

Chapter one

Introduction

1. General

The financial and economic crisis has had an adverse impact on the Sudan economy and construction industry... Some industries, such as construction; trade, transport and communications; and the industry sectors were most affected by the crisis. This increased pressure to improve quality, productivity and reduce costs, and the need for project strategies and management that can appropriately and effectively manage project risk management is one of the nine knowledge areas propagated by the Project Management Institute . Furthermore, risk management in the construction project management context is a comprehensive and systematic way of identifying, analyzing and responding to risks to achieve the project objectives . The benefits of the risk management process include identifying and analyzing risks, and improvement of construction project management processes and effective use of resources. PMI, 2013

Construction projects can be extremely complex and fraught with uncertainty. Risk and uncertainty can potentially have damaging consequences for the construction projects.Nerija ,2013

Therefore nowadays, the risk analysis and management continue to be a major feature of the project management of construction projects in an attempt to deal effectively with uncertainty and unexpected events and to achieve project success. Nerija ,2013

Construction projects are always unique and risks raise from a number of the different sources .Nerija ,2013.

Construction projects are inherently complex and dynamic and involving multiple feedback processes. A lot of participants – individuals and organizations are actively involved in the construction project and their interests may be positively or negatively affected as a result of the project execution or project completion. Different participants with different experience and skills usually have different expectations and interests. This naturally creates problems and confusion for even the most experienced project managers and contractors. Jaser 2005

Construction projects can be unpredictable. Managing risks in construction projects has been recognized as a very important process in order to achieve project objectives in terms of time, cost, quality, safety and environmental sustainability Patric,2006. Project risk management is an iterative process: the process is beneficial when is implemented in a systematic manner throughout the lifecycle of a construction project, from the planning stage to completion.

Objectives.

1-1The objectives of this study

The objectives were summarized as follows:

1. Identifying key risk factors that could stand in front of construction processes .
2. Investigating the severity of each identified risk factor according to the perspectives of contractors.
3. Examining the risk management actions efficiency that are applied in the industry by contractors.
4. Providing practical recommendations toward up grading the risk management process in construction contracting companies.

1.2 Research problem

The management of risks is a central issue in the planning and management of any venture the studies found a statistically significant relationship between management support for risk management processes and a reported project success. Jaser 2005

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.

1-3 Research methodology

The research methodology adapted in this research to achieve the above objectives is divided in two parts literature review and data collection through a questionnaire .

A. Literature review part

Investigate topic area to gain theoretical and historical background about R.M in construction and to investigate the typical risk factor which face construction project.

B. Data collecting

- After that questionnaire of six section is designed and directed to 60 respondent 50 of them are collected
- After that the data analysed and the result discussed .
- After that concussion about all stage was made
- Finally recommendations were written

1-4 Research Questions .

1. What is risk management ?
2. What are risk factors associated with construction project in sudan ?
3. How is risk managed in construction project in sudan ?

1-5 Research hypothesis:

- 1-Although the Sudanese construction contractors may have aknowlage about risk management but there is no structured systematic application of the risk management concepts .
- 2- The aggressive competitive nature of construction industry forced the contractors to accept risks of project without consideration.

Chapter Two

2-1 Introduction

Construction projects can be unpredictable. Managing risks in construction projects has been recognized as a very important process in order to achieve project objectives in terms of time, cost, quality, safety and environmental sustainability. Project risk management is an iterative process: the process is beneficial when is implemented in a systematic manner throughout the lifecycle of a construction project, from the planning stage to completion.

Patric, 2006

2-2 Project Risk Management Definition:

The definition of Project Risk Management, is defined by the PMI in the PMBOK (project management body of knowledge) Guide – “Project Risk Management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project.” The objectives of Project Risk Management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project “project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on a project’s objectives.” Project objectives include scope, schedule, cost, and quality PMI,2013

Project Risk Management aims to identify and prioritize risks in advance of their occurrence, and provide action-oriented information to project managers. This orientation requires consideration of events that may or may not occur and are therefore described in terms of likelihood or probability of occurrence in addition to other dimensions such as their impact on objectives Zenghua,2011

2-3 Role of Project Risk Management in Project Management

Project Risk Management is not an optional activity: it is essential to successful project management. It should be applied to all projects and hence be included in project plans and operational documents. In this way, it becomes an integral part of every aspect of managing the project, in every phase and in every process group. **PMI,2013**

Many of the project management processes address planning the project, from concept to final design and from procurement through daily management of execution and close-out. These processes often assume an unrealistic degree of certainty about the project and, therefore, they need to include treatment of project risks. **PMI,2013**

Project Risk Management addresses the uncertainty in project estimates and assumptions. Therefore, it builds upon and extends other project management processes. For instance, project scheduling provides dates and critical paths based on activity durations and resource availability assumed to be known with certainty. **PMI,2013**

Quantitative risk analysis explores the uncertainty in the estimated durations and may provide alternative dates and critical paths that are more realistic given the risks to the project.

Project Risk Management is not a substitute for the other project management processes. On the contrary, Project Risk Management requires that these project management processes (e.g. scheduling, budgeting, and change management) be performed at the level of the best practices available. Project Risk Management adds the perspective of project risk to the outputs of those other processes and adds to their value by taking risk

into account. For instance, risk management provides the basis upon which to estimate the amount of cost and schedule contingency reserves that are needed to cover risk response actions to a required level of confidence for meeting project objectives. **PMI,2013**

2-4 Critical Success Factors for Project Risk Management

The general criteria for success of each project risk management presses include:

1- Recognize the Value of Risk Management — Project Risk Management should be recognized as a valuable discipline that provides a positive potential return on investment for organizational management, project stakeholders (both internal and external), project management, and team members.

2- Individual Commitment/Responsibility Project participants and stakeholders should all accept responsibility for undertaking risk-related activities as required. Risk management is everybody's responsibility.

3- Open and Honest Communication Everyone should be involved in the Project Risk Management process. Any actions or attitudes that hinder communication about project risk reduce the effectiveness of Project Risk Management in terms of proactive approaches and effective decision-making. **PMI,2013**

4- Organizational Commitment Organizational commitment can only be established if risk management is aligned with the organization's goals and values. Project Risk Management may require a higher level of managerial support than other project management disciplines because handling some of the risks will require approval of or responses from others at levels above the project manager.

5- Risk Effort Scaled to Project Project Risk Management activities should be consistent with the value of the project to the organization and with its level of project risk, its scale, and other organizational constraints. In particular, the cost of Project Risk Management should be appropriate to its potential value to the project and the organization. **PMI,2013**

6- Integration with Project Management Project Risk Management does not exist in a vacuum, isolated from other project management processes. Successful Project Risk Management requires the correct execution of the other project management processes: **PMI,2013**

These critical success factors for Project Risk Management are illustrated in Figure (2-1).

Much good project management practice can be thought of as effective uncertainty management. For example, good practice in planning, coordination, setting milestones, and change control procedures seeks to manage uncertainty directly. However, most texts on project management do not consider the way uncertainty management should be integrated with project management more generally, in terms of a wide view of what a coordinated approach to proactive and reactive uncertainty management can achieve. **PMI,2013**

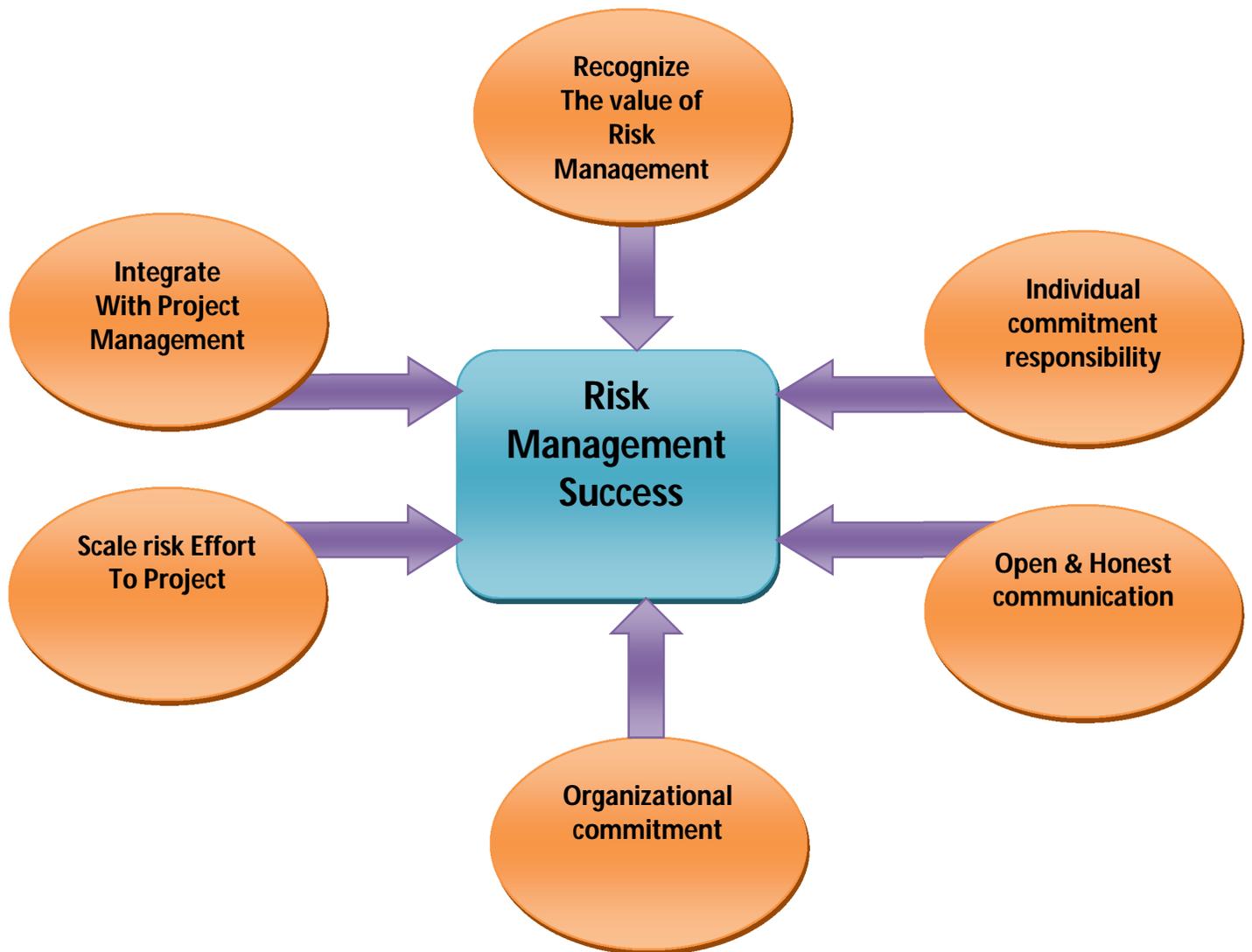


Figure (2-1) Critical Success Factors for Project Risk Management

PMI,2013

2-5 Threats and opportunities

A simplistic focus on project success and uncertainty about achieving it can lead to uncertainty and risk being defined in terms of ‘threats to success’ in a purely negative sense. For example, suppose success for a project is measured solely in terms of realized cost relative to some target or commitment. Then both ‘uncertainty’ and ‘risk’ might be defined in terms of the threat to success posed by a given plan in terms of the size of possible cost overruns and their likelihood. **PMI,2013**

From this perspective it can be a natural step to regard risk management as essentially about removing or reducing the possibility of underperformance. This is extremely unfortunate, because it results in a very limited appreciation of project uncertainty and the potential benefits of project risk management. **PMI,2013**

Often it can be just as important to appreciate the positive side of uncertainty, which may present opportunities rather than threats.

Risk an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective PMI (project management institute)

Risk an uncertain event or set of circumstances that, should it occur, will have an effect on the achievement of the project’s objectives. **PMI,2013**

These widely used definitions embrace both welcome upside and unwelcome .

Down side effects. In spite of this, there is still a tendency for practitioners to think of risk management in largely downside, threat management terms

It is important to keep ‘beating the drum’ to remind ourselves that we are dealing with the upside as well as the downside of uncertainty, with a balance appropriate to context. Even in a safety critical context, when the

downside has clear priority, it is a serious mistake to forget about the upside.
PMI,2013

2-6 Risk Definition

The meaning of the term “risk” must be understood clearly for effective project risk management. In the context of a project, we are concerned about potential impacts on project objectives such as cost and time. A general definition of “risk” in this context is:

Risk is an uncertainty that matters; it can affect project objectives negatively or positively. The uncertainty may be about a future event that may or may not happen and the unknown magnitude of the impact on project objectives if it does happen. Thus, a “risk” is characterized by its probability of occurrence and its uncertain impact on project objectives. **Bob,2012**

2-7 The Project Risk Management Process

All approaches to project risk management strive to maximize both efficiency and effectiveness. Although the details of risk processes may differ depending on the project, risk management has three important parts: identification, analysis, and action. Before risk can be properly managed, it must first be identified, described, understood, and assessed. Analysis is a necessary step, but it is not sufficient; it must be followed by action. A risk process which does not lead to implementation of actions to deal with identified risks is incomplete and useless. The ultimate aim is to manage risk, not simply to analyze it. **Bob,2012**

The project risk management process (Figure 2.2) is not difficult. It simply offers a structured way to think about risk and how to deal with it. A full project risk management endeavor includes these processes:

1. Risk Management Planning Deciding how to approach, plan, and execute the risk management activities for a project.
2. Risk Identification Determining which risks might affect the project and documenting their characteristics.
3. Qualitative Risk Analysis Prioritizing risks for subsequent further analysis or action by assessing and combining their probability of occurrence and impact.
4. Quantitative Risk Analysis Analyzing probabilistically the effect of identified risks on overall project objectives.
5. Risk Response Developing options and actions to enhance opportunities and to reduce threats to project objectives.
6. Risk Monitoring Tracking identified risks, monitoring residual risks, identifying new risks, executing risk response plans, and evaluating their effectiveness throughout the project lifecycle. **Bob,2012**

At its foundation, project risk management involves asking and answering a few simple questions:

- 1.What risks might negatively (threats) or positively (opportunities) affect achieving the project objectives? (Risk identification)
- 2.Which of these are most important? (Qualitative risk analysis)
- 3.How could these affect the overall outcome of the project in probabilistic terms of cost and schedule? (Quantitative risk analysis)
- 4.What can be done about it? (Risk response)
- 5.Having taken action, how did the responses effect change, and where is the project now? (Risk monitoring)

6. Who needs to know about this? (Communication)

While these questions are listed sequentially and are usually conducted in this order, they are often combined, repeated as the project progresses, or may even be performed out of sequence. **PMI,2013**

The questions constitute a process, shown in Figure 1, indicating how the different elements of project risk management interact and describing how risk management can be implemented. The process has a circular form to highlight that it is a continuous process throughout the life cycle of a project. The arrows signify the logical flow of information between the elements of the process. Communication is the core of this process. It is the means by which all the information flows and the project team continuously evaluates the consistency and reasonableness of risk assessments and their underlying assumptions. **Bob,2012**

It is the nature of projects that circumstances change as they are being planned and executed. The amount of information available about risks will usually increase as time goes on. Some risks will occur while others will not, new risks will arise or be discovered, and the characteristics of those already identified may change. As a result, the Project Risk Management processes should be repeated and the corresponding plans progressively elaborated throughout the lifetime of the project. **PMI,2013**

To ensure that Project Risk Management remains effective, the identification and analysis of risks should be revisited periodically, the progress on risk response actions should be monitored, and the action plans adjusted accordingly. If external circumstances change significantly, it may also be necessary to revisit the risk management planning process.

The development of an initial risk management plan and risk assessment is the start of the process, not the end. The frequency and depth of reviews and

updates will depend on the nature of the project, the volatility of the environment in which the project is being implemented, and the timing other project management reviews and updates. **PMI,2013**

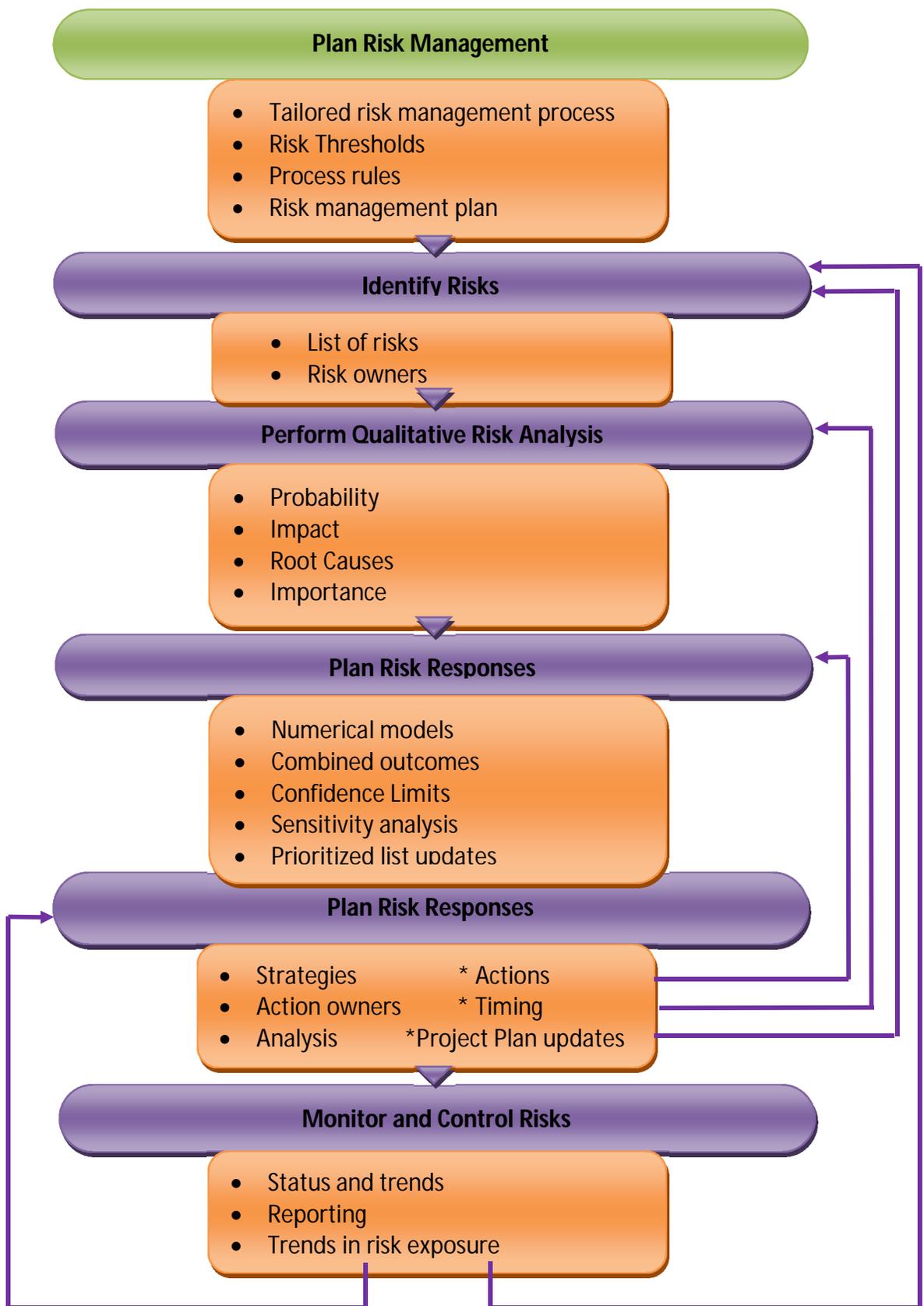


Figure (2-2)The project risk mangement processes

The Project Risk Management Team (PRMT) is the core group performing, updating, and reviewing risk management activities under the direction of the Project Risk Manager (PRM), who has been trained in the processes.

The members of the PRMT should collectively have all of the expertise required to identify, assess, and respond to risks of the project. However, they should not hesitate to draw on the extensive talent pool available to the project for assistance. Representatives from other agencies, if any, may be invited to participate at PRMT meetings to ensure that all parties are fully informed, and thus avoid surprises. The project manager generally acts as the PRM for small projects. **Bob,2012**

Communication and consultation with project stakeholders are a crucial factor in undertaking good risk management and in achieving project outcomes that are broadly accepted. It helps everyone to understand the risks and trade-offs that must be made in a project. Communication ensures that all parties are fully informed, and thus avoids unpleasant surprises.

Bob,2012

Regular reporting is an important component of communication. Reports on the current status of risks and risk management are required for managers and other parties to understand the risks. They complement other management reports in developing this understanding. The project risk manager will prepare and issue periodic risk management reports as required by the project manager to ensure a clear audit trail, the project risk manager will ensure that the risk management process is documented in such a way that it can be reviewed, the structure and assumptions can be examined, and the reasons for particular judgments and decisions can be identified.

Bob,2012

2-7-1 Planning Project Risk Management

The objectives of the Plan Risk Management process are to develop the overall risk management strategy for the project, to decide how the risk management processes will be executed, and to integrate Project Risk Management with all other project management activities. **PMI,2013**

Effective risk management requires creation of a risk management plan. This plan describes how the risk management processes should be carried out and how they fit in with the other project management processes. On a broader level, it describes the relationships among Project Risk Management, general project management, and the management processes in the rest of the organization. To provide the greatest benefit, initial risk management planning should be carried out early in the overall planning of the project, and the corresponding risk management activities integrated into the overall project management plan. The risk management plan may subsequently need to be adapted as the needs of the project and its stakeholders become clearer or change **PMI,2013**.

The Risk Management Plan (RMP) defines the level at which risk management will be performed for the project and the frequency of risk management meetings and risk register updates. It lists the members of the Project Risk Management Team by the various disciplines involved in the project and sets a budget for the risk management activities. The RMP should be completed early in project planning, since it is crucial to successfully performing the other processes described herein. **PMI,2013**

Depending upon the size and complexity of the project, some or all of the following elements will be present in a risk management plan.

1. Introduction;
2. Project description;

3. Risk management methodology;
4. Risk management organization;
5. Roles, responsibilities, and authority;
6. Stakeholder risk tolerance;
7. Criteria for success;
8. Risk management tools and guidelines for use;
9. Thresholds and corresponding definitions;
10. Templates;
11. Communications plan;
12. Strategy; and
13. Risk breakdown structure **PMI,2013**

2-7-2 Risk Identification:

A risk cannot be managed unless it is first identified. Consequently, after risk management planning has been completed, the first process in the iterative Project Risk Management process aims to identify all the knowable risks to project objectives: **PMI,2013**

It is, however, impossible to identify all the risks at the outset of a project. Over time, the level of project risk exposure changes as a result of the decisions and actions taken previously in the project (internal change) and of externally imposed change **PMI,2013**.

The purpose of risk identification is to identify risks to the maximum extent that is practicable. The fact that some risks are unknowable or emergent requires the Identify Risk process to be iterative, repeating the Identify Risks process to find new risks which have become knowable since the previous iteration of the process.

When a risk is first identified, potential responses may also be identified at the same time. These should be recorded during the Identify Risks process and considered for immediate action if such action is appropriate.

Where such responses are not implemented immediately, these should be considered during the Plan Risk Responses process. **PMI,2013**

Risk identification determines what might happen that could affect the objectives of the project and how those things might happen. It produces a deliverable (the project risk register) that documents the risks and their characteristics. The risk register is subsequently amended by the qualitative or quantitative risk analysis, risk response, and risk monitoring processes.

Risk identification is an iterative process because new risks may become known as the project progresses through its life cycle, previously-identified risks may drop out, and other risks may be updated **PMI,2013**.

A common challenge in risk identification is avoiding confusion between causes of risk, genuine risks,

and the effects of risks. A risk may have one or more causes and, if it occurs, one or more effects.

Causes are definite events or sets of circumstances which exist in the project or its environment, and which give rise to uncertainty. Examples include the need to use an unproven new technology, the lack of skilled personnel, or the fact that the organization has never done a similar project before. Causes themselves are not uncertain since they are facts or requirements, so they are not the main focus of the risk management process.

Entering Data into the Risk Register:

At this stage, complete the information in the following risk register columns:

Table (2-1) Risk Register

Identification						
status	ID #	Type	category	Threat /opportunity Event	Description	Current status /assumptions

2-7-3 Perform Qualitative Risk Analysis :

Qualitative risk analysis includes methods for prioritizing the identified risks for further action, such as risk response. The PRMT can improve the project’s performance effectively by focusing on high-priority risks.

Bob,2012

Team members revisit qualitative risk analysis during the project’s lifecycle. When the team repeats qualitative analysis for individual risks, trends may emerge in the results. These trends can indicate the need for more or less risk management action on particular risks or even show whether a risk mitigation plan is working. **Bob,2012**

Qualitative risk analysis for Level 1 projects assigns a Risk Rating to each risk in the risk register. The risk ratings determine where the greatest effort should be focused in responding to the risks. They facilitate structured risk response action and resource allocation.

The three ratings for small projects are:

1. “High” – First priority for risk response.
2. “Medium” – Risk response as time and resources permit.
3. “Low” – No risk response required at this time **Bob,2012**.

The qualitative risk analysis of each risk is entered into the following columns of the small project risk register.

Table (2-2)
Risk Register update

Column	Contents
Risk Rating	Select “High”, “Medium”, or “Low” as a measure of the importance of this risk for response action.
Rationale	Describe the reasons the PRMT selected this risk rating.

Qualitative risk analysis includes methods for prioritizing the identified risks for further action, such as risk response. The PRMT can improve the project’s performance effectively by focusing on high-priority risks.

Bob,2012

Team members revisit qualitative risk analysis during the project’s lifecycle. When the team repeats qualitative analysis for individual risks, trends may emerge in the results. These trends can indicate the need for more or less risk management action on particular risks or even show whether a risk mitigation plan is working.

Qualitative risk analysis for large projects assesses the priority of identified risks using their probability of occurring and the corresponding impact on project objectives if the risks occur. **PMI,2013**

Table (2-3)

Definition of impact and probability rating PMI,2013

Rating -->	Very Low	Low	Moderate	High	Very High
Cost Impact of Threat (CO + COS)	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase
Cost Impact of Opportunity (CO + COS)	Insignificant cost reduction	<1% cost decrease	1-3% cost decrease	3-5% cost decrease	>5% cost decrease
Schedule Impact of Threat	Insignificant slippage	<1 month slippage	1-3 months slippage	3-6 months slippage	>6 months slippage
Schedule Impact of Opportunity	Insignificant improvement	<1 month improvement	1-2 months improvement	2-3 months improvement	>3 months improvement
Probability	1–9%	10–19%	20–39%	40–59%	60–99%

The Perform Qualitative Risk Analysis process assesses and evaluates characteristics of individually identified project risks and prioritizes risks based on agreed-upon characteristics. **PMI,2013**

Assessing individual risks using qualitative risk analysis evaluates the probability that each risk will occur and the effect of each individual risk on the project objectives. As such it does not directly address the overall risk to project objectives that results from the combined effect of all risks and their potential interactions with each other. This can however be achieved through use of quantitative risk analysis techniques.

One step in the analysis is to categorize risks according to their sources or causes. If several risks arise from a common source, sometimes called a root cause, risk responses may be more effective when they focus on addressing this root cause. Identifying common effects from groups of risks allows identification of the areas of greatest risk exposure (e.g. to the project

completion date, the budget, or a particular deliverable's scope), facilitating risk response focus in these areas. **PMI,2013**

The methods of qualitative risk analysis are applied to the list of risks created or updated by the Identify Risks process to provide project management with the characteristics of the risks that have the most influence(positive or negative) on achieving the project's objectives. Risks that are assessed as high priority to either threaten or to enhance the achievement of project objectives will be an important focus in the Plan Risk Responses process. They may be further analyzed, such as in the analysis of the overall project risk that is discussed in Perform Quantitative Risk Analysis process **PMI,2013**

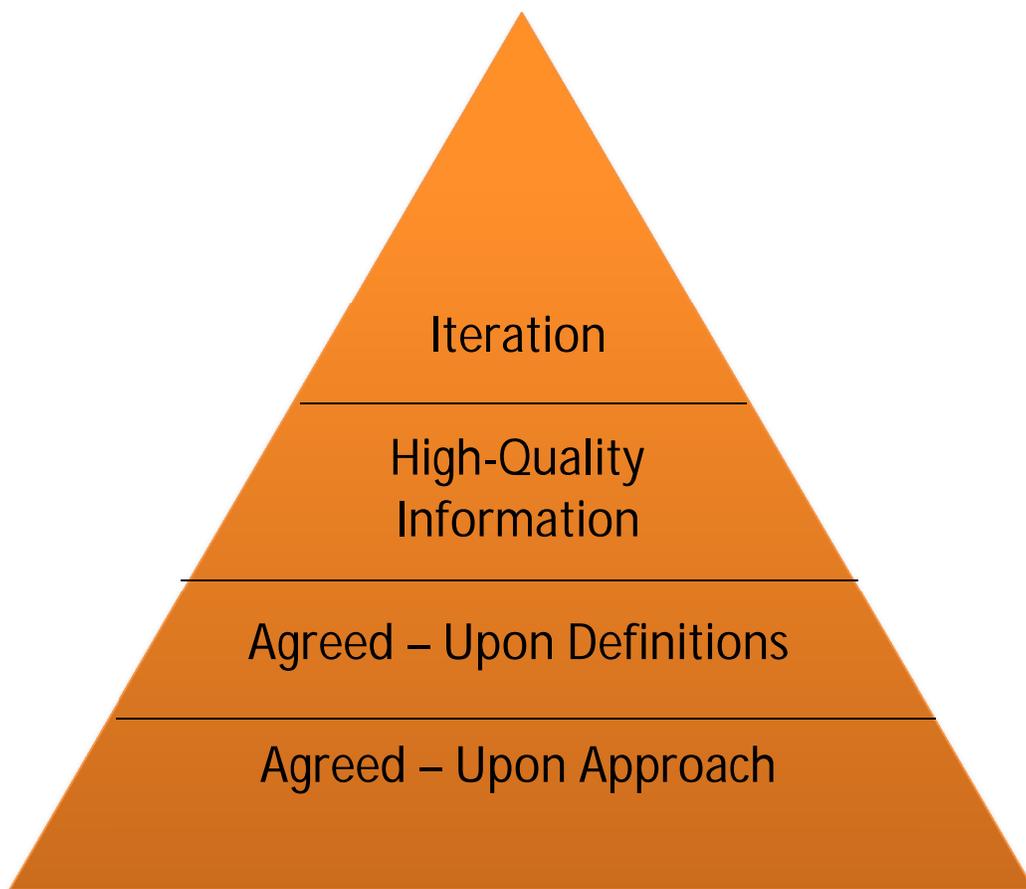


Figure (2-3)

Building risk analysis credibility

The PRMT assesses each identified risk in turn and assesses the rating for the probability of the risk occurring, and the rating of cost and time impact of each risk, should it occur.

The risk matrix in table (2-4) is used to determine the importance of each risk impact based on the probability and impact ratings. Each word descriptor of the rating has an associated number; the product of the probability number and impact number defines the risk score.

Table (2-4) The risk matrix

Probability Rating	5 – Very High					
	4 – High					
	3 – Moderate					
	2 – Low					
	1 – Very Low					
		1 Very Low	2 Low	4 Moderate	8 High	16 Very High
		Impact Rating				

For a particular impact, the combination of the probability rating of the risk occurring and the impact rating positions the risk into one of the three colored zones in the risk matrix. The color of the zone indicates the priority of the risk for risk response: red zone signifies high importance, yellow is medium importance, and green is low importance.

For example, a risk having a “Moderate” probability and a “High” impact falls into the red zone. Its impact score is $3 \times 8 = 24$. **PMI,2013**

Documenting the Results of the Perform Qualitative Risk

Analysis Process:

The Perform Qualitative Risk Analysis process adds structure to the list of undifferentiated risks into categories of priority. Priorities are usually based

on the risk’s probability of occurring and its potential impact on specific project objectives or on the whole project. Each identified risk is assigned a priority, perhaps by objective or for the entire project. This information is usually stored in the risk register

which is easy to use and update with new information. The risk register list of prioritized risks is posted to the project participants who are responsible for further analysis or action to improve the project plan. Risks that are judged to have high priority are segregated for further analysis and response planning and are generally monitored frequently. Risks of low priority to the project may be placed on a watch list and are reviewed less often for changes in their status. [PMI,2013](#)

The qualitative risk analysis of each risk is entered into the following columns of the risk register.

Table (2-5)
Risk register update

Column	Contents
Probability	Select the probability level from the drop-down list.
Cost Impact	Select the cost impact level from the drop-down list.
Time Impact	Select the time impact level from the drop-down list.
Rationale	Describe the rationale for these assessments.

The “Time Score” is equal to the Probability number times the Time Impact number. The risks in a colored zone may be further prioritized for risk response according to their Cost and Time Scores. The higher the score , the higher the priority for risk response and monitoring.

Other columns in the risk register will be completed or updated by the risk response process . **PMI,2013**

2-7-4 Quantitative Risk Analysis :

The Perform Quantitative Risk Analysis process provides a numerical estimate of the overall effect of risk on the objectives of the project, based on current plans and information, when considering risks simultaneously.

Results from this type of analysis can be used to evaluate the likelihood of success in achieving project objectives and to estimate contingency reserves, usually for time and cost that are appropriate to both the risks and the risk tolerance of project stakeholders **PMI,2013**.

It is generally accepted that analyzing uncertainty in the project using quantitative techniques such as Monte Carlo simulation may provide more realism in the estimate of the overall project cost or schedule than a non-probabilistic approach which assumes that the activity durations or line-item cost estimates are deterministic. However it should be recognized that quantitative risk analysis is not always required or appropriate for all projects. For example, qualitative risk analysis may provide enough information for development of effective risk responses, especially for smaller projects. Therefore, during the Plan Risk Management process, the benefits of quantitative risk analysis should be weighed against the effort required to ensure that the additional insights and value justify the additional effort . **PMI,2013**

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks, using Monte Carlo simulation by Risk Analysis software.

The result is a probability distribution of the project's cost and completion date based on the identified risks in the project. **PMI,2013**

Results of the quantitative analysis will be compared to the project plan (baseline or current) to give management an estimate of the overall project risk and will answer important questions such as

- 1- What is the probability of meeting the project's objectives?
- 2- How much contingency reserve (e.g., reserves or buffers of time, resources, and cost) is needed to provide the organization with the level of certainty it requires based upon its risk tolerance?
- 3- What are those parts of the project, such as line-item costs or schedule activities, which contribute the most risk when all risks are considered simultaneously?
- 4- Which individual risks contribute the most to overall project risk?

Estimating overall project risk using quantitative methods helps distinguish those projects where quantified risks threaten objectives beyond the tolerance of the stakeholders, from those for which the objectives are within acceptable tolerances even when risk is considered. The former may be targeted for vigorous risk responses aimed at protecting those objectives most important to the stakeholders. **PMI,2013**

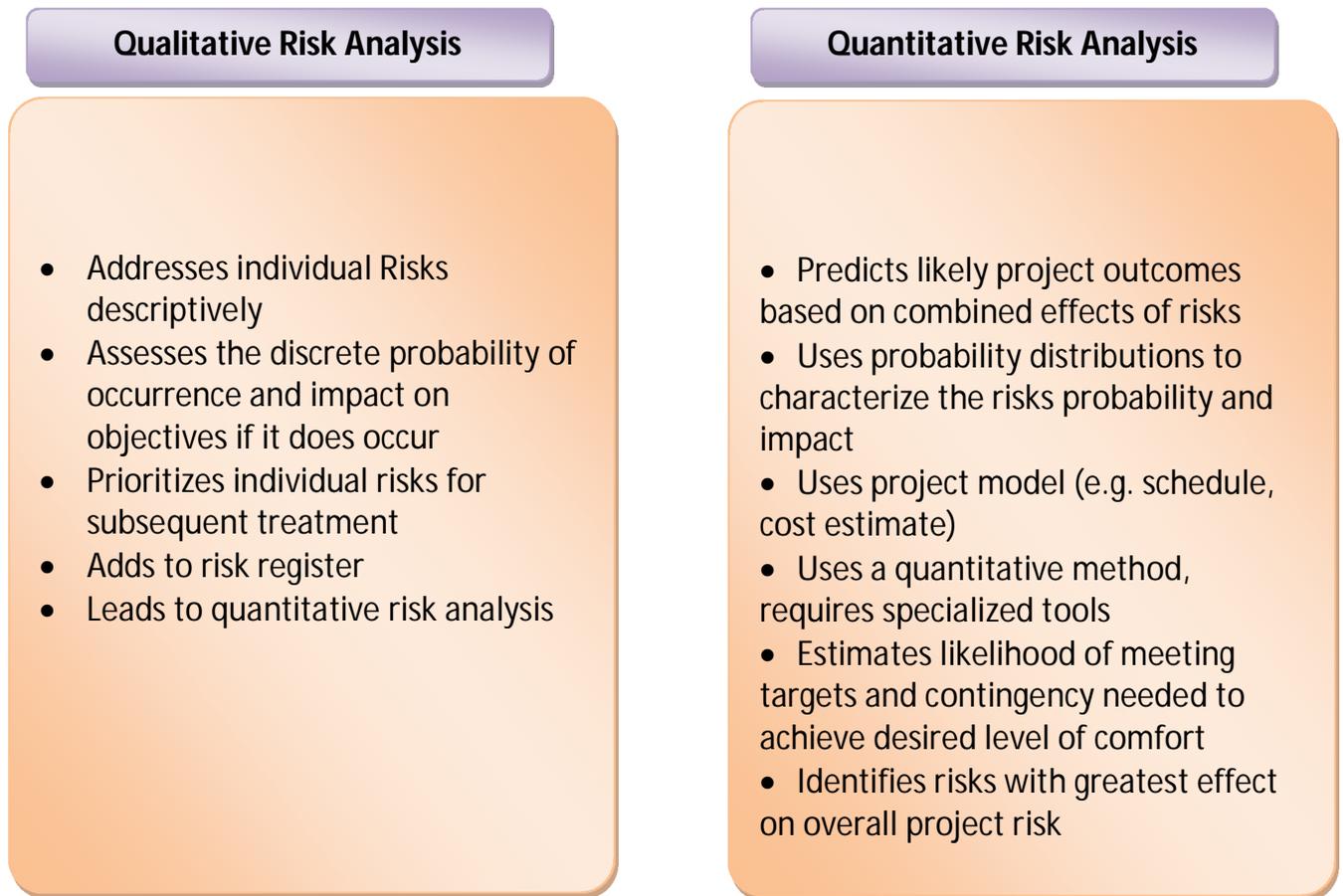


Figure (2 - 4) Comparison of qualitative and quantitative approach

PMI,2013

The qualitative risk analysis of each risk is entered into the following columns of the risk register.

Table (2-6)
risk register update

Column	Contents
Probability	Select the probability level from the drop-down list.
Cost Impact	Select the cost impact level from the drop-down list.
Time Impact	Select the time impact level from the drop-down list.
Rationale	Describe the rationale for these assessments.

probability curves of the total cost of the risks and the total delay to the project. This requires knowledge of special risk modeling tools such as @Risk, Crystal Ball, or Primavera Risk *Analysis* for schedule risk modeling. The project risk manager may perform these risk analysis tasks, if trained, or they may be performed by a Department specialist. The District Risk Management Coordinator can obtain expert services as needed. **Bob,2012**

The Risk Cost (RC) is the probability distribution of the total cost of all risks in the project risk register. Figure (2 – 6) is an example of a project’s Risk Cost probability distribution.

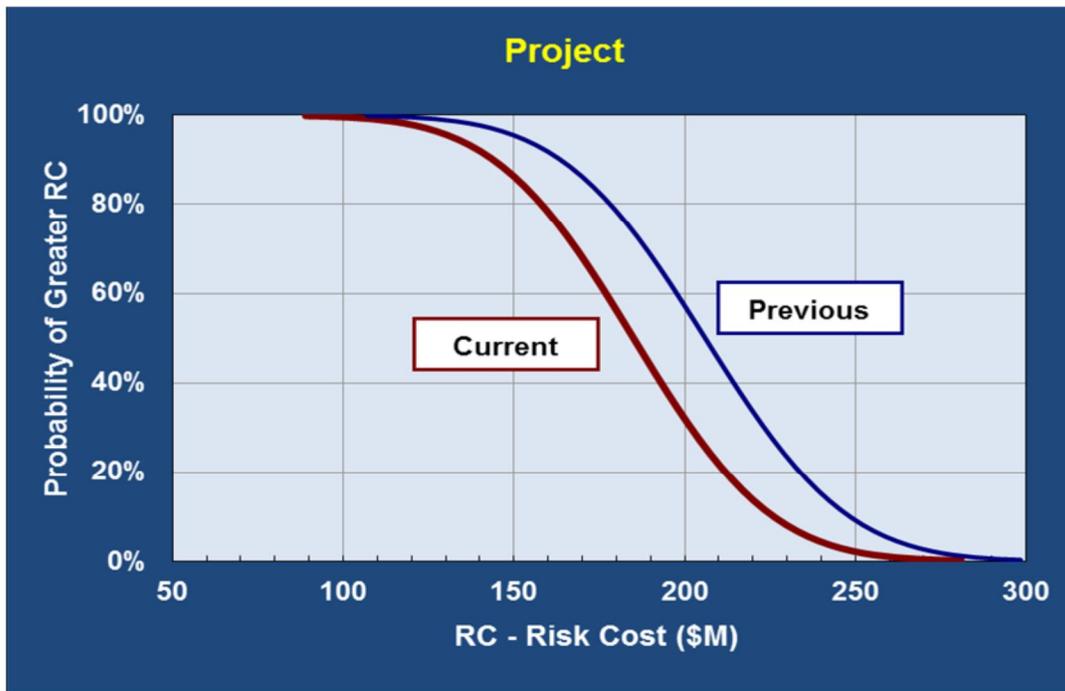


Figure (2 - 5) Project risk cost probability distribution example

Bob,2012

The chart shows the curves for the current assessment and the previous assessment, if available.

Selected values of RC at 90%, 50%, and 10% probability levels accompany the chart. For the example above, the table would indicate:

Current Previous

90% chance RC is greater than \$ 144 M \$ 164 M

50% chance RC is greater than \$ 185 M \$ 206 M

10% chance RC is greater than \$ 226 M \$ 248 M

Schedule risk analysis may be performed using a simple model that combines delay risks on the critical path to project completion. This simple version can be modeled using @Risk. This approach is satisfactory if a Critical Path Method (CPM) schedule is not available.

If a CPM schedule is available, the schedule is imported into *Primavera Risk Analysis*, and the delay risks are inserted. This tool runs the simulation and produces output probability curves for selected milestones. Expert knowledge is required to use this tool. The curve will look similar to Figure 3 except the horizontal axis will be a time scale.

2-8 Risk Response:

Risk response is the process of developing strategic options, and determining actions, to enhance opportunities and reduce threats to the project's objectives. A project team member is assigned to take responsibility for each risk response. This process ensures that each risk requiring a response has an owner monitoring the responses, although the owner may delegate Implementation of a response to someone else. **Bob,2012**

The objective of the Plan Risk Responses process is to determine the set of actions which most enhance the chances of project success while complying with applicable organizational and project constraints. **PMI,2013**

Once risks have been identified, analyzed, and prioritized, plans should be developed for addressing every risk the project team considers to be sufficiently important, either because of the threat it poses to the project objectives or the opportunity it offers. The planning entails agreeing upon the actions to be taken and the potential changes to budget, schedule, resources, and scope which these actions might cause.

Contingent risk response actions need to be executed at the optimum time. For this reason, the response specification for each such risk should include a description of any corresponding trigger conditions. **PMI,2013**

The responsibility for monitoring the project conditions and implementing the corresponding actions should be clearly assigned. Every risk should have been allocated to a risk owner as part of the Identify Risks process ,and each

of the corresponding risk responses should now be assigned to a specific risk action owner. The risk owner is responsible for ensuring that the risk response is effective and for planning additional risk responses if required, whereas the risk action owner is responsible for ensuring that the agreed-upon risk responses are carried out as planned, in a timely manner. The role of the risk owner and that of the risk action owner may be assigned to a single person.

A range of factors are important for the success of the Plan Risk Responses process. Figure (2-7).

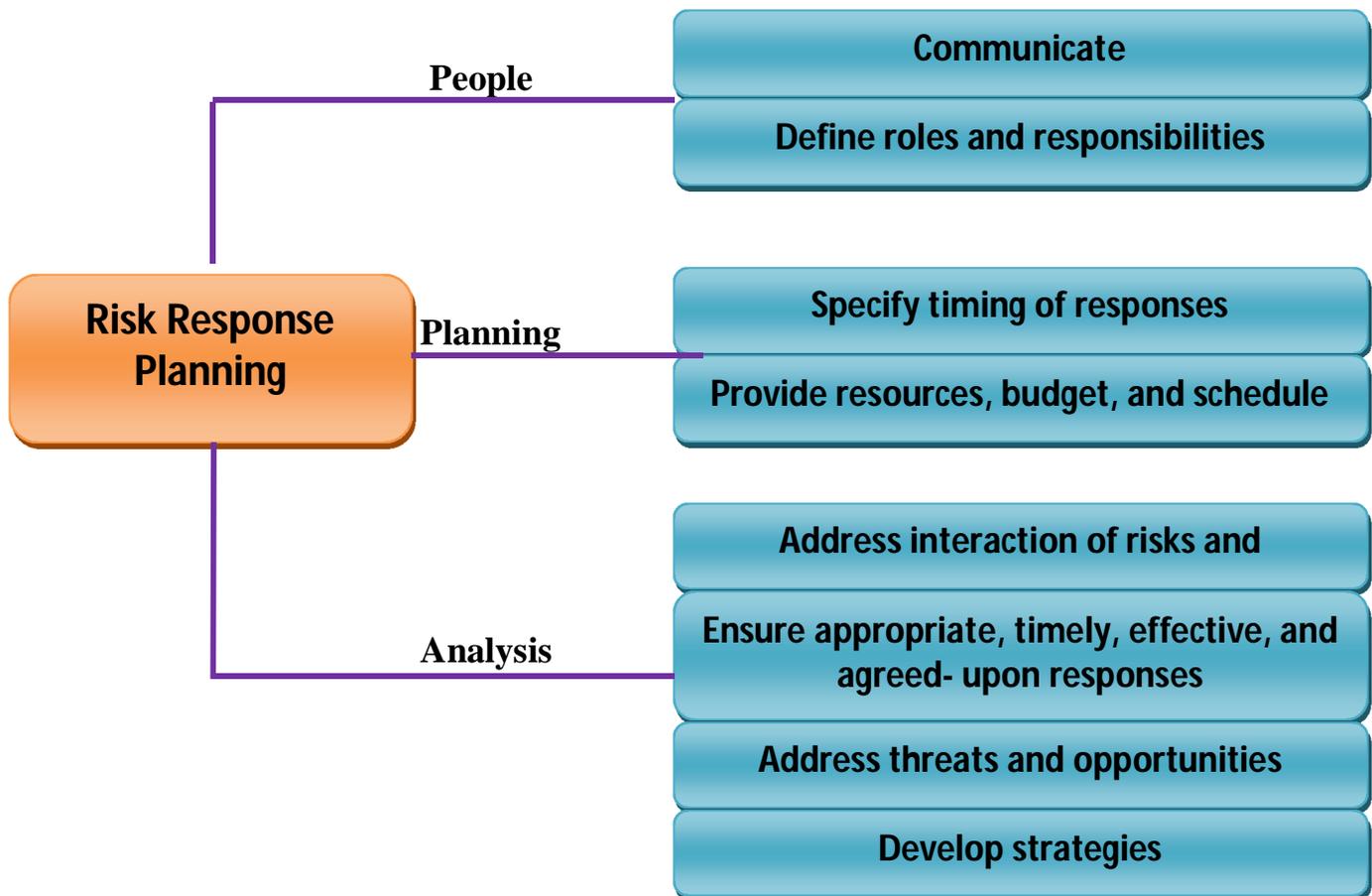


Figure. (2-6) Critical Success Factors for Risk Response Planning

PMI,2013

Avoid Risk can be avoided by removing the cause of the risk or executing the project in a different way while still aiming to achieve project objectives. Not all risks can be avoided or eliminated, and for others, this approach may be too expensive or time-consuming. However, this should be the first strategy considered. **PMI,2013**

Exploit : The aim is to ensure that the opportunity is realized. This strategy seeks to eliminate the uncertainty associated with a particular upside risk by making the opportunity definitely happen.

Exploit is an aggressive response strategy, best reserved for those “golden opportunities” having high probability and impacts.

Transfer : Transferring risk involves finding another party who is willing to take responsibility for its management, and who will bear the liability of the risk should it occur. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively. Risk transfer usually involves payment of a premium, and the cost effectiveness of this must be considered when deciding whether to adopt a transfer strategy.

Share : Allocate risk ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does occur. Transferring threats and sharing opportunities are similar in that a third party is used. Those to whom threats are transferred take on the liability and those to whom opportunities are allocated should be allowed to share in the potential benefits.

Mitigate : 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 trying to repair the damage after the risk has occurred. Risk mitigation may require

resources or time and thus presents a tradeoff between doing nothing versus the cost of mitigating the risk.

Enhance : This response aims to modify the “size” of the positive risk. The opportunity is enhanced by increasing its probability and/or impact,

Thereby maximizing benefits realized for the project. If the probability can be increased to 100 percent, this is effectively an exploit response

Acceptance: This strategy is adopted when it is not possible or practical to respond to the risk by the other strategies, or a response is not warranted by the importance of the risk. When the project manager and the project team decide to accept a risk, they are agreeing to address the risk if and when it occurs. A contingency plan, workaround plan and/or contingency reserve may be developed for that eventuality . **PMI,2013**

The steps of risk response is illustrated in figure (2-7)

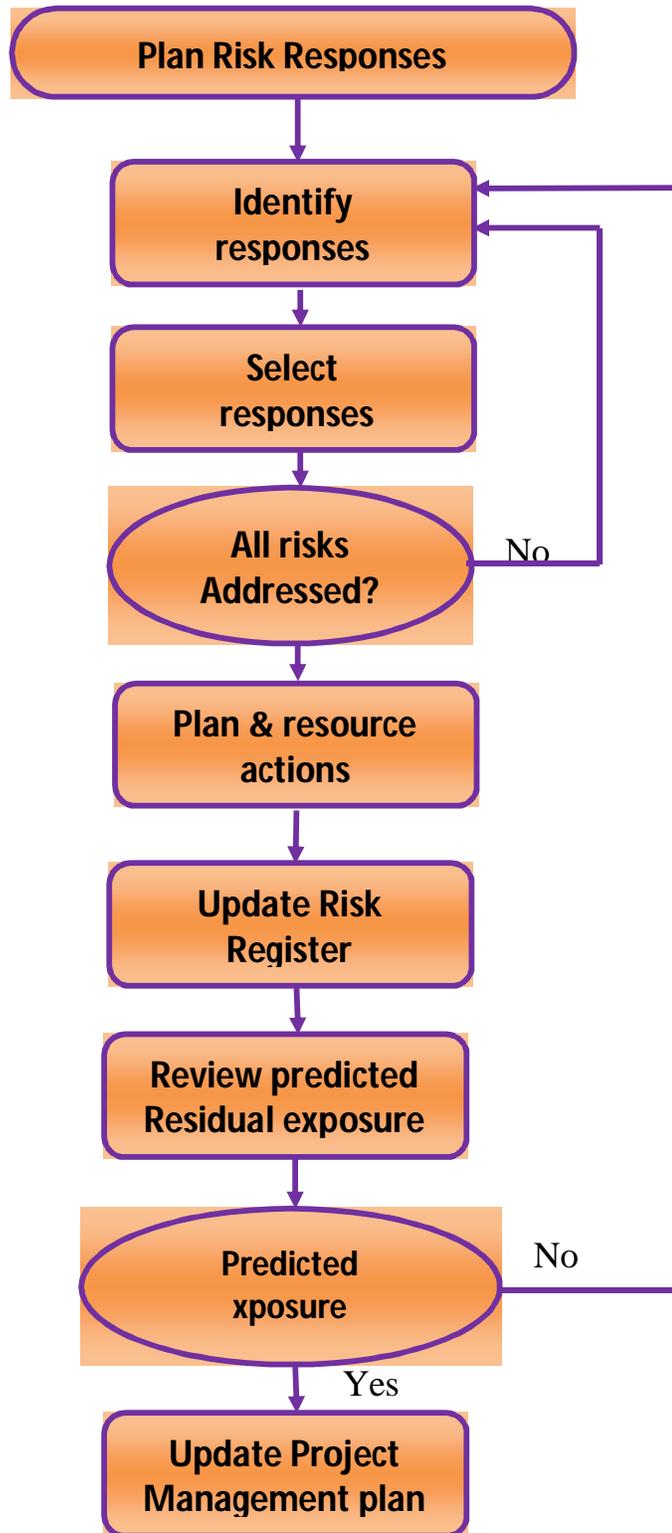


Figure (2-7)

2-8-1 Monitor and control risks :

The effectiveness of Project Risk Management depends upon the way the approved plans are carried out. These plans should be executed correctly, reviewed, and updated regularly. If this is carried out correctly, the invested effort will be rewarded and future projects will benefit from this project's experience. **Bob,2012**

The primary objectives of risk monitoring and controlling are to track identified risks, monitor residual risks, identify new risks, ensure that risk response plans are executed at the appropriate time, and evaluate their effectiveness throughout the project life cycle. **PMI,2013**

In addition to tracking and managing the risk response actions, the effectiveness of all of the Project Risk Management processes should be reviewed to provide improvements to the management of the current project as well as future ones. For each risk or set of risks for which a contingent response has been defined, the corresponding set of trigger conditions should have been specified. It is the responsibility of the action owner to ensure that these conditions are effectively monitored and that the corresponding actions are carried out as defined, in a timely manner.

Once the Plan Risk Responses process is complete, all of the approved unconditional response actions should have been included and defined in the current project management plan. The first action of risk monitoring and controlling is to check whether this is the case and take any appropriate action if necessary, such as invoking the change management process with respect to any missing actions. This will then ensure that the agreed-upon actions are carried out within the normal project execution framework.

Continuous monitoring by the project risk manager and the project team ensures that new and changing risks are detected and managed and that risk

response actions are implemented and effective. Risk monitoring continues for the life of the project. **PMI,2013**

Risk monitoring and control keeps track of the identified risks, residual risks, and new risks. It also monitors the execution of planned strategies for the identified risks and evaluates their effectiveness.

Risk monitoring and control continues for the life of the project. The list of project risks changes as the project matures, new risks develop, or anticipated risks disappear. Risk ratings and prioritizations can also change during the project lifecycle. **PMI,2013**

Typically, during project execution, risk meetings should be held regularly to update the status of risks in the risk register, and add new risks. Periodic project risk reviews repeat the process of identification, analysis, and response planning.

If an unanticipated risk emerges, or a risk's impact is greater than expected, the planned response may not be adequate. The project manager and the PRMT should perform additional responses to control the risk. Monitoring also determines whether:

The PRMT is performing periodic risk review and updating ,Risk management policies and procedures are being followed and The remaining contingency reserves for cost and schedule are adequate

And it may involve recommending:

Alternative risk responses , Implementing a contingency plan , Taking corrective actions and Changing the project objectives. **Bob,2012**

The final control action of risk monitoring and controlling is to record actual data for future use. This includes all of the relevant information relating to risk management from start to finish of the project. The definition of what

this information must include, as well as the storage mechanism, should have been previously specified in the risk management plan.

The goal is to ensure that the significant risk management information is recorded to provide concrete data to the lessons learned process for inclusion in a lessons learned document, report, or other communication vehicle.

Typical information includes the following:

1. For each identified risk or type of risk, whether it occurred, and, if so, when and how often. All irrelevant data should be recorded: impact, effectiveness of detection and of response, and any unplanned, additional actions that were carried out.
2. Effectiveness of avoidance or exploitation actions.
3. Effectiveness of transfer and sharing actions.
4. Unexpected or undocumented risks which occurred and data about them.
5. Effectiveness of risk mitigation and enhancement actions.
6. Occurrence of accepted threats or opportunities.

Consolidated information should be provided on the level of effort expended. Costs and benefits to the project of risk management activities should also be provided.

This information will need to be archived and indexed in a manner that will facilitate retrieval for easy review during the project, at closure, and for future projects, when the need arises. **PMI,2013**

Make any changes and additions to the risks and enter the revision date into the “Updated” column . **Bob,2012**

Chapter Three

RESEARCH METHODOLOGY

3.1 Introduction:

This chapter also provides the information about research strategy, research design, target population and sample size a detailed methodology and tools used are described.

3.2 Research Strategy

In this research, a quantitative approach is selected to determine the variables and factors that affect the risk management practices in construction project in Khartoum state to find out if there is a systematic risk management practices through the contracting companies.

3.3 Research design

The term research design refers to the plan or organization of scientific investigation, designing of a research study involves the development of a plan or strategy that will guide the collection and analyses of data [Polit,1999](#) In this research a closed-ended questionnaire is used to collect data from respondents.

3.4 Research population

A population consists of the totality of the observation with which we are concerned . In this research, the population is the total number of contractors (50 contracting companies)

3.5 Sample Size

Sampling defines the process of making the selections; sample defines the selected items . Jase (2005) defined the sampling as the process of selecting representative units of a population for the study in a research investigation. Unfortunately, without a survey of the population, the representativeness of any sample is uncertain but statistical theory can be used to indicate representativeness . One of the most frequent questions asked "what is size sample used ?" historically, the responses to this question at least 30 subjects 50 questionnaires are to be distributed to contracting firms to achieve objectives of the study,

3.6 Limitation of the research:

1. Due to time limitation, this research is concerned with building projects only and will not take into account that other categories of construction industry like heavy engineering construction (tunnels, bridges, dams, etc.), industrial projects (factories and workshops), and infra-structure projects (sewage and water supply).
2. This study is limited to the construction industry practitioners in Khartoum state.

3.7 Questionnaire design

The questionnaire survey was conducted to determine the opinion of contractors risk factors. A four pages questionnaire accompanied with a covering letter were delivered to 50 contracting companies .The letter indicates the objectives of the research and explained to the participants that the results of the questionnaire would be used to improve the ability of

contractors and owners to identify, analyze and estimate the risk factors impact on the construction phase of building projects.

A close-ended questionnaire was used for its advantages as it is easy to ask and quick to answer, they require no writing by either respondents or interviewer.

The questionnaire was composed of six sections to accomplish the aim of this research, as follows:

1. The organization profile (personal data)
2. Risk management and construction companies
3. The aggressive nature of compition in construction industry and its risks in contracting company .
4. Risk factors that have been identified by literature, experts and by the researcher.
5. Risk preventive methods, which could be used to avoid risk taking place.
6. Risk mitigative methods that could be used to mitigate risk impact or likelihood.

The questionnaire was prepared in English language (Appendix 1), but for the interest of the research and to have more accurate results the questionnaire were translated into Arabic (Appendix 2), Is any of the target population are not familiar with the English language.

Chapter Four

Result and Discussion

4-1 Introduction

The objectives of this research is identify the key risk factors, which could stand in front of construction project to determine the probability and impact of each key risk factors, then to determine the risk value of each risk factor ,to examine the risk management action those are applied in the construction industry in Sudan and to provide practical suggestion and recommendations regarding upgrading risk management process and improving the performance of contracting companies in this field .

The result of this study is presented and dicussed in this chapter.

The study focus mainly on the risk value which calculated by the formula

Risk value = probability * Impact. Chris,2003

Also in the result there is a tables ranks the probability , impact and the risk value for each risk factor .As mentioned in chapter , three the study divide the risk factor in to Seven main catogaries, each catogary contain a number of risk factors .The catogary are pretender risks group ,tendering risk group, contracting risk group construction phase risk group ,fainancial and economical risk group ,managerial risk group , physical and environmental risk group, and finally poltical and nature risk group

A Data which collected from so respondent to the questionnaire were analysed and discussed below.

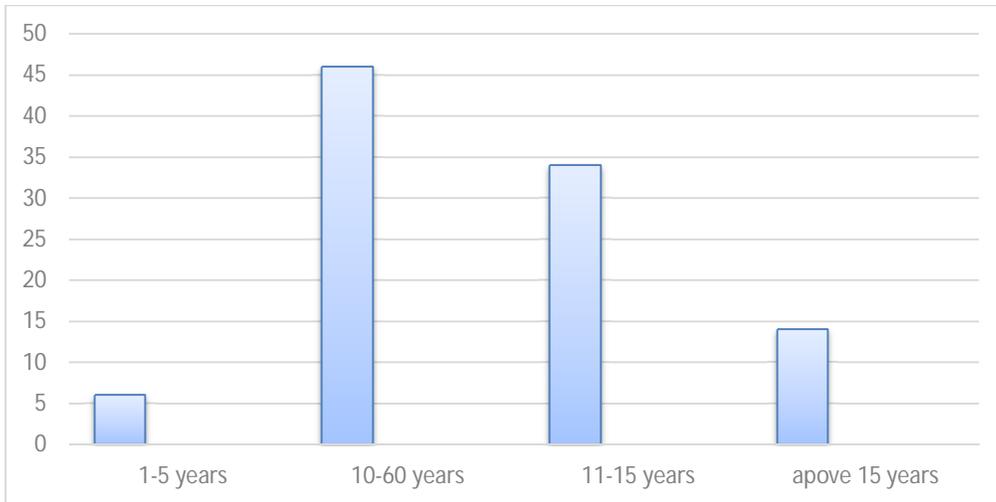


Figure No (4-2) The year of experience

Figure (4-2) shows that 6% of the respondent (1-5) years experience, 46% are (6-10) years experience they are the majority, 34% are (11-15) years and 14% those they are above 15 year experience. Thus 80% of the respondent are above 6 year's experience so they are a project management team member.

Questionnaire section (2) question (1)

How good is your knowledge about R.M principles

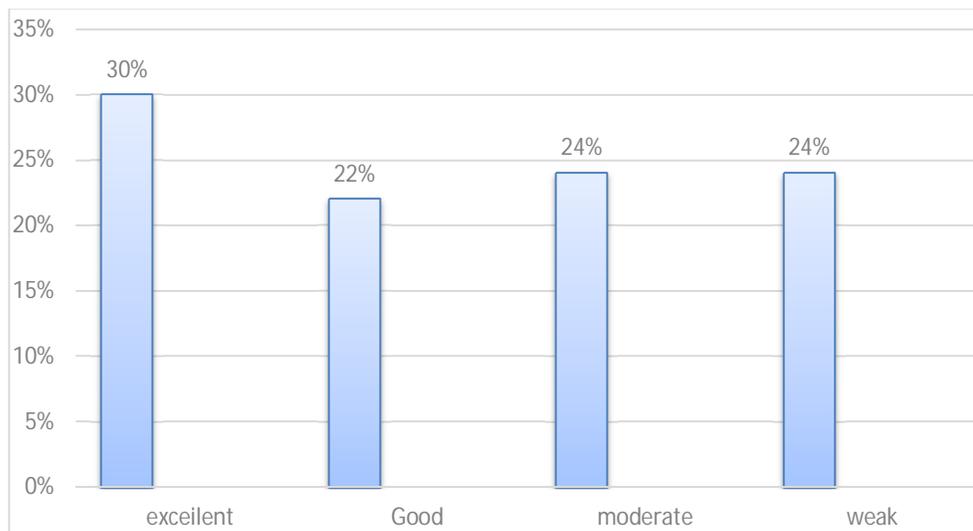


Figure (4-3): knowledge about RM .

According to the knowledge of RM,
Figure (4-3) shows that 30% of respondent have excellent knowlge about risk management principles, 22% have good knowledge ,24% have Moderate ,24%their knowledge is weak .
From this result we saw that the construction contractors personal are not suffer from lack of knowledge about R.M principle .

Questionnaire section (2) question (2)

Have your company separate R.M division

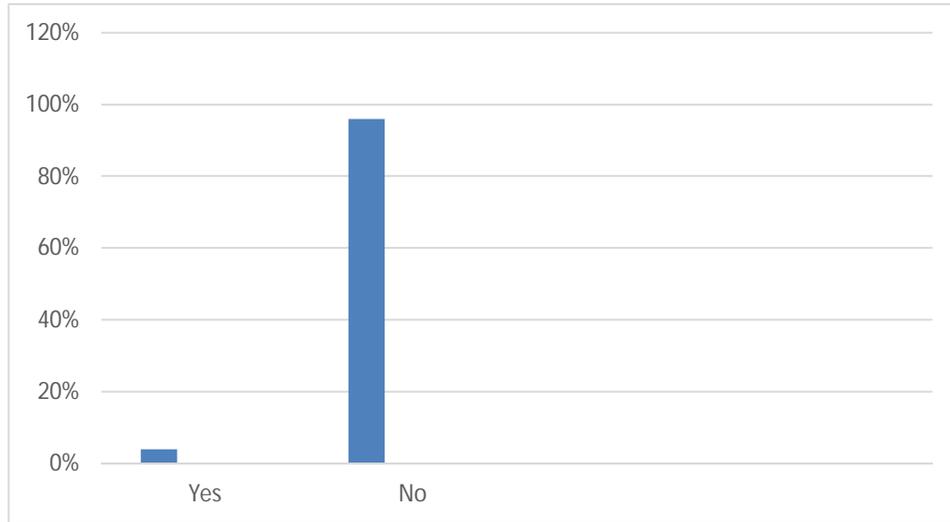


Figure No(4-4): The proportion of the companies which have RM division
According to RM division in companies ,

Figure (4-4) illustrate that 96% of the respondent companies have no R.M division only 4% they have this division The study result shows that in the Sudanese construction company there is no risk management division .

Questionnaire section (2) question (3)

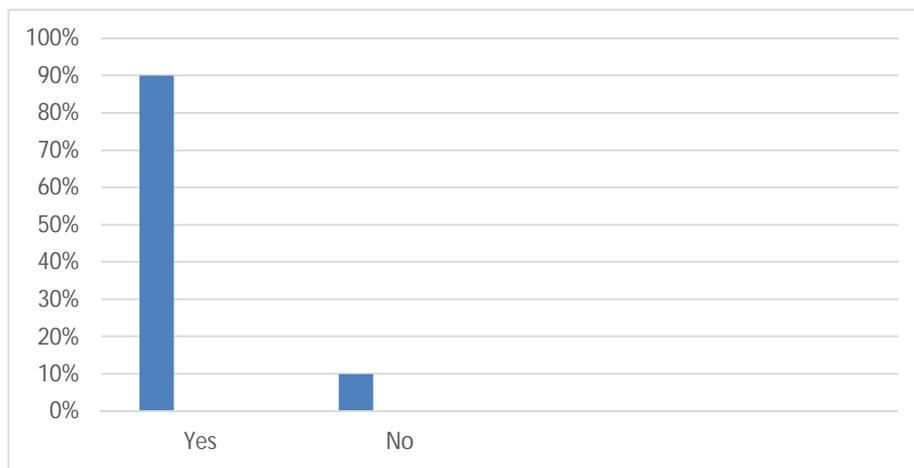


Figure (4-5) The rejection of a large contract due to high risk

The study result shows that in Figure (4-5), construction company like any other business avoid risky project by rejecting the contract which surrounded by too many risks 90% of the respondent say that their companies reject acontract because of its risk .10% say no .

Questionnaire section (2): question(4)

Does the refusal above was a result of scientific and systematic study of the risks surrounding this contract

questionnaire section (2) question (4)

Figure (4-6) The reasons of rejection

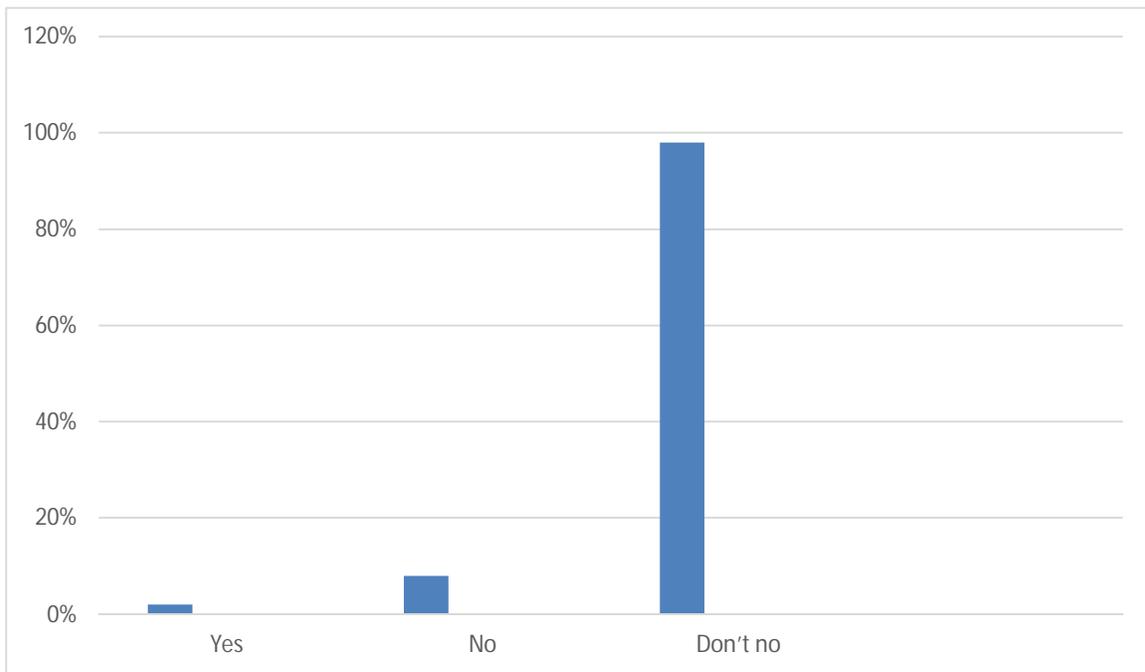


Figure (4-6) shows that the companies reject the risky project without systematic study of risk management . that because 98% answer no and 2% answer yes .This result comply with the result shows that the construction

companies has no Risk Management division so the risk management done was depend on the personal judgment of the decision maker in the company.

The result illustrates that 30% of the respondent has exelent RM knowlage 22% has good and 24% their knowledge in medium from this result we can say that the construction company personal have agood knowlage in risk management . But the same study show that 96% of the respondant,s companies has No R.M divisions and although this companies reject business contract because of it,s high risk , they reject without doing asystematic risk managment process .

4-3 The competitive nature of construction industry and its risk: questionnaire section (3) question (1)

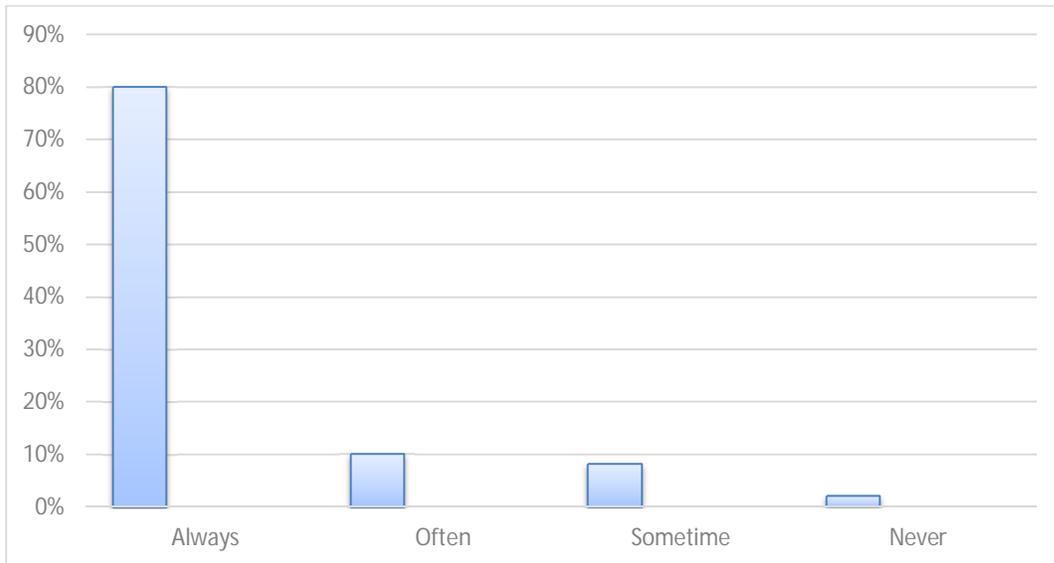


Figure (4-7) The aggressive competitions is one of the biggest factors which force the contractor to accept the risky construction contract

Figure (4-7) shows that 80% of the respondent says always the aggressive competition force the contractors to accept unfair risky contract 10% says often ,8% say sometimes and 2% say never .

The result shows that the aggressive competition in the construction industry always is one of the big factors forced the contractor to accept the risky unfair contract

questionnaire section (3) question (2)

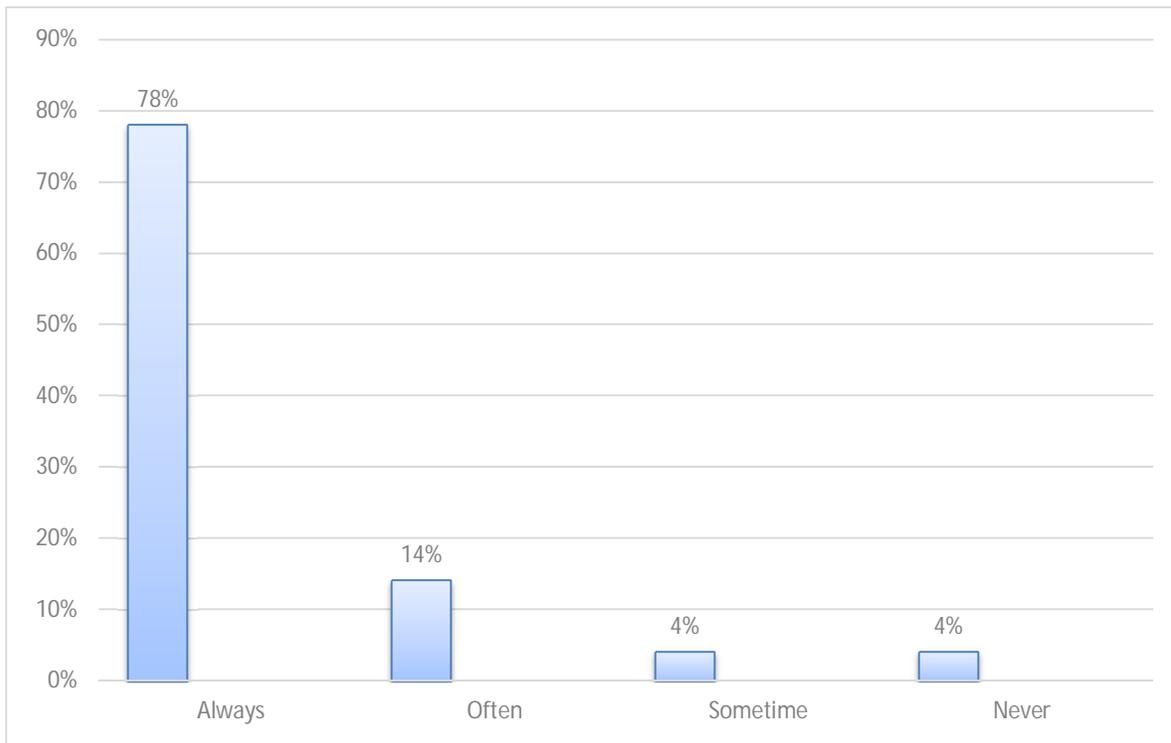


Figure (4-8) The public tenders contract is biased against the contractors party and allocate all risks on them

Figure (4-8) the results shows that in the formal bidding contract always did not protect the contractor interest like it did with the client,s 78% say always 14% say often 4% say sometimes and 4% say never that because the contract type and conditions chosen and written by the client party almost by lawyer whose not familiar with the construction and engineering works .

Questionnaire section (3) question (3)

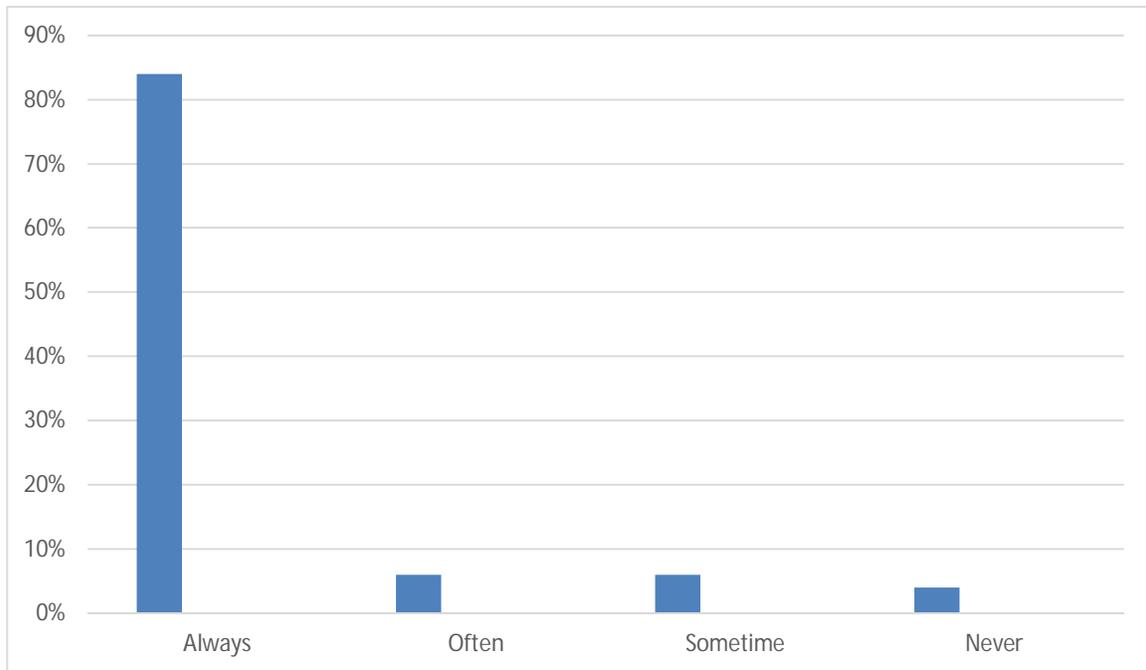


Figure (4-9) The contractor selection is biased on the tender price without professional evaluation to the technical and managerial offer

The study from Figure (4-9) shows that 84% say always in the formal bidding process the contractor selection depend on the financial offer only 6% say often , 6% say sometime and 4% say never .

When any one know that not always the lowest is the best it depend on his technical and managerial capabilities

Questionnaire section (3) question (4)

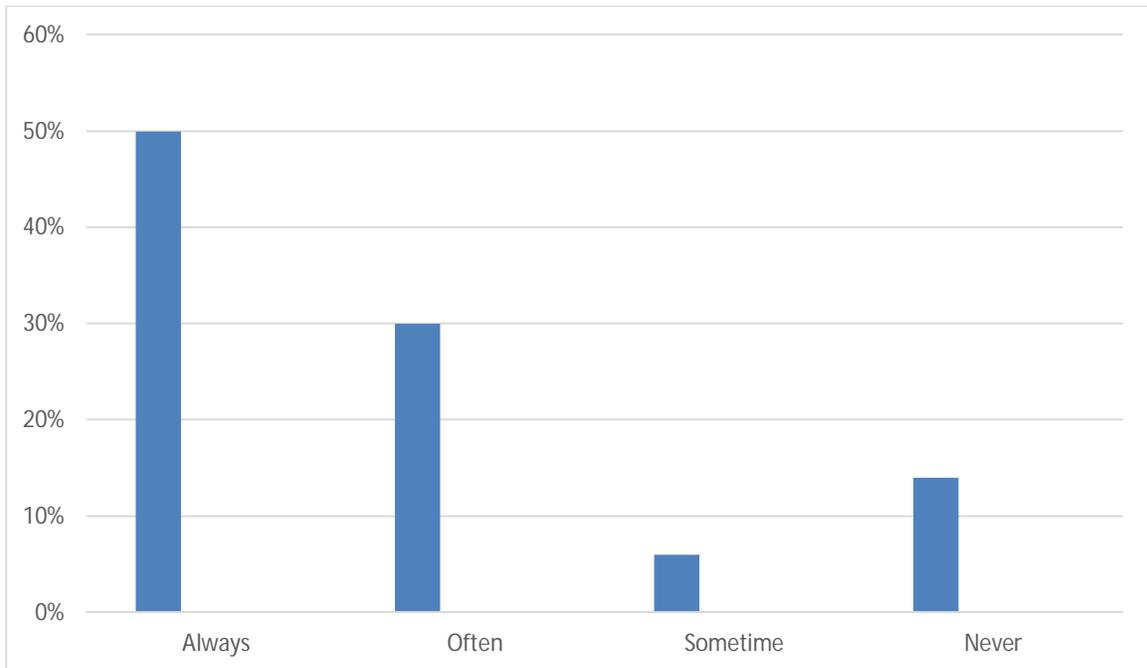


Figure (4-10): There is no contractors companies classification according to their technical ,fainancial , managerial capabilities .that lead to unfair competitions .

The result from Figure (4-10) shown that when there is no classification of contractor according to their capability and experience this lead to unfair competition 80% say always 30% say often 6% say sometime and 14% say never that because of the differences in the overheads and the quality of the work they will implement .

4-2 Risk factors

These risk factors were classified into groups

4.2.1 Group (1):

4.2.1.1 The pretending risk group

This group contain seven key risk factors they rank according to their probability in Figure (4-11) the most likely to happen is the error in design which score 244 point then the un completed specifications with 231 points .

From this result we see that the problem in the project begin from the pretending stage but their effected may last to the end of the project . because by the specification and the design the project is begin and end .

questionnaire section (4)

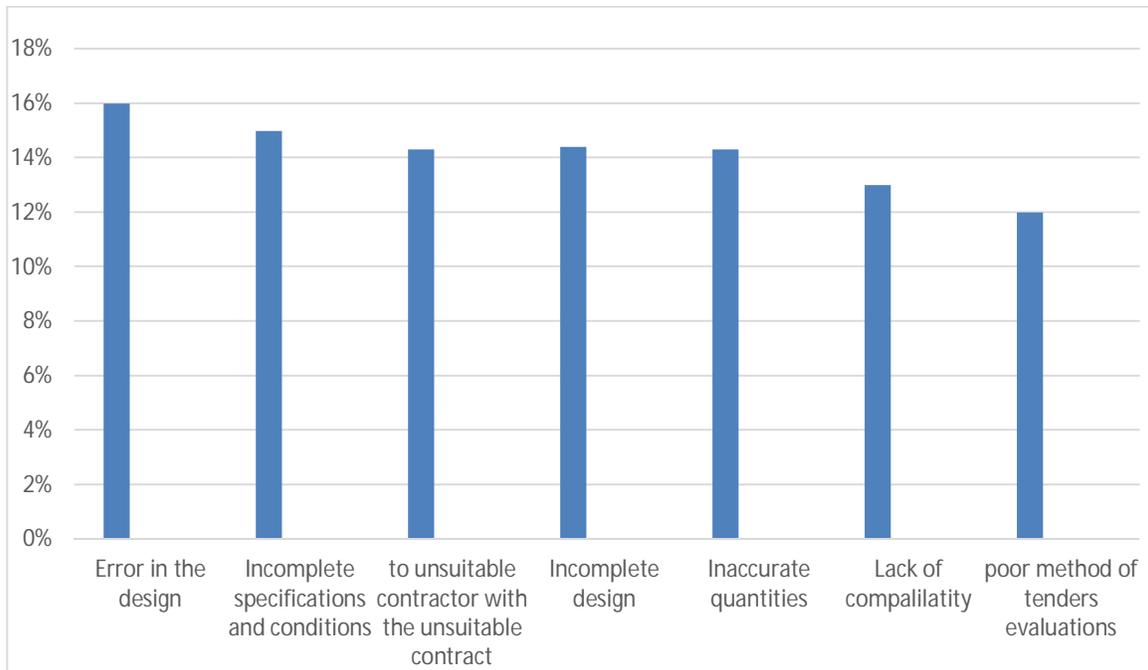


Figure (4-9): pre contracting risk group probability ranks according to its probability

4.2.1.2 The impact of risk factors in the pretending stage :

As show in Figure (4-11), the study result show that the evaluation and contractor selection criteria has the biggest impact in the project objectives with 226 point the second is the error in the designs with 222 points ,the third is the selection of inappropriate contractor with the inappropriate contract with 218 points .and the least impact risk factor is the incomplete specification with 118 point .

From the result, it was shown abig impact on the project objective source from the pretending stage specifically the tender evaluation and the selection criteria and the in complete design all these factors will remain to the end of the project .

Questionnaire section (4)

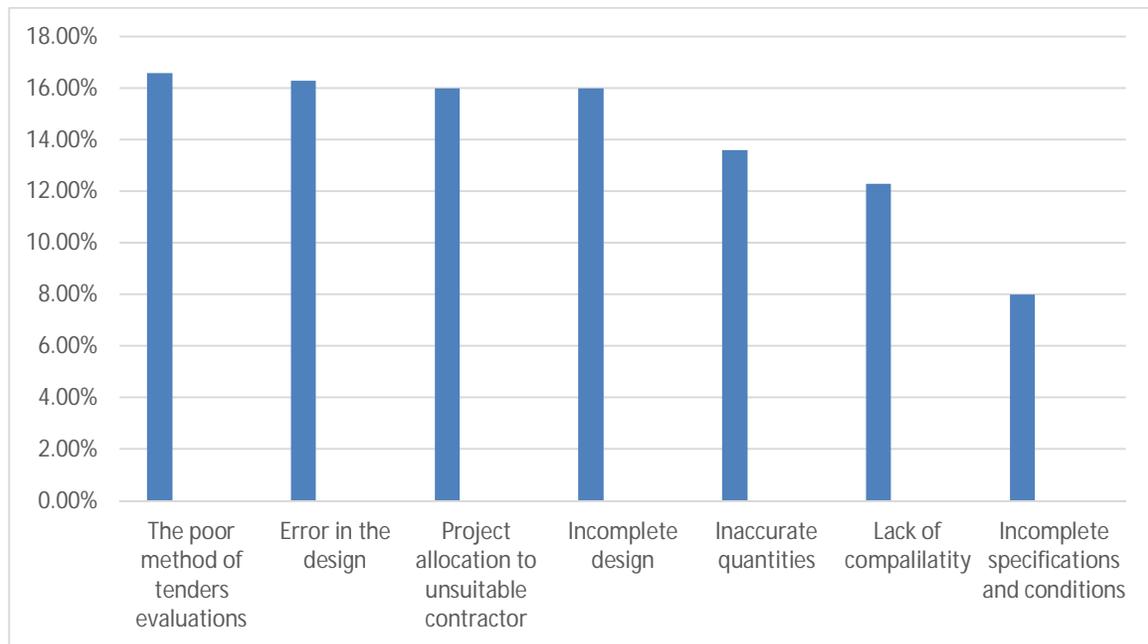


Figure (4-12): Group (1) precontracting risk group :Ranking according to its impact

4.2.1.3 The value of risk in the pretending stage

From results shown in Figure (4-13).the poor method of tender evaluation have the biggest risk value on the project The second is the design errors while the incomplete specification has the least risk value. The error in design has the biggest impact because the cost and time and quality is depend on this design .

Questionnaire section (4)

Table No (4-13) Group 1 Ranking according to risk value

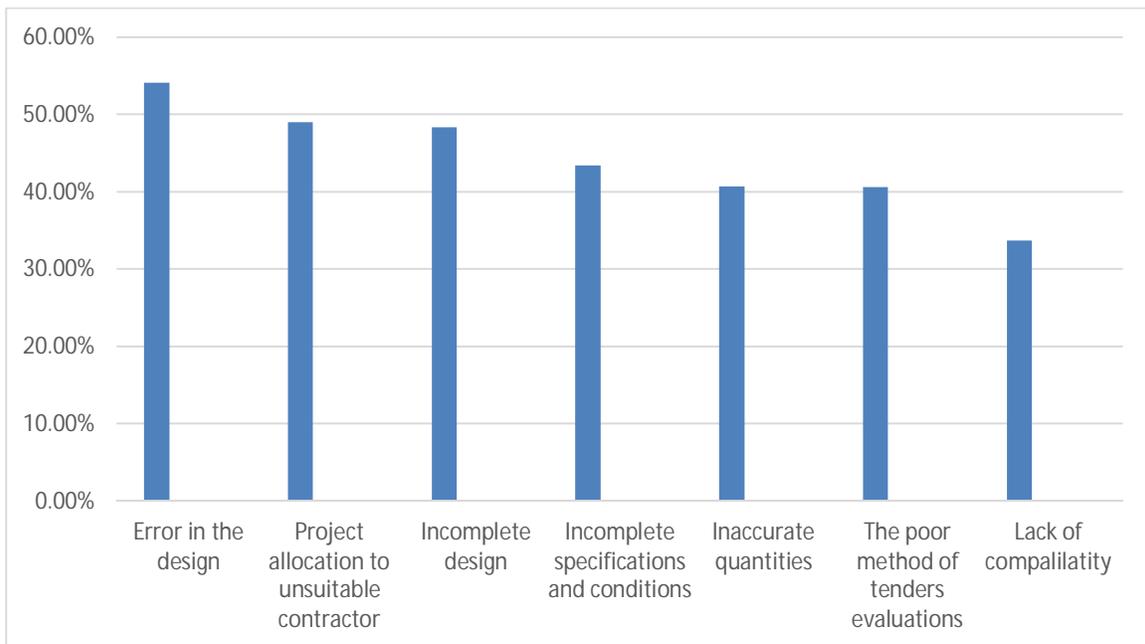


Figure no (4-13)The value of risk in the pretending stage Group 1

4.2.2 Group (2) tendering risk group:

The risk factors associated with tendering and selection criteria of the contractor .

4.2.2.1 probability of risk occurrence in group (2):-

Group (2) contain four factors they ranked according to their probability of occurrence Figure (4-14).

Poor cost estimating is a factor of most probability to occur with 212 point. This risk factor share between the owner in the pre-tendering stage through the engineer estimate and the contractor through his offer in the tendering phase .

The second factor according to the probability of occurrence is the inaccuracy of the tender document with 203 points. This risk causes several problems in the project and it affects all the project objectives: time, cost, quality, and customer satisfaction .

The third factor is the aggressive competition between the tenderers with 185 points , at last there is the contradictory document of contract (drawing , specification ,B.O.Q) with 165 points.

Questionnaire section (4)

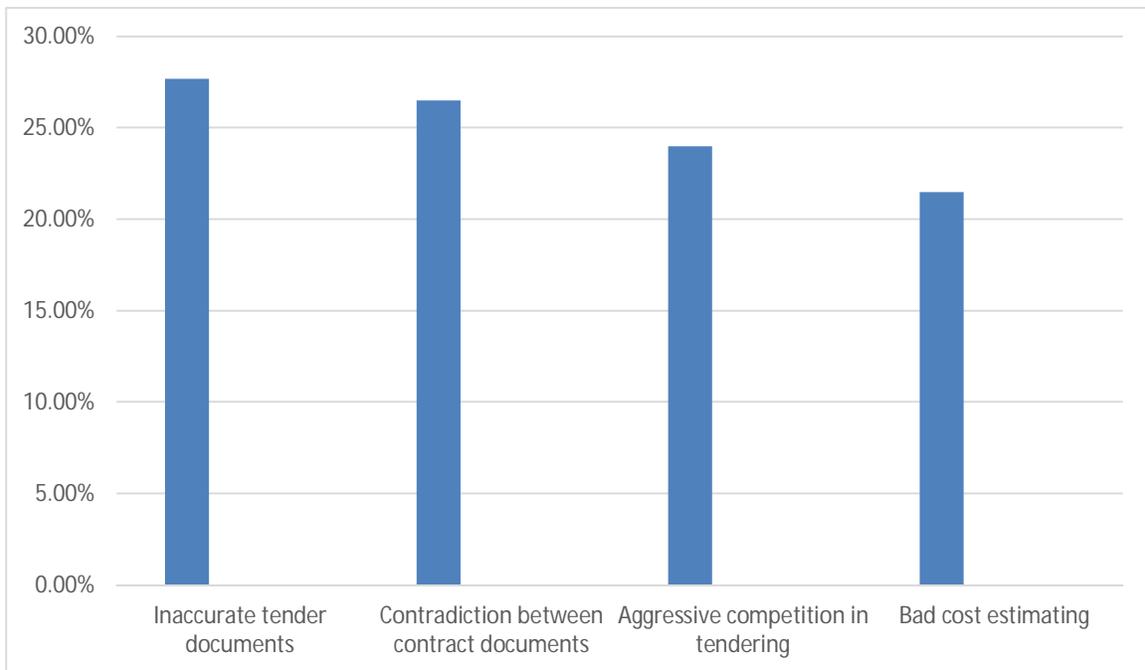


Figure No (4-14)

Group (2) tendering stage risk groups rank according to its probability of occurrence

4.2.2.2 Tendering and contractor selection risk group and their impact on the project objectives :

From result in Figure (4-15) shows that the bad cost estimating has biggest impact in the project objectives with 208 points , the inaccuracy of tender document come in the second order with 155 points and finally the contradiction between the contract document with 113 points .

Questionnaire section (4)

Table NO (4-15)

Tendering and contractor selection risk group and their impact on the project objectives :

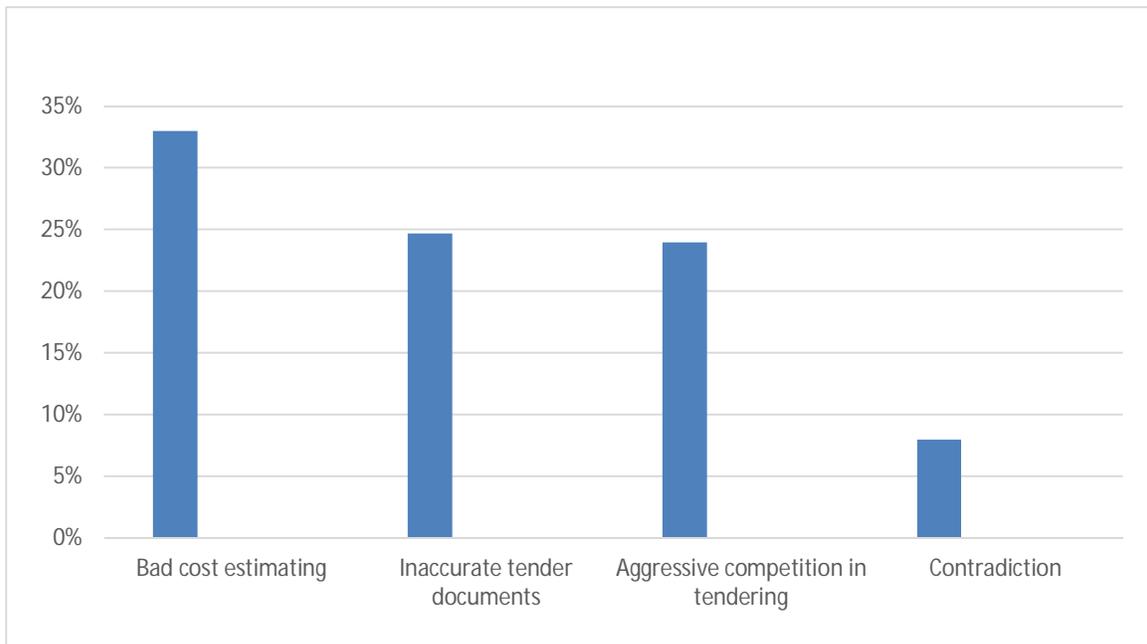


Figure (4-15):Tendering and contractor selection risk group and their impact on the project objectives .

4.2.2.3 Tendering and contractor selection risk group and their value :

According to study result in Figure (4-16) shows that the bad cost estimating for the projects item has the biggest value with 208, then the inaccuracy of tender document with 155 point and finally the contradiction between the contract document with 113 point. It was noticed that from the result there is no big difference in the value of the risks because in this phase all risk has significant value that for the lack of information in this phase.

Table No (4-16) Group 2 Rank according to risk value

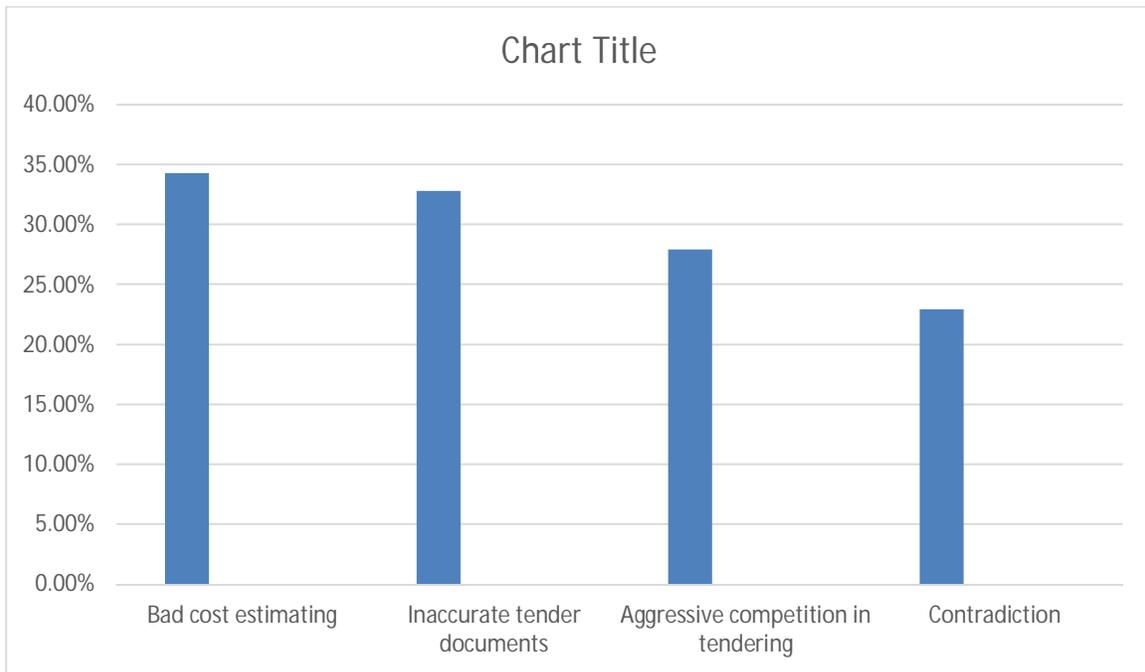


Figure No (4-16)

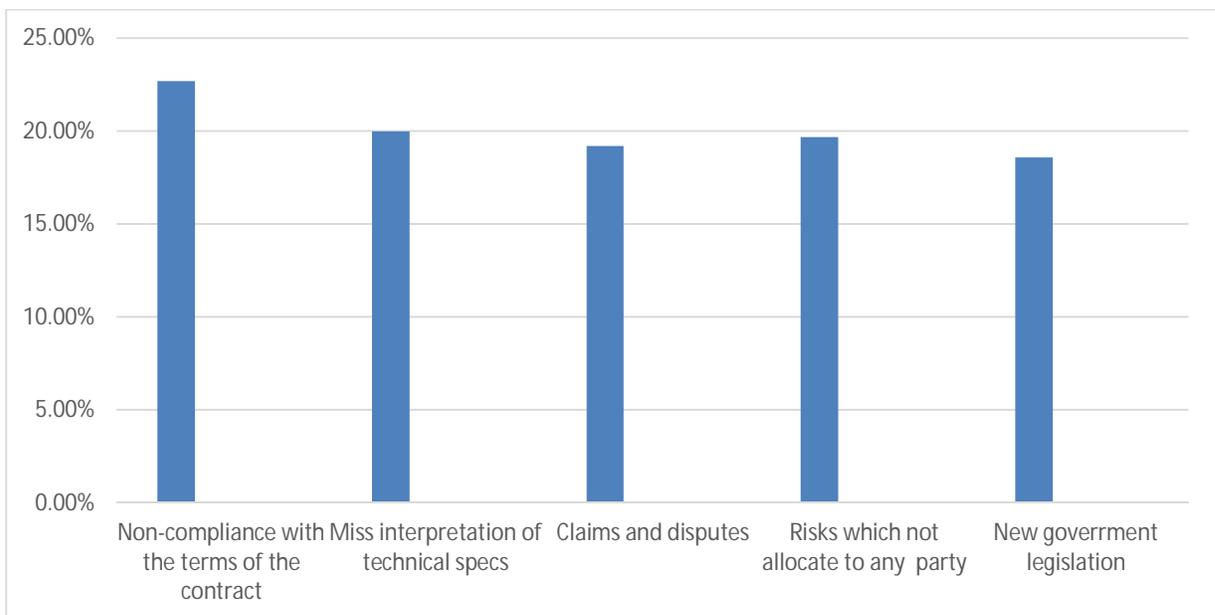
Figure no (4-6) Group 2 Rank according to risk value

4.2.3 Group (3)

Contractual risk groups :

4.4.3.1 The group probability of occurrence rank :

From result in figure (4-17) shows that the most probable factor is the non-compliance with the terms of the contract in full detail and without delay with 242 Then the miss with 218 and Miss interpretation of technical specs less probable factor is the government new legislation



Tble No (4-17)Contracting risk group3 : ranking according to stud their probability

Figure No (4-17) Contracting risk group3 : ranking according to stud their probability .

The Sudanese consturaction suffer from the bad use of alternative dispute resolution method (ADR) they use ADR and neglect the contract condition .

4.2.3.2 Contracting risk group3 : ranking according to stud their their impact :

From result Figure (4-18) the biggest impact is comes from the new .government legislation 227 points , secondly comes the contractual claim and disputes 173 points Finally with the least impact come the miss interpretation of specification with 146 points .

That because in the contract that is no term to deal with anew governmental legislation , which lead to the scond factor (claim and disputes).

Table NO (4-18) Contracting risk group3 : ranking their impact

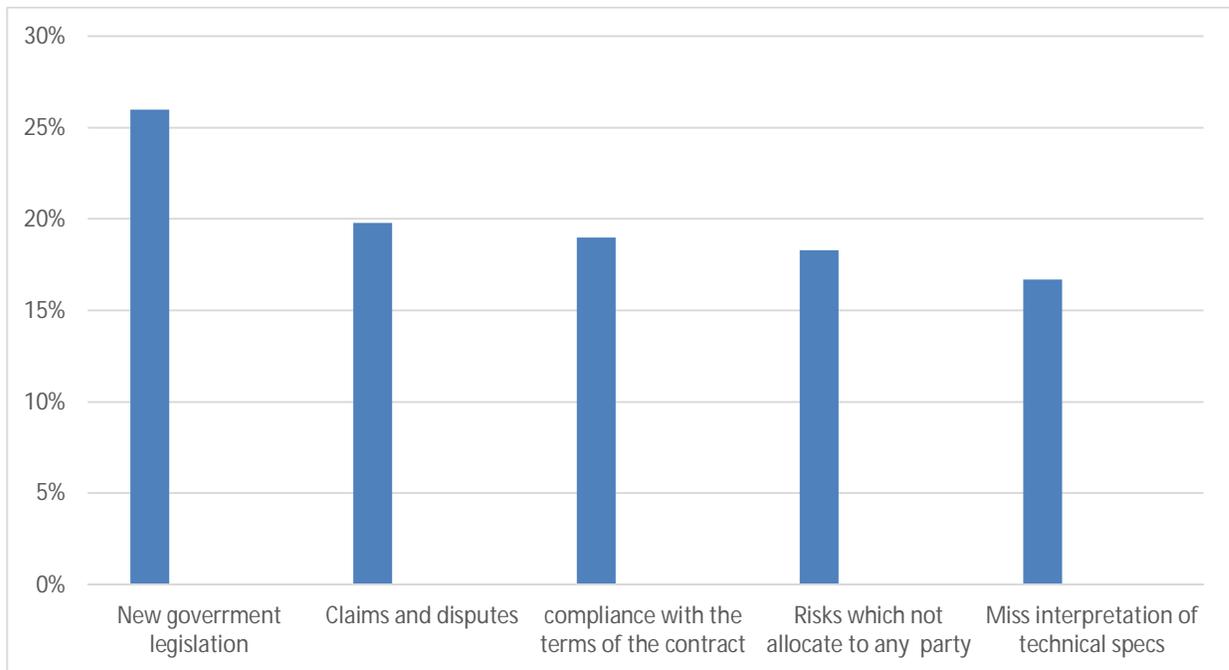


Figure No (4-18) Contracting risk group3 : ranking according to their impact :

4.2.3.3 Contracting risk group3 : ranking according to their Value

Figure (4-19) shows that the risk of new Government legislation have the biggest impact between the risk factors of this group with 227 points ,comes secondly the contractual claims and disputes with 173 points then comes the risk which is not allocate to any party with 166 finally with the least value comes the non-compliance with the terms of the contract in full detail and without delay with 146points.

From the result we saw that the government can protect the contractor from this risk and its consequences.

Table NO (4-19)

Contracting risk group3 : ranking according to their value

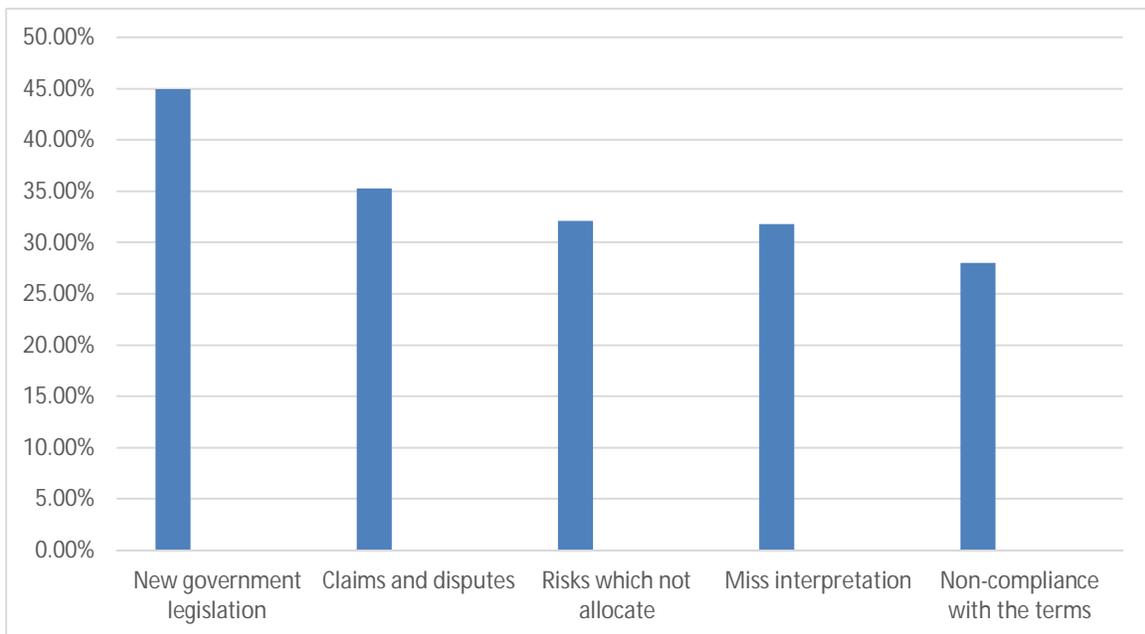


Figure No (4-19) Contracting risk group3 : ranking according to their value

4.2.4 Group (4) :

Construction phase risk group :

4.4.4.1 The probability ranks :

The Figure (4-20) shows that the most probable risk factor is the lack of experience of the consultant team in the site with 220 points , the second is the tight unrealistic schedule with 213 ,that because the contractor company compact the schedule in the tender phase to win the contract then later in the construction phase the tight schedule becomes arisk factor face the project finally the least probable factor is the supply of defective materials with 144 points .

Figure No (4-20) Construction phase risk group The probability ranks

questionnaire section (4)

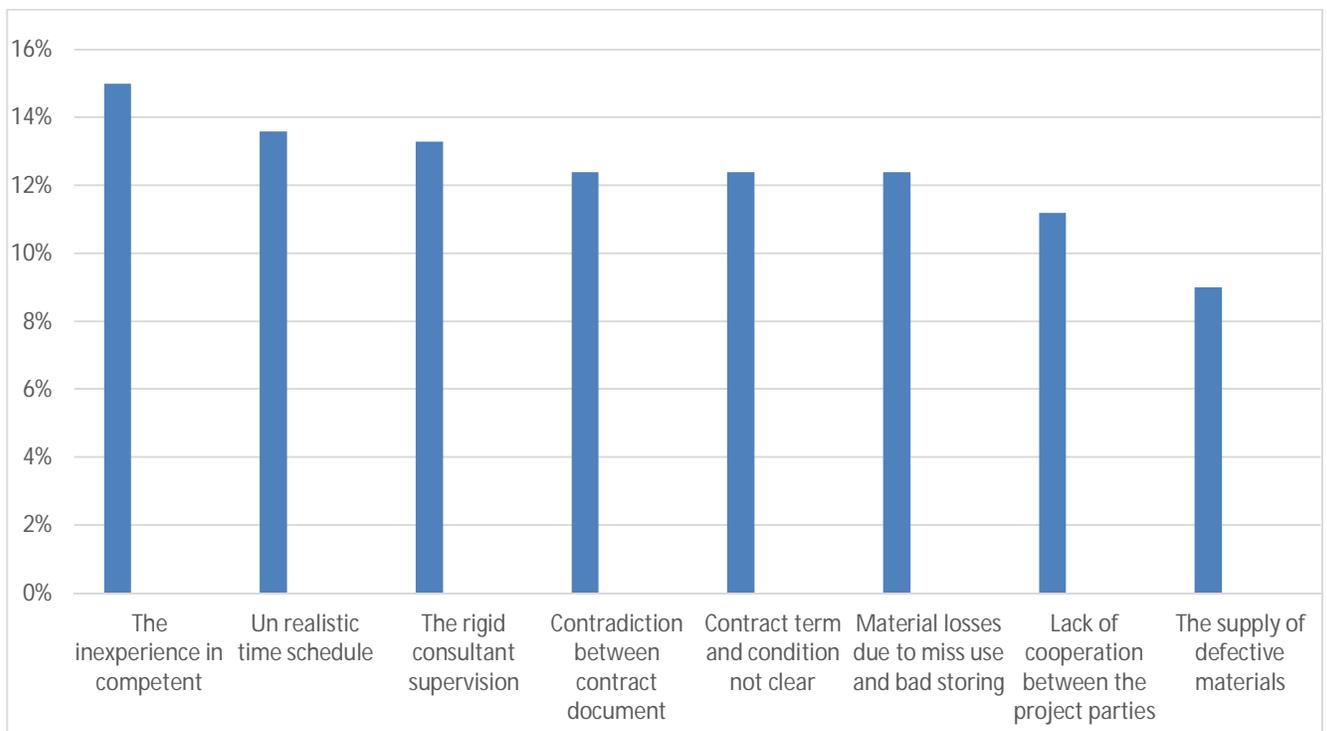


Figure No (4-20) Construction phase risk group The probability ranks

4.2.4.2 The impact on the project objective rank of group 4

As show in Figure (4-21), the result, **medicate** the lack of experience of the consultant team in the site has the biggest impact on the project objective 229, secondly the unrealistic tight schedule 208, finally with the smallest impact is the lost in the material cause by bad storing with 144 points .

From the result ,it was found big impact of the consultant role in the construction site which lead to a big impact on the project objective and the big impact of the tight schedule which also the responsibility of the consultant in the tender evaluation process .

Table NO (4-21)

The impact on the project objective rank of group 4

questionnaire section (4)

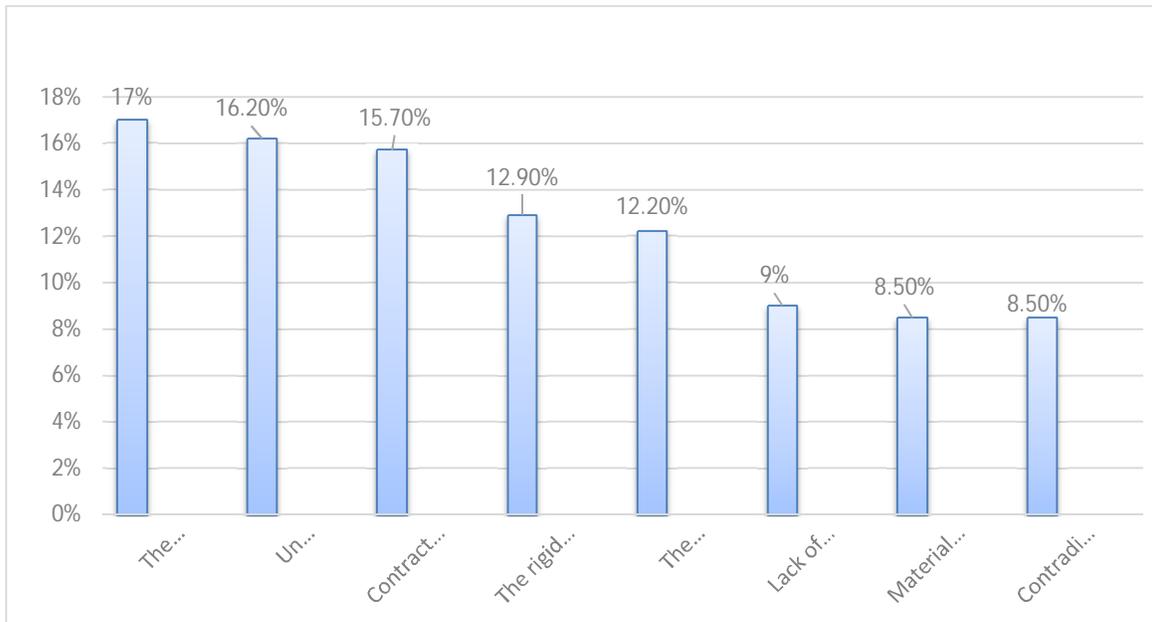


Figure NO (4-21) The impact on the project objective rank of group 4

4.4.4.3) The value of risk ranks :

The result shows that the lack of experience of the consultant team in the site has biggest value in this group with 51 points secondly the unrealistic tight schedule with 44 points .

Finally with smallest risk value is the lack cooperation between the contract parties with with 20 points .

Table NO (4-22)
The value of the risk in construction Group rank
questionnaire section (4)

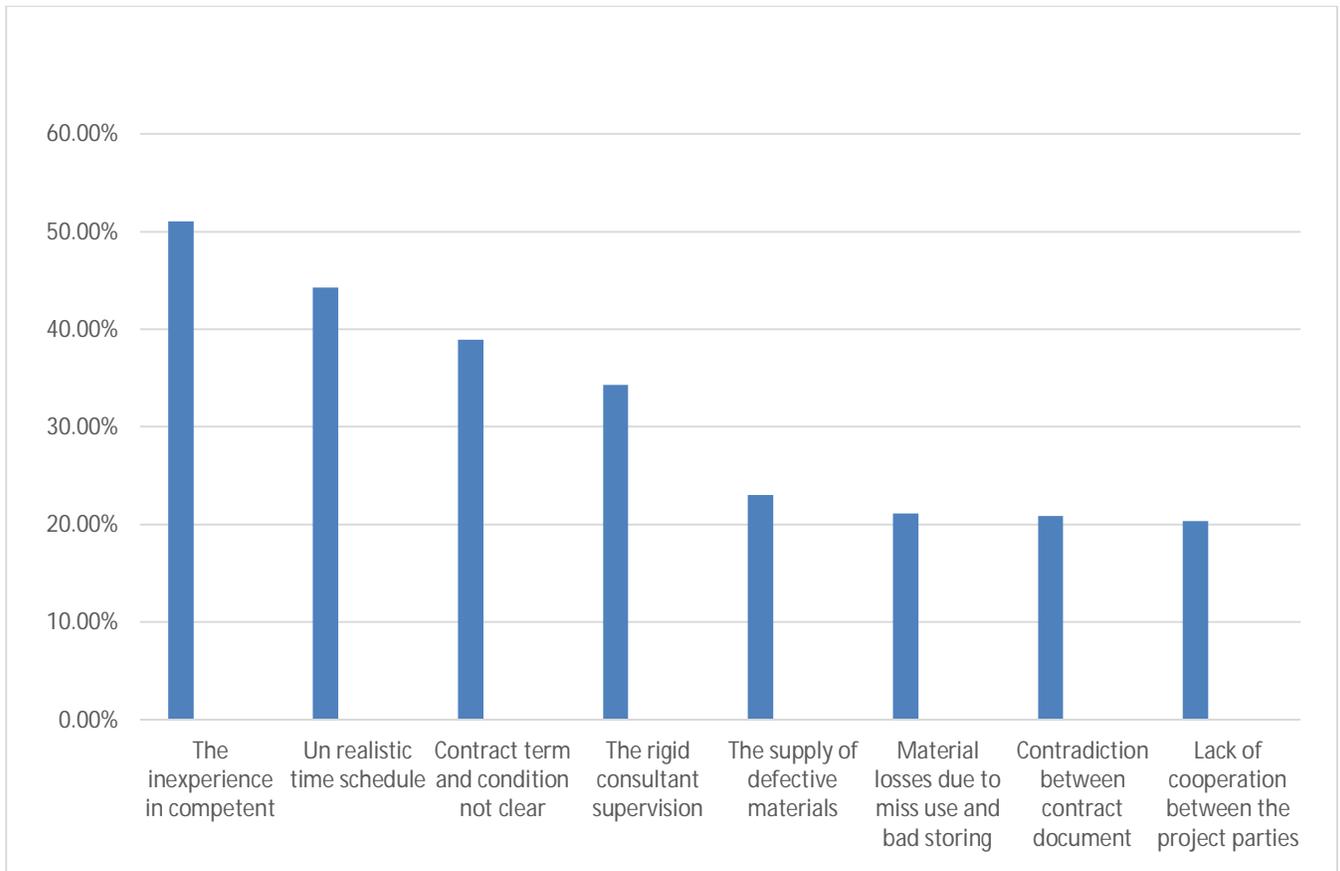


Figure No (4-22) The value of the risk in construction Group rank

4.2.5 Group (5) :

Financial and economic risk group :

4.4.5.1 The probability rank :

As shown in figure (4-23) table (4-23) the result illustrate that the inflation is the most probable risk factor in this group with 225 points ,then the payment dely due to government bureaucracy with 213 points ,then the fluctuation of currency rates with 211 points finally the least probable is the contractor banckruptcy with 137 .

The two most probable factors of inflation and the fluctuation of currency rate are due to economic disstability .

4.4.5.2 The impact rank of Group 5 :

As shown in table (4-24) and figure (4-24) the inflation has the biggest impact on the project objectives with 225 points then the payment delay with 221 points,then the contractor bankruptcy with 208 points ,finally with the least impact is the governmental beauragacy in payment with 125 points.

Questionnaire section (4)

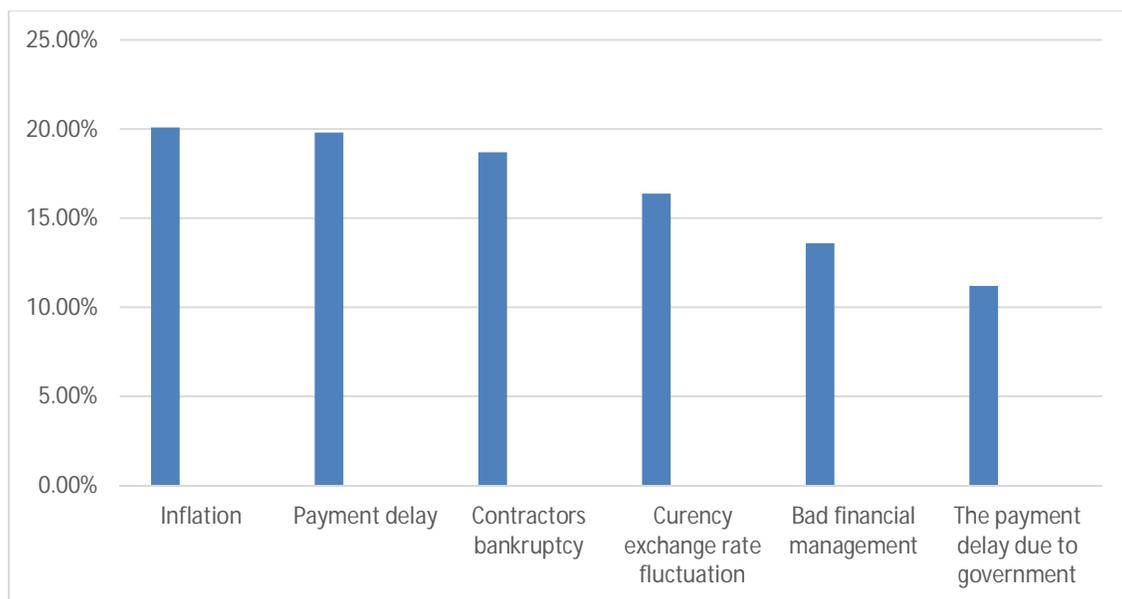


Figure No (4-24) The impact rank of Group 5

The inflation is one of the major source of claim and disputes which sometime leads to projects failure .

4.2.5.3 The value of risk rank :

The Figure (4-25) shows that the inflation has biggest risk value with 50 points that because the inflation as mention previously above has the biggest imapact and it is the most probable risk factor ,then the payment delay with 44 points and contractor bankruptcy with 28 ,Finally with the least value is the government bureaucracy in payment process with 26points .

Because the study was from the contractor perspective the payment delay have the smallest value that because always the contractors protected by the contract from any damage due to payment delay cause by the client .

Questionnaire section (4)

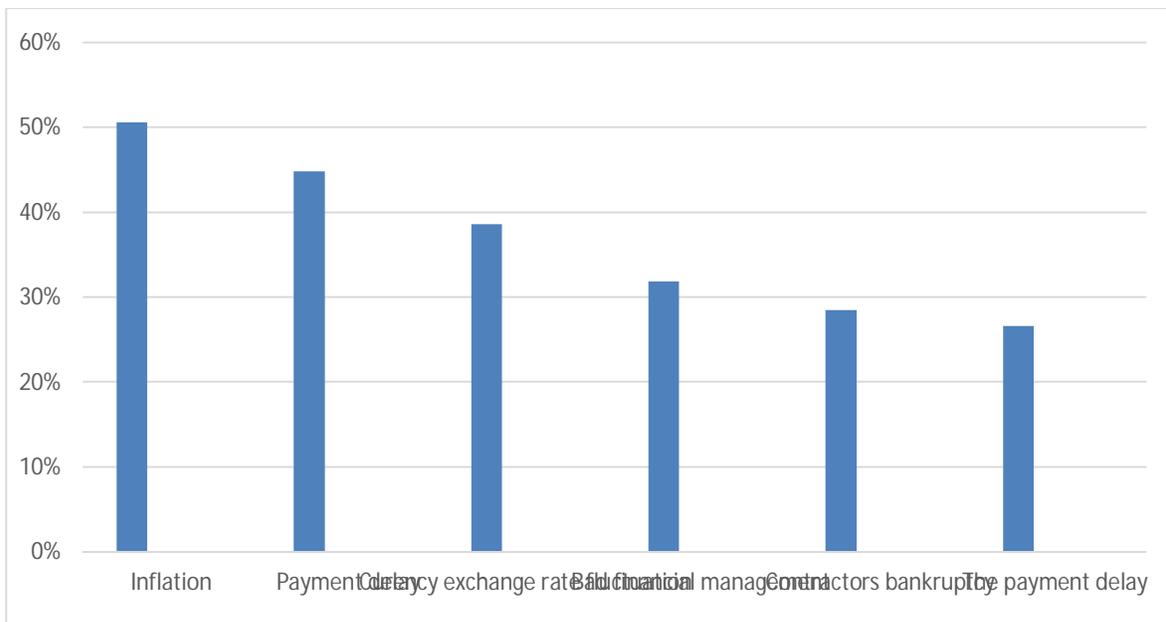


Figure No (4-25):The value of risk rank of group 5

4.2.6 Group (6)

The managerial risk group

4.2.6.1 The group probability rank :

From results in figure (4-26), the most probable factor is the disstability availability of skilled labours with 195 ,then the lack of competency of the project management team from the contractor side with 195 ,and the high rate of the staff change in the project with185 points ,Finally lack of cooperation between the parties of the project with 174 points .

Questionnaire section (4)

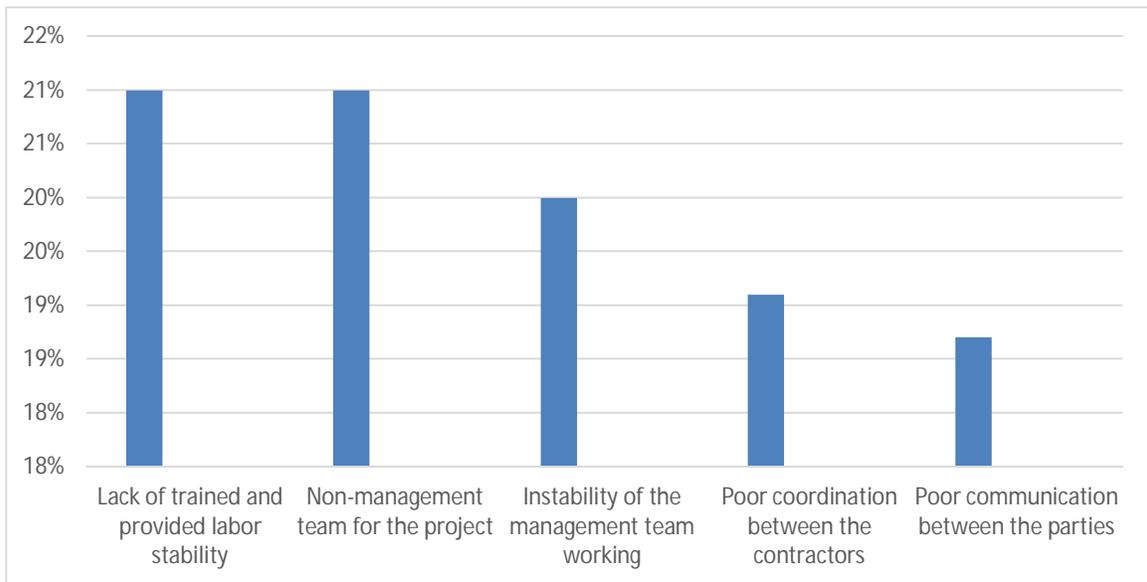


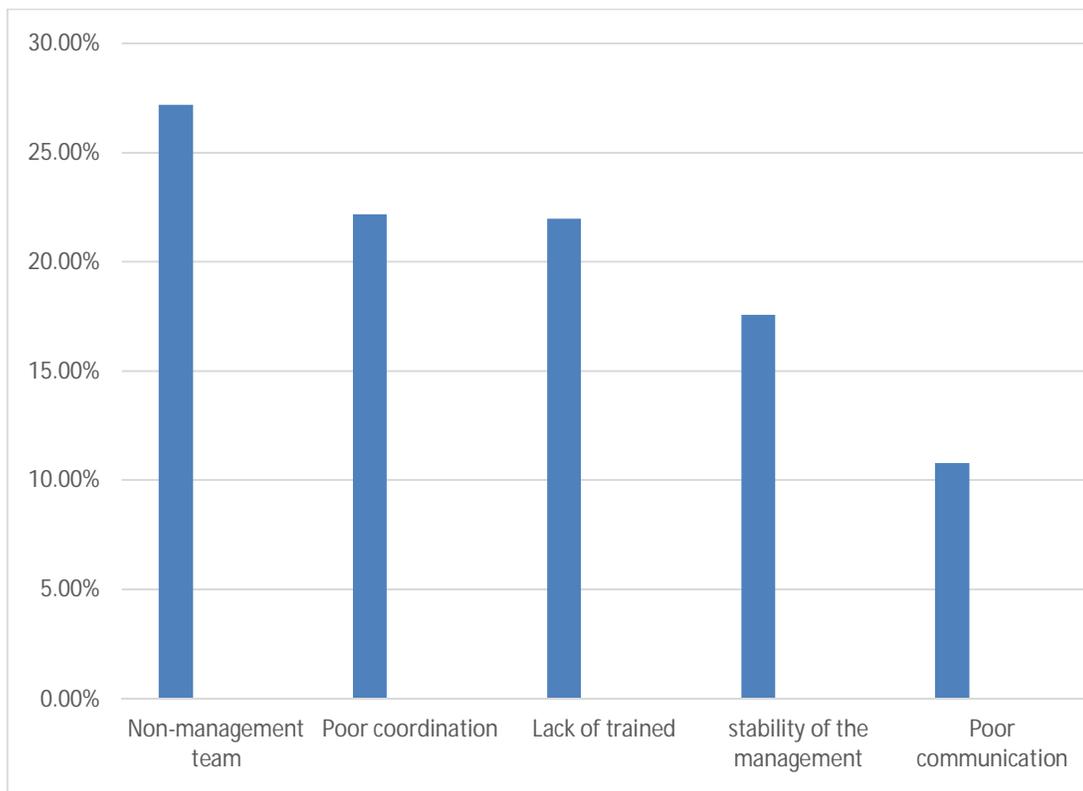
Figure No (4-26) The group 6 probability rank

4.2.6.2 The group 6 impact on the project objective rank

From results shown in figure (4-27), the serious impact in this group is the not competent team of contractor with 195, then the bad cooperation between subcontractors in the project with 195, then the lack of skilled labour and their stability with 185 points, finally with the least impact on the project objective is the bad communication between the contract parties with 174 points.

From the result, it was shown that the project management and its role to mitigate these serious risks factors .

Questionnaire section (4)



4.2.6.3 Risk value rank

From result in figure (4-27), it was found shows that the risk factor with the biggest value is the not competent contractor team with 44 points, then the lack of skilled stable labour with 36 points ,finally the bad communication between the project parties with 15 points .

Questionnaire section (4)

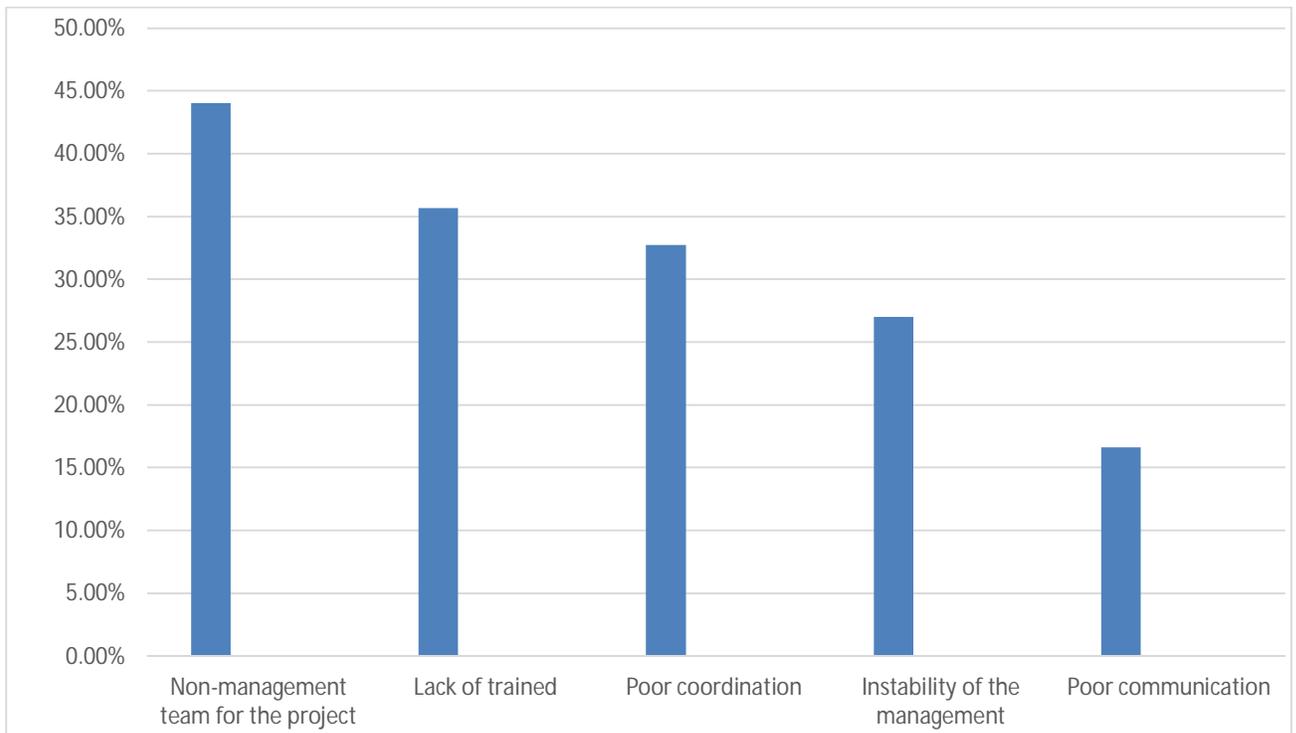


Figure No (4-28) Group 6 Risk value rank

4.2.7 The natural risk factor group 7

4.2.7.1 The group 7 probability rank

From the study Figure (4-29) the accident occurrence which cause human and financial lost is the most probable factor with 208 points then the bad climatic condition with 200 points ,finally with the lowest probability is the occurrence of force major with 125 points .

That because there is no applicable laws to forced the contractors to apply the safety regulation in their construction site .

Questionnaire section (4)

Table NO (4-29)

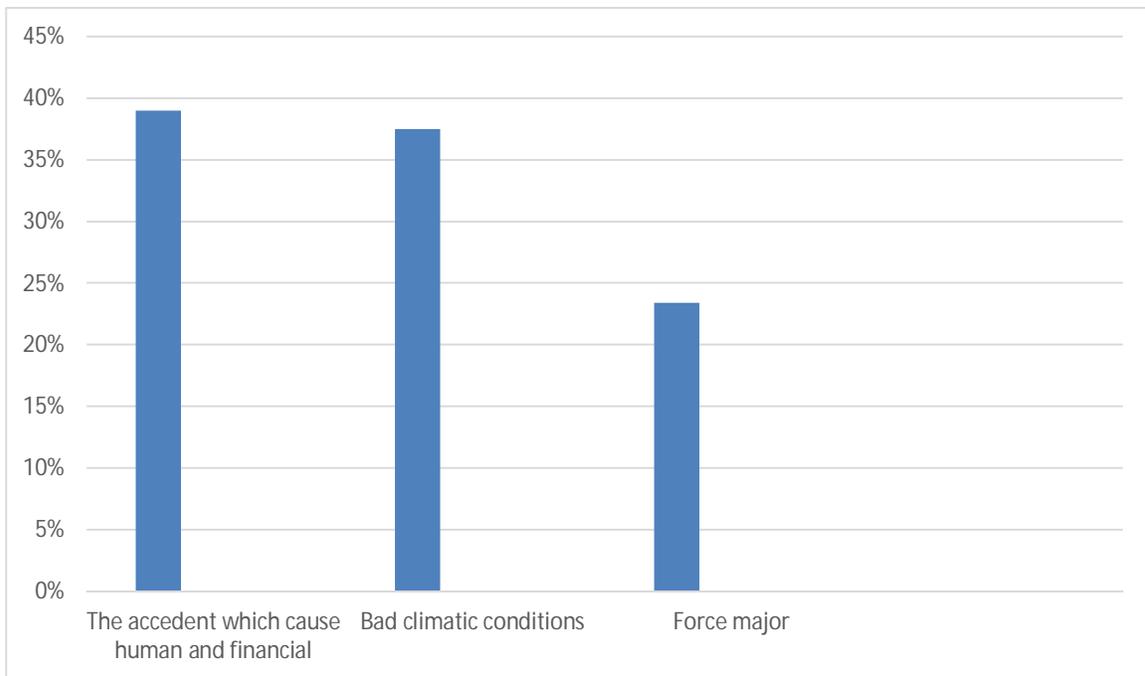


Figure No (4-29): The group 7 probability rank

4.2.7.b The group 7 impact rank :

From result shows that in table (4-30) in figure (4-30), the biggest impact come from the force major with 236 points , then the accident occurrence which cause human and fainancial lost with 211 and Finally the bad climatic condition with 131 points.

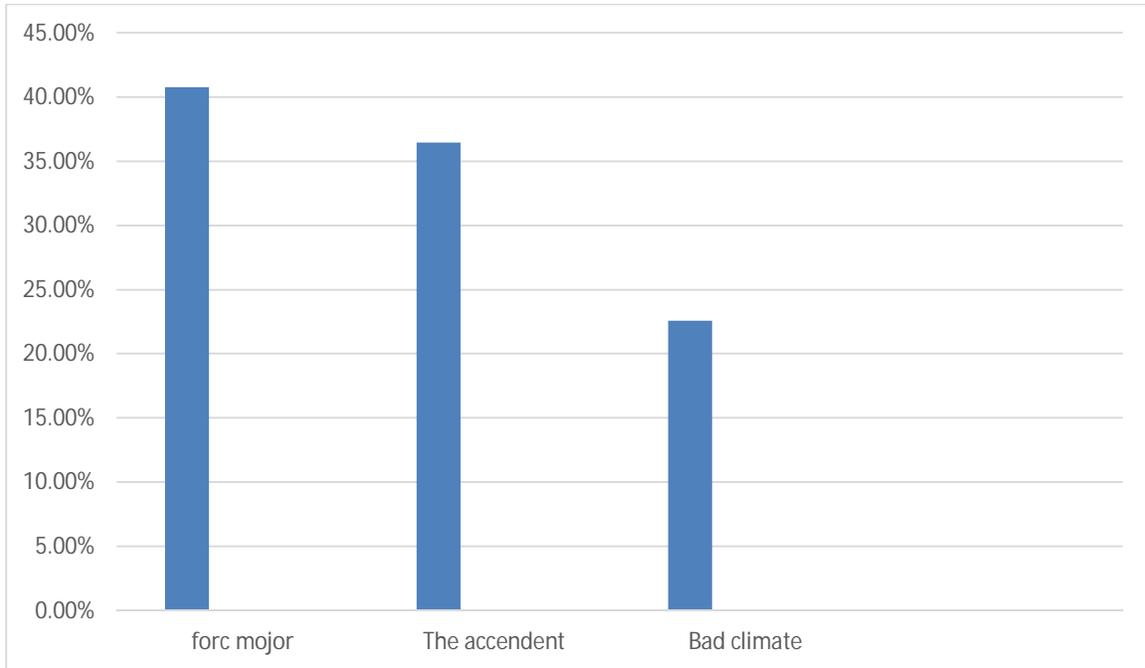


Figure No (4-30) The group 7 impact rank

4.2.7.3 The group 7 risk value :

The results shows in figure (4-31), the biggest risk value is that of the accident occurrence with 43 points the force majour with 30 points and finally the bad climatic condition with 26 points .

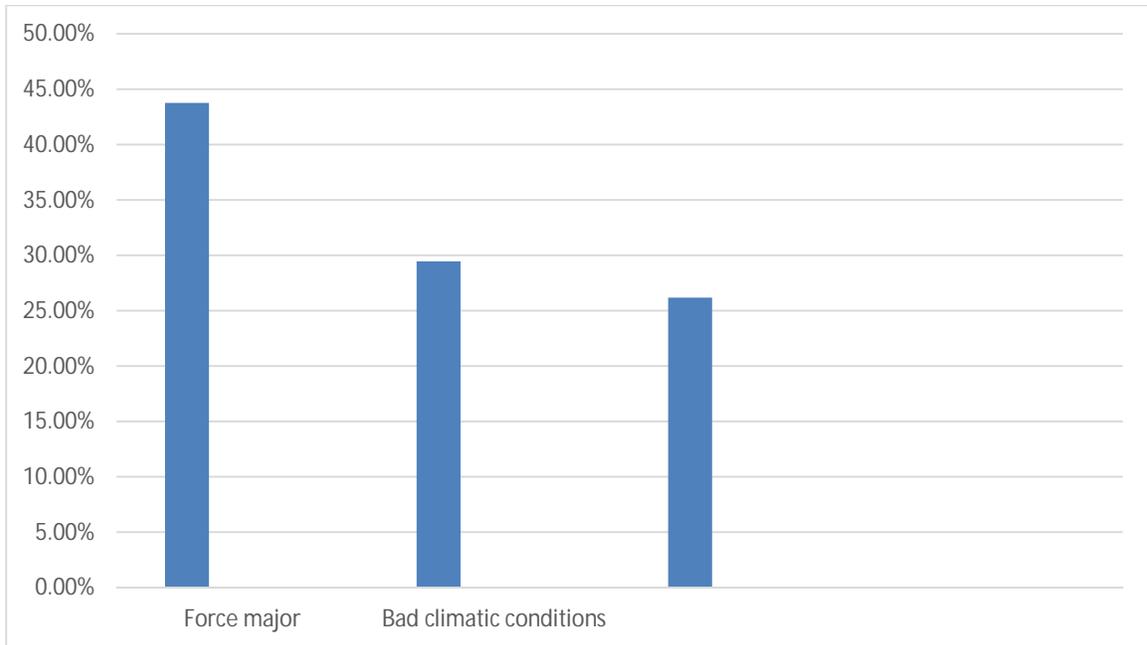


Figure No (4-31) The group 7 risk value

4.3 The method of risk response :

From results illustrated in Figure (4-32) , construction contractor usually depend on the experience to produce arealistic accurate program as amost effective risk preventive action, which score 90% effectiveness proportion . Because of the dynamic nature of construction environment, the dependency on the past experience alone is not enough, the decision maker must update his or her estimation continuously to avoid the estimation risks .

At the same time construction contractors consider that adding atime buffer to the construction program to be effective risk preventive method with 68% effectiveness proporation .

It was shown that the construction contractors use the traditional method to prevent the risk occurance .

Also the contractors plan to alternative method of construction to prevent the project risk with 60% effectiveness proportion while the constrction

contractors use the quantitative method to estimate the time period accurately with only 9% effectiveness proportion

Use a historical data from past similar project is considered as effective risk preventive method with 49% effectiveness proportion .

Questionnaire section (5)

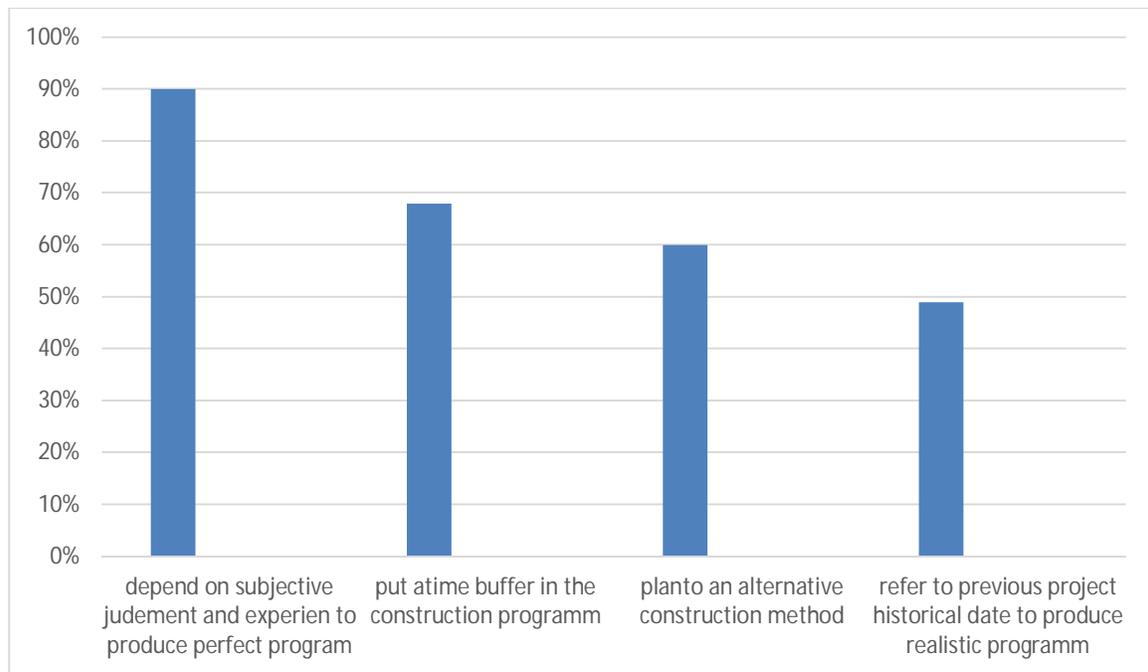


Figure (4-32) Preventive action effectiveness proportion

4.4 Mitigative action :

Figure (4-33) shows the five mitigatitive action contractors used reduce the risk impact when it is occur the first action is increase the labor and machines with 89% effectiveness proportion 90%, the second is working over time 85% effectiveness proportion ,the third changing the construction method 77%, the fourth is the close supervision to the subcontractors to minimize defective work then remedy work 77% ,last method is the fast tracking method because this method affect the work quality and cost.

Questionnaire section (6)

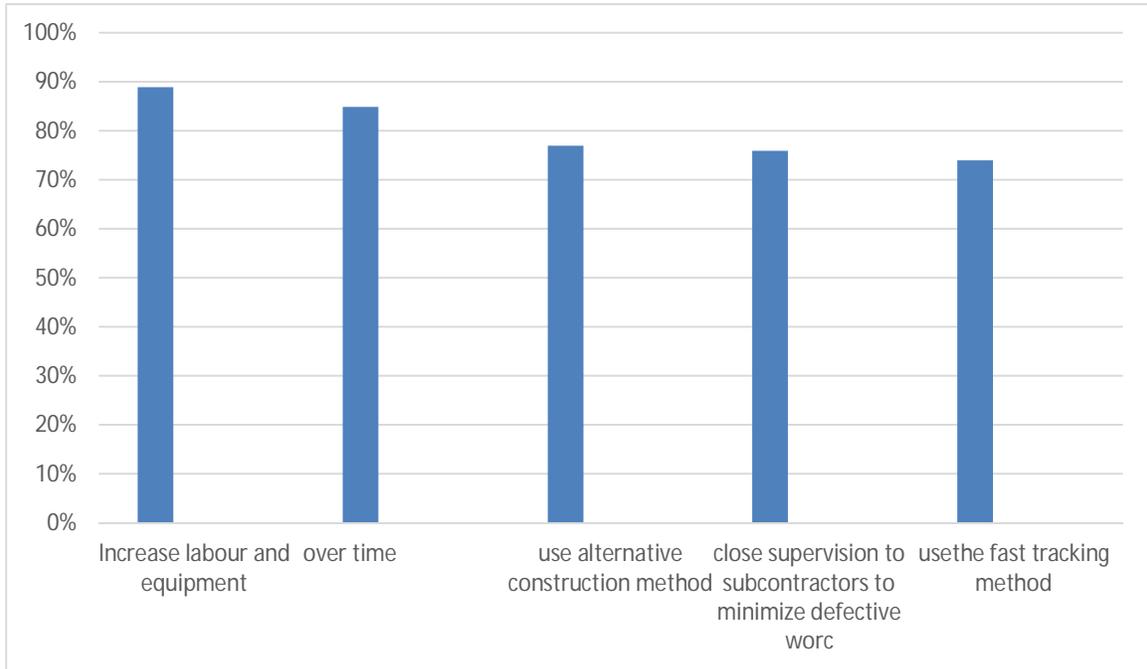


Figure (4-33): Mitigative action effectiveness

Chapter 5

Conclusions and Recommendations

5.1 Conclusions

This study was carried out to identify the construction industry risk factors, their importance and their probability and impact on the project objective. Moreover, risk management actions, and their effectiveness and usage were settled on. The above topics were examined from contractors perspective. These objectives were brought out, some tendencies were concluded and some actions that may improve risk management practices were recommended.

The focal point of this research is to explore the key risk factors and identify these factors that could be faced in construction industry in

Table (5-1) Most ten sever risk factor according to their impact in the project

1. The **conclusions** were summarized as follows from study, it was found that 96% of the Construction companies has no risk management divisions.
2. Contractors still depend on traditional approach to deal with project risk management, The use of decision maker experience to control risks factors was the most applied action with 90% effectiveness proportion used to deal with risk event.

When the use of quantitative method has only 9% effectiveness proportion

3. The contractors in Khartoum state mitigate the risk by :

- Increase labor and equipment 89% effectiveness proportion ;
- Over time 85 % effectiveness proportion ;
- Use alternative construction method 77% effectiveness proportion ;
- Close supervision to sub contractors to minimize defective work 76% effectiveness proportion ;
- Use the fast tracking method 74% effectiveness proportion .

5-2 Recommendations they were summarized as follows:

- 1- Contracting company must give more attention to risk management and must hire RM specialist or have separate RM division
- 2- The government must change the tendering procedure and contracting method to help industry to develop .
- 3- Contracting company have to use the quantitative method to determine the time schedule for its project
- 4- Consulting firm must prepare an estimation for the cost and time for the project in the pretendering stage and determine the selection criteria previously.
- 5- The escalation clause must use in any contract in Sudan because the economical instability.

References

- (1) Ewelina Gajewski & Mikaela Rope , Risk Management Practices in a Construction Project – a case study , Department of Civil and Environmental Engineering Division of Construction Management Chalmers university of Chalmers University Of Technology Göteborg, Sweden 2011.
- (2) Anna Klemetti , Risk Management in Construction Project Networks , Helsinki University of Technology Laboratory of Industrial Management Report 2006/2 Espoo 2006 .
- (3) Dr Patrick. X.W. Zou¹, Dr Guomin Zhang² and Professor Jia-Yuan Wang³ and 2: Faculty of Built Environment, University of New South Wales Identifying Key Risks in Construction Projects: Life Cycle and Stakeholder Perspectives, Sydney 2006 .
- (4) Martin Schieg , Risk management in construction project management, University of Applied Sciences Augsburg , Baumgartnerstrasse 16, Augsburg, 86161,Germany ,Published online: 14 Oct 2010.
- (5) Nerija Banaitiene and Audrius Banaitis , Risk Management in Construction Projects ,
- (6) Patel Ankit Mahendra, Jayeshkumar R. Pitroda, J. J. Bhavsar , A Study of Risk Management Techniques for Construction Projects in Developing Countries , ISSN: 2278-3075, Volume-3, Issue-5, October 2013.
- (7) contractors risk management practices ,An Educational Guide courtesy of DBH resources ,inc 8

(8)contractors risk management practices ,An Educational Guide courtesy of
DBH resources ,inc9

(9) (Polit&Hungler, 1999)

(10) Walpole & Myers, 1998

(11) Burns & Grove, 1987

(12) Fellows & Liu, 1997