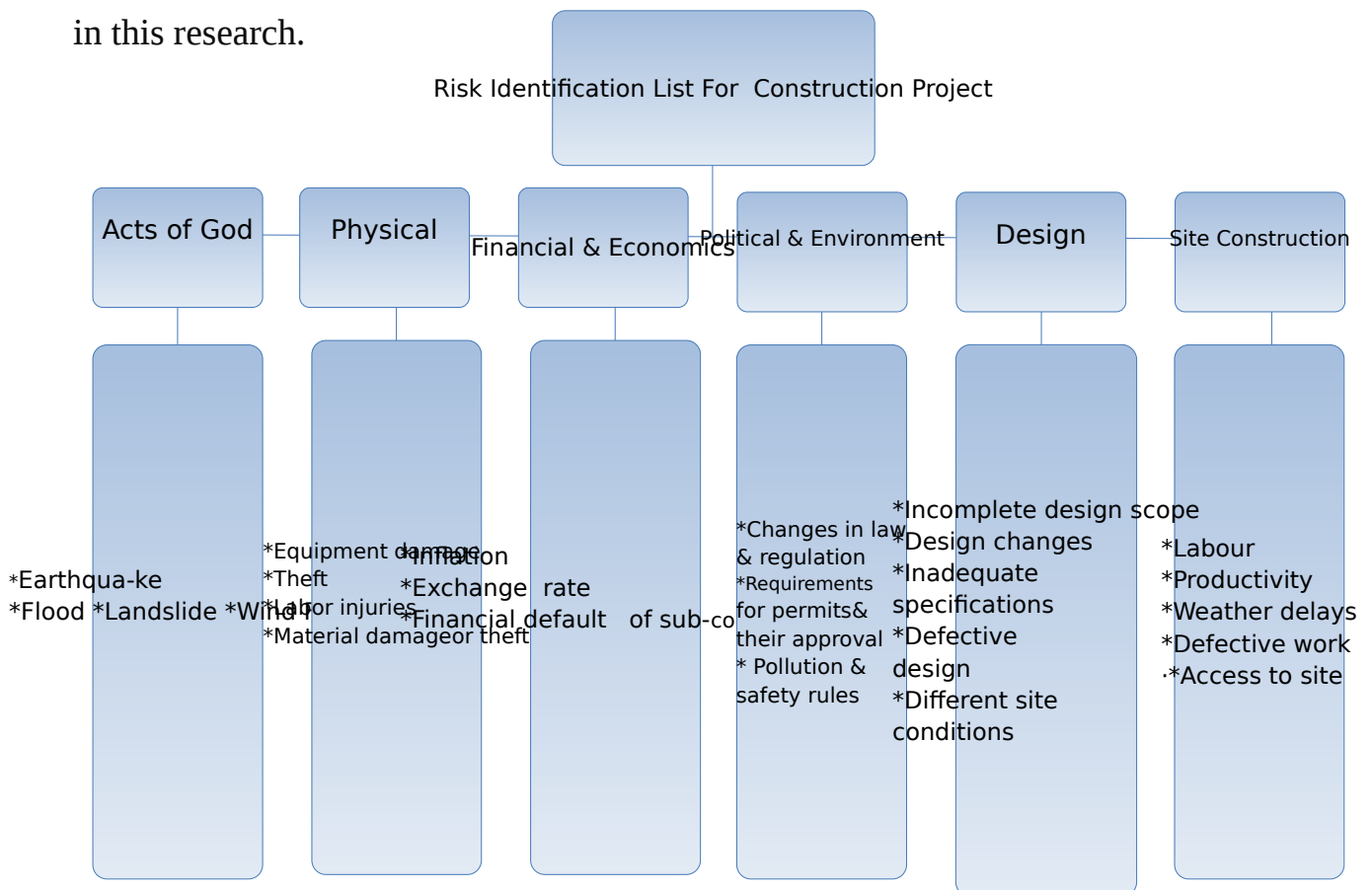


Figure 2.1 Risk Categorization List ⁽¹³⁾

2.6 Risk Management Process

In Risk management, risk identification and classification are needed in order to analyse the risk and start to treat process in the project. Risk management also concerns the decisions that are made when the results from the risk analysis are obtained. The decisions can be made towards risk reduction, avoiding or transferring to another phase of the project task, the building project or the project participants. ⁽¹⁴⁾

Figure (2.2) provides a summary of the literature research, in order to facilitate the use of the RMP. All four steps are included and are placed on the left hand side. On the right, the follow up procedures are listed to clarify some of the techniques used to manage the risks in the most effective way. By following the arrows on the graph, all the necessary steps of RM will be performed. This process should be continuously performed throughout the whole project in order to keep track of all potential risks.

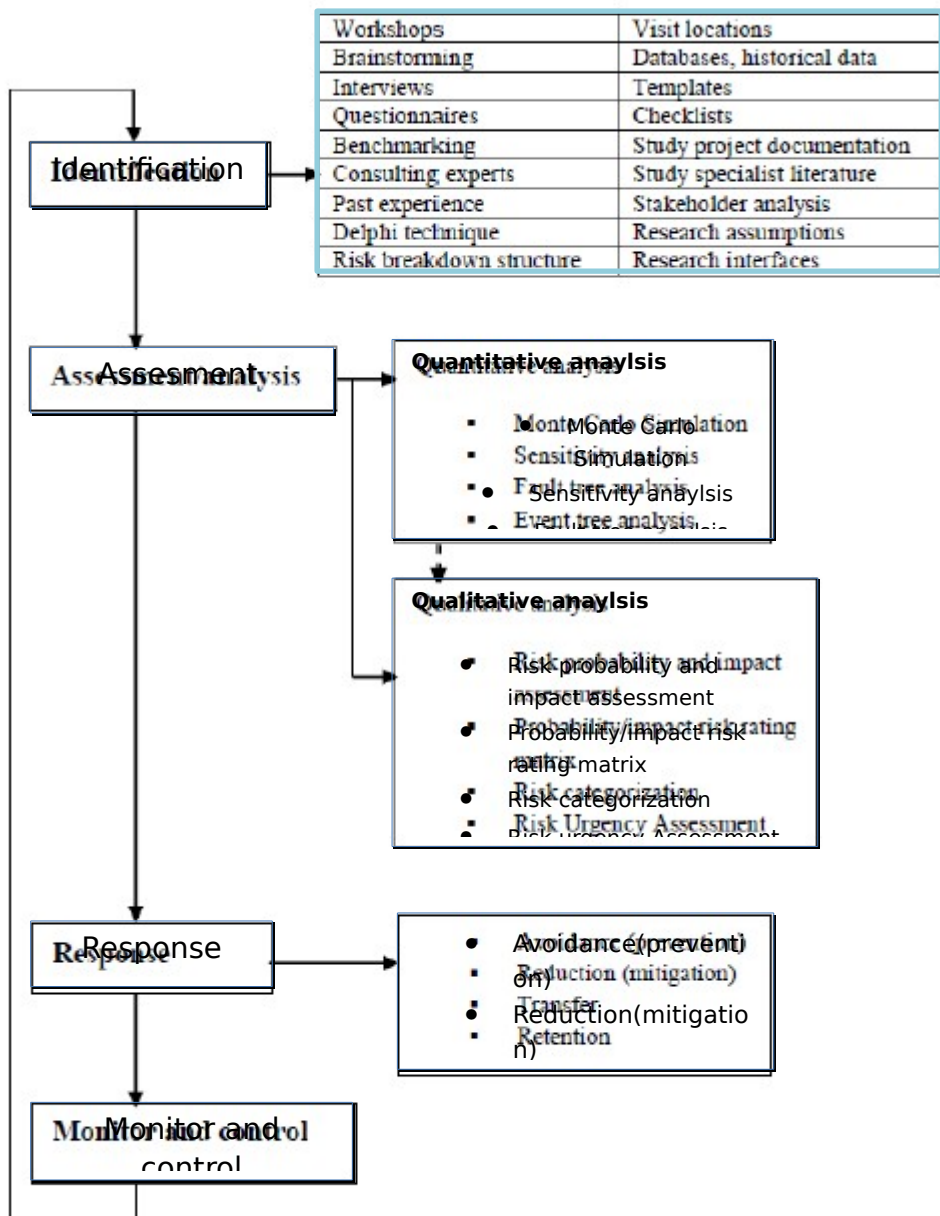


Figure 2.2 Diagram of Risk Management process (2)

Fig (2.2) illustrates the steps of managing risk where main four steps are concerned namely:

2.6.1 Risk Identification

This is the first stage in risk management and it entails capturing all the potential risks that could arise within the project. It is commonly acknowledged that of all the stages of risk management process, risk identification stage has the largest impact on the accuracy of any risk assessment. ⁽¹⁵⁾Risks and other threats can be hard to eliminate, but when they have been identified, it is easier to take actions and have control over them. If the causes of the risks have been identified and allocated before any problems occur, the risk management will be more effective. ⁽¹⁶⁾ RM is not only solving problems in advance, but also being prepared for potential problems that can occur unexpectedly. Handling potential threats is not only a way to minimize losses within the project, but also a way to transfer risks into opportunities, which can lead to economical profitability, environmental and other advantages. In project context, risk identification is also concerned with opportunities (positive outcomes) as well as threats (negative outcomes) a clear view of the event is the first equipment, focusing on the sources of risk and effect of the event.⁽¹²⁾While extensive catalogues of risk can be devised, these are always likely to be incomplete and therefore inadequate. This may lead to decision-makers failing to consider the full spectrum of potential risks for a project. Developing categories of risk is one

way of typifying risks so that this danger can be minimized. can be done by the following methods:

2.6.1.1 Brainstorming: This is one of the most popular techniques. Generally, it is used for idea generation; it is also very useful for risk identification. All relevant persons associated with project gather at one place. There is one facilitator who is briefing about various aspects with the participants and then after note down the factors. Before closing it the facilitator review the factors eliminate the unnecessary ones.

2.6.1.2 Delphi Technique: This technique is similar to brainstorming but the participants in this do not know each other and they are not at the same place. They will identify the factors without consulting other participants. The facilitator like in brain storming , sums up the identified factors.

2.6.1.3 Interview/Expert Opinion: Experts or personnel with sufficient experience in a project can be a great help in avoiding/solving similar problems over and over again. All the participants or the relevant persons in the project can be interviewed for the identification of factors affecting risk.

2.6.1.4 Past Experience: Past experience from the same kind of project, the analogy can be formed for identification of the factors. When comparing the characteristics of projects will provide insight about the common factors. ⁽¹⁸⁾

2.6.2 Risk Analysis

Risk analysis, a component of the risk management process, deals with the causes and effects of events which cause harm. The aim behind such analysis is a precise and objective calculation of risk. To the extent that this is possible, it allows the decision making process to be more certain ⁽¹⁷⁾ the essence of risk

analysis is that it attempts to capture all feasible options and to analyze the various outcomes of any decision. For building projects, clients are mainly interested in the most likely price, but projects do have cost over-runs and, too frequently, the 'what if' question is not asked ⁽¹²⁾

2.6.2.1 Methods of Risk Analysis

The analysis of risks can be *quantitative* or *qualitative* in nature depending on the amount of information available, Qualitative analysis focuses on identification together with assessment of risk, and quantitative analysis focuses on the evaluation of risk, Indeed there may be so little information about certain risks that no analysis is possible.

A. Methods of Quantitative Risk Analysis

Any specific risk analysis technique is going to require a strategy. It is best to begin by providing a way of thinking about risk analysis that is applicable to any specific tool might be used.

Sensitivity Analysis This is carried out to identify the uncertain project components which will have maximum impact on the outcome of the project. After a risk model is made a sensitivity analysis is carried out to check the sensitivity of different elements of the model on project outcome. To do these the values of one variable at a time is changed and the impact of these changes is then seen on the project. ⁽⁴⁾

Monte Carlo Simulation is presented as the technique of primary interest because it is the tool that is used most often. A project simulation is done using a model to show the potential impact of different level of uncertainties on project objectives. Monte Carlo Simulation is generally used for this analysis. It can quantify the effect of uncertainties and risks on project budget

and schedule. It simulates the full system many times, each time randomly choosing a value for each factor from its probability distribution. It uses three point estimates like most likely, worst case and best case duration for each task in time management. ⁽¹⁸⁾

Breakeven Analysis is an application of a sensitivity analysis. It can be used to measure the key variables which show a project to be attractive or unattractive.

Scenario Analysis: Scenario analysis gives the impact of different scenario of the project or impact of different risk if that occurs simultaneously. A fair decision can be made after this analysis, the option which will give lesser loss or hazards that option can be opted. The aim is to consider various scenarios as options. ⁽¹⁸⁾

Decision Trees: This analysis is carried out by decision tree diagram. Decision trees are very helpful to both formulate the problem and evaluate options. In this analysis there are graphical models used to represent a project and can clearly reflect the effects of each decision taken in the project. ⁽¹⁸⁾

B. Methods of Qualitative Risk Analysis

Qualitative methods for risk assessment are based on descriptive scales, and are used for describing the likelihood and impact of a risk. These relatively simple techniques apply when quick assessment is required in small and medium size projects ⁽¹⁹⁾ Moreover, this method is often used in case of inadequate, limited or unavailable numerical data as well as limited resources of time and money. The main aim is to

prioritize potential threats in order to identify those of greatest impact on the project.

- Risk probability and impact assessment
- Probability/impact risk rating matrix
- Risk categorization, and Risk Urgency Assessment

2.6.3 Risk response

This third step of the RMP indicates what action should be taken towards the identified risks and threats. The response strategy and approach chosen depend on the kind of risks concerned. Other requirements are that the risk needs to have a supervisor to monitor the development of the response, which will be agreed by the actors involved in this risk management process. ⁽¹⁶⁾

There are four distinct ways of responding to risks in a construction project, namely, risk avoidance, risk reduction, risk retention and risk transfer. Those ways are discussed in below briefly.

2.6.3.1 Risk Avoidance

The risk is classified as bringing negative consequences to the whole project, it is of importance to review the projects aim. In other words, if the risk has significant impact on the project, the best solution is to avoid it by changing the scope of the project or, worst scenario, cancel it. There are many potential risks that a project can be exposed to, and which can impact its success. ⁽²⁰⁾ This is why risk management is required in the early stages of a project instead of dealing with the damage after the occurrence of the risk. ⁽¹⁶⁾

list some activities that can help to avoid potential risk ⁽¹⁹⁾

- More detailed planning
- Alternative approaches
- Protection and safety systems
- Operation reviews
- Regular inspections
- Training and skills enhancement
- Permits to work
- Procedural changes
- Preventive maintenance

2.6.3.2 Risk Transfer

Transferring risk involves finding some other party who is willing to accept responsibility for its management, and who will bear the liability of the risk should it occur, transferring a threat does not eliminate it; the threat still exists however it is owned and managed by another party. Transferring risk can be an effective way to deal with financial risk exposure. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively. ⁽¹⁸⁾

2.6.3.3 Risk Retention

When a risk cannot be transferred or avoided, the best solution is to retain the risk. In this case the risk must be controlled , in order to minimize the impact of its occurrence ⁽²⁰⁾ .Retention can also be an option when other solutions are uneconomical.

2.6.3.4 Risk Reduction

Risk mitigation reduces the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective than attempting to repair the damage after the risk has passed. ⁽¹⁸⁾

2.6.4 Monitor & Control Risks

is the final step of the process. After we have implemented response actions, we must track and record their effectiveness and any changes to the project risk profile. Did the response actions have a positive or negative effect on achieving project objectives? Responses taken in risks should also be documented for future reference and project plans.

CHAPTER THREE: Data Collection

Methodology

3.1 Research tool (Questionnaire):

A -based cross- sectional survey tool was used as it is assumed to be the most appropriate way to answer the research questions and to compile data. A comprehensive questionnaire was designed and structured in many sections in order to achieve the research objectives.

3.2. Study variables:

The questions incorporated in the document addressed the variables such as:

3.2.1 Demographic variables:

Academic qualification, years of experience speciality, job description, sector

3.2.2. Variables according to the specific objectives:

- Type of risk factor
- Impact of risk factor
- Engineers' awareness level
- Risk responsibility (allocation)
- Type of preventive method before & through implantation phase

3.3 Scope of the research:

The construction industry in Sudan confronts a genuine challenges that constituted by risk impacts. There are many sources of risks which could affect the achievement of the project objectives.

This research is concerned of illustrating such factors that might be behind the risk attacks. The aim of any project is to achieve some prescribed objectives, so in order to do so it is every essential to manage the risks through the project life cycle. The study addressed the area of management that related to project risk management.

3.4 Research population:

As the research is about risks impact in construction projects, it is very vital to involve the groups that interact in this field. The engineers regarding-their professional levels as per Sudanese engineering council registrations are considered part of the

population. The engineering entities either in the field of contracting or consultancy works are part of the population.

3.5 Data collection

The established questionnaire was piloted and revised accordingly and then it was distributed (after pre-test was done) to the adopted samples (70) to be answered by the engineers in contracting and consultants firms (a copy is attached). The aim of the study was explained to the participants and a verbal consent was obtained from them before answering the questionnaire.

3.6 sample selection:

A statistical method was used in to identify the sample size, so out of the population the samples were taken in a random systemic way and it represented the characteristics of the population.

CHAPTER FOUR: Results and Discussion

4.1 Introduction

The aim of this study is to determine the risk factors impact degree in construction industry, allocation of these factors, methods used to deal with risks. The results of the study are concluded and discussed in details in this chapter.

4.2 Risk factors

The questionnaire included 27 risk factors, which have been categorized in nine main groups, these groups were: physical group, environmental group, design group, logistics group, financial group, legal group, construction group, political group and management group. The factors of each group will be demonstrated in the terms of severity and allocation according to the engineers answers.

| | | Frequency | Percent |
|------------------------|--------------------|-----------|---------|
| Academic Qualification | Bachelor's degree | 59 | 84.3 |
| | Master's degree | 7 | 10.0 |
| | Higher diploma | 4 | 5.7 |
| Years of experience | less than 5 years | 29 | 41.4 |
| | 5-10 years | 20 | 28.6 |
| | 11-15 years | 10 | 14.3 |
| | more than 15 years | 11 | 15.7 |
| Speciality | Architect | 24 | 34.3 |
| | Civil | 34 | 48.6 |
| | Other | 12 | 17.1 |
| Job Description | Consultant | 30 | 42.9 |
| | Contractor | 30 | 42.9 |
| | Owner | 4 | 5.7 |
| | Other | 6 | 8.6 |
| Sector | General | 8 | 11.4 |
| | Private | 61 | 87.1 |
| | Other | 1 | 1.4 |
| | Total | 70 | 100.0 |

Table 4.1 (illustrate demographic data)

4.2.1 Physical Factors

4.2.1.1 Risk impact

Results showed that the defective supply materials has the highest impact risk in the physical factors (65.7%), these results indicate the concerns about absence of a standardized description method for building materials in Sudan.

Occurrence of accidents was the second from importance (52.9%), and the third was decline in the productive capacity of workers and machinery breakdowns (32.9%) this result is supported by other researchers.

| Physical Risk Factors | Low impact risk | Medium impact risk | High impact risk |
|--|------------------------|---------------------------|-------------------------|
| Occurrence of accidents because of poor safety procedures | 11.4 | 35.7 | 52.9 |
| Poor / defective supply materials | 10.0 | 24.3 | 65.7 |
| Decline in the productive capacity of workers and machinery breakdowns | 12.9 | 54.3 | 32.9 |

Table4.2. Physical Factors

4.2.1.2 Risk Responsibility (allocation)

The respondents indicated that the contractor is responsible for all the physical risk factors, being the highest risk factor is the decline in the productive capacity of workers and machinery breakdowns (88.6%) ,and this finding is supported by the Sudanese terms & conditions for construction and Fidic Conditions.

Figure4.1. Physical Factors

4.2.2 Environmental Factors

4.2.2.1 Risk impact

Respondents considered that natural disasters as a main cause of delay (50 %) that due to this risk category increase the probability of uncertain, unpredictable and even undesirable factors in the construction site. However, the risks of adverse weather conditions and site accessibility did not appear with high significant risks among the surveyed risks. Environmental factors occurred hardly ever, that is why the impact of the risk of Environmental factors was relatively low.

| Environmental Risk Factors | Low impact risk | Medium impact risk | High impact risk |
|-----------------------------------|------------------------|---------------------------|-------------------------|
| Natural disasters | 22.9 | 27.1 | 50.0 |
| Difficulty to access the site | 30.0 | 44.3 | 25.7 |
| Adverse weather conditions | 41.4 | 35.7 | 22.9 |

Table4.3. Enviromental Factors

4.2.2.2 Risk Responsibility (allocation)

Figure (4.2) demonstrates that respondents could not decide on the allocation of natural disasters,(67.1 %) chose that the responsible is unknown, Risk of site access was considered as a high allocation to owner (34.3 %) ,this result indicate that site access risk need to be borne by the owner who should evaluate the needs during the planning phase, but some respondents allocate site access risk to contractor, but due to the on-going tense situation, contractors and owners have to coordinate their efforts to get a best handling of such risks. 64% of respondents supposed to allocate the risks of adverse weather conditions to insurance, but it is known that weather conditions are out of control and such risk should be shared to get better handling and to reduce conflicts probabilities.

Figure4.2. Environmental Factors

4.2.3 Design Factors

4.2.3.1 Risk impact

Regarding the design risk factors, the highest impact degree was found to be the lack of giving the design to unqualified designer (77.1%), and this high percentage might indicate the lack of awareness and good training procedures of the technical staff.

| Design Risk Factors | Low impact risk | Medium impact risk | High impact risk |
|---|------------------------|---------------------------|-------------------------|
| Not coordinated design (structural, mechanical, electrical, etc.) | 5.7 | 37.1 | 57.1 |
| Inaccurate quantities | 21.4 | 45.7 | 32.9 |
| Lack of consistency between bill of quantities, drawings and specifications | 15.7 | 44.3 | 40.0 |

| | | | |
|--|-----|------|------|
| Awarding the design to unqualified designers | 8.6 | 14.3 | 77.1 |
|--|-----|------|------|

Table4.4. Design Factors

4.2.3.2 Risk Responsibility (allocation)

(77.1%) of respondents indicated that the consultant is responsible for all the design risk factors except for the factor of awarding the design to unqualified designers which was referred to contractor’s responsibility. This finding explains the important role of the consultant from the initial phase of the project specially at the design stage, although (34.3%) of respondents allocate responsibility into owners who are in a better position to choose a qualified designer.

Figure4.3. Design Factors

4.2.4 Logistics Factors

4.2.4.1 Risk impact

Respondents believed that the risk of Shortage of human resources, machinery, and resources is medium significant risk relatively, It is obvious that the mentioned risk is serious risk that could be faced, the unavailability of labor and materials is somehow connected to the managing of the project, the second risk from importance is undefined scope of work and inaccurate project program approximately, it have medium impact which pointed to the misunderstanding of these matters among contractors. These risks need to be fully defined to manage the work properly.

| Logistics Risk Factors | Low impact risk | medium impact risk | High impact risk |
|---|------------------------|---------------------------|-------------------------|
| Shortage of human resources, machinery, and resources | 12.9 | 41.4 | 45.7 |
| Scope of work defining | 20 | 44.3 | 35.7 |

Table4.5. Logistics Factors

4.2.4.2 Risk Responsibility (allocation)

Contractors should give attention of this problem by working out and applying management standards to control such problems. It should be the contractor’s responsibility to make sure that labor and materials are available to execute the works.

Figure4.4. Logistics Factor

4.2.5 Financial Factors

4.2.5.1 Risk impact

Respondents considered the Instability of currency exchange (57.1%) is the highest impact risk in the financial Factors that’s due to the situations of the Sudan, Delayed payment on contract was the second from importance and (55.7 %) that’s could be because of lack of capital ,lack of experience in contracts or might be of awarding contracts to lowest price.

| Financial Risk Factor | Low impact risk | Medium impact risk | High impact risk |
|----------------------------------|------------------------|---------------------------|-------------------------|
| Financial inflation | 12.9 | 37.1 | 50 |
| Instability of currency exchange | 14.3 | 28.6 | 57.1 |
| Delayed payment on contract | 8.6 | 35.7 | 55.7 |
| Poor cash flow management | 18.6 | 31.4 | 50 |

Table4.6. Financial Factors

4.2.5.2 Risk Responsibility (allocation)

The respondents indicated that the owner is responsible for all the financial risk factors, this finding explains the role of the owner in financing the project.

Figure4.5. Financial Factors

4.2.6 Legal Factors

4.2.6.1 Risk impact

Disputes are normal in their occurrences it is very important to resolve any rising dispute before the increase of their impact. 54.3 % of the respondents believe that the delay in resolving such disputes represent a high score in impact causing by risk factors.

| Legal Risk Factors | Low impact risk | medium impact risk | High impact risk |
|---|------------------------|---------------------------|-------------------------|
| Difficulty to get permits | 22.9 | 50.0 | 27.1 |
| Occurrence of legal Disputes during the implementation phase of the project between the parties | 14.3 | 37.1 | 48.6 |

| | | | |
|--|------|------|------|
| Delays in resolving disputes between parties Project | 12.9 | 32.9 | 54.3 |
|--|------|------|------|

Table4.7. Legal Factors

4.2.6.2 Risk Responsibility (allocation)

The respondents indicated that the owner is responsible for difficulty to get permits (47.1 %) in the legal risk factors and that is a fact, this finding explains the role of the owner, figure (4.6) illustrates the allocation of legal risk factors according to respondents. It is obvious that the greatest part of respondents deal with legal risks allocation to owner, (47.1%) of respondents indicated that the owner is responsible for difficulty to get permits, but the allocation percentage of disputes during implementation was almost equal between consultant (32.9 %) and owner (30%) also the delays in resolving disputes was between consultant and owner some respondents(12.9%) answered as the responsible is unknown that's why disputes could originate due to mistake or misunderstanding by either party. Hence, these risks should really be shared risks.

Figure4.6. Legal Factors

4.2.7 Construction Factors

4.2.7.1 Risk impact

As illustrated in table 4.8 the highest risk impact (67%) was gaps between the implementation and the specifications due to misunderstanding of drawings and specifications this risk can

cause significant work delays, that is why contractors exhibit an awareness towards this risk, it's a fact in Sudan that's some delays happened because misunderstanding drawing because of unqualified site engineers, the second factor from severity is Lower work quality in presence of time constraints (42.9 %) due that contractors avoid any penalties written in the contract because of the delay of submitting the work in the planned time. Design changes (35.7%), difference between actual and contract quantities (38.6%) were in the same risk impact with medium severities, this reflects the little attention paid by contractors to these issues.

| Construction Risk Factors | Low impact risk | Medium impact risk | High impact risk |
|---|------------------------|---------------------------|-------------------------|
| Design changes | 24.3 | 40.0 | 35.7 |
| Gaps between the implementation and the specifications due to misunderstanding of drawings and specifications | 5.7 | 27.1 | 67.1 |
| Lower work quality in presence of time constraints | 10.0 | 47.1 | 42.9 |
| Actual quantities differ from the contract quantities | 18.6 | 42.9 | 38.6 |

Table4.8. Construction Factors

4.2.7.2 Risk Responsibility (allocation)

Figure (4.7) shows the allocation of construction risks. . Majority of respondents (51.4%) design changes of, and difference between actual and contract quantities (52.9%) allocate the risks on consultant. Allocating design changes risk category to the consultant reflects that contractors are not very much

concerned with changes in the work, but (12.9%) allocate changes in design to be shared between owner and consultant and that is could be a fact due consultant cannot bear all the responsibility while the responsible of these changes is the owner because he is the one who take decisions through the implementation phase in the construction project. Misunderstanding of drawings and specifications and low quality work allocation distributed between contractor and consultant that explains the obligations and role of each one facing these risks.

Figure4.7. Construction Factors

4.2.8 Political Factors

4.2.8.1 Risk impact

Respondents appear that Political risk factors have no high risk impact , The reason is that these acts have limited effects on construction issues, and rarely when it happens.

| Political Risk Factors | Low impact risk | Medium impact risk | High impact risk |
|--|------------------------|---------------------------|-------------------------|
| Unstable security circumstances (Demonstrations) | 32.9 | 28.6 | 38.6 |
| New governmental acts or legislations | 25.7 | 35.7 | 38.6 |

Table4.9. Political Factors

4.2.8.2 Risk Responsibility (allocation)

In figure (4.8) allocation of political risks is viewed. Clearly, respondents reported that responsible is unknown, In fact all risks that cannot be controlled should be shared risks but some respondents considered that government have a hand in these factors.

Figure4.8. Political Factors

4.2.9 Management Factors

4.2.9.1 Risk impact

Table (4.10) illustrates the importance of management risks. Poor Resource management was the most important risk (44.7%) in management factors, This could be interpreted by the lack of recourse management in the construction field whatever it is a human or material resource, The lack of training process might be an obvious phenomena in the sector, miss use of available. Other Management risks, ambiguous planning and poor communication are considered with medium importance with risk impact of (37.1%). It is thought that management of projects need more and more training to properly manage projects specially the large ones.

| Management Factors | Risk | Low impact risk | Medium impact risk | High impact risk |
|--|------------------|-----------------|--------------------|------------------|
| Ambiguous due to complexity | planning project | 20.0 | 42.9 | 37.1 |
| Poor management | Resource | 18.6 | 35.7 | 44.7 |
| Information unavailability (include uncertainty) | (include | 28.6 | 42.9 | 28.6 |

| | | | |
|---|------|------|------|
| Poor communication between involved parties | 22.9 | 40.0 | 37.1 |
|---|------|------|------|

Table4.10. Management Factors

4.2.9.2 Risk Responsibility (allocation)

In figure 4.9 it is obvious that respondents considered that consultant almost responsible of most the management risk factors, but in poor communication between involved parties the allocation distributed between contractor, consultant and owner this consideration is sensible, since it is contractors', consultants' and owners' responsibility to maintain a good level of communication. Results showed that poor resource management risk allocated to contractor (71.4%), that explain the important role of contractor on the site.

Figure 4.9 Management Factors

4.3 Risk Management Action

4.3.1 Use of preventive methods before the implementation phase

According to the survey results (Figure 4.10), respondents show the most used preventive method is usually depend on practical experience in preparing executable construction work (3.30) that may become the most valuable information source for the use when there is limited time for

preparing the project program, consider reserves timetable for the construction period as a precaution schedule, and updating work schedule according to project situation were the second used methods ,the third method mainly used was the Computer Systems such as programs like Ms. project, Primavera ,etc..., the 4th method was referring to similar projects,judgment or subjective probability uses the experience gained from similar projects undertaken in the past by the decision maker to decide on the probability of facing risk and the outcomes, the lowest rank of preventive methods are sharing risk among parties of the projects, and using quantitative methods to analyse the risks can face a project, that's explains when inflects happen due risk appearance without any one can bear it or take their responsibility.

Construction, however, is subjected to a dynamic environment, that is why risk managers must constantly strive to improve their estimates. Even with near perfect estimates, decision making about risk is a difficult task. Thus depending only on experience and subjective judgment may not be enough, and updated project information should be obtained and applied. Consequently, contractors considered getting updated project information and add risk time difference to time estimation at the project planning stage to be effective risk preventive method.

Figure 4.10 (Preventive methods)

4.3.2 Use of mitigative methods through the implementation

Figure (4.11) represents the five mitigative methods being proposed. The number above the column is mean of respondents use for each method. The first mitigative methods

used by the respondents are coordinate closely with subcontractors and close supervision to subordinates for minimizing abortive work. Increase manpower and working hours were the second most used mitigative methods for minimizing the impacts of delay while Change the construction method was rarely used as a mitigative method. This could mean that the effort driven on site is one of the most important variables to project progress, since construction projects generally include many labor-intensive operations. In fact, shortage of manpower in subcontractors' firms is one of the most serious risks to project delays. Therefore, increasing the work hours normally speeds up progress subject to the availability of materials and supervisors, physical constraints of the site, and construction sequence.

Figure 4.11 (**Mitigation** methods)

Chapter Five: Conclusions and Recommendations

5.1 Conclusions

The findings of this study concluded that the most significant risk factors identified to have a serious impact in construction projects were the following factors.

Note : Risk factors sequence are in the order which had been mentioned in chapter four

- **Physical Factors:** Poor / defective supply materials (65.7%) responsible by contractor
- **Environmental Factors:** Natural disasters responsible (50%) by contractor
- **Design Factors** :Awarding the design to unqualified designers responsible (77.1 %) by contractor
- **Logistics Factors** :Shortage of human resources, machinery, and material resources(45.7%) responsible by contractor
- **Financial Factors** : Instability of currency exchange(57.1%) responsible by owner
- **Legal Factors** : Delays in resolving disputes between parties Project responsible(54.3%) by consultant
- **Construction Factors** : Gaps between the implementation and the specifications due to misunderstanding of drawings and specifications (67.1%) responsible by consultant
- **Political Factors** : Unstable security circumstances (Demonstrations), New governmental acts or legislations (38.6%)responsible by contractor
- **Management Factors** : Poor Resource management(44.7%) responsible by contractor
- The findings of this study concluded that the highest **preventive method before the implementation phase** is depend on practical experience in preparing executable construction work (68.4%) and the highest **meditative method through the implementation phase** increase manpower and/or equipment (58.6%)

5.2 Recommendations

- After interpreting the obtained results in the light of the theoretical part and in order to close the gap of

misunderstanding concepts of risk management in construction projects, the research ended with general recommendations that could be useful if taken by firm such as :

- Possible risks should be allocated contractually and clearly on each party. That could be done by defining the potential risk factors and allocate them on the party which is in the best place to manage these risks.
- There is an essential need for more standardization and effective forms of contract, which address issues of clarity, fairness, roles and responsibilities, allocation of risks, dispute resolution and payment - this could be done by adopting a standard form of contracts e.g. "FIDIC".
- Allow engineers to develop a project's risk management based on best practices through identifying the risk factors, and also to improve the performance of this function.
- A satisfactory level of communications between parties should be maintained to exchange needed information using documents
- Contracting firms should compute and consider risks by adding the risk factors before quotation and time estimation.
- Contractors should learn how to share and shift different risks by hiring specialized staff or specialized sub-contractors.
- Contracting firms should utilize computerized approaches used for risk analysis and evaluation such as Primavera which integrates with widely used programs like Ms Project and Microsoft Excel. Otherwise, apply manual approach.
- Moreover, contractors should work on training their personnel to properly apply management principles. It is the duty of institutes to provide such training.

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Appendix

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

This questionnaire has been developed by a researcher as a requirement to obtain a master's degree in construction management titled by:

Allocation of Risk Factors and their Impact on Construction Projects on Sudan

The aim of this questionnaire is to collect data about the severity of Risk factors in construction projects in Khartoum city and its impacts on projects Implementation, allocation of each factor and methods of dealing with risks.
 (The data you will provide will remain confidential and only the researcher will has access to it)

Part 1: Social demographic Data

Put (√) in front of the selected answer:

1- Academic Qualification

Bachelor's degree

Higher Diploma

Master's degree

Ph.D

2- Years of experience

less than 5

5-10

10-15

more than 15

3- Specialty

Architect

Civil

..... other

Consultant

Mixed

4- Job description

Contractor

other

.....

General

other

5- Sector

Private

Part 2:

Risk Factors (Impact and Allocation)

Below is the table which contains the risk factors, please assign the impact of each factor, and allocate each on one of the parts shown.

| Meaning | Symbol |
|--------------------|--------|
| Low impact risk | A |
| Medium impact risk | B |
| High impact risk | C |

| Risk Responsibility (Allocation) | | | | Impact Degree of Risk Factors | | | Risk Factors | |
|-----------------------------------|------------|-------|------------|-------------------------------|---|---|---|----------|
| Other (specify) | consultant | Owner | Contractor | C | B | A | | |
| | | | | | | | Physical | 1 |
| | | | | | | | Occurrence of accidents because of poor safety procedures | 1.1 |
| | | | | | | | Poor / defective supply materials | 1.2 |
| | | | | | | | Decline in the productive capacity of workers and machinery breakdowns | 1.3 |
| | | | | | | | Environmental / geographical | 2 |
| | | | | | | | Natural disasters | 2.1 |
| | | | | | | | Difficulty to access the site | 2.2 |
| | | | | | | | Adverse weather conditions | 2.3 |
| | | | | | | | Design | 3 |
| | | | | | | | Not coordinated design(structural, mechanical, electrical, etc.) | 3.1 |
| | | | | | | | Inaccurate quantities | 3.2 |
| | | | | | | | Lack of consistency between bill of quantities, drawings and specifications | 3.3 |
| | | | | | | | Awarding the design to unqualified designers | 3.4 |
| | | | | | | | Logistics | 4 |
| | | | | | | | Shortage of human resources, machinery, and resources | 4.1 |
| | | | | | | | Scope of work defining | 4.2 |
| | | | | | | | Financial | 5 |
| | | | | | | | Financial inflation | 5.1 |

| | | | | | | | | |
|--|--|--|--|--|--|--|---|----------|
| | | | | | | | Instability of currency exchange | 5.2 |
| | | | | | | | Delayed payment on contract | 5.3 |
| | | | | | | | Poor cash flow management | 5.4 |
| | | | | | | | Legal | 6 |
| | | | | | | | Difficulty to get permits | 6.1 |
| | | | | | | | Occurrence of legal Disputes during the implementation phase of the project between the parties | 6.2 |
| | | | | | | | Delays in resolving disputes between parties Project | 6.3 |
| | | | | | | | Construction | 7 |
| | | | | | | | Design changes | 7.1 |
| | | | | | | | Gaps between the implementation and the specifications due to misunderstanding of drawings and specifications | 7.2 |
| | | | | | | | Lower work quality in presence of time constraints | 7.3 |
| | | | | | | | Actual quantities differ from the contract quantities | 7.4 |
| | | | | | | | Political | 8 |
| | | | | | | | Unstable security circumstances (Demonstrations) | 8.1 |
| | | | | | | | New governmental acts or legislations | 8.2 |
| | | | | | | | Management | 9 |
| | | | | | | | Ambiguous planning due to project complexity | 9.1 |
| | | | | | | | Poor Resource management | 9.2 |
| | | | | | | | Information unavailability (include uncertainty) | 9.3 |
| | | | | | | | Poor communication between involved parties | 9.4 |

Risk Management Action

Part Three :

: 3.1 Before the implementation phase

In the table shown below, please determine the relative use of each preventive method **before** the implementation phase in the table :

| always 4 | Often 3 | rarely 2 | In applicable 1 | | |
|-------------|------------|-------------|--------------------|---|-----|
| | | | | Preventive Method | |
| | | | | Use the methods of quantitative risk analysis to manage the expected duration of the establishment of the project | 1.1 |
| | | | | Depend on practical experience in preparing executable construction work. | 1.2 |
| | | | | Consider reserves timetable for the construction period as a precaution schedule. | 1.3 |
| | | | | Transfer or share risk to/with other parties Risk-sharing or transfer among the parties of the project | 1.4 |
| | | | | Refer to similar implemented or ongoing projects for accurate program | 1.5 |
| | | | | Work schedule updatable access to all the updated information about the project | 1.6 |
| | | | | Computer Systems (Ms project, Primavera, etc..) | 1.7 |

: 3.2 Through the implementation phase

In the table shown below, please determine the relative use of each preventive method **through** the implementation phase in the table :

| always 4 | Often 3 | rarely 2 | In applicable 1 | | |
|-------------|------------|-------------|--------------------|---|-----|
| | | | | Mitigative Method | |
| | | | | Increase manpower and/or equipment | 1.1 |
| | | | | Increase the working hours. | 1.2 |
| | | | | Changing in the implementation method or the sequence of work by overlapping activities | 1.3 |
| | | | | Coordinate closely with subcontractors | 1.4 |
| | | | | Close supervision to subordinates for minimizing abortive work | 1.5 |

THANK YOU

بسم الله الرحمن الرحيم
إستبيان
: متطلب تكميلي لنيل درجة الماجستير في إدارة التشييد بعنوان

Allocation of Risk Factors and their Impact in Construction Projects on Sudan

الهدف من الإستبيان جمع البيانات لدراسة عناصر المخاطر الرئيسية بقطاع التشييد بولاية الخرطوم وتأثيراتها على سير المشاريع وتحديد الطرف المسؤول ودراسة وسائل تدارك (المخاطر). (ستطل هذه البيانات سرية

الجزء الأول : الأسئلة العامة

ضع علامة (√) أمام الأحابة المختارة

1. المؤهل الأكاديمي :

دبلوم عالي

دكتوراه

بكالوريوس

ماجستير

2. سنوات الخبرة العملية :

10-5

أقل من 5

10-15

أكثر من 15

. التخصص 3 .

مدني
أخري.....

معماري

4. المُسمي الوظيفي :

مقال
أخري

إستشاري
مختلط

5-القطاع :

خاص
أخري

عام

عوامل المخاطر: (الأثر،المسؤولية (الجزء الثاني:)

فيما يلي عوامل المخاطر، الرجاء إعطاء درجة التأثير لهذه العوامل بالإضافة إلى تحديد 1. : الطرف الذي سيتحمل هذه المخاطر بالاستعانة بالرموز الموضحة أدناه

| الرمز | المعنى |
|-------|------------------------|
| A | مخاطر قليلة الأثر |
| B | الأثر للمتوسطة للمخاطر |
| C | مخاطر شديدة الأثر |

| عوامل المخاطر | درجة تأثير عوامل المخاطر | | | مسؤولية المخاطر | | | |
|--|--------------------------|---|---|-----------------|------------|---------------|--------------------|
| | A | B | C | المقا ول | المال ك | الإستشا ري | طرف أخر (حدد |
| 1 فيزيائي | | | | | | | |
| 1.1 وقوع الحواث بسبب قلة احتياطات الأمان | | | | | | | |
| 1.2 توريد المواد قليلة الجودة | | | | | | | |
| 1.3 إنخفاض القدرة الإنتاجية للعمل / عطل الآلات | | | | | | | |
| 2 بيئي/جغرافي | | | | | | | |
| 2.1 (قوي قاهرة (الكوارث الطبيعية | | | | | | | |
| 2.2 تعذر الوصول للموقع جغرافيا | | | | | | | |
| 2.3 أحوال جوية غير لائقة | | | | | | | |

| | | | | | | | | |
|----------|---|---------------------------------|----------|----------|------------------------|--------------|----------------|--------------|
| 3 | التصميم | | | | | | | |
| 3.1 | عدم تطابق التصميم وفقا للتخصصات المختلفة (إنشائي، ميكانيكي، كهربائي، إلخ) | | | | | | | |
| 3.2 | حساب الكميات الغير دقيقة | | | | | | | |
| 3.3 | عدم التوافق بين جدول الكميات والمخططات والمواصفات | | | | | | | |
| 3.4 | تكليف التصميم لمصمم غير كفؤ | | | | | | | |
| 4 | LOGISTICS عوامل لوجستية | | | | | | | |
| 4.1 | النقص في العمالة البشرية والآلات والمواد | | | | | | | |
| 4.2 | عدم تحديد نطاق العمل | | | | | | | |
| 5 | مالي | | | | | | | |
| 5.1 | التضخم المالي | | | | | | | |
| 5.2 | عدم استقرار أسعار صرف العملات | | | | | | | |
| 5.3 | تأخر الدفعيات وفقا للعقد | | | | | | | |
| 5.4 | سوء إدارة التدفق النقدي للمقاول | | | | | | | |
| 6 | قانوني | | | | | | | |
| 6.1 | صعوبة الحصول على بعض التصاريح اللازمة للعمل | | | | | | | |
| 6.2 | ظهور الخلافات القانونية خلال مرحلة التنفيذ بين أطراف المشروع | | | | | | | |
| 6.3 | التأخير في حل الخلافات بين أطراف المشروع | | | | | | | |
| 7 | إنشائي | | | | | | | |
| 7.1 | التغير في التصميم | | | | | | | |
| | عوامل المخاطر | درجة تأثير عوامل المخاطر | | | مسؤولية المخاطر | | | |
| | | A | B | C | المقا | المال | الإستشا | طرف |
| | | | | | ول | ك | ري | آخر |
| | | | | | | | | (حدد) |
| 7.2 | اخطاء في التنفيذ بسبب سوء فهم المخططات والشروط والمواصفات | | | | | | | |
| 7.3 | انخفاض مستوى جودة الأعمال بسبب وجود القيود الزمنية للتنفيذ | | | | | | | |
| 7.4 | الكميات الحقيقية تختلف عن كميات العقد | | | | | | | |
| 8 | سياسية | | | | | | | |
| 8.1 | (عدم الاستقرار الأمني)المظاهرات مثلا | | | | | | | |
| 8.2 | قوانين حكومية جديدة تؤثر على سير الأعمال | | | | | | | |
| 9 | إدارية | | | | | | | |
| 9.1 | عدم وضوح التخطيط بسبب تعقيد المشروع | | | | | | | |
| 9.2 | سوء إدارة الموارد | | | | | | | |
| 9.3 | عدم توفر المعلومات اللازمة | | | | | | | |
| 9.4 | سوء التواصل بين أطراف المشروع | | | | | | | |

الجزء الثالث :

وسائل تدارك آثار المخاطر

: قبل مرحلة التنفيذ

الجدول الموضح أدناه يحتوي بعض الوسائل لتدارك آثار المخاطر قبل مرحلة التنفيذ، 1. الرجاء تحديد نسبة استخدام هذه الأساليب تبعًا للرموز الموضحة:

| | | غير مستخدم ة | نادرًا | غالبًا | دائمًا |
|-----|---|--------------------|--------|--------|--------|
| 1 | المخاطر آثار تدارك طرق | 1 | 2 | 3 | 4 |
| 1.1 | استخدام طرق تحليل المخاطر الكمية لتوقع المدة الزمنية بشكل دقيق | | | | |
| 2.1 | الاعتماد على الخبرة العملية في عمل برنامج عمل قابل للتنفيذ | | | | |
| 3.1 | إضافة احتياطي زمني للمدة كاحتياط لمخاطر الجدول الزمني | | | | |
| 4.1 | نقل المخاطر أو تقاسمها مع أطراف المشروع | | | | |
| 5.1 | الرجوع إلى المشاريع المشابهة المنفذة أو الجاري تنفيذها والحصول على المعلومات لانتاج برنامج عمل دقيق | | | | |
| 6.1 | عمل جدول زمني قابل للتحديث بالحصول على كل المعلومات المحدثة عن المشروع | | | | |
| 7.1 | استخدام الأنظمة الحديثة (برامج كمبيوتر متكاملة) | | | | |

: أثناء مرحلة التنفيذ

الجدول الموضح أدناه يحتوي بعض الوسائل لتدارك آثار المخاطر أثناء مرحلة التنفيذ، - 2 الرجاء تحديد نسبة استخدام هذه الوسائل وفقًا للرموز الموضحة:

| | | غير مستخدم ة | نادرًا | غالبًا | دائمًا |
|-----|--|--------------------|--------|--------|--------|
| 2 | المخاطر آثار تدارك طرق | 1 | 2 | 3 | 4 |
| 1.2 | زيادة العمالة و/أو الآلات | | | | |
| 2.2 | زيادة ساعات العمل | | | | |
| 3.2 | تغيير تتابع عمليات التنفيذ أو التداخل بينها | | | | |
| 4.2 | التنسيق التام مع مقاولي الباطن | | | | |
| 5.2 | الإشراف الدقيق على الأعمال لتلاشي رفض الأعمال وإعادة التنفيذ | | | | |

شكرا لحسن تعاونكم