KWAME NKRUMAH UNIVERSITY OF
SCIENCE & TECHNOLOGY, KUMASI

COLLEGE OF ARCHITECTURE AND BUILDING TECHNOLOGY
DEPARTMENT OF BUILDING TECHNOLOGY

PROJECT RISK MANAGEMENT PRACTICES OF CONSTRUCTION COST CONSULTANTS IN GHANA

By

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A PROJECT REPORT PRESENTED TO THE DEPARTMENT OF BUILDING TECHNOLOGY, COLLEGE OF ARCHITECTURE & PLANNING, IN PARTIAL FULFILLMENT FOR THE REQUIREMENT AND AWARD OF MASTERS DEGREE IN CONSTRUCTION MANAGEMENT, KWAME NKRUMAH UNIVERSITY OF SCIENCE & TECHNOLOGY, KUMASI

MAY, 2013

DECLARATION

I do hereby declare that this work is the result of my own research and has not been presented by anyone for any academic award in this or any other University. All references used in the work have been fully acknowledged.

I bear sole responsibility for any shortcoming

....

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CERTIFICATION

I hereby certify that this long Essay was supervised in accordance with procedures laid down by the University

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DEDICATION

To my God who gave me the strength, my wife, Mrs Gloria Baffoe-Bonnie and my children, Appiagyei, Serwaa –Bonso and Kusiwaa for their support, love and encouragement.

ACKNOWLEDGEMENT

Many are those who have contributed in diverse ways to make this long essay possible. I am highly grateful to all for the contributions made. While I cannot mention everyone's name here, it is important for me to acknowledge the contributions of few but not the least, the contributions of those whose help has made this work possible.

To the Almighty God, for bringing me this far on this academic journey and granting me the enabling environment, good health and strength as well as all the needed resources – to God be the glory and honour.

I also wish to express my profound gratitude to Dr. T . Adjei - Kumi, my project supervisor for his untiring support, expert guidance, valuable comments, suggestions, assurances and hope for me.

My sincere thanks go to all the members of my Construction Management class, especially Evans Dadzie and Kofi Manteaw for their kind support and sincere words of encouragement.

Special thanks are also extended to Mr. Marc Baffoe-Bonnie and Gerald Baffoe-Bonnie who assisted me in getting some of the much needed information for my literature review and data analysis.

To Mr. Moses Kofi Abu of M/S ADK Consortium for his endless and timeless effort in the typesetting of this long essay, I say thank you.

Finally, I would like to express my profound appreciation to my family and friends, especially Gloria for her precious time in proof-reading and finalizing the typing of this research study. I humbly say thank you.

TABLE OF CONTENTS

Declaration i

Certification ii

Dedication iii

Acknowledgement iv

Table of Contents v

List of Tables v

List of Figures vi

Abstract vii

CHAPTER ONE: INTRODUCTION

1.0 Introduction 1

1.1 General 1

1.2 Background of Study 2

1.3 Statement of the Problem 5

1.4 General and Specific Purposes of Study 9

1.5 Research Objectives 10

1.6 Scope of the Research 11

1.7 Research Methodology 11

1.8 Justification of Research 13

1.9 Delimitation and Limitation of Study 15

1.10 Theoretical Definitions of Terms 16

1.11 Organization of the Research 17

CHAPTER TWO : LITERATURE REVIEW

2.0 Introduction 19

2.1 The idea of Risk and its Elements 19

2.1.1	Elements of Risk	20
2.2	Risk: Opportunities or threats in the construction industry	21
2.3	Measurement of Risk	22
2.4	Impact of risk and uncertainty on project objective	23
2.5	Principles of Risk Management	26
2.6	Benefits of Systematic Approach to Risk Management	29
2.7	Benefits of Project Risk Analysis to the construction industry	31
2.7.1	What is project Risk Analysis and Management?	31
2.7.2	What is involved in Project Risk Analysis and Management	33
2.7.3	Benefits of Risk Analysis and Assessment	34
2.7.4	Who Benefits from its use	35
2.7.5	What are the Cost of Using it	36
2.7.6	When should it be used and who should do it	37
2.7.7	Which Projects are suitable	38
2.7.8	What Type of Projects	38
2.7.9	When should it be done	39
2.7.10	When shouldn't it be done	39
2.7.11	Who should do it	40
2.8	Risk Origins	40
2.9	Outline of Project Risk Management	42
2.10	Risk Management Processes	43
2.11	Phases of Risk Management	44
2.11.1	Risk Management Planning	44
2.11.2	Inputs for Risk Management Planning	46
2.11.2.1	Enterprise/Company Environmental Factors	46
2.11.2.2	Organizational Process Assets	46

2.11.2.3	Project Scope Statement	47
2.11.2.4	Project Management Plan	47
2.12	Tools and Techniques used in Risk Management Planning	47
2.13	Outputs of Risk Management Planning	48
2.13.1	Risk Management Plan	48
2.14	Phase 2 – Risk Identification	52
2.14.1	Risk Identification	52
2.14.2	Approaches to Identification or Classification of Risks	54
2.14.2.1	Origin of Risks	55
2.14.2.2	Sources of Risk	55
2.14.2.3	Financial Statement Method	56
2.14.2.4	Flow Chart Approach	56
2.14.2.5	Questionnaire and Checklist Approach	56
2.15	Tools and Techniques used in Risk Identification	57
2.15.1	Documentation Reviews	57
2.15.2	Pre-workshop	57
2.15.3	Information Gathering Techniques	58
2.15.3.1	Workshop/Brainstorming	58
2.15.3.2	Delphi Techniques	60
2.15.3.3	Root Cause Identification	60
2.15.3.4	Strengths, Weakness, Opportunities and Threats (SWOT) Analysis	60
2.15.3.5	Checklist Analysis	61
2.15.3.6	Assumption Analysis	61
2.15.3.7	Diagramming Techniques	61
2.16	Outputs of Risk Identification	62

2.16.1	Risk Register as an Output	62
2.17	Phase 3- Qualitative Risk Analysis/Initial Analysis or Assessment	63
2.17.1	Qualitative Risk Analysis	63
2.18	Input for Risk Analysis or Assessment	65
2.18.1	Organizational Process Assets	66
2.18.2	Project Scope Statement	66
2.18.3	Risk Management Plan	66
2.19	Tools and Techniques used in Qualitative Risk Analysis	66
2.19.1	Risk Register	67
2.19.2	Risk Map/Grid	67
2.19.3	Risk Assessment Checklist	68
2.19.4	Risk Probability and Impact Assessment	69
2.19.5	Risk Factor Lists	70
2.19.6	Probability and Impact Matrix	71
2.19.7	Risk Data Quality Assessment	71
2.19.8	Risk Categorization	72
2.19.9	Risk Urgent Assessment	72
2.20	Outputs of Qualitative Risk Analysis: Output	72
2.20.1	Risk Register (Updates)	72
2.21	Phase 4 - Quantitative Risk Analysis	74
2.21.1	Qualitative Risk Analysis	74
2.22	Inputs for Quantitative Risk Analysis: Inputs	77
2.22.1	Organizational Process Assets	78
2.22.2	Project Scope Statement as in 2.11.2.3	78
2.22.3	Risk Management Plan	78

2.22.4	Risk Register	78
2.22.5	Project management Plan	78
2.23	Tools and Techniques used in Quantitative Risk	79
2.23.1	Data Gathering and Representation Techniques	79
2.23.1.1	Interviewing	79
2.23.1.2	Expert Judgement	79
2.23.1.3	Sensitivity Analysis	79
2.23.1.4	Expected Monetary Value Analysis	81
2.23.1.5	Decision Tree Analysis	81
2.23.1.6	Modeling and Simulation	81
2.24	Outputs of Quantitative Risk Analysis	82
2.24.1	Risk Register (Updates) as an Output	82
2.25	Phase 5 - Risk Response	83
2.26	Risk Response Actions	85
2.27	Role of the Contract	86
2.28	Inputs for Risk Response Planning	87
2.28.1	Risk Management Plan	87
2.28.2	Risk Register	90
2.29	Tools and Techniques used in Risk Response Planning	90
2.29.1	Responses to Threats	91
2.29.1.1	Mitigate or Risk Reduction Strategy	91
2.29.1.2	Risk Avoidance Strategy	92
2.29.1.3	Transfer Strategy	92
2.29.2	Responses to Opportunities	95
2.29.2.1	Exploit Strategy	95

2.29.2.2	Share/Allocation Strategy	96
2.29.3.1	Contingency Plans	97
2.29.4	Acceptance Strategy	98
2.29.5	Risk Contingency Reserve	99
2.30	Phase 6- Risk Monitoring and Control	
2.30.1	Risk Monitoring	99
2.30.2	Exercising Control	111

CHAPTER THREE : RESEARCH METHODOLOGY

3.1	Introduction	103
3.2	Data Collection Methodologies and Analysis	104
3.2.1	The Data	104
3.2.2	The Primary Data	104
3.2.3	Secondary Data	105
3.3	The Criteria for Admissibility of the Data	105
3.4	Data Needed, Location and Means of Obtaining the Data	106
3.5	The Research Methodology	107
3.6	Developing the Questionnaire and Interview Sessions	108
3.6.1	The Questionnaire	108
3.6.2	Interview Section	111
3.7	Method of Randomization in the Survey	112
3.8	Statistical Methods Used	113
3.9	Sample size Determination	113
3.10	Rating and Ranking	115
3.11	The Relative Importance Index	117
3.12	Risk Exposure Index	118

CHAPTER FOUR : DATA COLLECTION AND ANALYSIS

4.0	Introduction	121
4.1	The Risk Management Process	122
4.2	Construction Cost Consultants	123
4.3	Location of the Construction Cost Consultancy Firm and Practitioner	123
4.4	Experience of Construction Cost Managers and Surveyors In Construction Companies	124
4.5	Firms and Practitioner's Risk Identification and Classification Procedures	125
4.5.1	Risk Identification and Categorization	125
4.5.2	Qualitative Risk Analysis and Assessment – Rating of Identified Risk	127
4.5.3	Quantitative Risk Analysis and Assessment	128
4.5.3.1.	Risk Assessment Model Development and Study Methodology	131
4.5.3.2	Risk Weight Constant	133
4.5.3.3	Ei(xi) Determination	134
4.5.3.4	R-index Determination and Model Test Process	134
4.6	Risk Index (Ri) as a Project Ranking Method	135
4.7	Risk Exposure Index	136
4.7.1	Relative Risk Exposure Index	138
4.7.2	Notional Risk Exposure Index (Y)	138
4.6.3	The Overall Risk Exposure Index	139
4.8	Risk Allocation in the Construction Industry	140

CHAPTER FIVE : SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.0 Introduction 143

5.1 Summary of Key Findings 143

5.1.1 Reduction of Perceived Risks 143

5.1.2 Uncertainties in the Early Life of New Projects 143

5.1.3 Commonly used procedure, processes and tools used during risk identification 144

5.1.4 Qualitative Risk Analysis used in determining level of Impact of categories of risks 144

5.1.5 Quantitative Risk Analysis used in determining rankings of identified risks 145

5.1.6 Risk Index (RI) as Model for ranking risk events 146

5.1.7 Risk Exposure Index as a model for assessing risk avoidance measures of decisions in bidding 147

5.1.8 Relative Risk Exposure Index as a model for determining the category with the highest risk exposure 147

5.1.9 Notional and Overall Risk Exposure Index Models 148

5.2 Conclusions of the Study 149

5.3 Recommendations 149

REFERENCES 152

APPENDICES 156

LIST OF TABLES

TABLE			PAGE
Table	3.1	Respondent's Profit	107
Table	3.2	Construction Cost Consultants and Practitioners	108
Table	4.1	Regional Distribution of Quantity Surveyors	124
Table	4.2	Risk Identification Processes and Procedures by Firms and Practitioners	126
Table	4.3	Risk Index Determination	Appendix 'C'
Table	4.4	Rating and Ranking Precedence	130
Table	4.5	Ten Most Significant Risks According to Respondents	131
Table	4.6	Risk Exposure of Risk Events	Appendix 'C'
Table	4.7	Scale for Subjective Risk Assessment	138

LIST OF FIGURES

FIGURE			PAGE
Figure	2.1	Probability – Impact Matrix	24
Figure	2.2	Project Risk Management Overview	Appendix 'A'
Figure	2.3	Risk Grid	50
Figure	2.4	Risk Register	52
Figure	2.5	Risk Breakdown Structure	Appendix 'A'
Figure	2.6	Hierarchy of Risk Areas in the Micro Level	Appendix 'A'
Figure	2.7	Hierarchy of Risk Areas in the Micro Level	Appendix 'A'
Figure	2.8	A Risk Assessment Checklist with Probability and Impact Weighting Column	Appendix 'A'
Figure	2.9	A Risk Assessment Checklist (Questionnaire Style)	Appendix 'A'
Figure	2.10	A Risk Assessment Checklist Risk-Factor Style)	Appendix 'A'
Figure	2.11	Concept of Proper Risk Allocation	Appendix 'A'

ABSTRACT

The construction industry is one of the most dynamic, risky, and challenging business. However, the industry has poor reputation for managing risk, with major projects failing to meet deadlines and cost targets. This is influence greatly by variation in weather, productivity of labor and plant and quality of material. All too often, risks are either ignored or dealt with in a completely arbitrary way: simply adding 10% (percent) contingency onto the estimated cost of a project is typical. In a business as complex as construction, such an approach is often inadequate, resulting in expensive delays, litigation and even bankruptcy (Hayes et al, 1980).

The study among other things, sought to assess the level of awareness of practicing cost consultants regarding modern trends in systematic risk management techniques, identity and document the risk management practices adopted in the construction industry, to investigate the key potential risk factors in the industry and also identify the distinction between theories of action and actual practices in systematic risk management in the industry.

Data was gathered using interview sessions and questionaires to evaluate how risk management prescription was applied in practice in the construction industry. Respondents were selected using simple random sampling techniques.

The finding suggests that, it is more characteristic of construction cost consultants in the industry to often proceed with estimating and predicting the cost of projects without any serious in-depth systematic project profiling and appraisal of risk during the project life cycle. Thus the need to do a thorough systematic risk management to address some of the potential risk imminent in the industry are often overlooked or postponed, leaving cost consultants exercising highly intuitive and subjective discretion in the management of risk during the project life cycle of most projects.

The study concluded that, systematic risk management practices encourages stakeholder to critically itemize and quantity risk for eventual purposes of risk response planning, monitoring and control. Thus, instead of relying on the single value project cost estimate, proper distribution

of risk is analyzed and appropriate systematic project costs allowed for. This makes the estimating process realistic because it recognizes the risk and uncertainties that exist in the venture or enterprise.

CHAPTER ONE - INTRODUCTION

1.0 INTRODUCTION

1.1 General

Our lives are fraught with risk and have been so since the time of birth. The saying that, we can never know what tomorrow may bring is especially true in business and other ventures. Entrepreneurs and business risk-takers soon find out that, risk is their constant companion, and that, their ability to manage the risk depends largely on their attitude and perception to some extent. If entrepreneurs ignore risk, they are likely to fail in their efforts, but if they face up to the real realities, they can enhance their chances of survival and growth.

Risk defies easy definition. To the layperson, risk generally means the possibility of losing one's health, reputation or self-image. To the entrepreneur or construction contractor or consultant however, risk means the chances of financial loss.

Thus, in the day to day operation of the business as in the construction industry, there must be points at which a stand-off view should be taken to assess the current possibility of things going awry.

According to Hayes et al (1986), risk and uncertainty are part of all construction work regardless of the size of the project. Other risk factors that carry risk include: complexity, speed of construction, location of the project, and familiarity with the work. When serious risks occur on projects, the effects can be very damaging. In extreme cases, time and cost overruns turn a potential profitable project into a loss-making venture.

Project risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective, such as time, cost, scope or quality (i.e. where the project time objective is to deliver in accordance with the agreed-upon cost; etc or if for commercial purposes, on set objective such as maximize profit, optimize cash flow, protect and exploit intellectual property, minimize risk and maximize growth).

Hayes' research showed that cost and time targets are often missed due to unforeseen events that even an experienced Project Manager cannot anticipate. These events are known in advance, but their extent could often not be quantified. For example, industrial disputes, delayed decisions, or changed ground conditions may all be anticipated, but their likelihood and impact are hard to predict with any precision as no two construction projects are the same; this makes it important to identify risk sources for each project (Hayes et al; 1986; Godfrey, 1996)

Hayes recommended that it may be useful to group risks according to simple measures of their probability and likely impact, by focusing on what is important and the action which controls risk.

However, the outcome can always be unexpected, as costs may be less than anticipated, the weather may be kind; revenue may exceed expectation. Therefore, risk can sometimes be viewed as beneficial as long as they are allowed for. Indeed, it is the role of a construction manager to manage risk on behalf of the building client, and in return derive income or profit from the project.

1.2 Background of Study

The construction industry or business provides the majority of the nations fixed capital assets like roads, buildings and other heavy infrastructural works such as bridges, dams and other monumental edifices. Construction projects are unique and built only once. They also involve a temporary project team that is assembled from different entities or companies, countries and cultures etc. Moreover, the size and complexities of construction projects are increasing rapidly on a daily basis. Responsibility for the efficiency of that provision is shared between the client or owner, designers, contractors, sub-contractors, suppliers and other professional advisors/practitioners.

Sadly, many clients quickly become disillusioned by the perceived inability of the construction industry to create a product of the required quality within the expected cost/price and time limit. This is in addition to the seemingly unfavorable economic, political, social and cultural conditions where the project is to be undertaken.

Much of this disillusionment is caused by uncertainty and risk; uncertainty by the client in properly defining what he wants (detailed brief); uncertainty by the designer in identifying the optimum solution to the client's needs and requirements, the uncertainty by the Contractor in predicting accurately the true cost of the project – in other words, the uncertainty and risk associated with working in a real and imperfect world.

Risk and uncertainty are inherent in construction work. It would be a delusion to think that risk can be eliminated through the setting up and drafting of contracts.

Nevertheless, contractual arrangements and conditions have a significant role and influence on the risk carried by each party and on the clarity with which they are perceived.

However, construction projects are perceived to have more inherent risk due to the involvement of many contracting parts such as owners, designers, contractors and other affiliated professional bodies as mentioned earlier on. Project risk can be defined as an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective, such as time, cost, scope or quality.

Risks are related to rewards. Some risks should be accepted as long as they are in line with the rewards. Risks are threat to project success. Failure to adequately deal with risks has been shown to cause cost and time overruns in Construction Projects.

Trying to eliminate all risks in construction projects is impossible. It is this impossibility and uncertainty which fosters the growth of adversarial relationship between the parties to the contract; relationships serving no purpose other than to add to the client's disillusionment.

While risks are almost always present in our daily and everyday endeavors, their presence may not necessarily be a problem, particularly where their impact is low. However, even if their impact is high, they still may serve a useful purpose. Ignoring the risk is not an option. As most decisions are influenced by the decision-makers personal preference or ability, a risk-taker may attempt to use a better level of risk to generate a higher level of income.

It is the goal of every decision-maker to be able to perceive the presence of risks, and accurately predict their magnitude and likely impact on the business.

What is more, the risk-taker not only assesses probability and impact, he also looks at mitigation and holds a full-back plan in reserve. For instance, the painter waits for a sunny day when the weather should be safer before deciding to apply paint to the external surfaces of building and if it does rain unpredictably, decide to paint the inside of the building instead.

The goal of the risk-taker or decision-maker can only be satisfied through a systematic and disciplined approach to identification, evaluation and response to risks. Thus, there is a need for a formal risk management process to manage all types of risks associated with the venture or enterprise.

1.3 Statement of Problem

Both Godfrey (1996) and Hayes et al, (1986) found that the greatest degree of uncertainty is encountered early in the life of a new project. Therefore, decisions taken during the earliest stages of a project can have a very large impact on its final cost and duration. Change is an unavoidable feature or phenomenon of any major capital project, but its extent is frequently under estimated during these early phases.

In everyday business environment, it is always prudent to research the likelihood of the investment venture paying off. Only a fool fails to keep an eye on his investment. Only a fool fails to act if the risk of failure begins to materialize. A prudent person will do the opposite. This "management" of risk can be generalized by saying that in any venture risks should be identified, assessed for probability and impact and a decision made. If the risk is unconscionable, then the only possible decision is to avoid the risk by not embarking upon the enterprise. If the risk is tenable, then positive steps must be taken to control the risk, delegate it to or share it with others, limit its impact and insure against its consequences.

It has sometimes been claimed that all project management is risk management. The aim of the project manager is to combat the variety of different hazards to which a project may be exposed.

The construction industry is one of the most dynamic, risky, and challenging businesses. However, the industry has a very poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets. This is influenced greatly by variations in weather, productivity of labor and plant, and quality of material. All too often risks are either ignored, or dealt with in a completely arbitrary way: simply adding ten (10) percent contingency onto the estimated cost of a project is typical.

Studies suggest that, cost overrun occurred in almost 90% of the projects examined in Ghana. According to reports, approximately 60% of the projects financed by the central government experienced delays in final completion in Ghana. Other consequence due to poor project performance include, poor investment returns from the use of the project, delay in the utilization of the facilities and extended inconvenience to the ultimate user or client. All of these problems exert a huge financial and disruptive pressure on the government or client and they hold back or impair planned economic development as the situation seems to suggest now in the Construction Industry.

The high-risk exposure associated with road infrastructural development and general building construction has been one area least examined and addressed and this needs special attention from both contractors, and consultants to analyses and manage these risks. They cannot be eliminated entirely but can be mitigated and minimized or transferred from one project stakeholder to another. These projects carry out higher risk than other inter-related development because they entail high capital outlays and intricate site condition.

By practice, cost consultants normally allow an item of contingency sum during the preparation of their cost estimates for the client during the various stages of the project development. When contractors are obliged to assume the risk, they include very high contingencies in their mark-ups for events that may often not occur at all.

The contingency sum, usually expressed as a percentage mark-up on the base estimate, is used as an attempt to allow for the unexpected. The practice of presenting project cost estimate as a deterministic figure comprising a base estimate and the addition of single contingency amount (usually as a percentage addition) has been adopted on the construction industry for a long time for budgeting purposes. Usual practice is for this amount to be a single lump sum with no attempt made to identify, describe and value various categories and possible areas of uncertainty and risk.

In many cases, it amounts to an educated guess at best. Too many quantity surveyors and estimators just bump a load of money on the end to cover all eventualities.

With the traditional approach to guessing at contingencies in mind, it can be perceived then that, project proposal (what it is intended to build; e.g. the size and the level of quality) will be affected by the contingency amount.

Sometimes, project teams tend to inflate the contingency allowances in an attempt to avoid the need to seek additional funds if budgets become overspent. In such a case, if ultimately, there are no heavy calls on the contingency fund beyond what might reasonably have been expected, project budgets can be seriously under spent. The magnitude of the amount under spent but allocated undeservedly can be so large that it is possible to identify other facilities which were previously forgotten but could have been included in a construction programme in the first place.

In a business as complex as construction, such an approach is often inadequate, resulting in expensive delays, litigations, and even bankruptcy (Hayes et al, 1986)

It is also not uncommon for Project Consultants to accept to do a project for client's risks involved. Similarly, other stakeholders in the industry are quick to reprehend Project Consultants for any unsatisfactory work undertaken because of the perception that not enough due diligence was done to, fully appreciate the magnitude of imminent risks and uncertainties involved.

It is therefore necessary for project consultants to do a proper project assessment for both risk and uncertainties before making recommendations for a project to be undertaken.

Probably, project risks and uncertainties to the consultants and other stakeholders should have to be identified, and appraised at the earliest time of the project life cycle to be able to manage the risk by averting any loss which eventually occurs. A good risk management would enable construction cost consultants to determine the strength and weaknesses of the proposed development.

However, project cost consultants do not seem to have any systematic and structured risk management process for addressing these risks and uncertainties associated with the industry. The questions of what, who, how and when should risk be managed is more often than not unanswered. A mechanism must therefore be developed to manage risks and uncertainties in the industry. The development of such a mechanism will entail all the stages and processes of risk analysis and assessment associated with risk management.

Cogent risk management techniques could therefore assist the construction cost consultant to:

- assess the effect of these sources of risks and uncertainties in order to decide which projects are more risky to the client, contractor or other stakeholders

- plan for the potential sources of risk in each project
- manage each source during both pre and post construction stage of the project.
- identify and evaluate potential business opportunities and ventures
- adopt appropriate measures to mitigate the effects of risk

It is therefore, for the above stated problems associated with risks and uncertainty above that the work desires to undertake this study to identify the effects and consequences of risk management practices in Ghana with special emphasis on construction cost consultant and project risk management practitioners.

1.4 General and Specific Purposes of Study/Aims

Since the mid 1990s many authors have suggested that, the management of construction projects, large or small, benefits from a greater understanding brought about by the application of risk management techniques. Risk management is an important part of the decision-making process of all construction companies. Risk management is a formal and orderly process of systematically identifying, analyzing and responding to risks throughout the lifecycle of a project to obtain the optimum degree of risk elimination, mitigation and/or control (Wang SQ – Construct Manage Econom 2004; 22(3): 237-52). Risk management is now widely accepted as a vital tool in the management of projects and in recent years, an array of documents have been published which aim to provide guidance for practitioners undertaking the risk management process.

Therefore, in line with the above suggested importance of risk management, the purposes of the study is to explore how risk management facilitators or practitioners approach the management of risk during the lifecycle of projects to obtain the optimum degree of risk elimination, mitigation and/or control with special emphases on project management prescriptions.

Among others, the study aims to:

- draw out what actually happens in practice in Ghana, rather than simply reporting what respondents thought they ought to do in practice. This distinction between theories of action and actual practice is critical in identifying gaps between theoretical prescriptions and their application in the field or practices in Ghana
- and if they do, (from point above) examine the nature of risk management practices and services currently being practiced in Ghana and the procedures, tools and techniques adopted and also identify key areas of congruence and variance if any, and provide suggestions to improve risk management services in the construction industry

1.5 Research Objectives

The objectives of this research are:

1) To assess the level of awareness of practicing cost consultants regarding modern trends in risk management techniques.
2) To identify and document the risk management practices adopted in the construction industry.

3) To investigate the key risk factors involved in the construction industry.

4) To find out or explore the root causes of these factors of risk.

1.6 Scope of the Research

The research study considered only construction cost consultants/surveyors in good standing and approved by the Ghana Institution of Surveyors. In all 57 construction cost consultants were considered in this project.

Most of these Cost Consultants were located in Accra in the Greater Accra, Koforidua – Eastern Region, Kumasi – Ashanti, Sunyani – Brong- Ahafo and Takoradi – Western Region. Only two of these consultants were from the Northern Regions of Ghana.

1.7 Research Methodology

In this chapter, the strategies adopted for the study and the type of data used in the study would be broadly discussed. The criteria for the admissibility of the data and location of the data would all be considered. Furthermore, the treatment of the data, including the application of various statistical methods employed in the analysis of the data would be the subject matter in this chapter. The study involved an in-depth exploratory investigation of project risk management practices of construction cost consultants in Ghana.

The methodology for this study will take the form of literature review and survey involving the use of structured and exploratory interview sessions and questionnaire.

The purpose of this pilot study is to examine the nature of Risk Management services and to determine which Risk Management procedures, tools and techniques, are currently used by construction cost consultants. By adopting a qualitative approach, it aims to generate rich data relating to the attitudes and experiences of Risk Management facilitators in Ghana.

The study involved an in-depth exploratory investigation of construction cost consultants risk management practices, with the aim of extending their understanding of the extent to which standard risk management prescriptions are applied in the construction industry. In particular, the study aims to draw out what actually happens in practice, rather than simply reporting what respondents thought they ought to do in practice. This distinction between theories of action and actual practice is critical in identifying gaps between theoretical prescriptions and their application in the industry.

The research was carried out on a three-prong approach in order to achieve the main aims and objectives of the project study.

- The first approach was to undertake a literature search, to collate from construction and project management journals, articles, textbooks and other materials from the industry on risk management and related issues.
- The second stage or phase consisted of surveys in the form of interview sessions and questionnaires to evaluate how risk management prescriptions are applied in practice in the Ghanaian construction industry. On the other hand, the areas of variance are highlighted and potential areas of weakness that warrant further investigation for analysis using statistical techniques are suggested.
- Finally, these results are used to form the basis for suggesting and recommending suitable and appropriate tools and techniques for risk management and further case-study-based research.

This research acknowledges that many construction cost consultants are "risk seekers" who take on risks without understanding the full impact. However, the aim of this study is to demonstrate that systematic risk management practices can be useful for analyzing project success.

1.8 Justification of Research (Significance of the study)

All projects involve risk of some sort. This may stem from the nature of the work – for example if there is a lot of innovation involved ,– from the type of resources available, from the contractual relationship which is in place or from political factors which influence the project. It is usually not practicable to eliminate risk altogether – indeed, this would not be desirable since it would inhibit innovation and stifle creativity. But it is possible to manage projects in a way that recognizes the existence of the risks and prepares, in advance, methods of dealing with them if they occur.

In recent years, the subject of risk management has become increasingly important. This is partly because the use of project organizations, with associated project management techniques is now often seen as a means of achieving some desired change in an organization and is used more widely than in traditional areas such as the development of information system. In addition, projects are assuming ever greater levels of complexity, with many different skills and technologies being employed and the resulting interdependencies leading to a higher degree of uncertainty in the project's outcome.

The Construction industry is one of the most dynamic, risky, and challenging businesses. However, the industry has poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets. This is influenced greatly by variations in weather, productivity of labour and plant, and quality of materials. All too often, risks are either ignored, or dealt with in a completely arbitrary way: simply adding 10% (percent) contingency onto the estimated cost of a project is typical. In a business as complex as construction, such an approach is often inadequate, resulting in expensive delays, litigation and even bankruptcy (Hayes et al, 1986)

It is more characteristic of the construction industry in Ghana to often proceed with the construction process without any serious in-depth project profiling and appraisal of risk during both pre-tender and post construction stage. Thus, the need to do a thorough risk management to address some of the risks imminent in the industry is often overlooked or postponed, leaving construction companies to exercise their intuitive discretion in the management of risk during the project life cycle of most projects.

This study will therefore contribute in raising the awareness of the various types and categories of risk which are mostly associated in the construction industry and thus, perhaps encourage a paradigm shift in the way risk is seen and evaluated in the industry.

It will also offer or provide a tool and techniques for decision making in managing risk and substantially help reduce the contingencies in mark-ups during pricing, cut down disputes and thereby reduce the number of business challenges and difficulties normally faced in the Ghanaian construction industry.

This research is very important to all stakeholders in the Construction Industry – clients, construction professionals, builders, developer and the general public. This is because, the full benefits of risk management processes and practices will be achieved and this will improve productivity effectively and efficiently. The main objective of achieving value for money, within time and quality assurance will be greatly enhanced.

The research study will also help stakeholders to improve efficiency in the management of the varied sources of risk hampering and hindering the total development of projects from inception to completion or during the life cycle of the development project.

The benefits and advantages of risk management practices in improving efficiency and militating risk will also help enhance project productivity by bringing in management efficiency and creative skill from business practices gained from commercial ventures and activities.

The results of this research should provide invaluable benefits to both cost consultants and contractors alike in their future dealings on risks and their management generally. It will also provide invaluable opener to all stakeholders in the industry in the management of risks.

At the end of the research study, an attempt shall be made to investigate and analyses how risk is allocated in the construction industry. It shall also analyse the influence of risk allocation arrangement on project performance.

It will also be an educative material that will also provide reference to students, lecturers and all allied persons in academia.

1.9 Delimitation and Limitation of Study

This project is concerned with risk management process and facilities in the Construction Industry, with special emphasis on the role construction cost consultants and practitioners play in the achievement of better processes of managing risk throughout the life cycle of a defined project.

It takes into account the management of risk from inception, design and planning to the final completion and maintenance of the facility.

The various tested processes and models currently in use are also investigated

However, one of the strongest limitations to this research study is the finding of appropriate case studies and/or evidence of structured risk management practitioners or facilitators in the Ghanaian Construction Industry. Thorough studies and investigations were done through the internet, cost consultancy firms and construction companies, and there appeared to be no exact evidence of the application of current tools, technique and processes in risk management techniques of construction cost consultants in Ghana.

Another equally challenging limitation to this study was the challenges of getting highly honest answers from respondents to the questionnaires. This is because some professionals and stakeholders in the industry found it difficult to admit ignorance of the subject matter under review or study.

An attempt was therefore made to encourage stakeholders and would-be respondents to be as transparent as possible with their responses and they were entreated to avail themselves with the opportunity of reading more on the topic.

1.10 Theoretical Definitions of Terms

- Risk is the chance you take that things will not turn out as you expected. It is the chance of an event depending on the circumstances.
- Risk management may be defined as the identification, measurement and economic control of risks that threaten the assets and earnings of a business or other enterprise (Spence 1980). It is a systematic way of looking at areas of risk and consciously determining how each should be treated.

- Construction Cost Consultant – A firm (or individual) of professional Quantity Surveyors or Cost Management expert that undertakes and determines construction cost to the client, contractor or supplier through feasibility study stage, sanction, tendering, post-tender and at intervals during project implementation stages of the total project life cycle.

1.11 Organization of the Research

The study is organized in 5 chapters, including this introductory one which gives an overview and background study relevance of the study. The statement of the problem, aims and objectives of the study and scope are all dealt with in this chapter.

Chapter 2 looks at literature review of the research study.

It researches into literature reviews of authors, researchers and reports on the topic under study. Information was collected from previous study, research findings, publications and journals, articles and on the internet. The general research methodology and procedures, comprising method of data collection, treatment of data and data responses were discussed in chapter 3. Data collected are analysed in chapter 4.

Survey results were discussed and the results of the responses were analysed and inferences drawn in this chapter.

The final chapter, chapter 5 incorporates the conclusion and recommendation. It also outlines areas that can benefit from further research into project risk management in the Construction Industry.

Three (3) appendices containing details of risk management processes and procedure templates, the questionnaires used for the research study, and table summary of respondents and analyses are presented at the end of the report.

CHAPTER TWO
LITERATURE REVIEW

CHAPTER TWO - LITERATURE REVIEW

2.0 Introduction

This chapter involves the review of literature from published works. Some references are also made from the internet and other on-going study work on risk management, more especially on – "How to identify, mitigate and avoid the principal risks in construction project by stakeholders in the industry especially, construction companies and practitioners".

2.1 The Idea of Risk and its Elements

Risk defies easy definition. To the layperson, risk generally means the possibility of losing one's health, reputation or self-image. To the entrepreneur or construction contractor or consultant however risk means the chances of financial loss. When we discuss risk in this chapter under review, we mean all identifiable risk, in the construction industry that can result in cedi losses.

Risk is the chance you take that things will not turn out as you expected. It is defined as the chance of an event depending on the circumstances. At its general level, risk is used to describe any situation where there is uncertainty about what outcome will occur. The uncertainty concerns the occurrence of a loss. Life is obviously very risky. Even the short-term future is often highly uncertain. Risk is the probability that things will not turn out as desired.

Thus, in the day to day operation of the business as in the construction industry, there must be points at which a stand-off view should be taken to assess the current possibility of things going awry.

2.1.1 Elements of Risk

You require three elements to define risk. They are:

- anticipated event
- event probability, and
- expected impact.

An event is the occurrence of a circumstance or set of circumstances. It can be certain or uncertain and would have an impact if it happens. A project event can be a onetime occurrence or a series of happenings.

The chance of something happening is its probability of occurrence. An event that will not happen (zero probability) is a non-event; an event that is certain to happen or taken for granted that it will happen (unity probability) is an assumption. Between the non-issue and the assumption are risks because of the associated (non-zero or non-unity) probability.

Mathematically, the probability, p, of an event S can have a value between 0 and 1 such that it is greater than 0 and less than 1; thus:

- $0 < p < 1$; p is a risk.
- $P = 0$; p is an assumptive non-event;
- $P = 1$; p is an assumption.

The way an event affects a project is its impact or consequence on the project. The impact of an event on a project can be characterized in three ways:

- There can be more than one impact from an event; thus an event occurring on a project can have impacts on several project objectives;
- Impacts can be expressed qualitatively or quantitatively; organizational policy dictates how impacts are assessed and processed;

- Impacts are assessed as either beneficial (positive) or harmful (negative) to a project. This means that when dealing with risk, the project management team should look for both good and bad things that can happen to the project. A risk with anticipated positive impacts is an opportunity; a risk with anticipated negative impacts is a threat.

2.2 Risk: Opportunities or threats in the construction industry

Risks are related to rewards. Some risks should be accepted as long as they are in line with the rewards. Risks are threat to project success. Failure to adequately deal with risks has been shown to cause cost and time overruns in Construction Projects.

Trying to eliminate all risks in construction projects is impossible. It is this impossibility and uncertainty which fosters the growth of adversarial relationship between the parties to the contract; relationships serving no purpose other than to add to the client's disillusionment.

While risks are almost always present in our daily and everyday endeavours, their presence may not necessarily be a problem, particularly where their impact is low. However, even if their impact is high, they still may serve a useful purpose. Ignoring the risk is not an option. As most decisions are influenced by the decision-maker's personal preference or ability, a risk-taker may attempt to use a better level of risk to generate a higher level of income.

It is the goal of every decision-maker to be able to perceive the presence of risks, and accurately predict their magnitude and likely impact on the business.

What is more, the risk-taker not only assesses probability and impact, he also looks at mitigation and holds a full-back plan in reserve. For instance, the painter waits for a sunny day when the weather should be safer before deciding to apply paint to the external surfaces of building and if it does rain unpredictably, decide to paint the inside of the building instead.

The goal of the risk-taker or decision-maker can only be satisfied through a systematic and disciplined approach to identification, evaluation and response to risks. Thus, there is a need for a formal risk management process to manage all types of risks associated with the venture or enterprise.

2.3 Measurement of Risk

The likelihood, or the probability, of an adverse event, is usually expressed in terms of the number of such events expected to occur in a year (Godfrey, 1996). The consequence of an adverse event sometimes called damage is often expressed in monetary terms. In the case of fatalities or serious delays, it is more appropriate to use other measures, like day lost, or experience modification rating.

The true cost of risk can be much higher than is apparent. Much of it can be indirect and uninsured. A study carried out by the Health and Safety Executive "Iceberg" 1993 shows that, the uninsured cost (i.e. Product and material damage, Plant and building damage, Tool and equipment damage, Legal costs, Expenditure on emergency supplies, clearing site, Production delays, Overtime work and temporary labour, Investigation time, Supervision time and clerical effort, Fines and Loss of experience/expertise) of health and safety risk can be eleven times the direct cost (Employer's Liability, Corporate Liability, Third Party Liability, Property Damage) on a construction site. The risk therefore can be much more complex than appears at first sight.

Both Godfrey (1996) and Hayes et al, (1986) found that the greatest degree of uncertainty is encountered early in the life of a new project. Therefore, decisions taken during the earliest stages of a project can have a very large impact on its final cost and duration.

Change is an unavoidable feature or phenomenon of any major capital project, but its extent is frequently under estimated during these early phases.

In other situations, the term risk may refer to the expected losses associated with a situation. If you make a financial investment, you take the risk that the market economy will smile upon you and the value of the investment will increase to an appreciable degree. You take the chance that the value will not fall. You choose the investment according to the risk you are prepared to take – the greater the risk, the greater potential benefit you expect.

In everyday business environment, it is always prudent to research the likelihood of the investment venture paying off. Only a fool fails to keep an eye on his investment. Only a fool fails to act if the risk of failure begins to materialise. A prudent person will do the opposite.

This "management" of risk can be generalised by saying that in any venture risks should be identified, assessed for probability and impact and a decision made. If the risk is unconscionable, then the only possible decision is to avoid the risk by not embarking upon the enterprise. If the risk is tenable, then positive steps must be taken to control the risk, delegate it to or share it with others, limit its impact and insure against its consequences.

It has sometimes been claimed that all project management is risk management. The aim of the project manager or cost consultant is to combat the variety of different hazards to which a project may be exposed.

2.4 Impact of risk and uncertainty on project objectives

The impact of a risk can be measured as the likelihood of a specific unwanted event and its unwanted consequence or loss.

RI = L x C,

where

RI = risk impact

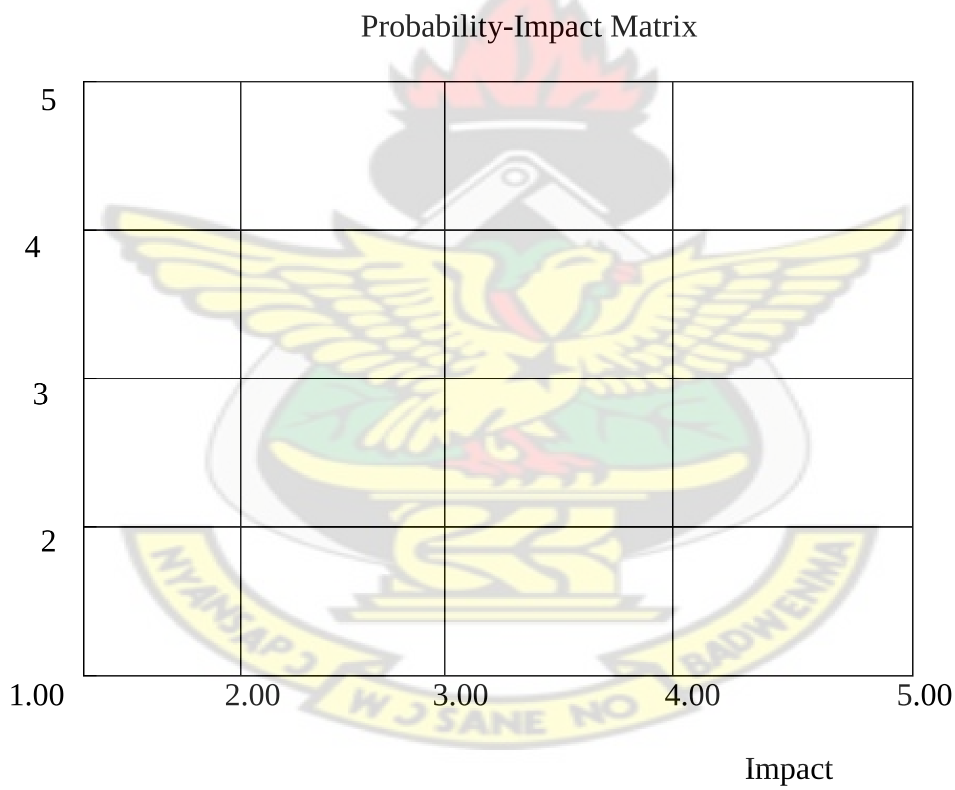
L = likelihood; and

C = consequence.

To properly evaluate construction risks, one must consider both the probability of risk occurrence and the impact on project objectives once the risk event occurs.

Some authors contend that multiplying the probability and impact values might be misleading. This is achieved best by plotting the risk probability-impact matrix in Figure 2.1 below.

Fig. 2.1 - Probability-Impact Matrix



Source: A Guide to the Project Management Body of Knowledge, 3rd Edition.

In the matrix, the ×-axis represents the impact value while the Y-axis represents the probability value. Both scales are 1-5 (1 being very low to 5 being very high).

According to Hayes et al (1986), risk and uncertainty are part of all construction work regardless of the size of the project. Other risk factors that carry risk include: complexity, speed of construction, location of the project, and familiarity with the work. When serious risks occur on projects, the effects can be very damaging. In extreme cases, time and cost overruns turn a potential profitable project into a loss-making venture.

Project risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective, such as time, cost, scope or quality (i.e. where the project time objective is to deliver in accordance with the agreed-upon cost; etc or if for commercial purposes, on set objective such as maximize profit, optimize cash flow, protect and exploit intellectual property, minimize risk and maximize growth).

A risk may have one or more causes and, if it occurs, one or more impact. For example, a cause may be requiring an Environmental Impact Assessment permit for the construction of a steel smelting factory at say, Tema Industrial Area, or having limited engineering personnel assigned to design the project. The risk event is that the Environmental Protection Agency, which is the statutory permitting agency, may take longer than the planned anticipated time to issue the permit or the design personnel available and assigned to do the design at that material time, may not be adequate for the activity. If either of these uncertain events occurs, there may be an impact on the project cost, schedule or performance.

Hayes' research showed that cost and time targets are often missed due to unforeseen events that even an experienced Project Manager cannot anticipate. These events are known in advance, but their extent could often not be quantified. For example, industrial disputes, delayed decisions, or changed ground conditions may all be anticipated, but their likelihood and impact are hard to predict with any precision as no two construction projects are the same; this makes it important to identify risk sources for each project (Hayes et al, 1986; Godfrey, 1996)

Hayes recommended that it may be useful to group risks according to simple measures of their probability and likely impact, by focusing on what is important and the action which controls risk.

However, the outcome can always be unexpected, as costs may be less than anticipated, the weather may be kind; revenue may exceed expectation. Therefore, risk can sometimes be viewed as beneficial as long as they are allowed for. Indeed, it is the role of a construction manager and/or the construction cost consultant to manage risk on behalf of the building client, and in return derive income or profit from the project.

2.5 Principles of Risk Management

The construction industry is one of the most dynamic, risky, and challenging businesses. However, the industry has a very poor reputation for managing risk, with many major projects failing to meet deadlines and cost targets. This is influenced greatly by variations in weather, productivity of labour and plant, and quality of material. All too often risks are either ignored, or dealt with in a completely arbitrary way: simply adding ten (10) percent contingency onto the estimated cost of a project is typical.(Mills, 2001)

Risk management is an important part of companies and allied institutions. Risk and uncertainty can potentially have damaging consequences for productivity, performance, quality, and the budget of a project.

In recent years, the subject of risk management has become increasingly important. This is partly because the use of project organizations, with associated project management techniques, is now often seen as a means of achieving some desired change in an organization and is used more widely than in traditional areas such as the development of information systems. In addition, projects are assuming ever greater levels of complexity, with many different skills and technologies being employed and the resulting interdependencies heading to a higher degree of uncertainty in the project's outcome.(Yeates et al; 1991)

Risk management is a formal and orderly process of systematically identifying, analyzing and responding to risks throughout the lifecycle of a project to obtain the optimum degree of risk elimination, mitigation and/or control. To be successful, the organization should be committed to addressing the management of risk proactively and consistently throughout the project.

Risk management may be defined as the identification, measurement and economic control of risks that threaten the assets and earnings of a business or other enterprise (Spence 1980).

Risk management is a systematic way of looking at areas of risk and consciously determining how each should be treated

It is a management tool which aims at identifying sources of risk and uncertainty, determining their impact and developing appropriate management responses.

Assessment of the impact of risk is a complex problem which must be approached systematically by breaking down the task into logical stages of risk identification, risk analysis and risk response.

The aim of risk management is not necessarily to eliminate risk. The presence of risk can be advantageous to decision-makers in that they may attempt to transform more risk into higher returns. In addition, the presence of risk increases a commitment to control.

Risk management has been applied to many business situations, including financial evaluation, feasibility, strategic planning, price prediction, life cycle costing and budgeting and project appraisal.

Risk management was originally presented as a useful addition to the range of techniques used in financial evaluations, making account of uncertainty in financial forecasts. Risk management is increasingly seen as a necessary and useful adjust to a strategic planning and thinking process. It can also help strategic thinking by encouraging constructive dialogue and debate about policy formulation and available options.

It must be recognized that an initial assessment of risk is no more than an attempt at problem understanding. Its role should be to encourage controversy and to allow members or stakeholders of the decision making group to discover where basic differences exist in problem assumptions, values and uncertainties.

This controversy should enable critical comments or suggestions and review to be obtained and should force the re-analysis, re-examination and sensitivity testing of the problem solution.

Once risk analysis has brought potential problems out into the open it is vital for senior management within the company to be aware, to react and to support the necessary counter-measures. Senior Management is the internal customer to whom the project/contract manager must "deliver" happy customers and lots of profit. Senior management, rather like external customers, does not like "surprises". A sudden adverse impact on the anticipated project profit caused by the manifestation of a risk that could and should have been exposed at the bid/no bid or contract award stage is unforgivable.

Most importantly, if the topic of risk and its impact on cost, time and performance can be drawn into open discussion with the customer or client, then inherently there will be a greater sense of realism. The customer or client must acknowledge at this stage that the level of risk and where the risk lies are quite distinct and separate issues and the latter should not be allowed to cloud or influence the view of the former. For example, to leave the cost risk with the company by the use of firm price tendering, or to leave the schedule risk with the company by contractual deadlines "backed up" by Liquidated and

Ascertained Damages, do not of themselves have any significant impact on the intrinsic risk to the success of the project. It is right for the customer or client to attempt to avoid the contractual liability for project failure, but all the contractual penalties on the company in the world cannot make the project a success if it is founded upon a flawed view of the real-world risk. Much better for both sides to be honest, realistic and to operate on a partnership basis than to pretend everything is all right, relying on the lawyers to earn their keep later. However, both sides (customer/client and company) will nevertheless have a weather eye on the extent of their contractual liability within whatever framework upon which they have settled and each will carefully seek to avoid prejudicing its position through the process of mutual risk management.

2.6 Benefits of Systematic Approach to Risk Management

Risk Management is not a new concept. Traditionally, it has been applied instinctively, with risks remaining implicit and managed by judgement, informed by experience. The systematic approach makes the risks clear, formally describing them and making them easier to manage. In other words, systematic risk management is a management tool, which requires practical experience and training in the use of the techniques.

According to Godfrey (1996), systematic risk management helps to:

- identify, assess and rank risks, making the risks explicit;
- focus on the major risks of the project;
- make informed decision on the provision for adversity, e.g. mitigation measures;
- minimise potential damage should the worst happen;
- control the uncertain aspects of construction projects;
- clarify and formalise the company's role and the roles of others in the risk management process;

- identify the opportunities to enhance project performance.

Although, all uncertainty cannot be removed, systematic risk management improves the chances of the project being completed on time, within budget, to the required quality, and with proper provision for safety and environmental issues.

There are often high levels of uncertainty in construction projects. Any feasibility study necessarily contains many assumptions about the future, predictably. Systematic risk management helps you quantity that uncertainty.

Confidence comes from certainty, but in the absence of such certainty, confidence can be enhanced or increased by knowing where the risks are coming from (sources), how extensive that uncertainty is, and what the potential consequences are (Bing, 1999). Therefore, systematic risk management is deemed to have the following benefits and advantages:

- questioning of the assumptions that most affect the success of your project;
- concentrates attention on actions to best control risks;
- assesses the cost benefit of such actions;
- learning from mistakes;
- ensuring that potential problems are exposed and given proper visibility
- contractors/consultants and client being realistic about cost, time and quality performance,
- promoting a relationship-based transaction,
- Improves decision making.

The application of risk management at the outset clarifies the objectives and helps refine the project brief. Risk management helps to recognize the importance of any constraints that may be set and to assess their impact on the project.

Systematic risk management allows the early detection of risks. Therefore, there is no need for contingency plan to cover almost every eventuality (Dawood, 1998). As a result, you can ensure that your limited resources are concentrated on the major risks to achieve maximum effect; i.e. the area where the greatest saving can be achieved and/or where there is maximum risk exposure.

Lack of clarity in the recognition or acceptance of risk is a risk itself that will tend to magnify the overall cost of risk. The start of a project presents the greatest opportunity to avert disaster by providing for risk at minimum cost.

A systematic approach which focuses on risk issues at an early stage is more likely to have high cost benefit and is therefore recommended from inception, through successive project phases, to completion and beyond.

Systematic risk management encourages the company to itemise and quantify risks and to consider risk containment and risk reduction policies. Instead of relying on a single value project cost estimate, the distribution of risk is analysed and appropriate project costs allowed for. This makes the estimating process realistic because it recognises the uncertainties that exist.

2.7. Benefits of Project Risk Analysis to the Construction Industry

2.7.1 *What is Project Risk Analysis and Management?*

Risk has long been recognized in the construction industry. Contractors are required to accept a certain level of risk due to unforeseen costs which they incur during construction. Risk is also an issue for clients. The term “clients” refers to those persons or organizations investing in the construction of built facilities. The risk manifests itself in unforeseen expenditure which was not envisaged at the planning stage. Construction and development is fraught with difficulty, and the basic notion of risk analysis is that it is useful to at least make an attempt to identify these risky items and attach some financial value to them.

A construction risk analysis identifies and quantifies risks which impact on the capital cost, or duration of a project. The allocation and division of risk between parties is usually established in the conditions of contract and the provision of appropriate project risk margin contingencies which can be modeled to help set allocation.

Where a risk does not materialize or is managed by other measures, the contingency allocation can be returned to the company for the benefit of investment elsewhere before the project is completed. Risk assessment/review therefore gives you the confidence and sharpens your commercial decision process to allow this.

At different stages of project development, there are different types of risk. At the feasibility and inception stages, for example the client might not have decided exactly on the floor area that is required, or an amount of additional floor area over that in a basic scheme may be in abeyance. Such matters will represent an uncertainty from the estimator's point of view. Some of the uncertainties will be eliminated or clarified as the planning of the project develops towards detailed design stage when, for example, the client has decided the floor area required. Some uncertainties will be carried forward to tender stage. There can be uncertainty both about the scope of the works in question and, flowing from that, its value.

Risk can arise from planning decisions, where the outcome cannot be adequately costed. The majority of risk, however, arises from matters yet to be decided (e.g. incomplete brief or no site investigation). Risk assessment of the cost of uncertain features will be present at all stages of a project. The number of risk will normally decrease as a project progresses through the various planning stages of the project development.

As the project is developed through the various stages the process of risk analysis and identification seeks to reduce the level of uncertainty.

Project Risk Analysis and Management is a process which enables the analysis and management of the risks associated with a project. Properly undertaken, it will increase the likelihood of successful completion of a project to cost, time and performance objectives.

Risks for which there is ample data can be assessed statistically. However, no two projects are the same. Often things go wrong for reasons unique to a particular project, industry or working environment. Dealing with risks in projects is therefore different from situations where there is sufficient data to adopt an actuarial approach. Because projects invariably involve a strong technical engineering, innovative or strategic content, a systematic process has proven preferable to an intuitive approach.

2.7.2 *What is involved in Project Risk Analysis & Management*

The first is to recognize that risk exists as a consequence of uncertainty. In any project there will be risks and uncertainties of various types as illustrated by the following examples:

- the technology is not yet proven
- industrial relations problems seem likely or apparent
- the management or financial authority structure are not yet established
- resources may not be available at the required level.

All uncertainty produces an exposure to risk to which, in project management terms, may cause a failure to:-

- achieve the required completion time,
- keep within budget

- achieve the required performance objectives

Project Risk Analysis and Management is a process designed to remove or reduce the risk which threaten the achievement of project objectives. The process of risk assessment is more than simply identifying specific risks. It means obtaining a clear definition of risks, including how important and urgent, the risk is to the project. This urgency of the risk has two aspects:

- The urgency with which the risk is likely to materialize,
- The urgency with which we need to take avoidance or amelioration actions

It may be, for example, that in comparing two risks, one is found to be somewhat more severe than the other overall. But, for the less severe risk, there may be an immediate need to take the identified avoidance action. In this case, this risk might be addressed with more urgency than its absolute severity might indicate.

2.7.3 *Benefits of Risk Analysis and Assessment*

The benefits gained from using Project Risk Analysis and Management techniques serve not only the project but also other parties such as the organization and its customers. Some examples of the main benefits are:

- an increased understanding of the project, which in turn leads to the formulation of more realistic plans, in terms of both cost estimates and timescales
- an increased understanding of the risks in a project and their possible impact, which can lead to the minimization of risks for a party and/or the allocation of risks to the party best able to handle them.
- an understanding of how risks in a project can lead to the use of a more suitable type of contract

- an independent view of the project risks which can help to justify decisions and enable more efficient and effective management of the risks
- a knowledge of the risks in a project which allows assessment of contingencies that actually reflect the risks and which also tends to discourage the acceptance of financially unsound projects.
- a contribution to the build-up of statistical information or historical risks that will assist in better modeling of future projects
- facilitation of greater, but more rational, risk taking, thus increasing the benefits that can be gained from risk taking
- assistance in the distinction between good luck and good management and bad luck and bad management
- greater confidence in achieving success of projects now and the future by enhanced understanding of the uncertainties of meeting project objectives of cost, time and performance
- increased commitment and proactive management/project team approach leading to innovative strategies to reduce risk and consequential loss for competitive advantage
- identification of the party best able to control the risk leading to improved value for money

2.7.4 *Who benefits from its use*

- An organization and its senior management for whom a knowledge of the risks attached to proposed project is important when considering the sanction of capital expenditure and capital budgets
- Clients, both internal and external, as they are more likely to get what they want, when they want it and for a cost they can afford

- Project managers who want to improve the quality of their work i.e. they want to bring their projects in to cost, on time and to the required performance levels

2.7.5 *What are the costs of using it*

The costs of using Project Risk Analysis and Management techniques vary according to the scope of the work and the commitment to the process. Below are some example of costs, timescales and resource requirements for carrying out the process:

- Cost

The cost of using the process can be as little as the cost of one or two days of person's time up to a maximum of 5-10% of the management costs of the project, even this higher cost, as a percentage of the total project cost, is relatively small. It can be argued that the cost incurred is an investment if risks are identified during the process that may otherwise have remained unidentified until it was too late to react.

- Time

The time taken to carry out a risk analysis is partially dependent upon the availability of information. A detailed cost and time risk analysis usually requires anywhere from one to three months depending upon the scale and complexity of the project and the extent of planning and cost preparation already carried out.

- Resources

The minimum resource requirement is obviously just one person within an organization with experience of using Project Risk Analysis and Management techniques.

However, if experience does not exist within the organization it can be readily acquired from outside consultants. It is also likely that, once Project Risk Analysis and

Management have been introduced to an organization, in-house expertise will develop rapidly.

2.7.6 *When should it be used and who should do it*

Project Risk Analysis and Management is a continuous process that can be started at almost any stage in the life-cycle of a project and can be continued until the costs of using it are greater than the potential benefits to be gained. As time progresses, the effectiveness of using project Risk Analysis and Management tends to diminish, therefore, it is most beneficial to use it in the earlier stages of a project.

There are five points in a project where particular benefits can be achieved by using it.

- Feasibility study – At this stage the project is most flexible enabling changes to be made which can reduce the risks at a relatively low cost. It can also help in deciding between various implementation options for the project.
- Sanction – The client can make use of it to view the risk exposure associated with the project and can check that, all possible steps to reduce or manage the risks have been taken. If a quantitative analysis has been carried out then the client will be able to understand the "chance" that he has of achieving the project objectives (cost, time and performance).
- Tendering – The contractor can make use of it to ensure that all risks have been identified and to help him set his risk contingency or check his risk exposure
- Post tender – The client can make use of it to ensure that all risks have been identified by the contractor and to assess the likelihood of tendered programs being achieved.

- At intervals during Implementation – It can help to improve the likelihood of completing the project to cost and timescale if all risks are identified and are correctly managed as they occur.

2.7.7 *Which projects are suitable*

Many experienced users of project Risk Analysis and Management would say "any and all" in answer to this question of which projects are suitable for its application – all because all projects contain risks and uncertainties and risk analysis and management is an integral part of project or business management

Attend any conference or read any literature material on risk and it is clear that the most extensive applications have occurred on large capital projects such as defence, oil and gas, aerospace, civil engineering and national power grid like the Construction of the Akosombo Hydro-electric Power Plant, Bui, Aboadze Thermal plant and the Asogli-State Power generating plant.

However, the process has been applied to smaller construction projects such as a water supply rehabilitation project at the Awabi and Weija Treatment Plant and the on-going construction of the West Africa Gas Pipe Project across the West African sub-region.

Other areas where risk analysis and management are also applied are in the areas of Insurance.

2.7.8 *What type of projects*

It can be used on any type of project, but it is more beneficial for some projects than others. Some examples of projects which would benefit from Project Risk Analysis and Management are:-

- innovative, new technology projects
- project requiring large capital outlay or investment
- fast track projects

- projects which interrupt crucial revenue streams
- unusual agreements (legal, insurance or contractual)
- projects with sensitive issues (environmental and relocation i.e. Sodom and Gomorrah to Adjankotey in Accra and Angloga carpenters/timber tradesmen to Sokoban wood village in Kumasi)
- projects with stringent requirements (regulatory/safety i.e. Dumpsites at Mallam in Accra and Ahinsan in Kumasi)
- projects with important political/economic/financial parameters

2.8.9 *When should it be done*

There are a few circumstances when it is particularly advisable to use Project Risk Analysis and Management techniques, these are:

- when there are specific targets that must be met
- when there is an unexpected new development in a project
- at points of change in the life-cycle of a project

2.7.10 *When shouldn't it be done*

There are no particular circumstance under which Project Risk Analysis and Management techniques should not be used except for repeat projects, where such analysis have already been carried out, unless, of course, there are specific differences between the projects.

In the presence of uncertainty, where severe constraints give rise to significant risk, the absence of relevant data may make a quantitative assessment not worthwhile; however, such circumstances must never prevent a rigorous qualitative analysis being carried out.

2.7.11 *Who should do it*

Many people advocate the use of an independent expert or external consultant to ensure that they receive an unbiased view, whereas, others suggest that project Risk Analysis and Management support should be an integral function. Opinions however differ widely at this stage but essentially anyone can do it provided consideration is given to the angle" from which they are viewing the project. In any event, the project management team should be closely involved in the analytical process to ensure validity of the analysis and also to allow them to believe in the results.

Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one of the primary project objectives of scope, schedule and cost. Risk affects project performance and customer satisfaction as well. Every risk is future oriented. An event which has already happened is a fact; and for as long as actions on it are not closed, it is called an issue.

2.8. Risk Origins

Projects are characterized by uncertainty. Project risk originates from this uncertainty and may be related to the context, people or the process of the project. It may alternatively be perceived as relating directly to the product of the project or may be due to external project dependencies. Risk causes or triggers thus are conditions that create the possibility of positive or negative outcomes that impact a project. They include:

- Incompleteness of assumptions
- Incomplete identification of constraints
- Unclear requirements
- Unexpressed stakeholder expectations
- Inadequate requirements gathering

- Technology inappropriateness

Enterprise Environmental factors such as policy, financial and resource constraints.

Internally, the project organization's environment may contribute to risk. Factors within the control of the performing organization that may present a project with risks include:

- Project team competence,
- Team member attitudes and behaviours,
- The nature and complexity of the project,
- Management systems,
- Programme management practices,
- Inappropriate project organization,
- Unclear or incomplete requirements, and
- Misplaced assumptions and constraints.

Risks external to a project depend on or originate from its externalities. These include:

- the political environment
- economic conditions
- socio-cultural issues
- vendor and supplier relationships
- regulatory change
- competitor actions
- stakeholder risk attitudes and tolerances
- market forces, and
- third party linkages, processes or activities that have direct or indirect interactions with the project.

In every project, the project management team has the responsibility to identify, assess and prepare for risks.

2.9 Outline of Project Risk Management

Project Risk Management includes the processes concerned with conducting risk management planning, identification, analysis, responses and monitoring and control on a project, most of these processes are updated throughout the project.

The objectives of Project Risk Management are to increase the probability and impact of positive events, and decrease the probability and impact of events adverse to the project.

Risk management is therefore a management tool which assists systematic examination of areas of risk and consciously determining how each should be treated and generally involves:

- Identifying preventive measures to avoid a risk or to reduce its effects
- Establishing contingency plans to deal with risks if they should occur
- Initiating further investigations to reduce uncertainty through better information
- Considering risk transfer to insurers
- Considering risk allocation and evaluation of risk in contracts
- Setting contingencies in cost estimates, float in programmes and tolerance in performance specifications

Reduced to its essentials, risk management requires:

- The establishment of mechanisms to keep risks under review and to make sure that they are addressed,
- A means of identifying the potential risks to the project,
- An assessment of the likelihood of each risk materializing,
- An assessment of the probable impact of each risk,
- The formulation of measures to avoid each risk occurring,
- The development of fallback measures to mitigate the risks if avoidance action fails,

- The determination of the urgency of the risk and of taking appropriate countermeasures.

All the above illustrations and outlines point to a lot more similarities than differences in the general approach to the management of risks.

Project risk has its origins in the uncertainty that is present in all projects. Known risks are those that have been identified and analyzed, and it may be possible to plan ahead to mitigate or if not eliminate imminent risks should it become feasible. Unknown risks cannot be managed proactively, and a prudent response by the project team can allocate general contingency against such risks, as well as against any known risks for which it may not be cost-effective or possible to develop a proactive response.

Organizations perceive risk as it relates to threats to project success, or to opportunities to enhance chances of project success. Risks that are threats to the project may be accepted if the risk is in balance with the reward that may be gained by taking the risk.

Persons and by extension, organizations have attitudes towards risk that affect both the accuracy of the perception of risk and the way they respond. Attitudes about risk should be made explicit whenever possible.

A consistent approach to risk that meets the organization's requirements should be developed for each project, and communication about risk and its handling should be open and honest. Also key to successful risk management is the issues of "ownership" – that someone should be responsible for each risk.

2.10Risk Management Processes

The Project Risk Management processes or procedure include the following phases or steps as illustrated by Project Management Body of knowledge (3rd Edition):

Phase 1: Risk Management Planning

Phase 2: Risk identification and classification

Phase 3: Qualitative Risk Analysis/Initial Analysis or Assessment

Phase 4: Quantitative Risk Analysis/Modeling

Phase 5: Risk Response Planning

Phase 6: Risk Monitoring and Control or Management

To describe these as phases is slightly misleading as it implies seriality. In fact once analysis or planning has started, it does not mean that identification must cease. Handling risk is a highly dynamic process which involves not only the management of previously known risks but also reacting effectively to an evolving situation. It therefore demands not only constant review and a capacity to react quickly and effectively against new situations, but also needs a willingness to ensure that the changing position and countermeasures proposed have appropriate visibility within the company or business enterprise.

Figure 2.2 "Appendix 'A' provides an overview of the Project Risk Management processes or steps as indicated by Project Management Body of Knowledge – 3rd Edition.

2.11 Phase 1 - Risk Management Planning/Programme

2.11.1 Risk Management Planning /Programme

Construction is a risky industry and the type of risks associated with it is always the same no matter what is being built. It generally follows that, when a tender is prepared and accepted, the building contractor and its operatives/staff execute the job efficiently and manage the possible risk factors which can be the cause of disaster and/or profit erosion. The objective of the contractor's risk management programme is to control the cost of risk. Therefore, it should seek to reduce the potentially adverse impact of such risk; thus enabling the contractor to absorb it internally or transfer it to an insurer at an acceptable cost to his/her company or organization. However, according to Ward and 9 others

(1991), the success of a contractors risk management programme requires the following pre-conditions:

- Full and complete specification of the construction project and all associated risks,
- Clear perception of the type of risks being borne by each party,
- Sufficient capacity, capability, competence and experience to manage the risks,
- Motivation to manage the risks, which requires a clear linkage between party's management of risks and the party's receipt of reward.

The above pre-conditions is an indication that the building contractor or developer requires the clients input (i.e. production of adequate construction information) in his/her risk management endeavors. This need therefore, places an obligation on the clients professional advisors to improve the quality of information that they provide in contract documentation and/or at tender stage of a construction project to assist the building contractor in his/her risk management endeavors.

It is therefore imperative that, careful and explicit planning at the initial stage of any venture or development will enhance the possibility of success of every projects risk management processes.

Risk Management Planning is the process of deciding how to approach and conduct the risk management activities for a project. Planning of risk management is therefore important to ensure that the level, type and visibility of risk management are commensurate with both the risk and importance of the project to the Organization or company, to provide sufficient resources, information, and time for risk management activities, and to establish an agreed-upon basis for allocating and evaluating risks. The Risk Management Planning process should therefore be completed early during project planning (i.e. before bidding), since it is crucial to successfully performing the other processes or procedure in project risk management.

2.11.2 Inputs for Risk Management Planning.

Risk Management Planning is done with inputs from the following sources:

- Enterprise Environmental Factors
- Organizational Process Assets
- Project Scope Statement, and
- Project Management Plan
- Planning Meetings and Analysis
- Pre-workshop
- Workshop
- Post-workshop

2.11.2.1 Enterprise/Company Environmental Factors

The attitudes of both employees and employers toward risk and risk tolerance of organization or company and people involved in the project on hand will influence the extent of project management plan.

Risk attitudes and levels of tolerance may be expressed in the policy statement of the organization or revealed in the actions of management personnel.

2.11.2.2 Organizational Process Assets

Organizations or enterprises may have a well laid-down procedures or predefined approaches to risk management such as risk categories or classifications, common definitions of concepts and terms, roles and responsibilities, and authority levels of decision-making.

2.11.2.3 Project Scope Statement

Project Scope Statement describes, in detail, the project's deliverables and the work required to create this deliverables. It also provides a common understanding of the project scope among all project stakeholders and describes the projects major objects such as time, cost and performances. The project scope statement enables the project team to undertake more detailed planning, guides the project team's work during the project implementation and provides the baseline or benchmark for evaluating whether changes and variations suggested are contained within or outside the parameters of the proposed project. Managing the project scope properly will determine how well the project team can plan, manage and control the implementation of the project.

2.11.2.4 Project Management Plan

Project Management Plan process includes the actions necessary to define, integrate, and coordinate all subsidiary plans into a project management plan. It defines how the project is executed, monitored, controlled and closed. The project management plan documents the collection of outputs of the planning processes of the Planning Process Group.

2.12 Tools and Techniques used in Risk Management Planning

Planning Meetings and Analysis is one of the tools or techniques used in Risk Management Planning.

During this period (ie planning meeting and analysis,) Project teams hold planning meetings to develop the risk management plan. Almost all risk management practitioners attempt to convene a risk management workshop where attendances may include, where possible, all major stakeholders like clients, project managers, designers, cost consultants, contractors (where appointed), end users and even in some instances external organizations such as a local residents association if the project is a community-initiated one or anyone in the organization with responsibility to manage the risk planning and execution activities, and others, as needed.

Basic plans for conducting the risk management activities are defined in these meetings. Risk cost elements and schedule activities will be developed for inclusion in the project budget and schedule respectively. Here, risk responsibilities will be assigned. General organizational templates for risk categories or areas and definitions of terms such as levels of risk, probability by type of risk, impact by type of objectives, and the probability and impact matrix will be tailored to the specific project. The outputs of these activities will be summarized in the risk management plan – outputs.

2.13 Outputs of Risk Management Planning

The following are some of the outputs of the Risk Management Planning:

2.13.1 Risk Management Plan

The risk management plan describes how risk management will be structured and performed or implemented on the project. It therefore becomes a subset of the overall project management plan to control and mitigate risk. The risk management plan at this stage includes the following:

- Methodology – Defines the approaches, tools and techniques, and data sources that may be used to perform or undertake risk management on the project in mind or to be pursued;
- Roles and responsibilities – Defines the lead, support, and risk management team membership for each type of activity in the risk management plan, assigns people to these roles and clarifies their responsibilities to the plan;

- Budgeting – Assigns resources and estimates costs needed for risk management for inclusion in the project cost baseline;
- Timing - Defines when and how often the risk management process will be performed throughout the project life cycle, and also establish risk management activities that is to be included in the project schedule;
- Risk categories – Provides a structure that ensures a comprehensive process of systematically identifying risk to a consistent level of detail and contributes to the effectiveness and quality of Risk Identification. An organization can use a previously prepared categorization of typical risks. Another approach is the use of a typical Risk breakdown structure of a known project. The risk categories may be revisited during the Risk Identification process. A good practice is to review the risk categories during the Risk Management Planning process prior to their use or adaptation in the Risk Identification process. Risk categories based on prior projects may need to be tailored, adjusted, or extended to suit the new situation under study before those categories are used on the current project.
- Definitions of risk probability and impact – The quality and credibility of the Qualitative Risk Analysis process require that different levels of the risks' probability and impacts be defined. General definitions of probability levels and impact levels are tailored to the individual project during the Risk Management process for use in the Qualitative Risk Analysis process.

  A relative scale representing values from "very unlikely" to "almost certainly" could be used. Alternatively, assigned numerical probabilities on a general scale (e.g. 0.1, 0.3, 0.5, 0.7, 0.9) can also be used. Another approach to calibrating probability involves developing descriptions of the state of the project that relate to the risk under consideration.

The impact scale reflects the significance of impact, either negative for threats or positive for opportunities on each project objective if a risk occurs.

Impact scales are specific to the objective potentially impacted, the type and size of the project, the organization's sensitivity to particular impacts. Relative scales for impact are simply rank-ordered descriptors such as "very low", "low", "moderate", "high" and "very high", reflecting increasingly extreme impacts as defined by the organization. Alternatively, numeric scales assign values to these impacts. These values may be linear (e.g. 0.1, 0.3, 0.5, 0.7, 0.9) or nonlinear (e.g. 0.05, 0.1, 0.2, 0.4, 0.8). Nonlinear scales may represent the organization's desire to avoid high impact threats or exploit high-impact opportunities even if they have relatively low probability. In using nonlinear scales, it is important to understand what is meant by the numbers and their relationship to each other, how they were derived, and the effect they may have on the different objectives of the project.

- Probability and Impact matrix Risks are prioritized according to their potential implications for meeting the projects objectives. The typical approach to prioritizing risks is to use a look-up table or a Probability and Impact Matrix or Risk Grid as Fig 2.3 below.

  Figure 2.3 Risk Grid

Probability

Medium Priority	High Priority
Low Priority	Medium priority

Impact

Source: Commercial Risk Management, By Tim Boyce

The specific combinations of probability and impact that lead to a risk being rated as "high priority" "medium priority" or "low priority" importance-with the corresponding importance for planning responses to the risk are usually set by the organization. They are reviewed and can be tailored to the specific project during the Risk Management Planning process. Thus, the discipline of causing individuals to identify all risks and to consider both the impact and probability of each specific risk helps to point out where attention most needs to be directed.

- Revised stakeholders' tolerances

  Stakeholders' tolerance may be revised in the Risk Management Planning process, as they apply to the specific project.

- Reporting formats – Describes the content and format of the risk register as well as any other risk reports required. The risk register, figure 2.4 is the repository for all risk. This provides the essential reporting and control medium which should be updated and reviewed on a regular basis. The Risk Register draws together in one place all the principles of sound risk management i.e. identification, ownership, probability, Impact, Mitigation and Fall-back.

Figure 2.4 Risk Register

Serial or Reference	Risk or Title and Description	Risk Owner	Probability	Potential Impact C T P O I E S M R T E F	Actions or Mitigation	Action log or Fall-back Plan	Fall-back Deadline

Source: Commercial Risk Management by Tim Boyce,(1995)

The Risk Register defines how the outcomes of the risk management process will be documented, analyzed, and communicated.

- Tracking – Documents how all facets of risk activities will be recorded for the benefit of the current project, future needs, and lessons learnt. Tracking also documents whether and how risk management processes will be audited in the course of time.

The second phase after Risk Management planning is the Risk Identification and classification phase.

2.14 Phase 2 - Risk Identification

2.14.1 Risk Identification

Clearly, the first step involved in managing risk is to

discover what they are but this is more easily said than done. Williams (1995) found that the identification of each risk is an essential first step in risk management. The identification of each source of risk and the consequences allows the risk item to be separated from others. Consideration of each influencing factor will simplify the analysis and management of the risk (Bajaj, 1997). In risk identification, the key question to ask is: *What are the discrete features of the project (risk sources) which might cause such failure? (Godfrey, 1996)*

The identification of possible sources of risks is an essential area in the risk management process because it allows project parties to recognize the existence of uncertainty in the project and hence, to analyses its potential impact and consider an appropriate strategy to mitigate its effect in the project. Risk identification includes the recognition of potential sources of risk and uncertainty event conditions in the project and the clarification of risk and uncertainty responsibilities. It is accompanied by a structured search for a response to the question – *what events may reasonably occur that will impede the achievement of key elements of the project objectives*?

Many decision-makers believe that the principal benefits of risk management come from the identification rather than the analysis stage. This is a difficult task but the building contractor or consultant should at all times (i.e. throughout the life of a project) be in a position to identify risk associated with projects he/she undertakes and also, determine whether the risks are capable of being passed from one party to another and equally capable of being addressed. Failure to identify beforehand risks associated with a project one is about to undertake invariably leads to arguments, disputes and heavy legal bills.

The realism of risk estimates increases as the project proceeds. However, the major decisions should be made early in the life of the project, as contingency steps need to be put into place to counter the risk. So despite the difficulties, a realistic estimate of the final cost and duration of the total project is required as early as possible.

There is a second, but equally important, reason for the early identification of risk and uncertainty, it focuses the attention of project management on the strategies for the control and allocation of risk e.g. through the choice of a contract strategy. It will also highlight those areas where further design, development work, or classification is needed. While it is true to say that most projects contain a number of reasonably standard and recognizable risk situation, each new project requires careful and individual consideration.

New situations arise as a result of new risks being generated. Risk identification is an iterative process because new risks may become known as the project progresses through its life cycle. The frequency of iteration and who participates in each cycle will vary from case to case. The project team should therefore be involved in the process so that they can develop and maintain a good sense of ownership of belongingness and responsibility for the risks and associated risk response actions. Participants in risk identification activities can include the following, where appropriate, project manager, project team members, risk management team (if assigned), subject matter experts from outside the project team, customers, end users, other project managers, stakeholders, and risk management experts in the industry. However, while these personnel are often key participants for risk identification; all project personnel should be encouraged to identify risks.

2.14.2 Approaches to Identification or Classification of Risks

Approaches to categorizing / classification / identification of risk includes some of the following:

2.14.2.1 Origin of Risks

Perhaps the most common is to use the origin or consequence of the risk, for example, programme risks, cost risks, site risks etc. or to use specific building elements such as structure, services or even a full BCIS type breakdown. A number classify risks according to the stages within the development process along the lines of the RIBA plan of work – design development, specification, procurement, tendering, construction, etc. On larger projects, risks are often grouped either within different phases or in line with the project work breakdown structure,

The Risk Breakdown Structure (RBS) shows the risk groups, risk categories and risk events at the lowest level.

2.14.2.2 Sources of Risk

Project risks can also be divided into two groups, according to their source – internal and external. Internal risks are those that are project-related and usually fall under the control of the project management team. External risks are those risks that are beyond the control of the project management team. Other researchers divide projects risks into internal and external. Internal risks are initiated inside the project while external risks originate due to the project environment. Internal risks are then divided according to the party who might be the originator of risk events such as owner, designer, contractor, etc. External risks are those initiated at the macro level.

The approach to risk classification must be structured and comprehensive and can be extracted from a combination of the management organization and risk breakdown structure in Figure 2.5.(See Appendix 'A') This highly stylized diagram shows that every function within the business and every task covered by the project is a potential source of risk. Thus, whether individuals are business function oriented or project task oriented, everyone has a role to play in the process of identifying risk.

Others also take a broader view by using categories such as political environmental, commercial risks such as Pre-contract, financial, technical, time frame supplier and post-delivery risks etc or by focusing on capital costs, maintenance costs and life-cycle costs. Figures 2.6 and 2.7 shows the hierarchies of risk areas in the Macro (company) and micro (project) level risk areas and sub-areas of a Chinese Highway Project using the analytic hierarchy process (AHP). The differentiation of risk and uncertainty and the classification of risk offered by some texts such as dynamic, static, pure, speculative, controllable and uncontrollable, etc. are hardly ever adopted.

2.14.2.3 Financial Statement Method

The Financial Statement Method is based on the premises that financial statement account entries serve as reminders of various exposures to economic loss. Analysis of such statements would reveal the degree of exposure to economic loss which affects assets. The weakness of this method is that it provides little help in identifying construction-related risks.

2.14.2.4 Flow Chart Approach

The Flow Chart Approach attempts to construct a flow chart of the actual production process involving raw materials, other resources and the end product. By focusing on different elements of the chart at a time and simultaneously considering the possibility of something going wrong with those elements, a series of important risks may be identified.

2.14.2.5 Questionnaire and Checklist Approach

The Questionnaire and checklist Approach attempts to compile a comprehensive list of risk to which a firm has been exposed in the past and apply it as a checklist against new projects for ease of identifying potentially damaging risks.

According to Mason (1973), this offers the most usable risk identification method for construction contracting by allowing the firm to identify risks in a rational manner. However, the list, after a period of time, becomes very long. The danger is that the decision-maker may place too much emphasis on risks which are either irrelevant to a new project or their real impact is too small to warrant any form of analysis.

2.15 Tools and Techniques used in Risk Identification

Some of the tools and techniques used in identifying risks are as follows:

2.15.1 Documentation Reviews

A structured review may be performed of project documentation, including plans, assumptions, prior project files, and other related and relevant information. The quality of the plans as well as consistency between those plans and with the project requirements and assumptions can be indicators of risk in the project.

2.15.2 Pre-workshop

Where time permits and the scale of the project allows, many consultants prefer to interview stakeholders prior to the workshop. The intention here is to get a general feel for the principal concerns of those involved in the project. This is seen by some as a crucial part of the process because of the quality of information obtained during this session. It is realized that tểte-ấ-tểte can lead to the exploration of some quite sensitive risks. This session is identified as the only real opportunity for an honest exchange. The interviewing technique relies heavily on the skills of the interviewer in questioning managers, engineers, technicians, etc. as to the possibility of risk existing in the areas for which they were individually responsible. It is surprising how often people will give the knee jerk reaction that "there is no risk in my area" (perhaps to avoid the impression of being a poor manager) only to agree upon being interviewed that, not all is as safe as it seems. On the other hand, the individual who confesses to high risk, perhaps because of an ulterior motive (e.g. to gain a bigger budget), may find, upon careful questioning that the risk is not so great after all.

Interviewing experienced project participants, stakeholders, and subject matter experts can identify risks. Interviews are one of the main sources of risk identification data gathering.

When interviews are not possible, consultants often send out briefing papers to introduce risk management process and explain its aims and objectives. In addition, some send out questionnaires or round robins as a means of obtaining at least some impressions of the stakeholders' view prior to the workshop. They are sometimes referred to as risk identification forms and provide the basis for a first draft initial risk listing which can be tabled at the workshop.

2.15.3 Information Gathering Techniques

2.15.3.1 Workshop/Brainstorming

The length of time dedicated to workshops tends to range from a half-day to two days depending on the nature of the project and the willingness of the client to pay. The most common duration is a half of full day. The workshops themselves tend to follow a similar format involving other information gathering techniques used in identifying risks initially.

A number of facilitators use prompt lists to direct and stimulate the group's thinking and subsequently they employ checklists to ensure all issues have been aired. All consultants use the workshop to at least rank the identified risks, and most go on to perform some kind of scoring system to take account of both probability of the risk occurring and the consequent impact on the project.

Some of the most interesting observations relate to the perceived benefits of the workshop. Most acknowledge that brainstorming encourages lateral thinking and that the ranking and scoring process captures the collective intelligence of the project team and achieves a consensus on what are the major project risks.

Brainstorm should take place at all levels to drive out all the imponderable "what its" questions such as, if the contract staff do prove to be too slow, and we apply the countermeasure of reassigning work to our own staff, what will be the impact on the project outcome". This is just as important at the strategic level (e.g. what happens to overhead rates on this contract if business volumes declines elsewhere while this project is underway) as it is in the technical forum on the particular contract. In brainstorming, the emphasis is very much on the brainstormers producing their own ideas of where risk might lie. The goal of brainstorming is to obtain a comprehensive list of project risks. The project team usually performs brainstorming, often with a multidisciplinary set of experts not on the team. Ideas about project risk are generated under the leadership of a facilitator. Categories of risk such as risk breakdown systems can be used as a framework.

One of the benefits is a better understanding of what the real risks are to the project and not the perceived risks.

In addition, some suggest the workshop also provides an opportunity for valuable interfacing between all stakeholders, opens up channels of communication and can even become a team building event. It is noted that, there are a lot of hidden things that people are trying to deal with by themselves which they see as "my particular issue – "I will deal with it under the table", I will get it sorted out", when often the best thing to do can be to share that with people and get their input to it, get some advice, get some help.

Concern is also expressed that the views of participants can remain hidden in the workshop situation. For instance, if certain members of the design team are perceived by others to be the major contributor to risk, it is unlikely that this would surface at a round-the-table meeting.

2.15.3.2 Delphi Techniques – The Delphi technique is a way to reach a consensus of experts. Project risk experts participate in this technique anonymously. A facilitator uses a questionnaire to solicit ideas about the important project risks. The responses are summarized and are then recirculated to the experts for further comments. Consensus may be reached in a few rounds of this process. The Delphi technique helps reduce bias in the data and keeps any one person from having undue influence on the outcome.

2.15.3.3 Root cause identification

This is an inquiry into the essential causes of a project's risks. It sharpens the definition of the risk and allows grouping risks by causes. Effective risk responses can be developed if the root cause of the risk is addressed.

2.15.3.4 Strengths, weaknesses, opportunities, and threats (SWOT) analysis

This technique ensures examination of the project from each of the SWOT perspectives, to increase the breadth of considered risks.

2.15.3.5 Checklist Analysis

Risk identification checklist can be developed based on historical information and knowledge that has been accumulated from previous similar projects and from other sources of information. The lowest level of Risk Breakdown Structure (RBS) can be used as a risk checklist. Historical database is a good way of both validating the magnitude of the perceived view and of double-checking that no category or type of risk has been accidentally omitted from the brainstorming and interview processes discussed earlier on. The checklist should be reviewed during project closure to improve it for use on future projects.

2.15.3.6 Assumption Analysis

Every project is conceived and developed based on a set of hypotheses, scenarios or assumptions. Assumption analysis is a tool that explores the validity of assumptions as they apply to the project. It identifies risks to the project from inaccuracy, inconsistency, or incompleteness of assumptions.

2.15.3.7 Diagramming Techniques

Risk diagramming techniques may include:

The output or outcome from risk identification is documented and put into a Risk Register.

a. Cause – and – effect diagrams. These are also known as Ishikawa or fishbone diagrams, and are useful for identifying causes of risks.

b. System or process flow charts – These show how various elements of a system interrelate, and the mechanism of causation.

c. Influence diagrams. These are graphical representations of situations showing caused influences, time ordering of events and other relationships among variables and outcomes.

2.16 Outputs of Risk identification

2.16.1 Risk Register

One important output of risk identification is the Risk Register. The outputs from Risk Identification are typically contained in a document that can be called a Risk Register. This register could take various forms – loose leaf register, word-processor file, spreadsheet or database and will act as a central repository for the information gained in each risk. Specifically, you need to record:

- *A reference* - each risk needs a unique identifier, perhaps keyed to the phase, task or product on which it impacts,
- *A title and description* – of the risk
- *The current status of the risk* – for example, candidate (identified but not yet quantified), live or closed.
- *Potential Impact* – there may be more than one of these and, for each, you need to record a description and assessment of its likelihood and scale of impact
- *Risk Owner* – The person who will be responsible for carrying out the identified risk actions
- *Actions* – The avoidance and/or mitigation actions that have been identified
- *Action Log* – a record of the progress made in discharging the risk actions

The storage medium for the risk register will depend on the scale of the project and on the volatility of the risks identified. For a small project with a few fairly long-term risks, a paper-based system would be quite adequate, for a larger project, with many changeable risks; a computerized system of some sort would clearly be advantageous.

The primary outputs from Risk Identification are the initial entries into the risk register, which becomes a component of the project management plan. The risk register ultimately contains the outcomes of other risk management processes as they are conducted. The preparation of the risk register begins in the Risk Identification process with the following information, (and then becomes available to other project management and Project Risk Management Processes).

- List of Identified risks – The identified risks, including their root causes and uncertain project assumptions, are described.
- List of potential responses – Potential responses to a risk may be identified during the Risk Identification process. These responses, if identified, may be useful as inputs to the Risk Response Planning process.
- Root Causes of Risk – These are the fundamental conditions or events that may give rise to the identified risk
- Updated risk categories – The process of identifying risks can lead to new risk categories being added to the list of risk categories.

The Risk Breakdown Structure (RBS) developed in the Risk Management Planning process may have to be enhanced or amended, based on the outcome of the Risk Identification process.

2.17 Phase 3 – Qualitative Risk Analysis/ Assessment

2.17.1 Qualitative Risk Analysis/Initial Analysis or Assessment

Qualitative Risk Analysis or Initial Analysis/Assessment includes methods for prioritizing the identified risks for further action, such as in Quantitative Risk Analysis or

Risk Response Planning stages. A qualitative analysis allows each risk factor to be assessed and then classified/labeled (high level, middle level or low level risk) in terms of both its potential impact on the project and its probability of occurrence. Risk and uncertainty rating identifies the importance of the sources of risk and uncertainty to the goals of the project. It comes as a response to the questions:

- What is the probability that, the risk will occur? and
- What is the severity of the impact on the project if a risk is allowed to take place?

With the various risk identified and described, it is next necessary to make an assessment of their impact on performance, cost, schedule quality and likelihood. This is so that management attention can be focused on those risks with the greatest probability of occurring and/or those that will most damage the project if they do happen. For a given risk, there may of course be more than one possible impact. The other factor to consider is the likelihood or probability, of the risk materializing during the execution of the project – the projects exposure.

Risk Assessment is more than simply identifying specific risks. It means obtaining a clear definition of risks, including how important the risk is to the project – what the severity of its occurrence would be, its sensitivity – and the likelihood of that risk occurring. It also involves prioritizing the risks according to exposure, effect and problems associated with compounding risks to enable management to monitor these risk factors so as to take the necessary action during the execution of the project. Identification can be achieved by:

- Interviewing key members of the project team,
- Organizing brainstorming meetings with all interested parties,
- By using the personal experience of the risk analyst,

- Reviewing past corporate experience if appraisal records are kept,

All of the above methods are greatly enhanced by the use of checklists which can either be generic in nature i.e. applicable to any project or specific to the type of project being analyzed.

Once identified, the risks are then subjected to an initial assessment that categorizes the risks into high/low probability of occurrence and major/minor impact on the project should the risk materialize. It is often advisable to prepare initial responses to each identified risk, especially if risk are identified that require urgent attention. The analysis may be terminated during this phase if the assessment immediately suggests a way in which many identified risks can be mitigated.

One of the golden rules of risk analysis is to keep a broad perspective and avoid the "cannot see the wood for the trees" syndrome.

Thus while the final project model may have hundreds of individual activities, it is important to start out at the macro level, for which it is necessary to return to the primary sources of risk mentioned earlier at the identification stage.

Qualitative Risk Analysis is usually a rapid and cost-effective means of establishing priorities for Risk Response Planning, and lays the foundation for Quantitative Risk Analysis if this is required. Qualitative Risk Analysis should be revisited during the projects life cycle to stay current with changes in the project risks. Qualitative Risk Analysis requires outputs of the Risk Management Planning and Risk Identification processes. This process can lead into Quantitative Risk Analysis or directly into Risk Response Planning.

2.18 Inputs for Risk Analysis or Assessment

Some of the key inputs for Qualitative risk analysis include the following:-

- Organizational Process Assets
- Project Scope Statement
- Risk Management Plan
- Risk Register

2.18.1 Organizational Process Assets

Data information, lessons and experiences on past and previous projects can be used in the Qualitative Risk Analysis process.

2.18.2 Project Scope Statement

Projects of a common or recurrent type such as in Mass proto-type buildings tend to have better understood risks. Projects using state-of-the-art or first-of-its's-kind technology and highly complex projects tend to have more uncertainty. This uncertainty can be evaluated by examining the initial project scope statement.

2.18.3 Risk Management Plan

Important points of the risk management plan for Qualitative Risk Analysis include key roles and responsibilities for conducting risk management, budgets, and schedule activities for risk management, risk categories, definitions of probability and impact, the probability and impact matrix, and revised stakeholders' risk tolerance. These inputs are usually tailored to the project during the Risk Management Planning process and if these inputs are not available, they can be developed during the Qualitative Risk Analysis process.

2.19 Tools and Techniques used in Qualitative Risk Analysis

Some of the tools and techniques used in Qualitative Risk Analysis are as follows:

2.19.1 Risk Register

A key item from the risk register for Qualitative Risk Analysis is the list of identified risks during the Risk identification input stage.

2.19.2 Risk Map/Grid

An important step in the whole process of Qualitative Risk Analysis is to list the most significant risks and set them in an order of ranking. To make such ranking or ratings, the project manager has to have a specification of what is involved in the project: the tasks to do and the deliverables to be made. It is worth beginning the risk assessment process with a fairly firm work breakdown structure and even the work package definitions or statements of work in hand. This can be converted into a risk map to give an overall impression of where attention most needs to be concentrated. This also provides the means to create a risk grid, as in Figure 2.3 earlier on.

Obviously, the most important ones are those with a large impact and a high probability of occurrence. At the other extreme, we need to be less concerned about those with a low probability and small impact. In between, there are various graduations of severity we can consider. The risks shown in the top right-hand corner of figure 2.3 shows those with the highest impact and probability and therefore, probably, the ones that need the closest management attention. Organizations can therefore improve the project's performance effectively by focusing on high-priority risks.

Thus, the discipline of causing individuals to identify all risks and to consider both the impact and probability of each specific risk helps to point out where attention most needs to be directed.

2.19.3 Risk Assessment Checklist

The next step in the initial analysis (qualitative risk analysis) is to take each identified risk and assess the probability of the risk arising and the impact of the risk should it materialize by asking the project manager or stakeholders to score the risk on a scale such as low, medium or high likelihood of occurrence and perhaps also to assess the risk as having a low, medium or high impact on the project or its key deliverables. Figure 2.8 (Appendix 'A') illustrates typical risk assessment checklist with probability and impact weighting columns of a proto-type project.

There are other kinds of risk assessment list which can be used to assessed whether a project is a risky venture. Figure 2.9 (Appendix 'A') shows a form of questionnaire that can be used to diagnose potential areas of risk.

In Figure 2.9 (Appendix 'A') the risk assessor ticks which statement in each category most loosely describes the project being assessed. The number in square brackets on the right are the risk weighting indicator associated with that statement: 1 indicates low risk and 6 indicates very high risk. The risk scores can be added together to produce an overall risk figure, which will help the project manager to know whether he or she is dealing with a low, medium or high-risk project. There is little point in assessing the risk of a project if the only purpose such an assessment serves is to disturb the peaceful sleep of the project manager. A thorough risk assessment must lead to something being done about the risks or planned for the eventuality that they might occur.

Figure 2.10 (Appendix A) is a variant of the previous checklist. The assessor ticks the box that closely describes the project being assessed, but in this case, the box is labeled "low", "Medium" or "high" and overall project risk is not a matter of summing up weightings. The emphasis in this type of checklist is more on identifying high-risk factors than on arriving at an overall project risk figure.

2.19.4 Risk Probability and Impact Assessment

Risk probability assessment investigates the likelihood that each specific and identified risk will occur (i.e. the probability of occurrence of the said risk). Risk impact assessment investigates the potential effect of a specific risk on a project objects such as time, cost, scope, or quality, including both negative effects for threats and positive effects for opportunities. Thus risk assessment is accompanied by estimating the probability of occurrence and severity of risk impact.

Probability and impact are assessed for each specific and identified risk. Risk can be assessed in interviews or meetings with stakeholders or participants selected for their unique familiarity with the risk categories being discussed or to be encountered. Project team members and, perhaps, knowledgeable persons from outside the project, are included. As indicated earlier on, on who should undertake the Qualitative Risk Analysis, the project management team should be closely involved in the analytical process to ensure validity of the analysis and also to allow them to believe in the results. Expert judgement is also acquired, since there may be little information on risk from the organization's data base of past or previous projects. An experienced facilitator may, lead the discussion, since the participants may have little experience with risk assessment.

Most risks can be assessed by identifying what kinds of risk may occur, rating their probability of occurring and their impact if they do, and then assessing the result of this data-gathering exercise. Used by experts in risk assessment, this method or technique is probably also the most accessible one for the project manager who is not an expert.

Stakeholders can also give valuable assistance in carrying out a risk assessment.

This can be a group effort organized by the project manager and including anyone having a significant stake in the outcome of the project. Other people who may have little or no stake in the project can usefully participate if they have experience of similar projects, are expert in particular technical or other subject areas, or are familiar with the risk assessment process. Working in a group this way, everyone will build an understanding and belongingness of what risks exits.

2.19.5 Risk factor lists

A number of aids to risk assessment exist in the form of risk factor lists. Some of these are part of proprietary systems of project management. Some have been drawn up by organizations as they have gained experience of projects. Some are simply the result of an experienced project manager keeping a log for each project of what went wrong, why it went wrong, and what was done about it to eliminate or mitigate the wrong.

The level of probability for each risk and its impact on each objective is evaluated during the interview or meeting. Explanatory detail, including assumptions justifying the levels assigned, is also recorded. Risk probabilities and impacts are rated according to the definitions given in the risk management plan. Sometimes, risks with obviously low ratings of probability and impact will not be rated but will be included on a watch list for future monitoring.

Definitions of the level of probability and impact, and expert interviewing, can help to correct biases that are often present in the data used in this process. The time criticality of risk-related actions may magnify the importance of a risk. An evaluation of the quality of the available information on project risks also helps understand the assessment of the risk's importance to the project.

2.19.6 Probability and Impact Matrix

Risks can be prioritized for further quantitative analysis and response, based on their risk rating. Ratings are assigned to risks based on their assessed probability and impact. Evaluation of each risk's importance and, hence, priority for attention is typically conducted using a look-up table or a probability and impact matrix.

Such a matrix specifies combinations of probability and impact that lead to rating the risks as low, moderate, or high priority as in Figure 2.1. Descriptive terms or numeric values can also be used, depending on the organizations preference. In addition, it can develop ways to determine one overall rating for each risk. Finally, opportunities and threats can be handled in the same matrix using definitions of the different levels of impact that are appropriate for each.

The risk score helps guide risk responses. For example, risks that have a negative impact on objectives if they occur (threats), and that are in the high-risk zone of the matrix, may require priority action and aggressive response strategies. Threats in the low-risk zone may not require proactive management action beyond being placed on a watch list or adding a contingency.

Similarly, for opportunities, those in the high-risk zone that can be obtained most easily and offer the greatest benefit should, therefore be targeted first. Opportunities in the low-risk zone should be monitored.

2.19.7 Risk Data Quality Assessment

A qualitative risk analysis requires accurate and unbiased data if it is to be a credible one. Analysis of the quality of risk data is a technique to evaluate the degree to which the data about risk is useful for risk management. It involves examining the degree to which the risk is understood and the accuracy, quality, reliability, and integrity of data about the risk. If data quality is low-quality and unacceptable, it may be necessary to gather better data. More often than not, collection of information about risk is difficult, inclusive and consumes time and resources beyond that originally planned.

2.19.8 Risk Categorization

Risk to the project can be categorized by sources of risk (e.g. using Risk Breakdown System), the area of the project affected (e.g. using the Work Breakdown System) or other useful category (e.g. project phase) to determine areas of the project most exposed to the effects of uncertainty. Also grouping risks by common root causes can lead to developing effective risk responses.

2.19.9 *Risk Urgent Assessment*

Risks requiring near-term responses may be considered more urgent to address. Indicators of priority can include time to effect a risk response, symptoms and warning signs, and the risk rating.

2.20 Outputs of Risk Analysis /Assessment

One important output or outcome of Qualitative Risk Analysis or Assessment is the updated Risk Register.

2.20.1 Risk Register (Updates)

The risk register is initiated during the Risk Identification process. The risk register is updated with information from Qualitative Risk Analysis and the updated risk register is included in the project management plan. The risk register updates from Qualitative Risk Analysis includes:

- *Relative ranking or priority list of project risks*. The probability and impact matrix can be used to classify risks according to the individual significance. The project manager can then use the prioritized list to focus attention on those items of higher significance to the project, where responses can lead to better project' outcomes. Risks may be listed by priority separately for the various project objectives such as cost, time, scope and quality or performance, since organizations may value one objective over another. However, a description of the basis for the assessed probability and impact should be included for risk assessed as important to the project.
- *Risk grouped by categories*. Risk categorization can reveal common root causes of risk or project areas requiring particular attention. Discovering concentrations of risk may improve the effectiveness of risk responses.
- *List of risks requiring response in the near-term*. Those risks that require an urgent response and those that can be handled at a later date may be put into difference groups.
- *List of risks for additional analysis and response*. Some risk might require more analysis, including Qualitative Risk analysis, as well as response action.
- *Watch list of low priority risks*. Risks that are not assessed as important in the Qualitative Risk Analysis process can be placed on a watch list for future and continued monitoring.
- *Trends in qualitative risk analysis results*. As the analysis is repeated, a trend for particular risk may become apparent and obvious, and can make risk response or further analysis more or less urgent/important.

The fourth phase after Quantitative Risk Assessment in Risk Management Process is Qualitative Risk Analysis .

2.21 Phase 4 - Quantitative Risk Analysis

2.21.1 Quantitative Risk Analysis

Quantitative Risk Analysis is performed on risks that have been prioritized by the Qualitative Risk Analysis process as potentially and substantially impacting the projects competing demand. The Quantitative Risk Analysis process analysis the effect of those risk events and assigns a numerical rating to those risks. It also presents a quantitative approach to working decisions in the presence of uncertainty.

Williams (1995) defined the quantification of risk as the magnitude and frequency or time frame of each event. Each event may be a single incident or an aggregate of incidents. Risk analysis sets out to quantify the effects of the major risks that have been identified. In some cases, the analysis of the impact of the risks extends to judging the probability of occurrence of each risk. According to Hayes et al (1986), only on a few project and contracts is risk considered in a consistent and logical manner; much assessment is too subjective. Quantitative analysis 'sub-stage' therefore focuses on an objective assessment of the risk

In simple terms, a risk potentially impacts upon cost, time, scope and quality or performance or combination thereof. The question then arise as to whether it is possible to produce an accurate prediction for example, as to the cumulative net effect of all the risks that may affect time or cost or quality or performance objectives of the project. Such a quantitative process would provide further insight beyond the qualitative stages of assessing impact for individual risks at the crude level of high, medium or low.

The combination of often more sophisticated statistical techniques and computer processing power has allowed the development of commercially available risk modeling packages that provide just this sort of prediction. It is at the highly detailed level that these techniques produce the most useful results. For example in a large project for which detailed activity planning is done, the overall plan may have thousands of discrete activities, each of which has a potentially variable duration depending upon its level of complexity as well as its intrinsic size. The modeling process requires that the engineers (or other personnel as appropriate) responsible for producing the time estimates for those activities are required to generate so-called "three-point estimates" rather than a single estimate for each activity. The three points are worst case, best case and most likely. The most difficult task in assessing subjective probabilities is related to their measurement. Many present-day construction personnel do not relate well to uncertain data expressed in terms of probabilities and ranges of possible value. They are more comfortable with a deterministic single-point estimate procedure.

However, the more objective quantitative risk analysis process of method involves

- Measurement of uncertainty in cost and time estimates
- Probabilistic combination of individual uncertainties.

Generally, the choices of techniques which is the first step for quantifying risks are usually constrained by the available experience, expertise and computer software

. Sophistication, realism and confidence are achieved by incorporating probabilities and interdependence of risks, but the techniques become complex. Whichever technique is chosen, the next step requires that judgements are made of the impact by each risk and, in some cases, of the occurrence probability for each risk, and of various possible outcomes of the risk.

Statistical methods and computation are tools to aid the professional; they are not substitute for professional judgement. The application of any risk analysis technique requires that the uncertain data can take on a range of different values and be represented by probability distribution. However as experience has shown, for most decisions in the Construction Industry, probabilities need to be assessed subjectively rather than objectively. The required probability will be that on which the decision-maker is prepared to base his decision, given the present state of knowledge and his past experience. In any assessment of subjective probability, the decision-maker must make a conscious effort to be honest and consistent. For this reason, a quantitative analysis can be beneficial to a building contractor as it promotes initially, an understanding of specific risk issue. Risks scoring more highly are given further analysis to quantify accurately their effect on the project in terms of cost and time. It may also serve to highlight possibilities for risk "closure" i.e. the development of a specific-plan to deal with a specific risk issue. Experience has shown that qualitative analysis, identifying and Assessing Risks-usually leads to an initial, if simple, level of quantitative analysis. This will enable the impacts of the risks to be quantified against the three basic project success criteria: Cost, time and performance.

Several techniques have been developed for analyzing the effect of risks on the final cost and time scale of projects. However, such techniques do not always readily apply themselves to the analysis of performance objectives. Techniques which may be used in the evaluation of risk include: Code optimization (which is based on subjective estimation), sensitivity analysis, probabilistic analysis, Monte Carlo simulation (Songer, 1997), and kinetic tree analysis (which allows the estimated probability of each alternative to be recorded and the probability of sequence of events to be determined). (Mendenhall et al, 1986).

All these technique analysis are used to:

• Quantify the possible outcomes for the project and their probabilities,

• Assess the probability of achieving specific project objectives,

• Identify risks requiring the most attention by quantifying their relative contribution to overall objectives,

• Identify realistic and achievable cost, schedule, or scope targets, given the project risks,

• Determine the best project management decision when some conditions or outcomes are uncertain,

Quantitative Risk Analysis generally follows the Qualitative Risk Analysis process, although experienced risk managers sometimes perform it directly after Risk Identification. Availability of time and budget resources, and the need for qualitative or quantitative statements about risk and impacts, will determine which method(s) to use on any particular projects.

Quantitative Risk Analysis should be repeated after Risk Response Planning, as well as part of Risk Monitoring and Control, to determine if the overall project risk has been satisfactorily decreased. Trends can indicate the need for more or less risk management action. It is an input to the Risk Response Planning process.

2.22 Input for Quantitative Risk Analysis

Quantitative Risk Analysis is done with inputs from some of the following sources:

- Organizational Process Assets
- Project Scope Statement
- Risk Management Plan
- Risk Register
- Project Management

2.22.1 Organizational Process Assets

Information on prior, similar completed projects, studies of similar projects by risk specialists, and risk databases that may be available from industry or proprietary sources.

2.22.2 Project Scope Statement as in 2.12.2.3

2.22.3 Risk Management Plan

Key elements of the risk management plan for Quantitative Risk Analysis include roles and responsibilities for conducting risk management, budgets, and schedule activities for each risk management, risk categories, the Risk Breakdown structure, and revised stakeholders' risk tolerances.

2.22.4 Risk Register

Key items from the risk register for Quantitative Risk Analysis include the list of identified risks, the relative ranking or priority list of project risks, and the risks grouped by categories.

2.22.5 Project Management Plan

- The project management plan includes:
- Project Schedule Management Plan

The project schedule management plan sets the format and establishes criteria for developing and controlling the project schedule.

- Project Cost Management Plan

The project cost management plan sets the format and establishes criteria for planning, structuring, estimating, budgeting, and controlling project costs.

Some of the tools and techniques used in Quantitative Risk Analysis are as follows:

2.23 Tools and Techniques used in Quantitative Risk

One major tool and technique used during quantitative risk analysis stage is the Data gathering and representation technique

2.23.1 Data Gathering and Representation Techniques.

These techniques also involves some of the following:

2.23.1.1 Interviewing

Interviewing techniques are used to quantify the

probability and impact of risks on project objectives. The information needed depends upon the type of probability distributions that will be used. For instances, information would be gathered on the optimistic (low), pessimistic (high), and most likely scenarios for some commonly used distributions, and the mean and standard deviations for others. Documenting the rationale of the risk ranges is an important component of the risk interview, because it can provide information on reliability and credibility of the analysis.

2.23.1.2 Expert Judgement

Subject matter experts internal or external to the organization, such as engineering or statistical experts, validate data and techniques.

Other techniques used in the evaluation of risk during Quantitative Risk Analysis also include:

2.23.1.3 Sensitivity Analysis

- Sensitivity Analysis seeks to place a value on the effect of change for a single variable within a project by analyzing that effect on the project plan. It helps to determine which risks have the most potential impact on the project. It examines the extent to which the uncertainty of each project element affects the objective being examined when all other uncertain elements are held at their baseline values. In sensitivity analysis, each risk is considered individually and independently with no attempt to quantity probability of occurrence. The importance of sensitivity analysis is that often the effect of a single change in one parameter can product a marked difference in the project outcome.

In practice, a sensitivity analysis will be performed for a large number of risks and uncertainties in order to identify those which have a high impact on cost, time or economic return and to which the project will be most sensitive. If the decision-maker is interested in reducing uncertainty or risk exposure, then sensitivity analysis will identify those areas on which his efforts should be concentrated.

It also indicates in the comparison of alternatives, the conditions under which the ranking of those alternatives will change. Sensitivity analysis provides the following benefits to the decision-makers:-

• the recognition by management that there is a possible range of outcomes for a Project;

• the relative importance of each variable on which attention should be focused;

• the conditions under which the ranking of those alternative will change;

• the robustness of the project to specific uncertainties;

• the combined effect of variations in variables;

However, sensitivity analysis is not without its limitations. Some of the limitations include:

• only one parameter is varied at a time;

• there is no indication of the probability of occurrence of a specific value;

• the range of variation for a variable usually has to be based on a subjective Judgement;

The results of sensitivity analysis need to be treated with caution where the effects of combinations of variables are being assessed.

2.23.1.4 Expected monetary value analysis

Expected monetary value (EMV) analysis is a statistical concept that calculates the average outcome when the future includes scenarios that may or may not happen (i.e. analysis under uncertainty). The EMV of opportunities will generally be expressed as positive values, while those of risks will be negative. EMV is calculated by multiplying the value of each possible outcome by its probability of occurrence and adding them together, which is given by the equation or formula,

$$EMV = \sum_{i=1}^{n} P_1 V_1,$$

where V_1 is the value possible of outcome, P_1 is the probability that the outcome will occur, and n is the number of possible outcomes. A common use of this type of analysis is in decision tree analysis.

2.23.1.5 Decision tree analysis.

Decision tree analysis is usually structured using a decision tree diagram that describes a situation under consideration, and the implications of each of the available choices and possible scenarios. It incorporates the cost of each available choice, the probabilities of each possible scenario, and the rewards of each alternative logical path. A decision tree is a way of representing graphically the decision processes and their various possible outcomes. They are particularly useful when you have to make a decision about a choice of route when there are uncertainties about the results of adopting that route. Solving the decision tree provides the EMV (or other measure of interest to the organization) for each alternative, when all the rewards and subsequent decisions are quantified.

2.23.1.6 Modeling and Simulation

Probabilistic Analysis specifies a probability distribution for each risk and then considers the effect of a risks in combination. This is perhaps the most common method of performing a quantitative risk analysis and is the one most people consider,

incorrectly, to be synonymous with the whole Project Risk Analysis and Management process. The most common form of probabilistic analysis uses "sampling techniques" usually referred to as "Monte Carlo Simulation".

The output of outcome from quantitative risk analysis assessment is documented in a further Risk Register (updates)

2.24 Outputs of Quantitative Risk Analysis

The following are some of the outputs of Quantitative Risk Analysis:

2.24.1 Risk Register (Updates)

The risk register is initiated in the Risk Identification process and updated in Qualitative Risk Analysis. It is further updated in Quantitative Risk Analysis. The risk register is a component of the project management plan. Updates of the risk register include the following main components:

- *Probabilistic analysis of the project*

  Estimates are made of potential project schedule and cost outcomes, listing the possible completion dates and costs with their associated confidence levels. This output, typically expressed as a cumulative distribution, is used with stakeholder risk tolerances to permit quantification of the cost and time contingency reserves. Such contingency reserves are needed to bring the risk of overrunning stated project objectives to a level acceptable to the organization.

- *Probability of achieving cost and time objectives*

  With the risks facing the project, the probability of achieving project objectives under the current plan can be estimated using quantitative risk analysis results.

- *Prioritized list of quantified risks*

  This list of risks includes those that pose the greatest threat or present the greatest opportunity to the project. These include the risks that require the greatest cost contingency and those that are most likely to influence the critical path.

- *Trends in quantitative risk analysis results*

  As the analysis is repeated, a trend may become apparent that leads to conclusions affecting risk responses.

2.25 Phase 5 – Risk Response Planning

Risk Response Planning is the process of developing options, and determine actions to enhance opportunities and reduce threats to the projects objectives i.e. cost, time, quality or performance. It follows the Qualitative Risk Analysis and Quantitative Risk Analysis. It includes the identification and assignment of one or more persons the ("risk response owner") to take responsibility for each agreed-to and funded risk response.

Risk Response Planning addresses the risks by their priority, inserting resources and activities into the budget, schedule, and project management plan, as needed.

It is an action or a series of actions by the decision-maker in response to the presence of risk. Planned risk responses must be appropriate to the significance of the risk, cost effective in meeting the challenge, timely, realistic within the project context, agreed upon by all key stakeholders and assigned to a competent and responsible person.

2.25.1 Risk Response

Having analyzed the situation of risk and uncertainty in the Construction Industry, the next step is to decide what to do about the risks. Risk response is the final element in the risk management approach. It is an action or a series of actions by the decision-maker in response to the presence of risks. The final phases of risk management involve establishing specific plans to mitigate the risk and, most importantly, the identification of fall-back plans and the dates by which those plans must be implemented. The management of risk demands the active process of regular risk reviews and the commitment to actually enact the fall-back plan and adopt its deadline.

Essentially, the action to mitigate a risk can either be a "passive" one, in which the mitigation action is only taken once the risk has materialized, or it can be an "active" one in which early steps are taken to ensure that if the risk does materialize, then its impact is much reduced or effectively eliminated entirely. Inevitably, any action taken to mitigate the effect of a risk has a cost associated with it. Thus, an active mitigation action may have an "upfront" cost which may be a prudent investment to make or it may prove to be an unnecessary expenditure. Clearly, the choice between active and passive strategies requires a careful cost benefit analysis. Risk Management therefore identifies countermeasures necessary to meet the requirements identified in risk analysis (PRINCE 1993, P.5).

Risk Management uses the information collected during the risk analysis phase to make decisions on how to improve the probability of the project achieving its cost, time and performance objectives. This is done by reducing the risk where advantageous to do so and monitoring and managing the risk which remains.

The project manager uses the information at his disposal to choose between the feasible responses to each risk identified during the qualitative phase. This may involve amending the project plans to reduce the risk , eg moving high risk activities off the critical path, developing contingency plans to allow rapid response if certain risks occur or setting up monitoring procedures for critical areas in order to get early warning of risks occurring.

Risk identified in the risk analysis should be tackled in the following order:

• High-impact, high-probability risks,

• High-impact, lower-probability risks

• Lower-impact, high-probability risks

The risk management phase begins immediately the qualitative analysis is completed and is then a continuing process through the complete life cycle of the project. The information gained during the quantitative analysis allows the project manager to trade off - taking actions now against the likelihood and impact of risk occurring.

The project manager may choose to immediately amend his overall time and cost plan in order to increase the probability of achieving his time and cost objectives.

Risk management should be seen as an integral part of business management. It is simply another tool which should be used as part of the day-to-day running of the company. For example, risk management should be seen as part of project management and not a separate "off-line" activity albeit that the project manager may draw upon a risk management source of expertise, just as he might draw upon specialists in estimating or quality assurance.

2.26 Risk Response Actions

So far, we have identified the risks and quantified their effects. However, this is rather useless unless some action or an effective countermeasures are applied or taken to deal with the risk. These may need to be specified in great detail, depending upon the complexity of the countermeasures. The greater the uncertainty associated with a project, the more deliberate the response must be. There are ways to respond to risk, some of which may be used in combination:

- avoid the risk (avoidance actions that we can do to try to prevent the risk from occurring i.e. dealing with the likelihood);
- reducing the risk (mitigation actions and steps that we can take to reduce the impact of the risks if they occur i.e. dealing with the impact);

- transferring the risk to others (insurance) i.e. risks can be passed on to other parties, unfortunately this does not normally eliminate the risk, it just makes someone else worry about it;
- contingency plan (to be implemented should the risk occur i.e. risks that can be eliminated from the project and therefore no longer pose a threat;
- accepting the risk (just monitor the situation i.e. the benefits that can be gained from taking the risk should be balanced against the penalties);
- however, the most efficient response to risk is to allocate the risk to the party that is in the best position to accept it. This idea has long been part of the understanding of contract lawyers. The contract that the tender is awarded on becomes the instrument that defines the duties and responsibilities of each party. This means that invariably the owner allocates risks to one of the other contracting parties in the contract.

2.27. Role of the Contract

Within construction contracts, uncertainty in so far as it comes within the contemplation of the contracting parties, translates into risk. The principal purpose of the contract is to define how the risk is to be shared between the client and the contractor. In the United Kingdom alone, there are more than thirty (30) so called "Standard" conditions of contract. This proliferation simply reflects how different client seek to allocate risk in different ways. Risk is an inevitable part of construction. Hayes et al make the point that one of the main areas where risk management can be applied is in developing the conditions of contract. A clear definition of the risks and their allocation provides incentives for the efficient management of risk as they occur during the construction process. Each party to the contract has a clear understanding of their rights, duties and liabilities. For this to occur, a conscious decision must be made in the drafting of any new contract to appraise each part of the consequences of each risk occurring. The less well-defined the allocation of risks, the greater the scope for dispute.

Among other things, risk response planning can be effectively done with inputs such as risk management plan and risk register.

2.28 Inputs for Risk Response Planning

Risk Response Planning is done with inputs from one of the following sources:

2.28.1 Risk Management Plan

The initial identification of risks and their countermeasures is only part of risk management. As a project proceeds, the nature of risk changes: That is,

- Some of the predicted risks materialize and have to be managed like other project issues – hopefully using the mitigation actions previously identified
- Some of the predicted risks disappear, having been overtaken by events
- New risks appear, not anticipated at the start of the project.

Risk management is therefore an ongoing process. There needs to be a procedure to revisit the risk register regularly and to reassess the status of each risk. There is also a need to be a forum where the risk "owners" can meet and discuss the steps they have taken to deal with their risks. On many projects, the review of risks is undertaken at regular progress meetings. Probably, only the major risks are reviewed here, with others being dealt with individually outside the meeting. On very large projects, with a large number of complex risks, there might be a specific risk review meeting.

Whatever the approach taken, it should be documented in a risk management plan.

The goal of risk management is to essentially decrease the various risks which are associated with reaching any specific goal. Threats can come in a wide variety of different forms, and some of them include threats involving the environment, humans, technology, and politics. Risk management strategy may not be effective if you use the wrong plan.

The goal of risk management is to create an approach which is structured when it comes to handling uncertainty, especially those which are related to threats. An effective risk management plan must comprise a number of important things, and these things include risk assessment, along with strategies that are designed to mitigate risk. Much of this will be done through the usage of managerial tools.

An effective risk management plan can use a number of different strategies in order to handle risk in an effective way. The risk management plan can transfer risk to another group, or it can avoid the risk altogether. It can also be designed in such a way that the impact of the risk is decreased in case it does occur.

In risk management planning, it is crucial to make use of a process for prioritization, one in which the risks which have the greatest losses and highest probability of occurring are addressed first, while the risks which have a lower impact and probability of occurring are given a lower level of importance. The problem with low probability risks is that they are often mishandled, and this can lead to problems down the road.

The goal of your risk management plan should be to reduce the amount of spending to the lowest level possible while maximizing the reduction level of risks at the same time. No matter what your organization specializes in, there are a number of features that your risk management plan should have. First, risk management must be capable of creating value.

All good risk management plans must be structured, and this should be done in a manner which is systematic. No risk management plan should be created which isn't dependent on the absolute best information which is available. It is also important for your risk management plan to be tailored properly, and it should be both transparent and inclusive at the same time.

This, depending on the project might form part of the project plan or it might be a document in its own right. The risk management plan should set out:

- a statement of the scope and intensity of the risk management to be applied to the project. Risk management, like other project management tasks, must be tailored to the size, value and complexity of the individual project,
- an explanation of the risk management cycle to be used on the project, showing how and when risk reviews will be carried out and whether they will be a separate process or part of the ongoing project monitoring work,
- roles and responsibilities. Who will be in charge of the risk management process and the mechanism by which risks will be reviewed and controlled,
- a description of the products of risk management – for example, a regular risk assessment report prepared for senior management.

Important components of the risk management plan therefore include roles and responsibilities, risk analysis definitions, risk thresholds for low, moderate, and high risks, and the time and budget required to conduct Project Risk Management. Some important Inputs to Risk Response Planning may include risk thresholds for low, moderate, and high risks to help understand those risks for which responses are needed assignment of personnel and scheduling and budgeting for risk response planning.

2.28.2 Risk Register

The risk register is the repository for all risk first developed in the Risk Identification Process which is then updated during both Qualitative and Quantitative Risk Analysis process stages. This provides the essential reporting and control medium which should be updated and reviewed on a regular basis The Risk Response Planning process may have to refer back to identified risks, root causes of risks, lists of potential responses, symptoms, and warning signs in developing risk responses and risk owners.

The risk owner should be someone who:

- has sufficient information concerning the risk,
- has the necessary resources, and
- possesses the authority to do something about the risk

Other important inputs to Risk Response Planning include the relative rating or priority list of project risks, a list of risks requiring response in the near term, a list of risks for additional analysis and response, trends in qualitative risk analysis results, root causes, risks grouped by categories, and a watch list of low priority risks.

2.29 Tools and Techniques used in Risk Response Planning

Several risk response strategies are available. The strategy or mix of strategies most likely to be effective should be selected for each risk. Risk analysis tools, such as decision tree analysis, can be used to choose the most appropriate responses, from where specific actions are developed to implement the chosen strategy. A fallback plan can also be developed for implementation if the chosen strategy turns out not to be fully effective, or if an accepted risk occurs. Sometimes too, contingency plans may be developed along with identification of the conditions that trigger their execution.

The response to any risk must be in balance with the risk itself; the cost and/or time invested in mitigating a risk must be net with the gains of reducing the impact and probability of the risk. There are four categories of strategies used in Risk Response Planning:

- Strategies for threats;
- Strategies for opportunities;
- Contingent strategies, and
- Strategies common to threats and opportunities

2.29.1 Responses to Threats

There are four commonly used strategies for threat management. They are avoid, transfer, mitigate and acceptance.

2.29.1.1 Mitigate or Risk Reduction strategy response of the threats

Reducing the risk means reducing either the likelihood or the impact of the threat (or both) Risk mitigation implies a reduction in the probability and/or impact of an adverse risk event to an acceptable threshold.

Risk reduction or mitigation is an important strategy; it can be an expensive one or it can be a very cheap one, but in most cases it is likely to be cost-effective when compared to the cost of incurring the unreduced risk. Risk mitigation or reduction may be achieved, for example, by imposing control on project activities through implementation of workable programmes, and activity schedules, procuring well, controlling expenditure and controlling this against budget and managing activities within the constraints of time, cost and quality. Taking early action to reduce the probability and/or impact of a risk occurring on the project is often more effective than trying to repair the damage after the risk has occurred. Adopting less complex processes, conducting more tests, or choosing a more stable supplier or subcontractor are examples of mitigation actions. Where it is not possible to reduce probability, a mitigation response might address the risk impact by targeting linkages that determine the severity.

2.29.1.2 Risk Avoidance strategy response of threats

Avoiding the risk means removing the risk totally from the work to be done. Avoiding a risk may mean not doing the project, if the risk occurs in one of the key elements of the project. It may be possible to redefine the project to exclude the risk area.

Where, for example a construction contract places an excessive burden of risk upon the building contractor, it is most unlikely that it will attract many bidders. An example of risk avoidance relates to tax, or rather the risk of paying too much tax. Tax avoidance in many countries has become an industry in itself.

Entrepreneurs can avoid risk in dozens of ways. For example, by leasing rather than buying such assets as machines and trucks, they bypass the risks connected with owning them. By incorporating ventures, they avoid many of the risks connected with the unlimited liability of general partnerships and sole proprietorship. Risk avoidance involves changing the project management plan to eliminate the threat posed by an adverse risk, to isolate the project objects from the risks impact, or to relax the objectives that is in jeopardy, such as increasing the scope by the issuance of site instructions or reducing the scope as it were.

2.29.1.3 Transfer strategy response of threats

Risk transfer is a form of handling risk which involves shifting the risk burden from one party to another. This may be accomplished either through contract conditions or by insurance. Insurance is a means of transferring the financial impact of having a risk occur. Insurance provides financial compensation for losses actually incurred. Compensation as the result of an insurance claim may not be adequate to keep a project on track, because the financial compensation may only be enough to compensate the organization for time and resources lost not for repairing the damage so that the project can continue. The purpose of insurance is to convert the risk (expressed as a contingency) into a fixed cost. In this manner, the real cost of risk is known. However, not all risks can be insured, and for those which are insurable, the cost of the premium may be considerable. The decision maker should therefore decide how much he is willing to pay in premiums for the insurance of risks, after taking into account probability of such risks occurring.

Risk transference requires shifting the negative impact of a threat, along with ownership of the response, to a third party. However, transferring the risk simply gives another party responsibility for its management; it does not eliminate it. Transferring liability for risk is most effective in dealing with financial risk exposure. Transference tools can be quite diverse and include, but are not limited to, the use of insurances, performance bonds, warranties, guarantees, etc.

The direction and intensity of contractual Transfers are often governed by the contractual strength of individual parties. A client could, if necessary, place a greater burden of risk to a contractor, while a contractor, after securing a head contract, could transfer risk to a subcontractor. Subcontracting the risk to a specialist subcontractor can reduce the risk considerably by combining two risk management strategies: risk reduction and risk transfer. The risk transfer element arises if the subcontractor undertakes to complete the work to the standard required at the time required at a fixed price. If the subcontractor is reliable and backed by sufficient resources to cope with the identified risks (which should of course be discussed with the subcontractor) then the risk will be sufficiently transferred. However, transferring the risk does not always help in the long run.

It should be noted that while a contractor or client may wish to transfer risk to a subcontractor, it is not always clear in such a situation who will be held responsible should a risk actually occur and result in problems. The client or contractor needs to give a detailed specification to the subcontractor which include known risk factors and the parties need to understand clearly who has identified the risks, what these are, who will be responsible for risk management and who (if worst comes to worst) will have to shoulder the financial and legal responsibilities, and this should be backed up by the wording in the contract and other documents. The most that the client can gain from risk transfer is some financial protection in the event that the project fails. Risk transfer does not guarantee that a project will be completed successfully, and the financial protection may not be sufficient to prevent the bankruptcy of the client if the project was key to his or her business. The project manager cannot simply dispose of his or her responsibilities by subcontracting and insuring.

Parties to whom risk has been transferred generally respond by including an appropriate risk allowance in cost estimate. The problem for the client is that he does not know the extent of risk allowances which reflect the value of transferred risk by a contractor and subcontractors. The greater the intensity of risk, the greater is the amount of risk allowance. If the risk allowance is too high, he pays too much for the project.

Alternatively, if the risk allowance is too low, he runs the risk of either a contractor or subcontractors losing money. This could lead to more contractual claims, lowering of quality, or even bankruptcy of the contractor/subcontractors. Contractors, upon receiving a bid request, evaluate the cost of building the project, and will, consciously or not, add contingencies for risks. Very often, contingency premiums are added to the cost "intuitively", because too often there is no formal risk analysis, so there can be no scientific premium calculation.

The essential principle of the transfer response is that risks, if they occur, should be equitably shared among the parties to a contract on the basis of their ability to control and their capacity to sustain such risks. Only then would it be possible to assess the real cost of risk more accurately.

Under the terms of Insurance Contract, an insurance company agrees, for a monetary consideration, to assume the financial impact of a particular risk for a given time.

The most common routes for the transfer of risk in construction projects and contracts are:

- client to contractor or designers,
- contractor to subcontractor;
- client, contractor, subcontractor or designer to insurer

When risk cannot be transferred for whatever reason, management action is required to reduce it, avoid it or retain it.

2.29.2 Responses to Opportunities

Like threats, there are four commonly applied responses to opportunities. They are Share, Enhance, Exploit and Accept.

2.29.2.1 Exploit strategy response of opportunities

This strategy may be selected for risks with positive impacts where the organization wishes 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. Directly exploiting responses including assigning more talented resources to the project to reduce the time to completion, or to provide better quality than originally planned.

2.29.2.2 Share/Allocation strategy response of opportunities

Risk Allocation is an important issue. It refers to the proper allocation of risk to the contracting party, mainly the owner or the contractor. Sometimes, risks cannot be handled by one party alone so the two share that risks. Generally, risk should be allocated to the party that can best handle it. However, due to an asymmetry in commercial power, there are no rules regarding risk allocation in construction contract as owners can place any risks to the contractor. Contractors usually respond to these risks by increasing their contingency and mark-up which ultimately increase the contract price to the owner. According to Ward et al, (1991) Edwards (1993) and Flanagan and Norman (1993), several conditions must be satisfied to determine whether project risks have been properly allocated or not.

These conditions are:

- Risk should be allocated to the party with the best capability to control the events that might trigger its occurrence;
- , Risks must be properly identified, understood and evaluated by all parties;
- A party must have the technical/managerial capability to manage the risks;
- A party must have the financial ability to sustain the consequences of the risk or to prevent the risk from occurring;
- A party must be willing to accept the risk.

However, these conditions are basically criteria that must be evaluated against each party before allocating a project risk to a particular party.

In otherwords, it only helps to determine where the risk should be allocated. On the other hand, risk allocation strategy is more than just deciding which party should accept the risk

It should go beyond that. Proper risk allocation should also be able to acknowledge the most appropriate time to allocate the risk and provide an alternative solutions. Therefore, besides just determining which party (*who*) has the best capabilities to accept the risk (*what*), the when and how factors should also be considered to ensure proper risk allocation as illustrated in Figure 2.11 (Appendix 'A')

Based on this perception, a risk allocation table is formed using those four main factors to assess the actual risk allocation strategy performed by the owner of the project as well as providing the possible alterative risk allocation strategy.

2.29.3 Contingency Plans

Involves identifying the range of alternative options for providing acceptable recovering strategies in the event of loss (PRINCE, 1993, P.13) Contingency plans can involve the allocation of a fund of money to cover minor cost-overruns or elaborate plans for alternatives or the restoration of lost resources, work or services. For each alternative option identified, its benefits and disadvantages must also be identified so that the optimum solution can be presented to management for a decision. General contingency strategies are:

- do nothing (choosing this option should be a positive choice, not a default because no one has taken the time to identify other possibilities of dealing with the risk)

- alternative procedures, previously identified and described in detail or alternative ways to proceed from the point at which the hazard occurs;
- reciprocal arrangements with other organizations, the client, contractor or sub-contractor to provide specific resources and facilities in the event of a hazard arising

2.29.4 Acceptance strategy category for both threats and opportunities

The final strategy for managing a risk is the possibility of risk acceptance. Here, the project manager decides nothing can or needs to be done at present, but notes that the situation needs review from time to time during the course of the project. It will be too costly to develop a contingency plan against everything that could go wrong. During the course of the project's execution, it will be necessary to review the list of risks and risk factors to determine:

i. whether any has become or is likely to become critical at any time soon
ii. whether any new risk and any management and contingency plans should be reviewed on a periodic basis to ensure that, should the worst happen, the project manager will have given some thought about what to do.

A strategy for accepting risk is adopted because it is seldom possible to eliminate all risks from a project. This strategy indicates that the project team has decided not to change the project management plan to deal with a risk, or is unable to identify any other suitable response strategy. This strategy may be adopted for either threat or opportunities, and it can either be passive or active. Passive acceptance requires no action, thus, leaving the project team to either deal with the threats or opportunities as they occur. The most common active acceptance strategy is to establish a contingency reserve, including amounts of time, money or resources to handle known-or even sometimes potential unknown–threats or opportunities.

2.29.5 Risk Contingency Reserve as an active acceptance strategy

Risk contingencies are a result of past experiences concealed or hidden within the bid process. They then submit their bid with the hope of winning the work. Contingencies protect the contractor's interests in the event of a risk occurrence. A single-figure contingency approach has the following weaknesses:

- It is most likely that the percentage figure has been arrived at arbitrarily and is not appropriate for the specific project.
- There is a tendency to double-count risk as some estimators are inclined to include contingencies in their best estimates of individual cost items;
- a percentage addition results in a single figure prediction of the estimated cost, implying a degree of certainty that is simply not justified;
- it reflects only the potential for detrimental or downside risk and does not highlight any potential risk for cost reduction (so may be used to hide poor management performance);
- it tends to direct attention away from time and performance or quality risks.

The last but not the least phase of Risk Management Process is Risk Monitoring and Control.

2.30 Phase 6 – Risk Monitoring and Control

2.30.1 Risk Monitoring

Risk monitoring can be achieved in many ways according to the scale of the project risk involved, but the objective is always to provide management and all stakeholders with information they need to control that risks. Monitoring must never be confused with control, nor knowledge be mistaken as action. It is management of deviation from plan so that collective action can be taken, but successful control relies on the scale and experience of the project manager and supervisors.

Risk Monitoring and Control is therefore the process of identifying, analyzing, and planning for new emerging risks, keeping track of identified risks and those on the watch list, re-analysing existing/identified risks, monitoring trigger conditions for contingency plans (if need be), monitoring residual risks and then reviewing the execution of risk responses selected earlier on during the risk response stage of the risk management processes, while evaluating the effectiveness of these chosen monitoring and control processes. Risk Monitoring and Control processes apply techniques such as variance and trend analysis. All the phases or stages of the Risk Management process are processes that go through or are ongoing during the life cycle of every project.

Other purposes of Risk Monitoring and Control are to determine if:

- Project assumptions are still valid and relevant
- Risk, as assessed earlier on, has changed from its prior or previous state, with its analysis of trends
- Proper risk management policies, programmes and procedures are being followed
- Contingency reserves of cost or schedule should be modified in line with the risks of the project.

Therefore, Risk Monitoring and Control can involve choosing alternative strategies, executing a contingency or fallback plan, taking corrective action, and modifying the project management plan. Risk Monitoring and Control also includes updating the organizational process assets (which include any or all of the assets that are used to influence a project's success during say, the development of a project charter and subsequently project documentation) including project lessons – learned databases and risk management templates for the benefit of future projects.

2.30.2 Exercising Control

Exercising control really has four elements. The first stage is to evaluate the current situation - *in order words what will happen if things continue as they are*?

The second is to consider various collective measures that could be applied and to assess the pros and cons of adopting each alternative cause of action.

The third stage is to select and implement one of the courses of action.

The fourth stage links back into the monitoring process since you need to check that the control action has had the desired corrective action on the project.

However, inadequacy to control a risk properly becomes visible if one or more of the following occurs:

- Inability to make the right decision at the right time
- Discriminative contract document which tends to provide more advantage to the project owner
- Misinformation
- Inability to provide the proper response
- Improper project planning and control
- Ineffectiveness and inefficiency during construction and operation stage
- Unsatisfied users

CHAPTER 3

RESEARCH METHODOLOGY

CHAPTER 3 - RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the strategies adopted for the study and the type of data used in the study are discussed. The criteria for the admissibility of the data and location of the data is considered. Furthermore, the treatment of the data, including the application of various statistical methods employed in the analysis of the data would be the subject matter in this chapter. The study involved an in-depth exploratory investigation of project risk management practices of construction cost consultants in Ghana.

The methodology for this study took the form of literature review and survey involving the use of structured and exploratory interview sessions and questionnaire.

The purpose of this study is to examine the nature of Risk Management services and to determine which Risk Management procedures, tools and techniques, are currently used by construction cost consultants. By adopting a quantitative research design, it aims to generate rich data relating to the attitudes and experiences of Risk Management facilitators in Ghana.

The study involved an in-depth exploratory investigation of construction cost consultants risk management practices, with the aim of extending their understanding of the extent to which standard risk management prescriptions are applied in the construction industry. In particular, the study aims to draw out what actually happens in practice, rather than simply reporting what respondents thought they ought to do in practice. This distinction between theories of action and actual practice is critical in identifying gaps between theoretical prescriptions and their application in the industry.

The research was carried out on a three-prong approach in order to achieve the main aims and objectives of the project study.

- The first approach was to undertake a literature search, to collate from construction and project management journals, articles, textbooks and other materials from the industry on risk management and related issues.
- The second stage or phase consisted of surveys in the form of interview sessions and questionnaires to evaluate how risk management prescriptions are applied in practice in the Ghanaian construction industry. On the other hand, the areas of variance are highlighted and potential areas of weakness that warrant further investigation for analysis are recommended for further studies.
- Finally, these results are used to form the basis for suggesting and recommending suitable and appropriate tools and techniques for risk management and further case-study-based research.

This research acknowledges that many construction cost consultants are "risk seekers" who take on risks without understanding the full impact. However, the aim of this study is to demonstrate that systematic risk management practices can be useful for analyzing project success.

3.2 Data collection methodologies and analysis

3.2.1 The Data

Both primary and secondary data are used in the study

3.2.2 The Primary Data

The primary or field data was collected or collated on properly structured questionnaires served to the specified and targeted study sample and also from side discussions, interactions and interviews with construction cost consultancy firms in both private and public sector providing risk management services. Respondents were also interviewed using a critical decision interview approach, which has been demonstrated to be effective in enabling experts in the industry to verbalize difficult-to-articulate tacit knowledge, particularly knowledge related to actual practice rather than theories of action. Samples of 50 construction cost consultancy firms were selected at random from 68 construction cost consultancy firms across the country and data were collected through questionnaires that had been sent to them within the limited time and financial constraints. These are the main construction cost consultancy firms in Ghana registered with the Ghana Institution of Surveyors as at the time of the study and in good standing. The basis of the size of the sample size or frame will be discussed in section 3.4 later. The primary function of the survey was to collect data that can be analyzed, and inferences and conclusions made about project risk management practices.

3.2.3 Secondary Data

The secondary data which forms the literature review is collected from a variety of published reports or data and current on-going studies and works. Other multiple sources of evidences from sources, such as newspapers, articles, journals, project documents dealing with the subject matter are used.

3.3 The Criteria for Admissibility of the Data

Only responses from questionnaires returned were used in the project analysis. All the respondents had trained as professional quantity surveyors, estimators or project managers associated with the construction industry and were professional members of the Ghana Institution of Surveyors. The admissibility of the data was made on the basis that the respondents were practicing practitioners in the industry and were working for well-established firms who were working for both the public and private sectors of the economy and as such, highly exposed to all forms of risks in the industry and has been working for between 5 and more than 20 years (See Table 3.1).

3.4 Data Needed, Location and Means of Obtaining the Data

The data used for Risk Management practices of construction cost consultancy services in Ghana were views or opinions of respondents from active construction cost consultants (Quantity Surveyors). The firms of Cost Consultants sampled for the study were practitioners from across the country obtained from the directorate of the Ghana Institution of Surveyors. However, majority of these firms were concentrated in the Greater Accra Region, since it happens to be the capital and the hub of government business and activities (See Table 4.1 for details).

The data for the study were questionnaire survey forms distributed to construction cost consultants and professionals associated with risk management services in the industry. Each of these randomly selected firms was given four (4) of the questionnaires to be assessed and returned. Out of 200 distributed questionnaires, 155 were retuned (or collected). 124 (fully completed in response) out of 155 questionnaires were used in the analysis (See Table 3.2). Table 3.1 summarises the respondents' profile. Eighty percent (80%) of respondents had more than ten (10) years of experience. (See Table 3.1 for details).

Table 3.1 - Respondents' Profile

Category	Respondents Number	%
Years of Experience		
>20 years	63	50.62
10-20 years	39	31.38
5-10 years	7	5.80
<5 years	15	12.20
	124	
Position		
Principal Consultant	6	4.9
Partner(s)/Associate(s)	50	40.40
Senior Quantity Surveyor	48	38.70
Quantity Surveyor	20	16.00
	124	

3.5 The Research Methodology

The questionnaire survey method and interview sessions was employed to collect and gather data. Structured questionnaires we used to collect data. Questionnaires were distributed either personally or through self-addressed return postal services. The completed responses were collected either personally, or received through regular postal mails. Most of the questionnaires were delivered in Accra, Kumasi, Tamale, Wa, Sunyani and Takoradi, where delivery were easier and more receptive. Colleagues and friends in the other parts of the country also supported in the delivery and collection of completed questionnaires. Self-addressed envelopes, affixed with postage stamps were posted to individual consultants and consulting firms and the responses were to be addressed per addressee.

The response levels are as illustrated in Table 3.2.

Table 3.2 Construction Cost Consultants and Practitioners

Cost Consultants	Target Population	Questionnaires Distributed	Questionnaires Completed and Returned	Level of Response (in %)
Quantity Surveyors	800	200	124	62%

Samples of the questionnaire could be found in Appendix 'B' attached.

3.6 Developing the Questionnaire and Interview Sessions

3.6.1 The Questionnaire

The questionnaires were structured to achieve the following objectives:

a) to assess the level of awareness of risk management practices by construction cost consultants in the building industry

b) to help identify and document the extent of risk management practices adopted by industry cost consultants

c) to help identify the most significant risk factors associated with the construction industry as perceived, rated and ranked by construction cost consultants

d) to help identify the root causes of significant risk factors in the construction industry

e) to ascertain the best forms or framework of risk management practices used by construction cost consultants (if any).

The questionnaires were set within the important stages of risk management processes of risk management planning, risk identification, risk analysis/quantification, risk allocation, risk response measures, risk monitoring and control. A section of the questionnaire was designed for the respondents to indicate the inputs, tools and techniques and output used in the various stages of risk management practices.

Questionnaires were designed to assess the extent of the understanding of Project Risk Management and Analysis. Other specific questions were posed to understand what was involved in risk analysis and management and the benefits to the industry. Further questions were posed to find out the cost of using Project risk analysis and when and who should use it. Questions were also asked to find out which projects were suitable to use and the type of projects thereof.

Questions were also posed to find out whether Risk Management Planning as a process of deciding how to approach and conduct risk management activities for a project were done or undertaken at any time of the project life cycle.

With respect to risk identification and classifications, questions were posed to find out the methods of risk identification and classification. Specific questions were also posed to find out the methods of risk analysis and assessment and the personnel who undertook those assessments. A section of the questionnaire was designed for the respondents to identify the risks associated with the construction industry.

The respondents were asked to give information on their firms' procedure for risk management processes and practices and the method used by the firms to manage risk and uncertainties in the industry.

A list containing 55 potential risk factors in the construction industry, identified during the literature search and interview session was provided. Respondents were to indicate the risk exposure of risk factors/event and how these risk exposures affect owners, designers, contractors, sub-contractors, suppliers, and others using a scale of 1-10, where 1 = least exposure and 10 = most highest exposure.

In other words, questionnaires also indicated to the respondents to indicate their rating and ranking of the listed risk factors or events. A numerical scale of 1-10 was provided assigning risk appointment options. The choice for risk allocation ranged from 0-100% to owners, contractors or shared between the parties as addressed by the conditions of contract.

To achieve the aims and objectives of the research study as spelt-out earlier, questionnaires with closed-ended questions were designed to find out the respondents profile and experiences in the first place.

The questionnaire were structured to underscore the importance of project risk management in the construction industry and how well prepared, and applied is risk management practice and processes understood and used by Construction Cost Consultants in Ghana. Four major thematic questions relating to the 55 identified risks factors were asked. The first question relates to the identification and probability of the risk event occurring on the construction building projects. Questionnaires were also designed to indicate the relative importance of the identified risk using a score of between 1-5 where '1' means Not Important and '5' means Extremely Important.

It includes the recognition of potential sources of risk and uncertainty event conditions in the project and the clarification of risk and uncertainty responsibilities. It is accompanied by a structured search for a response to the question – *what events may reasonably occur that will impede the achievement of key elements of a project*. The second question refers to the impact or consequence on the project objectives once the risk event occurs. Risk and uncertainty rating identifies the importance of the sources of risk and uncertainty to the goals of the project. It comes as a response to the questions – *what is the probability that this risk will occur*? and *what is the severity of the impact on the project if a risk is allowed to take place*? Risk assessment is accomplished by estimating the probability of occurrence and severity of risk impact. The third question relates to the various risk response planning and mitigation options. Mitigation establishes a plan, which reduces or eliminates sources of risk and uncertainty impact to the project's deployment. The question is – *what should be done*, and *whose responsibility it is to eliminate or minimize the effect of risk and uncertainty*? And the fourth and last question relates to risk monitoring and control measures. For risk response planning, monitoring and control, a numerical scale was provided assigning risk apportionment options for risk avoidance, transfer, and acceptance and shared. Questions were made simple with corresponding boxes against questions, where appropriate, for either checking or ticking in the box for their appropriate answers.

3.6.2 Interview Section

The interview questions were developed in an open-end format with a specific rationale which performs a guide to keep the answer within the intended purposes. However, the questioner provided freedom for the respondents to express their opinion in each question. The questions are classified into four main sections with the following objectives.

- To get an overview and general information of construction project
- To explore the cost consultants or respondents perception on project risks as well as their risk management strategies (if any)
- To investigate the construction cost consultant's perception on project success
- To discover whether project risks are really allocated properly to establish good project risk management practices in the industry.

A loosely defined interview protocol was developed, with a range of cognitive probes to encourage respondents to reflect on their own risk management practices. Respondents were asked to focus on recent projects they were involved in so that they were reporting on events that had actually occurred rather than talking about their general conceptions of rules and procedures.

During the interview session, respondents were first encouraged to “tell the story” of their experiences from a project management perspective and angle. Then a series of probing questions was used to elicit details of specific experiences of risk management from various stages of the project implementation that were interesting and challenging from a risk perspective. These interviews were granted to 40 willing senior members of the Ghana Institution of Surveyors (Q.S. Division) at various foras and encounters.

However, due to the constraint of time and logistics, proper interaction and analysis could not be done using the interview transcript and coding to determine the extent of congruence or variance with theoretical prescriptions. This data was therefore not used in the research analysis undertaken in chapter four of the research study.

3.7 Method of Randomization in the Survey

The sample size was selected without any bias to reflect the true picture and characteristics of the sample population. The simple random sampling technique was used in the selection of the sample frame. The choice of the sample frame was made on the basis that they are the well-established firms by virtue of the type and size of projects they handle and therefore more prune to project risk factors mostly encountered in the construction industry. Moreover they were firms of good standing at the period of the study.

The procedure that was followed to ensure fairness, and unbiased randomness was the use of simple random sampling selection of construction cost consultancy firms. In this sample frame, every member had an equal chance of being selected for the survey. The firms selected were therefore, truly random and thus were likely to be representative of the entire population.

3.8 Statistical Methods Use

The following statistical formulas were used in the selection of the sample sizes, and analysis of the data:

(a) Sample size determination

(b) Rating

(c) Ranking

3.9 Sample Size Determination

The sample size was determined by the use of the following formula by Kish (1965) as:

$$n = \frac{n^1}{1 + \frac{n^1}{N}}$$

where n = sample size

$$n^1 = \frac{S^2}{V^2}$$ and

where S = The maximum standard deviation of the population elements,

(Total error = 0.1 at a confidence level of 95%)

$S^2 = \rho(1 - \rho) = 0.5(1 – 0.5) = 0.25$

V = the standard error of sampling distribution (5%)

P = proportion of population elements that belong to the defined class

N = Total population

For the construction cost consultants and practitioners,

$$n = \frac{n^1}{1 + \frac{n^1}{N}} \qquad (1)$$

and re-arranging and substituting, n becomes,

$$= \frac{\frac{S^2}{V^2}}{1 + \frac{\frac{S^2}{V^2}}{N}} \qquad (2)$$

and substituting figures in equation (2), because

$$= \frac{\frac{0.25}{(0.05)^2}}{1 + \frac{\frac{0.25}{(0.05)^2}}{800}}$$

$$= \frac{\frac{0.25}{0.0025}}{1 + \frac{\frac{0.25}{0.0025}}{800}}$$

$$= \frac{100}{1 + \frac{100}{800}}$$

$$= \frac{100}{1 + 0.125}$$

$$= \frac{100}{1.125}$$

$$= 88.88$$

$$= 89$$

===

Therefore, applying the Kish formula, the sample size for a sample space of 800 is given by 89. But the total number of respondents was 124 which is more than the determined sample size.

3.10 Rating and ranking

The R – index (R) model is designed to assess the effect of sources of risk and uncertainty on a construction project from a contractor or consultant's perspective. It provides a logical, reliable, and consistent method of evaluating potential projects, prioritizing them, and facilitating company's decision in the promotion of a project based upon potential sources of risk and uncertainty. The risk index (R) model characterizes the various sources of risk and uncertainty in a project and assesses their effect on such project in order to be able to take the remedial proactive management procedures that defeat these sources. The function of R – index is to only assess the effect of these sources on a project.

The R – index consist of two parts:

weight of risk areas or sub-areas and their effect score. Weights of risk areas will be determined using Analytic hierarchy process (AHP) developed by Saaty,1980 ; however, the effect score will be assessed using utility function or fuzzy logic approach.

Validation process will be performed to check the R – index by comparing their results with the holistic evaluation of say building construction experts or cost consultants in the Ghanaian Construction Industry.

The *R*-index can be represented using model

$$R_k = \sum_{i=1}^{n} W_i * E_i(x_i)$$

Where:

Rκ = Risk Index for a proposed construction project using k levels (Probability of failure)

Wi = Weight for each risk area *i* using Eigen value method

Ei (xi) = Effect score for each risk are (xi),

Xi = Different risk areas i

i = 1, 2, 3,……………………………………n

n = Number of risk areas

k = 1st level risks

Based on the risk areas shown in Table 4.3, the R – index uses n = risk areas *xi*.

The overall contribution of each risk area is given by its effect score

Ei(xi) multiplied by its composite weight Wi. The term *xi* is added to the model to allow using the risk of sub-areas. The effect score of a risk area Ei(xi) reflects the one-dimensional value of the performance level of the risk area as it exists for a Specific construction project.

To determine the one-dimensional risk area effect score Ei(xi), it is necessary to evaluate the performance (quality) level *xi* of the *ith* risk area for a given project and then to use a value function Ei(xi) to transform it into an equivalent effect score.

The transformation from the performance (quality) level xi of the *ith* risk area into an equivalent effect score requires two steps. The first step is to assess how well a given project performs with respect to a given risk area *i* using a meaningful qualitative scale. This is essentially a "risk area measurement" step in which the outcome is project specific. The second step is to transform the qualitative performance into a one-dimensional effect (or value) score (from 0 to 100). This is a "preference measurement" procedure where the outcome depends on the preference and judgement of the person doing the analysis. The *R*-index can therefore be used to prioritize building construction projects. The lower the *R*-index value, the higher the project ranking because *R*-index represents risks associated with the project under consideration. Consequently, the construction company will have the flexibility to select the appropriate project based on its workload and the need for projects or work. The developed *R*-index also attracts the company's attention to the project that has high potential risk to consider risk management procedures should it become apparent and necessary to do so under that circumstances.

3.11 The Relative Importance Index

The relative importance index (R11) for each risk is calculated for the probability, impact and rating. The risk rating is calculated for the by multiplying the probability and impact for each risk. The risk rating can be used to prioritize risks for further quantitative assessment or response planning like risk avoidance decision making. The specific combination of probability and impact lead to a risk being rated as “high”, “moderate” or “low” importance.

Relative importance index $RII = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i}$,

where

Wi = weight assigned to *ith* response; Wi = l,2,3,4 and 5 for *i* = 1,2,3,4 and 5 respectively

Xi = frequency of the *ith* response

i = response category index = 1,2,3,4 and 5 for very low, low, moderate, high and very high, respectively

or where W = the weight given to risk by the respondents, and ranges from 1 to 5

A = The highest weight

N = The total number in the sample

3.12 Risk Exposure Index

Before the risk avoidance decision is made, a team consisting of experts and stakeholders achieve consensus on identifying risk existing at the time, and in this study, fifty-five (55) identified risk during the literature study shall be adopted. These risks are then evaluated and the risk-exposures are scored for related risk items. Suppose the risk items within a single stage are independent, then risk avoidance decision-making which occurs in the *k* stage with a cumulative *RE* of risk factor *i* will be given by

$$RE_i = \sum_{j=k}^{m} \propto_j RE_{ij}$$

132.

where RE_{ij} denotes the *RE* of the *ith* risk factor in the *jth* stage, and *m* is the number of stages, *xi* denotes the weight of RE_{ij} in the *jth* stage, and it can be adjusted by the evaluation team to meet different situation.

Suppose there are *ni* risk factors in the *tth* risk category, the integrative risk exposure (IRE) of the *tth* risk category and IRE of the project are respectively defined as,

$$IRE_t = \sum_{i=1}^{nt} RE_t$$

$$\text{IRE} = \sum_{t=1}^{l} IRE_t = \sum_{t=1}^{n} RE_t$$

where l is the number of risk categories, *n* is the number of risk factors,

$\sum_{t=1}^{l} n_t = n. IRE_t$ and IRE are used to decide the risk avoidance strength of risk categories and the project, respectively. Based on IRE_t and IRE, we take bid/no bid policy, risk response measures and corresponding strengths into account to reduce the bidding risk during pre-tender/bit period.

All the above discussed Statistical Methods and formulas would be used in chapter 4.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

CHAPTER 4 - DATA COLLECTION AND ANALYSIS

4.0 Introduction

Since the mid-1990s, many authors have suggested that the management of construction project whether large or small, benefits from a greater understanding brought about by the application of risk management techniques. Perry and Hayes (1985) established risk management as a concept of relevance to construction projects and elaborated on a three-stage process that comprises; identification, analysis and response. They concluded that risk and uncertainty were not the sole preserve of large capital project, but that, factors such as complexity, speed of construction and location also contributed to the inherent risk within a project. Risk Management is now widely accepted as a vital tool in the management of project and in recent years, an array of documents and information have been published which aim to provide guidance for practitioners and facilitators undertaking the Risk Management process.

The greater use of case study techniques using real experiences of project cost consultants as against opinion-survey and its methodological weakness which undermine the validity and usefulness of their findings will be the basis for this research study. This research, in part, responds to this challenge by exploring the attitudes and experiences of Risk Management facilitators and practitioners in the Ghanaian construction Industry, with particular focus and emphasis on the process, tool and techniques currently being used by construction cost consultants who offer Risk Management services to varied clientele.

Accordingly, the research study is drawn from the opinions of practitioners and construction cost consultants representing firms and senior personnel in such firms who are recognized by the Ghana Institution of Surveyors. The cost consultants who were interviewed and responded to the questionnaires were in many instances, the principals, partners, senior and quantity surveyors of the respective organization or firms.

Perry and Hayes (1985) recognized that the greatest degree of uncertainty is encountered during the early stages in the project life-cycle and the cost implications of decisions made at this time would have a dramatic effect on the overall viability of the scheme. It is therefore not surprising that all consultants should want to be involved as soon as possible, and indeed most Risk Management studies are undertaken during the conceptual phase where clients are seeking to evaluate and compare different options.

4.1 The Risk Management Process

There are a variety of approaches to Risk Management practices and processes. However, for the purposes of this study, the processes adopted in the literature review shall be adopted. The first most important step towards the processes was to identify the risks associated with the industry. Perhaps, the most common is to use the origin or consequence of the risk.

Various risks which were identified in our literature study and review shall be used. The Risk Breakdown Structure (RBS) of the study in figure 2.2 shall be developed to organize the different categories of risk. To improve the risk identification process, risk is categorized according to the source of risks. The Risk Breakdown Structure (RBS) shows the risk groups, risk categories and risk events at the lowest level.

The fifty-five (55 No) identified risk in the Risk Breakdown Structure will be analyzed in this chapter with the view of developing a model for the second stage (risk analysis and assessment) of the management process of construction cost consultants in the industry.

The analysis will be based on response to questionnaires administered to randomly selected firms perceived to be practicing risk management processes and services. The questionnaires were discussed in chapter 3, with a sample in Appendix “B”.

The ratings of the respondents were used as the basis for ranking the 55No risk factors at the lowest level of the Risk Breakdown Structure. Following from the rankings, the next step will be the analysis and assessment of these risk factors for the development of an assessment model. The model was based on the Statistical Decision Theory. Kometa et al (1995) used this concept in developing a model for Quantifying risk by construction cost consultants and the R-index model to assess the effect of sources of risk and uncertainty on a construction project.

4.2 Construction Cost Consultants

Professional Quantity Surveyors were considered in the study for analysis and findings. They were made up of 200 surveyors in 50 Construction Cost Consultancy firms perceived to be practicing risk management practices in the industry. As indicated earlier on in chapter 3, the structured questionnaires were either delivered personally or posted and returned through the postal mail services based upon their addresses posted in the current edition of the Newsletter of the Ghana Institution of Surveyors, Gh15/Jan-May 2009/Vol 8. Table 3.2 shows the population target, the number of questionnaires sent out, the questionnaires completed fully and returned and the percentage level of response.

4.3 Location of the construction cost consultancy firm and practitioners.

The majority of these consultancy firms and practitioners are located in the Greater Accra/Tema region, although their services cut across the length and breath of the country . Table 4.1 illustrates the regional distribution of Quantity Surveying firms in

Ghana as per GhIG/Mar-Dec 2006/Vol. 4 edition of their Newsletter.

Table 4.1- Regional Distribution of Quantity Surveyors

Region	Number	% Over Total
Greater Accra	34	59.7
Ashanti	8	14.1
Western	3	5.3
Upper East	2	3.5
Upper West	2	3.5
Eastern	2	3.5
Brong Ahafo	2	3.5
Northern	3	5.3
Volta	1	1.6
Total	57	100

4.4 Experience of Construction Cost Consultancy Firms and Practitioners.

Work experiences of respondents to the questionnaires ranges from between 5 years to over 20 years practice and involvement in the industry. Over 80% of the respondents have worked for more than 10 years. (See Table 3.1) The survey illustrates that, the respondent firms and practitioners have quite a reasonable store of experiences in the industry.

From the point of view of job titles and positions of the various respondents, about 79.1% of them were either Partners/Associates or Senior Quantity Surveyors in their firms or practitioners of good standing. This indicates that, the project target was achieved. Moreover, the sample provides a realistic profile, which can be used to represent the generality of practicing risk management practitioners in the industry for which a reasonable level of credence can be given to their answers.

4.5 Firms and Practitioner's Risk Identification and Classification Procedures

4.5.1 Risk Identification and Categorization

From literature review point of view, some of the tools and techniques used during the risk identification were surveyed and tested for their use and application in the Ghanaian construction industry and Table 4.2 illustrates the procedures and processes best adopted by the respondents for the identification of risks.

Table 4.2 – Risk Identification Processes and Procedures by Firms and Practitioners

Procedures/Processes	Number of Responses(Cons- -truction Cost Practitioner)	Overall % of Response to Risk Identification Processes
Risk Source and potential impact	20	16.5
Project work breakdown structure	5	3.7
Financial Statement Method	0	0
Flow chart Approach	0	0
Documentary Review	3	2.3
Pre-workshop	8	6.2
Workshop	13	10.7
Delphi Techniques (Risk Assessment Model)	0	0
Root cause identification	7	6.0
Strengths, Weakness, opportunity and threats (SWOT)	4	3.2
Checklist	20	16.2

Subjective judgement by cost Practitioner	38	30.6
None of the above	6	4.6
Total	124	100%

Table 4.2 gives an illustration of results of perceived risk management practitioners processes and procedures for the identification of risk in the construction industry. From the table, 30.6% of the respondents used their intuitive subjective judgement to identify various risks that they perceive to be associated to a project. Documented checklist was also used for the risk identification -2.3%

Risk was also identified from the point of view of the Source of the risk and its potential impact or consequence of the risk – 16.5%. The use of the benefits of pre-workshop interviews and interactions, workshop brainstorming of experienced experts/stakeholders within the industry has a result of 10.1%. 4.6% of the respondents used none of the prescribed processes and three of the prescribed processes were not used at all.

The survey implies that, about 74% of the respondents used 4 of the prescribed procedures for the identification of risk. Thus, varied methods and procedures were used in the identification of risk by risk management practitioners and facilitators.

4.5.2 Qualitative Risk Analysis and Assessment – Rating of Identified risk

On a scale of 1 – 5, the respondents were asked to choose between Very low which is represented by 1, Low by 2, Moderate by 3, High by 4 and Very High by 5, all for the perception on the rating of each of the identified risk. Risk and uncertainty rating identifies the importance of the sources of risk and uncertainty to the goals of the project.

The ratings of the respondents were first tallied with the summary presented in Table 4.3. As indicated in chapter 3, 124 respondents from across 50 construction cost consultancy firms and practitioners responded completely to the questionnaires. Apart from few items which were not rated, all the other items or description of risk events were properly assigned with appropriate ratings. From table 4.3 (See Appendix 'A'), Owners risk event-item 1 for instance, has the following ratings and corresponding respondents; Very low(1) – 5 respondents, Low (2) – 6 respondents, Moderate (3) – 8 respondents, High (4) - 21 respondents, Very High (5) – 84 respondents, giving a total respondent of 124 No. Also for Designers risk events-item 12, Very Low (1) was rated by 8 respondents, Low (2) – 4 respondents, Moderate (3) – 9 respondents, High (4) – 62 respondents and Very High (5) – 41 respondents. The total also gives 124 No. respondents.

4.5.3 Quantitative Risk Analysis and Assessment

As mentioned in section 3.11 of chapter 3, Quantitative Risk Analysis is performed on risk events that have been prioritized during the Qualitative Risk Analysis stage of the Risk Management process.

The ranking of the 55 identified and rated risk events will be done by the Relative Importance Index Techniques based on the ratings of the respondents in Table 4.3. The method as discussed in section 3.11 is calculated for by multiplying the probability and impact for each risk event and this is given by,

$$\text{Relative Importance Index, RII} = \frac{\sum_{i=1}^{5} W_i x_i}{\sum_{i=1}^{5} X_i} \text{ or } \frac{\sum W}{A \times N} \text{ as discussed earlier}$$

To demonstrate the calculation of the relative importance index for rating a risk event as High, Moderate or Low, the rating scale of 1 – 5 inclusive in Table 4.3 will be used. For item 1 – Owner’s delayed payment to contractors, the relative importance index (RII) will be given by;

$$\frac{(5\times1) + (6\times2) + (8\times3) + (21\times4) + (84\times5)}{5 + 6 + 8 + 21 + 84} = \frac{545}{124} = 4.396$$

141.

And for item 2 – Owner’s unreasonably imposed tight schedule, the relative importance index (RII) is also given by;

$$\frac{(2\times1) + (15\times2) + (16\times3) + (29\times4) + (62\times5)}{2 + 15 + 16 + 29 + 62} = \frac{506}{124} = 4.08$$

The relative importance index (RII) was repeated for all the risk event and the results were entered in Table 4.3. The percentage of the respondents qualitative rating using the scale of 1 -5 illustrates that, 35.2% of the respondents gave a Very High impact rating to the list of risk event in Table 4.3, 20.6% respondents gave High rating, 18.5% gave a very low rating, 14.5% gave a Moderate rating and 11.2% gave a Low rating to the risk event identified for the study. However, it was realized that, some of the risk event had the same levels of relative importance indices. For example, items 2 (owners unreasonably imposed tight schedule) and item 22 (inadequate estimates) had a relative importance index of 4. 08. Moreover, items 3 and 35 had a relative importance index of 3.984. Therefore, to bring about cohesiveness in the rating for an effective ranking, these items are grouped into three instead of the scale rating of 1 – 5 and the grouping with the largest percentages in scale 5 rating is chosen and ranked above the others. Table 4.4 illustrates the rating and ranking precedence.

Table 4.4 – Rating and Ranking precedence

Item Description	RII	X≤2	3	X≥4	Ranking
Risk event 3	3.984	12.1%	26.7%	61.3%	2nd
Risk event 35	3.984	8.1	7.3	84.7	1st
Risk event 31	3.146	37.9	9.7	52.5	1st
Risk event 46	3.146	42.0	22.6	35.5	2nd
Risk event 9	4.250	19.4	2.5	79.1	3rd
Risk event 25	4.250	10.5	5.7	83.9	2nd
Risk event 51	4.250	8.1	8.7	83.9	1st
Risk event 2	4.081	13.7	12.9	73.4	2nd
Risk event 22	4.081	10.5	10.5	79.1	1st

In Table 4.3, column 3 shows the ranking of the various risk event used in the study and

Table 4.5 illustrates the 10 most significant risks according to the respondents

Table 4.5. Ten most significant risks according to respondents.

Item	Description	RII	RANKING
34	Inflation and sudden changes in prices	4.605	1
5	Lack of proper brief or scope of work by owner	4.549	2
47	Cost and Time overrun	4.533	3
1	Owner's delayed payment to contractors	4.396	4
36	Shortage in material supply and availability	4.307	5
7	Owner's breach of contracts and disputes	4.299	6
51	Termination of contract by contractors	4.250	7
25	Difficulty in controlling nominated sub-contractors	4.250	8
9	Inadequate project budget	4.250	9
54	Corruption and bribe	4.234	10

4.5.3.1 Risk Assessment model development and study methodology

One of the models used for the assessment of construction risk by risk management practitioners would be the one based on the Decision Theory or risk index (R_I) model. This risk index (R_I) theory combines the decision results of alternative actions to decide on the best courses of actions (for both responses and strength) which would prove more appropriate in order to be able to take the remedial proactive management procedures to mitigate the effect of the sources of the risk. The risk index model (R) or the Expected value (or the Expectation method) which is the use of probability to predict the possibilities of happenings under similar situations would be used. The expected value is obtained mathematically by multiplying the probability (or the occurrence) of an event happening by the utility (outcomes or value of a risk event) and summing up all

the risk event, i.e.,

$$R_K = \sum_{i=1}^{n} Wi*Ei(Xi).$$

In other words, the overall contribution of each risk event is given by its effect score E_i (X_i) multiplied by its composite weight W_i.

The term x_i is added to the model to allow using the risk events. The effect score of a risk area event as it exists for a E_i (X_i) reflects the one – dimensional value of the performance level of the risk area event as it exists for a specific project. The decomposed weight of a risk area event W_i reflects its importance relative to the other areas risk event, irrespective of any particular project.

The risk weight constants for each risk event computed from the relative importance index (Table 4.3) would form the basis of the probability component $P_{(x)}$ of the expected value. The Relative Risk Exposure Indices (X) would represent the utilities (outcome or values of an event). Represented mathematically, the Expected value or risk index (R_I) model can be expressed as;

$$\text{Expected value} = \sum xP(x) \text{ or } \sum_{I=1}^{n} Wi*Ei(Xi)$$

This model provides a logical, reliable and consistent method of evaluating potential project, prioritizing them, and facilitating enterprise decisions. The risk index (R_i) model characterises the various sources of risk and uncertainty in a project and therefore assesses their effect on such projects in order to be able to take the necessary remedial proactive management procedures that defeat these sources. The function of R-index is to only assess the effect of these sources of risks.

4.5.3.2 Risk Weight Constant [$P_{(x)}$] or W_i

The Risk Weights Constants of risk area events is obtained by evaluating all the risk events and estimating a relative importance weight for each risk area against the other in addition to sub-areas against the other within the same risk area (pair-wise comparison). The relative importance indices were transformed to risk weight constants by employing the formula;

$$\text{Risk weight constant } P(x) \text{ or } Wi = \frac{\text{Relative Importance Index of Risk event}}{\sum \text{Relative Important Indices}} \times 100\%$$

From Table 4.3, the total summation of the Relative Importance Indices was 188.956. Therefore, the Risk Weight constants for the various risk area event of risk factors i, is calculated for the 55 identified risk events and the results were presented under $P_{(x)}$ or Wi in column 5 of Table 4.3. For example, P(x) for item 1 in Table 4.3 is given by;

$$P(x)_1; = \frac{4.396}{188.956} \times 100 = 0.024 \times 100 = 2.4$$

For item 2, $P(x)_2; = \frac{4.081}{188.956} \times 100 = 2.20$

In other words, the risk weight constants represent relative weights of the various risk events to the others. Results show that, Inflation and Sudden Changes in prices has the highest relative weight of 2.50, followed by Lack of Proper brief or Scope of work which has a relative weight of 2.40. The third highest relative weight is also given by Cost and Time overrun in a relative weight of 2.40. Lack or departure of qualified staff has the lowest relative weight of 1.0. These results compare favorably well with the ranking done on the basis of the use of the Relative Importance Index (RII) in column of 3 of Table 4.3. These results therefore show how much emphasis prominence should be given to risk and the effect of inflation and sudden changes in prices when bidding for a project. However, it should be mentioned that, the aforementioned analysis is based upon the collected data sample; therefore, it is limited to the project research under study.

4.5.3.3 $E_{(i)}(x_i)$ Determination

The collected data were analyzed to determine the risk effect score of the risk event of the 55 identified risk. Column 6 in Table 4.3 shows the average subjective evaluation of the 55 identified risk event and their average effect score. These subjective evaluations were estimated accordingly to a performance scale using rating scores of respondents and dividing them by 100 before entering them in column 6 of Table 4.3.

4.5.3.4 R-index determination and Model test process

The value of W_i will be multiplied by the value of E_i (X_i) to generate the R-index of t he various risk event as in column 7 of Table 4.3.

To test the model, convergent valuation was used to verify the robustness of predicting construction project risks, which will provide a logical, reliable and a consistent method of evaluating potential projects, prioritizing them, and facilitating company's decision in the promotion of a project based upon potential sources of risk and uncertainty.

4.6 Risk Index (R_i) as a project ranking method

The developed R-index in Table 4.3 can be used to prioritize construction projects from risk perspective. For example, if two or more projects are being considered for bidding or promotion, the R-index will provide a value to prioritize them from the perspective of the sources of the risk and its effects. The lower the R-index value, the higher the project rank because R-index represent risk associated with the project. The developed R-index attracts the company's attention to the risk event or project that has a high potential risk to consider risk management procedures. From column 7 of Table 4.3, the lowest R-index risk event is 0.019 for risk event – Lack or departure of qualified staff. The next lowest R-index value is 0.024 for risk event – Tax or capital movement restrictions.

4.7 Risk Exposure Index

The implementation of risk response measure is one of the important steps in risk management processes. As a prerequisite for successful bidding for a project, risk avoidance measures needs to be made. Before the risk avoidance decision is made, a team of experts and stakeholders achieves consensus on identifying the risk existing at any time, the risk is then evaluated and scored for the risk exposure. The calculation of the risk-exposure index will help determine the avoidance strengths and risk response measures. Thus, the risk avoidance strength of the measure will help managers understand the significance of the measures to take to either minimize or eliminate the risk event. The next stage therefore is aimed at developing a model, which will combine the above ranking with a quantitative merit values by experts in evaluating the risk degree, which in this study is defined by five levels as 1,3,5,7 and 9. These merit values to the identified risks depend on the judgment of the manager or the decision maker at any point in time before committing his/her time, money and scarce resources to a given project. In this study, of risk assessment of risk degree, relative significance in Analytic hierarchy process (AHP) is used. As Relative Exposure Index is decided by so many potential factors, it is difficult to evaluate by an absolute values precisely and that most literature study uses a relative value to measure the risk.

4.7.1 Relative Risk Exposure Index

As mentioned earlier on in Section 4.6 above, the Relative Risk Exposure Index is the suggested quantitative merit value variable factor of the model and it is dependent on;

- the individual construction cost consultant/practitioner and
- The project(s) involved or anticipated

The quantitative merit value which evaluates the degree of risks is subjectively provided for the personnel responsible for the risk assessment. For testing the model, the 6 principal consultants in the study were targeted for the analysis.

However, due to time constraint, only one of the principle consultants was chosen at random by the toss of a die for the study. For the proper implementation of the

risk response measure, definite rules were followed in the handling of the various risk events or factors. As a prerequisite for any successful bidding, for example, proper risk avoidance measure will have to be made to manage the risk during the early stages of the project life cycle. In view of the importance of this risk management measure, the motive and the essence of the study were explained to the chosen principal consultant. The various categories and stages were discussed and agreed upon by the randomly chosen principal consultant for the study.

Using figure 2.2 (Risk Breakdown Structure) as the basis for the study, Table 4.6 (Appendix 'A') illustrates the Risk Exposure values of the various risks events in the various stages of a typical life – cycle of a project he was about to tender for. In this study, the principal consultant submits his/her evaluation of the Risk Exposure of the risk items and thereafter the risk analysis is performed using the Risk Exposure discussed in section 4.6. Here, representing m = 7, n = 55, l = 9, Let k = 1, and $\alpha j = 1/j$, then IRE_i is obtained for the various risk events. Representing Owners risk event by IRE_1, Designers risk event by IRE_2, Contractors risk events by IRE_3, Sub-contractors by IRE_4, Suppliers by IRE_5, Political risk event by IRE_6, Economic by IRE_7, Natural risk event by IRE_8, and all others by IRE_9, the various integrative risk exposure (IRE) of the ith risk category and IRE of the project are respectively defined and entered in Table 4.6.

For example, IRE, is calculated as follows:

= (1+3+3) × 1/1 + (3+5+3) × ½ + (3+9+7+5) × 1/3 + (5+3+5+5+9+7+3+1) × ¼

+(9+5+9+9+9+9+9+9+9+7) × 1/5 + (9+3+1+1+5+3+3+3+1) × 1/6 + (3+5+1+1+1+1+3+1)×1/7

= 7 + 11/2 + 24/3 + 38/4 + 84/5 + 29/6 + 16/7

= 7 + 5.5 + 6 + 9.5 + 16.8 + 4.83 + 2.29

= 51.92

For IRE_2, the calculation is as follows:

5 × 1/1 + 5 × 1/3 + (3+3) ×1/4 + (5+7+7+7+5) ×1/5 + (1+1+1+1+1+1+3+1) × 1/6 + 3 × 1/7

= 5 + 5/3 + 6/4 + 31/5 + 5/6 + 3/7

= 5 + 1 + 6.7 + 1.5 + 6.2 + 0.83 + 0.43

= 15.63

From the results of the study, the category with the highest risk exposure is Economic, i.e. IRE_7 = 72.40. This is followed by IRE_9 with a value of 59.99. The category with the lowest IRE is IRE_5 = 3.07 for Supplier category. Risk avoidance strength of a project increases in IRE. Therefore, within a project, the strength of risk response measure increases in IRE_t. The measures are not always used singly, but are used partly or entirely with different strength. Thus, the risk avoidance strength of the measure which is sorted will help managers understand the significance of the measures in practice.

The Relative Risk Exposure Indice in column 9 of Table 4.6 are converted into decimals by dividing the indices by 100 before entering them in column 8 of Table 4.3

Table 4.7 provides a guide for suggested ranges for merit values in assessing risk.

Table – 4.7: Scale for subjective Risk Assessment

x≤20	20<x≤40	40<x≤60	60<x≤80	80<x≤100
Very low (or 1)	Low Risk event (or 3)	Average Risk event (or 5)	High Risk event (or 7)	Very high risk event (or 9)

Table 4.7 was based on a similar one cited by Kometa et al (1995) from the unpublished PhD thesis presented to the University of Cincinnati, Ohio, U.S.A on Bidding Strategy Multi-criteria Decision Making Approach by Armed, I (1988). For comparing purposes, the merit values were given in Table 4.7 as percentages as these seems to carry more meaning and weight in appreciating the level of degrees of risk.

4.7.2 Notional Risk Exposure Index (Y)

The product of the Risk weight for each risk event or area and the Relative Risk Exposure Index or Utility would give the Notional Risk Exposure Index(Y)

Mathematically,

$$Y = P(x) * RE$$

All the values of the Notional Risk Exposure Indices were calculated by this formula and recorded in the 9th column of Table 4.3.

The summation of the various Notional Risk Indices will give the overall National Risk Index (I_o)

That is, $I_o = \sum Y = \sum P(x) * RE$

From Table 4.3, I_o is found to be 46.11 for all the 55 identified risk events by the principal consultant chosen for the study.

4.6.3 The overall Risk Exposure Index

The Risk Exposure model used in the risk avoidance decision processes in bidding for a project ends with the calculation of I_o. However, management and stakeholders cannot work with I_o effectively. There is therefore, the need to use the Overall Risk Exposure Index (I). I is found by subtracting the sum of the Notional Risk Index (I_o) from 100.

$$I = 100 - I_o$$
$$= 100 - 46.11$$
$$= 53.89$$
$$= 54$$

I, is interpreted by management and stakeholders for the most effective and efficient risk management decision to be taken. Thus, depending on the risk analysis undertaken, various risk response measures and their corresponding risk avoidance strength is adopted to reduce the perceived or real bidding risk.

From the study, I, falls within the range of 40 – 60 with an average degree of risk level 5. The various risk events should therefore be monitored. During the monitoring, special attention should be paid to the possibilities of various risk transformation and the relationship between risk events. Dynamic risk management practices should be advocated and risk avoidance policy adjusted in time according to changes in risk.

The Risk Exposure model for risk avoidance in bidding takes account of all the identified risks and represents the whole risk event by a single identifiable indicator known as the Overall Risk Exposure Index. Since the stage "Invitation to Bid/Select a bidding" project is in the most complex and all important in any project life cycle, it is important that risk avoidance measures and responses are undertaken during the early stages of any project. Risk exposure is an important factor in choosing a bidding project. Therefore, when the project bidding risks are not too high, the value of the contract becomes a preferential factor to decide on which projects to choose from and which risk event category to appropriately apply the proper risk management measure or strength to manage the risk by either of the following risk management process: avoiding the risk, reducing the risk, transferring the risk, accepting the risk or planning the risk management by using a contingency plan.

4.8 Risk Allocation in the construction Industry

Risk allocation is one of the most important tools in managing risk in the construction industry. It refers to the proper allocation of risks to the contracting party, that is, mainly the client/owner or the contractor. Sometimes, risks cannot be handled by one party alone, so the two parties will have to share the risk perceived or identified.

Generally, risk should be allocated to the party that can best handle it. However, due to an asymmetry in commercial power in the construction industry, there are no concise rules regarding risk allocation in construction contracts as clients/owners can place any risks to the Contractor. Contractors usually responded to these risks by increasing their contingency and mark-up which invariably increases the contract price to the owner/client. Seventy (70) percentage of the questionnaire respondents indicated that risks are not properly allocated in the Ghanaian Construction industry. Table 4.3 (Appendix ‘A’) shows the survey results as to the allocation of each risk event and the recommended allocation. The recommended allocation is for the party that got more than 50% of the votes for each of the risk events. From the survey, if a risk event did not have a party with more than 50% of the votes by the respondents, it is labeled “undecided”.

It is surprising to note that only five risk events are allocated to the Owners, the majority of the risk events are shared between the Contractors or Shared between the parties. From the study, most of the owner/designer risk categories were noted to be undecided. This is probably due to the culture and widespread use of the traditional contract systems that places most of the risk on the contractor and sometimes on the designer. Although, some of the study results do not appear to be rational, the majority of them are properly allocated. It is observed that the risk of Delay in obtaining site for instance, was undecided. This risk event is generally beyond the control of the contractor and should be allocated to the owner. Another controversial risk event is the risk of Owners' delayed payment to contractors. The respondents' responses were split among the Owners, Contractors or shared among the parties. Results from the study revealed that, most of the risk events from the Owners and designers categories were usually allocated to either the owners or not decided. However, contractors, sub-contractors and suppliers risk event are allocated to the general contractor. On the other hand, external risk events are normally shared between the owners and the contractors as they are beyond their control. Studying the responses however revealed that major differences existed between construction cost consultants risk allocation strategies.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

5.0 Introduction

Risk and uncertainty are inherent in all construction activities and that, it will be elusive to think that, all risk in the industry can be eliminated through the setting up of the best risk management processes.

The management of risk can be generalized by saying that, in any venture, risks should be identified, assessed for probability and impact and a decision made. If the perceived risks are unconscionable, then the only possible option or decision is to avoid the risk by not embarking upon the enterprise. However, if the risk is tenable, then positive steps must be taken to control the risk, delegate it or share it with others, limit its impact and insure against its consequences.

5.1 Summary of key findings

5.1.1 Reduction of Perceived Risks

Perceived risk could be reduced by increasing the certainty of the consequence and/or decreasing the severity of the consequences, the greater is the likely action to reduce the risk.

5.1.2 Uncertainties in the early life of new projects

It was also found that, the greatest degree of uncertainty about the future is encountered early in the life of a new project and that it was not only useful to apply risk analysis techniques but it was also necessary to highlight the dangers associated with using incomplete assumptions in risk analysis and assessment model in order to legitimize a certain view about the market outlook and other economic indicators and trends.

5.1.3 Commonly used procedure, processes and tools used during risk identification

From the study undertaken the most commonly used procedure, processes or tools noted to be used by managers, quantity surveyors and project managers during risk identification was through the use of subjective judgement, followed by risk source and potential impact, checklist and through workshop identification processes. The least risk identification process was the use of Documentary Reviews and SWOT analysis. Financial Statement Method and Flow Chart Approach were noted not to have been used. About 4.6% of the respondents never used any of the categorized processes and procedures used in risk identification in risk management.

The survey results imply that about 74% of the respondents used four (4) of the prescribed procedures for the identification of risk by risk management practitioners and facilitators in the construction industry. This therefore suggests that varied methods and procedures were used in the identification of risk by risk management practitioners and facilitators.

5.1.4 Qualitative Risk Analysis used in determining level of impact of categories of risks

Using Qualitative Risk Analysis and Assessment in determining the level of impact of the various risk categories, or event, Lack of proper brief or scope of work by the Owners of project had the highest risk score or a project. For Designers risk event, Late issue of drawings recorded the highest risk scores. For Contractors risk event, difficulty in controlling nominated sub-contractors had the highest scope. More so, Sub-contractors breach of contracts and disputes scored the highest qualitative score with respect to sub-contractor's risk event. Threats of political instability and changes in laws and regulations were lowly scored for political (government-related) risk event.

With respect to Economic risk event, Inflation and Sudden Changes in prices, Shortage in material supply and availability and Increases in wages were highly scored for risk management.

For other (project-related) risk event, Cost and time overrun, Delays in resolving disputes, Corruption and bribery were highly scored for risk management purposes.

5.1.5 Quantitative Risk Analysis used in determining rankings of identified risks

From the scores recorded during the Qualitative Risk Analysis stage, Quantitative Risk Analysis performed at this stage indicates the rankings of the successive identified risks event under the study. Relative Importance Index techniques were used to determine the rankings of the rated risk events.

The ten most significant risk factors identified by the respondents in order of ranking were as follows:

1st- Inflation and sudden changes in price,

2nd- Lack of proper brief or scope of work by owner,

3rd- Cost and time overrun,

4th- Owner's delayed payment to contractors,

5th- Shortage in material supply and availability,

6th- Owner's breach of contracts and disputes,

7th- Termination of contracts by contractors,

8th- Difficulty in controlling nominated sub-contractor,

9th- Inadequate project budget and,

10th- Corruption and bribery

For a proven confirmation of the appropriateness of the ranking of the significant risks identified above, Risk Weight constants formula model were developed and this comparably confirms that, except for a small variation, the rankings determined by the risk weight constants follow the same rank pattern (as per Relative Importance Index). For the risk weight constant, Inflation and Sudden changes in prices had the highest relative weight of 2.50 (as previously determined by using the relative importance index). The second and third relative weights were also given by Lack of proper brief or scope of work by owner and Cost and Time overrun respectively. These results therefore show how much emphasis or prominence should be given to risk and its effect on say, Inflation and sudden changes in price when bidding for a project.

However, it should be mentioned here that, the aforementioned analysis is based upon the collected sample data used in this study and as such, it is limited to the project study.

5.1.6 Risk Index (RI) as a model for prioritizing and ranking risk events

Furthermore, Risk Index (RI) model was also used to rank projects. This model was used to prioritise construction projects from the perspective of risk. The R-index can be used to provide value for comparison when comparing the sources of a risk and is effect on two or more projects. It is noted that, the lower the R-index value of a project, the higher the project rank in terms of position (and importance) because R-index represent the risk (that is R-index value is inversely proportional to the project risk ranking in position). Thus, developed R-index of a risk attracts the company's attention to the risks event or project that has a high potential risk to consider during the risk management process or procedure.

Analysis from the study (see table 4.3) indicates that, the lowest R-index risk event is 0.019, which is risk event- Lack or departure of qualified staff. The next lowest R-index value is 0.024, which has a risk event- Tax or capital movement restrictions. These low

R-index value risk event will therefore not attract immediate risk management attention. However, high R-index value risk event such as 0.115 and 0.111 for risk events Inflation and Sudden changes in price and Lack of proper brief or scope of work by owner respectively will attract immediate management's attention to these risks so as to minimize or mitigate the effects and potential consequences.

5.1.7 Risk Exposure Index as a model for assessing risk avoidance measures or decisions in bidding

The calculation of the risk-exposure index helps in determining the avoidance strengths and the appropriate risk response measures to be adopted so as to ether minimise or eliminate the risk event. The model developed here combines the ranking developed earlier with a quantitative merit values given by experts in evaluating the degree of riskiness of a risk event.

These merit values defined by the judgement of managers or decision makers are made at any point in time before the commitment of resources, time and money to a given project. However, since these merit values are decided by so many potential factors, it becomes difficult to do any reasonable evaluation by the use of these absolute values. It is therefore relevant to use relative exposure indices instead of absolute values.

5.1.8 Relative Risk Exposure Index as a Model for determining the category with the highest risk exposure

Using table 4.3 from the study, "Economic" category recorded the highest risk exposure of 0.72, followed by "Other" category with an exposure index of 0.59. "Suppliers" category scored the lowest risk exposure index of 0.03. From the above analysis, it is noted that risk avoidance strength of the study increases with increases in the value of integrated risk exposure index (IREI). Table 4.7 provides a guide for suggested ranges for the merit values in assessing the risk event of the study. Thus, it is noted that, the highest risk exposure category of the study were in the range of 60<x>80 (i.e. Economic category).

5.1.9 Notional and Overall Risk Exposure Index

Analysis of the study in Table 4.3 indicates that, the product of the risk weight (Px) for each identified risk event or area and the relative risk exposure index (RE) gives the National Risk Exposure Index (Y) of each risk event (N) in any one category.

These models are normally used in risk avoidance decision processes before projects are bidded. The models demonstrate the degree of exposure of risks to any project before the decision to bid or not to is taken.

From Table 4.3, the summation of the various Notional Risk Indices gives the overall Notional Risk Index (Io)

i.e. $Io = \Sigma (Y) = \Sigma P (x) * RE$

Io is found o be 46.11 for all the 55 identified risk events by the respondents of the study.

However, management and stakeholders cannot work with Io effectively because the merit values used in the calculation of these indices are relative in nature and are influenced by subjective human judgement and other potential factors. There is therefore, the need to use the Overall Risk Exposure Index (I).

I is found by subtracting the sum of the Notional Risk Index (Io) from 100, to give an average figure of 54. This figure falls between the range of 40 and 60 (see table 4.7), and this is interpreted by management and stakeholders to be a project with an average degree of risk exposure.

The degree of risk exposure is an important factor to consider when deciding to bid for a project. Thus, when the degrees of risk are not too high before bidding, the value of the contract becomes a preferential factor to decide on before choosing a project for bidding. This factor also influences the choice of the best risk management process to adopt, that is, avoiding the risk, reducing the risk, transferring the risk, accept the risk or plan the risk management by the use of a contingency plan.

5.2 Conclusions of the Study

Among the various risk management processes identified during the study, risk transfer or allocation was realized to be popular among the respondents.

Generally, Risk should be allocated to the party that can best handle it. Risks were identified to be allocated to either the client /owners or contractors or sometimes shared between the two parties.

Due to an asymmetry in commercial power in the construction industry, there are no concise rules regarding risk allocation in construction contracts as clients/owners can place any amount of risk to the contractor if they so wish. However, contractors usually respond to these set of risks by either increasing their level of contingency or mark-up which invariably increases the overall amount of the tender to the owner/client.

Table 4.3 (Appendix A) shows the survey results as to the proper allocation of each risk event and the recommended allocation.

5.3 Recommendations

As already elucidated in previous chapters, the study also gave an indication of the potential sources of risk in the industry. Risk identification and assessment were identified as important steps in project risk management and also showed the significance of several risks present in the construction industry. This study also lays the foundation for comparison with other countries, helps international companies and firms interested in working in Ghana understand and appreciate the risks involved, and assist local companies and firms in negotiating their contracts as to the proper allocation of risks. This study also helps in decision making regarding risk response, planning and control.

Generally, if proper risk response measures and strength are implemented for proposed and ongoing projects, the efficiency of say, the bidding risk avoidance, based on life cycle management theory cannot be only used in the construction industry, but also in other industries. The method can forecast, prevent, discover and reduce related risk completely and in timely fashion, thus, enhancing the probability of a successful bid and project.

The findings from the study also provides evidence that, proper risk allocation can only be achieved if it considers the type of risk (what) to be allocated, which party should accept the risk(who), when to allocate the risk as well as application of proper strategy to prevent or minimize its consequences (how). If the involved parties in such project failed to acknowledge this, it will result in an improper risk control. Incapability to control risk properly will be reflected in absence of good project governance, thus resulting in an unsuccessful project.

The study also revealed that, more often than not, the implementation project manager is not responsible for the identification of the risk and the planning of risk responses. They therefore, feel little ownership of the risk management plan and the probability of failure of the project becomes high.

The burden of responsibility for identifying risks and dealings with them remains with the party that carries the risk. Risk management will not remove all risk from a project; its principal aim is to ensure that, risks are managed in the most efficient manner. Project managers and stakeholders in the industry will greatly recognize that, the client must always carry certain residual risks. This risk must be analyzed in an organized and systematic way considering the full impact of time, cost and performance.

Risk management is not intended to kill off worthwhile projects, nor to dampen levels of investments. It aims to ensure that, only projects that are genuinely worthwhile are sanctioned and developed. When applying risk management techniques, the attitude of the project managers especially, is important. Steps should be taken to ensure that as much realism as possible is included in the analysis. Risk management should be viewed as a positive process, and can be one of the most creative tasks of the project manager and project teams. Its aim is to generate realistic expectations and increase the control of the process. In addition, it can open the way to finding innovative solutions that may not have otherwise been considered.

It is also recommended that, further research is done to investigate why many of the respondents did not regard risk assessment as an ongoing project activity but rather something done once at the pre-contract stage and then almost forgotten about. Risk management is presented in literature as a separate section and a process that must be completed at the beginning of a project. While the risk monitoring process is identified as something that should continue throughout the project, the remaining sections focus on operational aspects of managing the project and rarely refer again to on-going risk monitoring.

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APPENDIX ‘A’

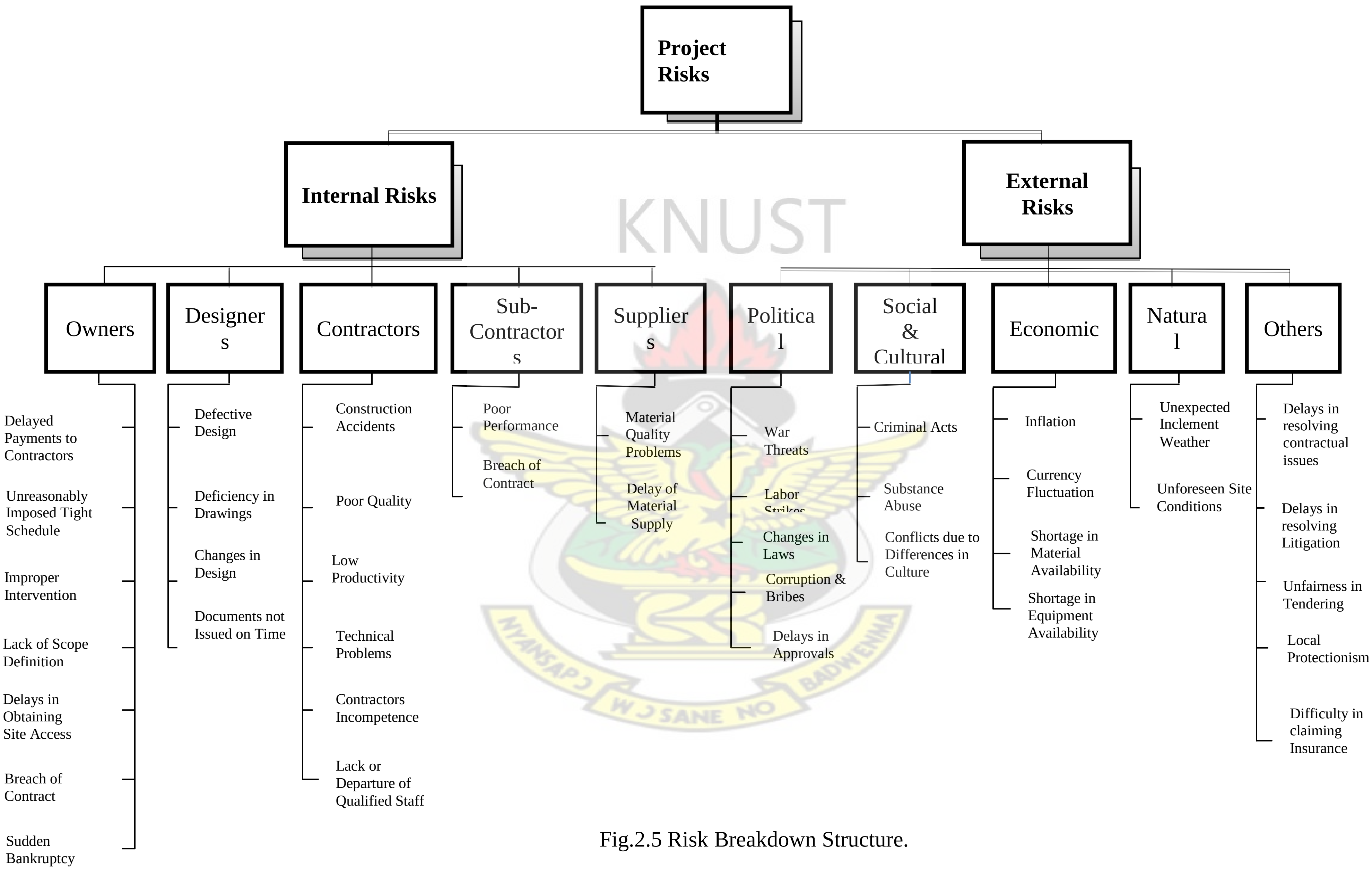

Fig.2.5 Risk Breakdown Structure.

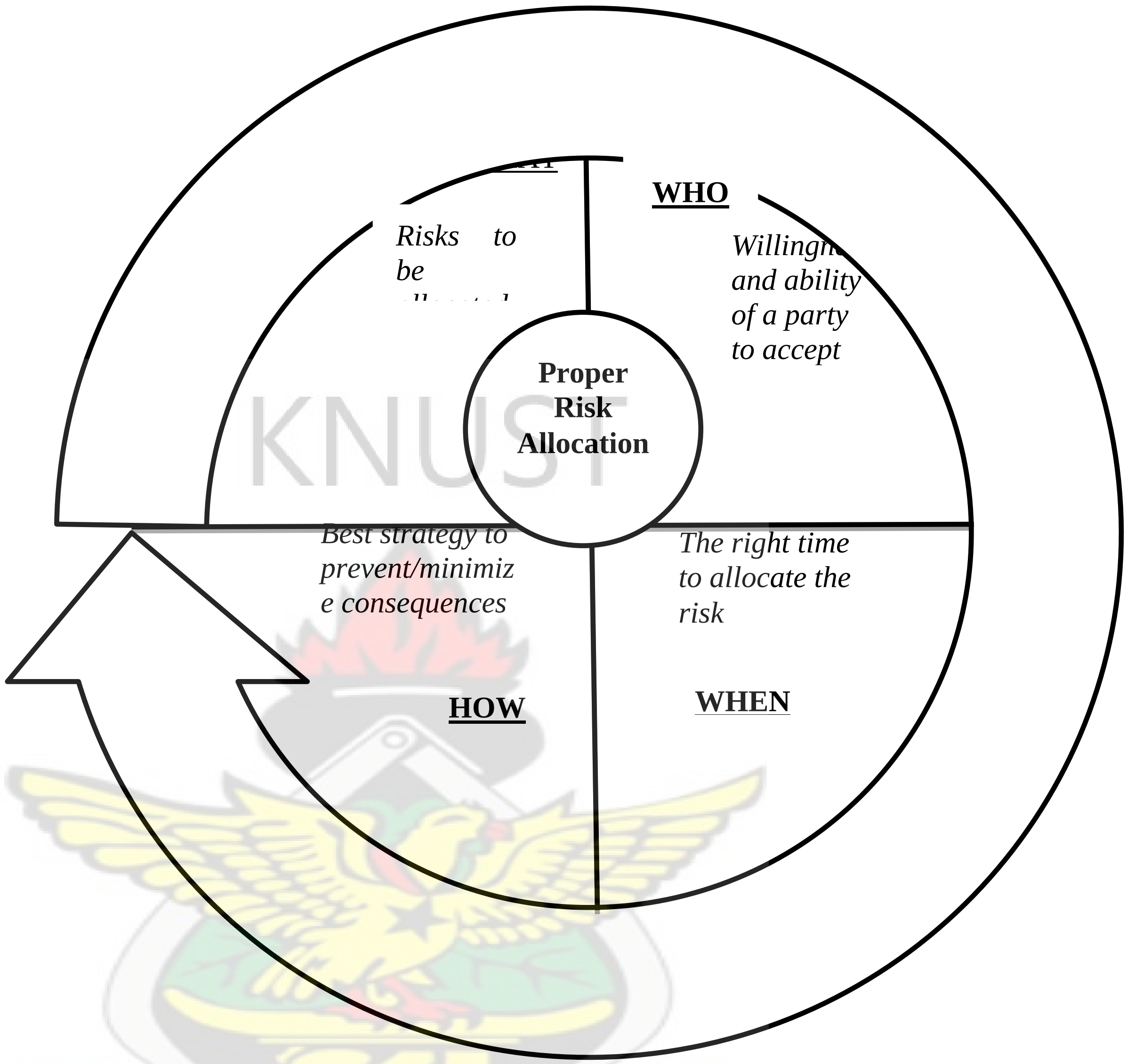

Fig 2.11 Concept of proper risk allocation

Risk Factor	Risk Description	Score
Complexity:	The system must interface with:	
Interface to other systems 0		low
1 to 5	medium	☐
>5 other systems	high	☐
System type	The system is:	☐
batch processing	low	
real-time(not safety-critical) or interactive	medium	
real-time, safety-critical or distributed	high	
System size	The system will consist of approx.	☐
1 to 10 modules	low	☐
11 to 25 modules	medium	☐
>25 modules	high	
System requirements	The system requirements are:	☐
agreed and signed off	low	☐
minor changes remain to be made	medium	☐
major changes are possible	high	
System data	The data relationship of items as defined is:	
Simple	low	☐
Moderately complex	medium	☐
Very complex	high	☐
		☐
		☐
		☐

FIGURE 2.10 A risk assessment checklist (risk-factor style)

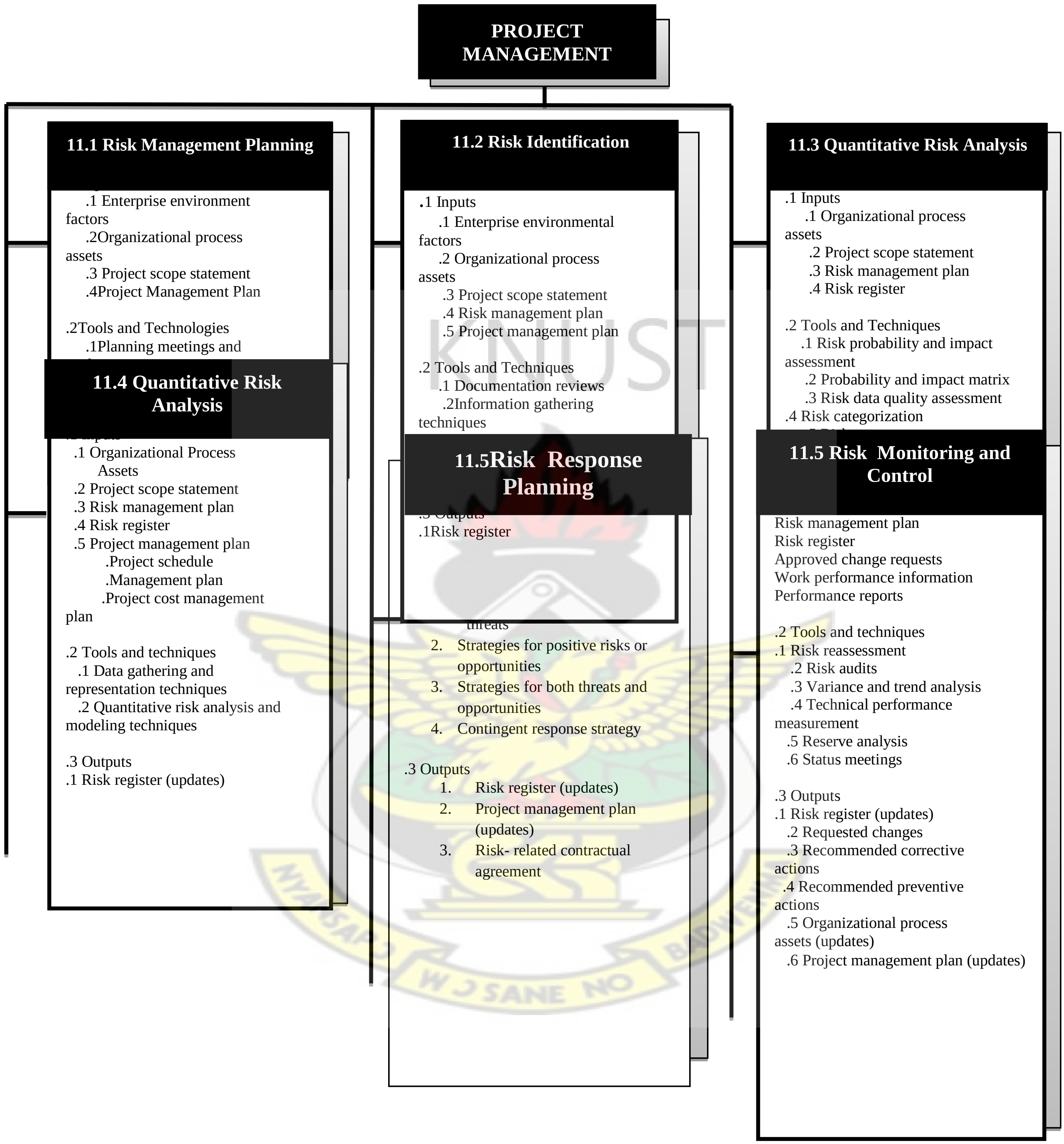

Figure 2.2. Project Risk Management Overview

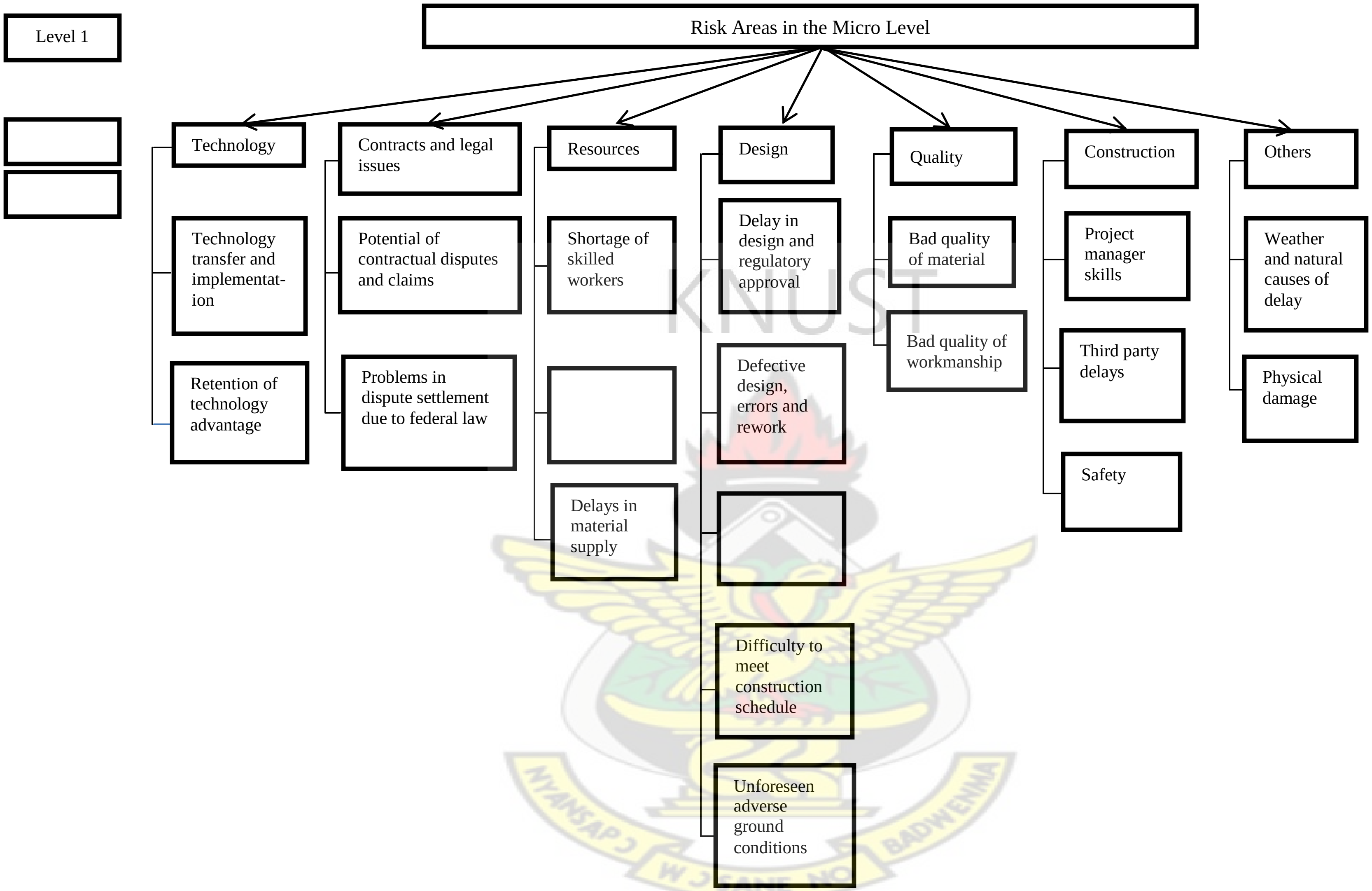

Fig 2.7 Hierarchy of risk factors in the micro level

Risk Description	Probability (1=low, 5=high)	Impact (1=low, 5=high)
Problems due to system interface with other systems?		
System more complex than planned?		
System less reliable than planned?		
System larger than estimated?		
System requirement subject to change?		
Likelihood of major changes after project start?		
Likelihood of minor changes after project start?		
Mechanisms for introducing change inadequate?		
Difficulties in defining parameters?		
Data definition tool not available on time?		
Data definition tools and dictionary tools unavailable?		
Hardware platform subject to change?		

FIGURE 2.8 A risk assessment checklist with probability and impact weighting columns

A. Project structural risks

For each question, tick the answer that most closely applies to the project you are assessing.
The risk score for each answer is contained in square brackets on the right. Add all risk scores for each category and refer to Section 3.3. ('Risk Assessment') in the Standards and Procedures Manual for guidance in interpreting the results.

1. Is this project:
   - a Modification to an existing system/existing equipment? [1]
   - a replacement for an existing system/existing equipment? [2]
   - a new system/new equipment? [3]
   - a pilot study or pilot project? [5]

2. Who identified most of the requirements?
   - the client [1]
   - the project team expected to undertake the project [2]
   - another group within this company [3]
   - other, specify ______________ [4]
   - requirements not fully identified [5]

3. Is completion of this project defined as these items to be reviewed and signed off separately?
   - standard deliverables for project of this type [1]
   - non-standard but agreed deliverables [2]
   - non-standard deliverables [4]
   - deliverables not identified [6]

4. Are project planning, tracking and reporting methods and techniques committed for this project?
   - yes, tried and tested [1]
   - yes, but new to this team [2]
   - no [5]

5. Has the client been on change control and status reporting methods and:
   - Agreed [1]
   - Disagreed? [4]
   - Not been briefed? [5]

FIGURE 2.9 A risk assessment checklist (questionnaire style)

APPENDIX ‘B’

COLLEGE OF ARCHITECTURE AND BUILDING TECHNOLOGY
DEPARTMENT OF BUILDING TECHNOLOGY, KNUST

PROJECT RISK MANAGEMENT PRACTICES OF CONSTRUCTION CONSULTANTS IN GHANA

QUESTIONAIRE

1. Please, state your Job Title/Position in the Company that you work (Please tick)
   Principal/Managing Partner ☐ Partner ☐ Senior Quantity Surveyor ☐ Consultant Quantity Surveyor

2. Could you state which of the following consultants you belong to? (Please tick)
   Civil Engineering ☐ Architectural ☐ Quantity Surveyor ☐
   Service Engineering ☐

3. Could you state the region(s) in which your head office is located? -----------------------

4. How long have you been in the Construction Industry? (Please tick)
   Less than 5 years ☐ Between 5-10 years ☐ Between 10-20 years ☐
   More than 20 years ☐

5. Do you perform any form of risk management practices in your company? (Please tick)
   Yes ☐ No ☐ ☐

6. If your answer to question 5 above is yes, go to question 7. If no, go to question 11

7. State who undertakes the risk management practice
   Principal Consultant ☐ Associated Partner ☐ Senior Quantity Surveyor ☐
   Quantity Surveyor ☐

8. Do your company go through all the basic steps of risk management

That is						
	a)	Risk Planning	Yes	☐	No	☐
	b)	Risk Identification	Yes	☐	No	☐
	c)	Risk Analysis	Yes	☐	No	☐
	d)	Risk Allocation	Yes	☐	No	☐
	e)	Risk Response	Yes	☐	No	☐
	f)	Risk Monitoring and Control	Yes	☐	No	☐

9. If all your answers to question 8 is Yes, go to question 11, But if Not, go to question 10

10. State the reasons why you do not go through all the stated stages of risk management in question 8 (Please tick)
    Lack of Time ☐ Insufficient Data ☐ Not necessary ☐ None ☐

11. Do you use risk management planning as a process for deciding how to approach and conduct risk management activities during the project life cycle of any project?
(Please tick) Yes [ ] No [ ] None [ ]

12. Who does the identification and classification of risk during the early life cycle of a project? (Please tick)
Principal Consultant [ ] Associate Partner [ ] Senior Quantity Surveyor [ ]
Quantity Surveyor [ ]

13. What time(s) of the project life cycle is risk identification most important? (Please tick)
Early stage of the project (i.e. Initiation Stage) [ ]
Planning and Organization Stage [ ]
Executing and Implementation Stage [ ]
Monitoring and Control Stage [ ]
Closure [ ]

14. What are the potential source(s) of risks and uncertainty in the construction industry (please name them)

----

15. What is your company's tools and techniques for identifying or classifying risks? (Please tick)
Risk source and Potential Impact [ ]
Project Work Breakdown Structure [ ]
Financial Statement Method [ ]
Flow Chart Approach [ ]
Documentary Review [ ]
Pre-Workshop [ ]
Workshop [ ]
Delphi Techniques [ ]
Roof Cause Identification [ ]
SWOT Analysis [ ]
Check Lists [ ]
Subjective Institution [ ]
None of the Above [ ]

16. Do you do a thorough risk analysis and assessment of risk during the life cycle of a project? (Please tick)
Yes [ ] No [ ] If yes go to question 15

17. If No to question 16, give reasons (please tick)
Lack of time ☐ Unsufficient data ☐ Not necessary☐ None ☐

18. Who does the risk analysis/assessment in your company during the life cycle of a project
Principal Consultant ☐ Partner ☐ Senior Quantity Surveyor ☐
Quantity Surveyor ☐

19. What is your method for assessing risk? (Please tick)
By intuition ☐ From Experience ☐
By the use of known assessment model ☐
- i/State type(s) of model

None ☐

20. How are the assessed risk factors classified or labeled? (Please tick or underline where appropriate)
- High level, middle level or low level
- High impact, medium impact or low impact
- High probability of occurrence, low probability

21. What key factors would you look out for when assessing risk? (Please State)

a)	------------------------------------	f)	----------------------------------
b)	------------------------------------	g)	----------------------------------
c)	------------------------------------	h)	----------------------------------
d)	------------------------------------	j)	----------------------------------
e)	------------------------------------	k)	----------------------------------

22. Do you measure perceived risk in terms of any of the following or none? (Please tick)
Uncertainty ☐
Consequence of loss ☐
None ☐

23) What factors are mostly considered for impact and probability of occurrence during assessment of identified risk factors? (please tick)
Performance ☐
Cost ☐
Schedule ☐
Quality ☐

24. Please, find in the table 1 attached, a list of 55 potential risk factors in the construction industry identified during the literature search and interview sessions.

Kindly rate these risk factors on a scale of 1-5, with 1 representing Very low in uncertainty, 2 represented by Low, 3 represented by Moderate, 4 represented by High and lastly 5, represented by Very High

25. Please, find in Table 2, a list of Risk items identified as potential risk factors in the construction industry and the various assigned stages of typical project life cycle.
Using five levels of risk degree in evaluating or rating risk exposure index (i.e. 1,3,5,7 and 9) with 1 representing the lowest degree of risk and 9 representing the highest degree of risk in the implementation of risk response measure. Kindly rate these risk degrees in bidding for a typical project you are undertaking (or have undertaken)

26. At what periods(s) of the project life cycle is risk response review processes undertaken? (Please tick)
    - Early stage of the project ☐
    - Regular progress meetings ☐
    - Mid-way through the contract period ☐
    - Stated period in the current period ☐
    - None ☐

27. Does your firm have an effective risk response strategy for managing risk in the construction industry? (Please tick)
    - Yes ☐
    - No ☐

28. If Yes, kindly state some of the risk response strategies adopted.

    ----

29. Are your risk response strategies ranked in the order of usefulness depending on type of project, risk type or proposed location of the project? (Please tick)
    - Yes ☐
    - No ☐
    - None ☐

30. If Yes to Question 29, rank in the order of importance the following fair risk response measures.
    - Avoid the risk ☐
    - Transfer the risk ☐
    - Mitigate the risk ☐
    - Accept the risk ☐

31. What are some of the risk response measure adopted during avoidance of risk? (Please tick)
    - Risk identification ☐

Risk assessment
Risk analysis ☐
Risk reduction ☐
Risk monitoring ☐
None ☐
☐

32. What form(s) of risk transfer measures caters for risks catered for in the management of risk in the construction industry (Please tick)

Insurance	☐	Bond	☐
Warranties	☐	Guarantees	☐
Others	☐	None	☐

33. How is risk mitigation or reduction achieved in the management of risk in the construction industry? (Please tick)
Imposing control on project activities through
- Implementation of workable programmes ☐
- Proper procurement method ☐
- Activity Schedules ☐
- Expenditure Control ☐
- Budgetary control ☐

34. Please indicate on the scale below your company's preferred choice in the allocation of risk. The risk scale allocation is between either the owner, contractor or shared between the two parties (Note that if a risk event did not have a party with more than 50% of the scale rating, it should be lebelled as "undecided"

APPENDIX ‘C’

Table 4.3 – Risk Index Determination

Item	Description	SCORE					Relative Importance Index (R11)	Ranking	P(i) Or W1	Ei(xi)	R-Index	Relative Risk Exposure Index (RE)	Notional Risk Exposure (P(x) * RE)	Risk Allocation			
		1	2	3	4	5								Owner %	Contractor %	Shared %	Allocation
	Owners risk events																
1	Owners delayed payment to contractors	5	6	8	21	84	4.396	4	2.40	0.044	0.106	0.52	1.25	29.3	41.32	29.38	Undecided
2	Owners' unreasonably imposed tight schedule	2	15	16	29	62	4.081	13	2.20	0.041	0.091	0.52	1.14	19.50	35.29	45.21	Undecided
3	Owners improper intervention	10	5	33	5	71	3.984	19	2.10	0.040	0.084	0.52	1.09	25.59	27.75	46.66	Undecided
4	Change of design required by owner or variation in specification required by owner	17	9	64	21	13	3.033	39	1.60	0.031	0.050	0.52	0.83	65.21	8.01	26.78	Owner
5	Lack of proper brief or scope of work by owner	3	0	15	14	92	4.549	2	2.40	0.046	0.111	0.52	1.25	42.80	21.13	36.07	Owner
6	Delay in obtaining site access and right of way	6	20	36	21	41	3.573	29	1.90	0.036	0.069	0.52	0.99	12.66	42.13	45.21	Undecided
7	Owners' breach of contracts and disputes	5	3	7	44	65	4.299	6	2.30	0.043	0.099	0.52	1.20	42..10	19.45	38.45	Undecided
8	Owners sudden bankruptcy	6	19	0	34	65	4.073	14	2.20	0.041	0.091	0.52	.1.14	63.41	19.40	17.18	Owner
9	Inadequate project budget	7	17	3	13	85	4.250	9	2.30	0.043	0.099	0.52	1.20	51.31	41.28	7.41	Owner
10	Lack of project control by owner	65	3	17	26	13	2.347	47	1.30	0.024	0.032	0.52	0.68	37.46	41.25	21.31	Undecided
	Designers risk events																
11	Defective designs by designer	14	7	14	31	58	3.904	23	2.10	0.039	0.082	0.16	0.34	23.86	14.91	61.23	Shared
12	Deficiency in drawing and specifications	8	4	9	62	41	4.00	17	2.20	0.040	0.088	0.16	0.35	26.66	30.41	42.93	Undecided
		148	108	322	321	691	46.489					C/F	11.46				

Table 4.3 (cont'd)

Item	Description	SCORE					Relative Important Index (R11)	Ranking	P(i) Or W1	Ei(xi)	R-Index	Relative Risk Exposure Index (RE)	Notional Risk Exposure (P(x) * RE)	Risk Allocation			
		1	2	3	4	5								Owner %	Contractor %	Shared %	Allocation
												B/F	11.46				
13	Frequent changes of design by designers	11	3	27	44	39	3.783	27	2.00	0.038	0.076	0.16	0.32	31.41	22.38	46.21	Undecided
14	Late issue of drawings and documents (or delays in design)	8	18	5	24	69	4.033	15	2.20	0.041	0.091	0.16	0.35	37.17	21.64	41.19	Undecided
15	Ambiguities and inconsistencies in design and design changes	17	9	61	14	23	3.137	36	1.70	0.032	0.055	0.16	0.27	24.15	32.14	43.71	Undecided
	Contractors risk events																
16	Accidents during construction	14	28	61	1	20	2.879	40	1.60	0.029	2.047	0.43	0.69	14.32	72.40	21.17	Contractor
17	Poor quality of work	10	0	17	67	30	3.863	24	2.10	0.039	0.082	0.43	0.90	4.60	74.23	21.17	Contractor
18	Low productivity of labour and equipment	33	16	21	16	38	3.081	38	1.70	0.031	0.051	0.43	0.73	4.90	85.20	14.31	Contractor
19	Unpredicted technical problems in construction	51	7	0	53	13	2.758	44	1.50	0.028	0.42	0.43	0.65	2.31	82.13	15.56	Contractor
20	Contractors incompetence (or lack of experience)	37	23	21	16	27	2.783	42	1.50	0.0280	0.042	0.43	0.65	8.36	73.35	18.29	Contractor
21	Lack or departure of qualified staff	62	42	3	8	9	1.87	55	1.00	0.019	0.019	0.43	0.43	4.61	84.17	11.22	Contractor
22	Inadequate estimates	8	5	13	41	57	4.081	22	2.20	0.041	0.091	0.43	0.95	2.21	96.45	1.34	Contractor
23	Financial difficulties	23	12	41	27	21	3.089	37	1.70	0.31	0.003	0.43	0.73	13.37	31.42	55.21	Shared
24	Poor Contract Management	5	3	29	25	62	4.097	11	2.20	0.041	0.091	0.43	0.95	27.13	63.75	9.12	Contractor
25	Difficulty in																

	controlling nominated sub-contractors	13	0	7	27	77	4.250	8	2.30	0.043	0.099	0.43	0.99	21.31	27.37	51.32	Shared
		292	166	306	363	485	90.193					C/F	20.07				

Table 4.3 (cont'd)

Item	Description	SCORE					Relative Important Index (R11)	Ranking	P(i) Or W1	Ei(xi)	R-Index	Relative Risk Exposure Index (RE)	Notional Risk Exposure (P(x) * RE)	Risk Allocation			
		1	2	3	4	5								Owner %	Contractor %	Shared %	Allocation
							90.193					B/F	20.07				
	<u>Sub-Contractors risk event</u>																
26	Sub-contractors' poor performance	3	7	28	40	46	3.960	21	2.10	0.040	0.084	0.04	0.08	4.16	82.13	13.71	Contractor
27	Sub-contractors breach of contracts and disputes	9	18	14	31	52	3.799	26	2.10	0.038	0.080	0.04	0.08	4.39	72.48	23.13	Contractor
28	Suppliers' risk events	19	20	21	16	48	3.436	32	1.90	0.035	0.067	0.03	0.06	4.42	68.27	27.31	Contractor
29	Delay of materials supplied by suppliers Quality problems of suppliers materials	42	6	27	33	16	2.799	41	1.50	0.028	0.042	0.03	0.05	6.07	64.35	29.58	Contractor
	<u>Political (Government-related risk event</u>																
30	Threat of political instability	78	13	1	14	18	2.041	53	1.10	0.021	0.024	0.34	0.37	4.62	28.10	67.28	Shared
31	Labour strikes and disputes	18	29	12	47	18	3.146	34	1.70	0.032	0.055	0.34	0.58	6.46	71.13	22.44	Contractor
32	Changes in laws and regulations	53	27	21	19	4	2.146	51	1.20	0.022	0.627	0.34	0.41	4.40	38.41	57.19	Shared
33	Delays in Approval by Political Authority (or Delays in obtaining permit/permission	14	25	28	16	41	3.363	33	1.80	0.034	0.062	0.34	0.61	38.15	27.23	34.62	Undecided
	<u>Economic Risk events</u>																
34	Inflation and sudden changes in prices	2	4	4	21	93	4.605	1	2.50	0.046	0.115	0.72	1.80	6.41	31.28	62.31	Schared

35	Currency fluctuation	7	3	9	71	34	3.984	18	2.10	0.040	0.084	0.72	1.51	5.96	41.13	52.91	Shared
36	Shortage in material supply and availability	4	2	13	38	67	4.307	5	2.30	0.043	0.099	0.72	1.66	2.71	63.21	34.08	Contractor
		249	154	178	346	437	127.719					C/F	27.28				

Table 4.3 (cont'd)

Item	Description	SCORE					Relative Important Index (R11)	Ranking	P(i) Or W1	Ei(xi)	R-Index	Relative Risk Exposure Index (RE)	Notional Risk Exposure (P(x) * RE)	Risk Allocation			
		1	2	3	4	5								Owner %	Contractor %	Shared %	Allocation
							127.719					B/F	27.28				
37	Shortage in manpower supply and availability	8	14	44	21	37	3.523	30	1.90	0.036	0.069	0.72	1.37	1.45	73.11	28.34	Contractor
38	Shortage in equipment availability	13	18	14	37	42	3.621	28	2.00	0.037	0.074	0.72	1.44	1.47	78.22	20.31	Contractor
39	Foreign currency exchange difficulties	62	1	34	8	19	2.362	46	1.30	0.024	0.032	0.72	0.94	1.52	61.21	37.27	Contractor
40	Tax or capital movement restrictions	71	40	6	4	13	2.017	54	1.10	0.021	0.024	0.72	0.79	38.21	41.27	20.52	Shared
41	Increases in wages	13	5	7	41	58	4.017	16	2.20	0.041	0.091	0.72	1.58	20.54	48.19	31.27	Shared
	Natural risk events																
42	Unexpected inclement weather	16	24	6	37	41	3.508	31	1.90	0.035	0.067	0.19	0.36	4.08	43.73	52.19	Shared
43	Force majeure	58	4	7	18	37	2.775	43	1.50	0.028	0.042	0.19	0.29	10.67	27.19	62.14	Shared
	Other (Project-related Risk events																
44	Delays in resolving contractual issues	8	21	16	21	58	3.807	25	2.10	0.038	0.080	0.60	1.20	3.70	39.27	57.03	Shared
45	Delays in resolving disputes	7	22	5	23	67	3.976	20	2.10	0.040	0.084	0.60	1.20	1.71	27.19	71.10	Shared
46	Unfairness in tendering	15	37	28	3	41	3.146	35	1.70	0.032	0.055	0.60	1.02	31.03	35.80	33.17	Undecided
47	Cost and time overrun	3	1	14	15	91	4.533	3	2.40	0.046	0.111	0.60	1.44	21.58	47.28	31.14	Undecided

48	Difficulty in claiming insurance compensation	44	12	33	7	28	2.702	45	1.50	0.087	0.041	0.60	0.90	2.70	40.11	57.19	Shared
49	Delays of tendering and selection procedures	13	10	9	32	60	3.936	22	2.10	0.040	0.084	0.60	1.26	48.19	27.13	24.68	Shared
50	Poor communication between project parties	41	60	0	8	15	2.162	50	1.20	0.022	0.029	0.60	0.72	31.28	28.09	40.63	Shared
		372	269	223	275	607						C/F	41.79				

Table 4.3 (cont'd)

Item	Description	SCORE					Relative Important Index (R11)	Ranking	P(i) Or W1	Ei(xi)	R-Index	Relative Risk Exposure Index (RE)	Notional Risk Exposure (P(x) * RE)	Risk Allocation			
		1	2	3	4	5								Owner %	Contractor %	Shared %	Allocation
							173.866					B/F	41.79				
51	Termination of contract by contractor	6	4	10	37	67	4.250	7	2.30	0.043	0.099	0.60	1.38	21.19	63.14	15.67	Contractor
52	Termination of contract by client	65	19	3	16	21	2.267	48	1.20	0.073	0.028	0.60	0.72	72.33	19.19	8.48	Owner
53	Health and Safety issues on site	58	31	13	9	14	2.113	52	1.20	0.022	0.027	0.60	0.72	21.10	62.71	16.19	Contractor
54	Corruption and bribe	7	4	16	23	74	4.234	10	2.30	0.043	0.099	0.34	0.78	41.23	34.16	24.61	Shared
55	Geographically remote	67	6	21	16	14	2.226	49	1.20	0.023	0.028	0.60	0.72	28.17	34.56	37.27	Shared
		203	64	62	101	190	188.956						46.11				

Table 4.6 – Risk Exposure of Risk Events

Risk Item	Stages of a typical project life cycle							
	Invitation to Bid 1	Submission of Bid 2	Award of Contract 3	Mobilization to Site 4	Project Implementation/ Execution 5	Defects Liability Period 6	Handing Over/ Taking-Over 7	Integrated Risk Exposure (IREi)
Owners								51.92
- Delayed payments to contractors	-	-	-	5	9	9	3	
- Unreasonably imposed tight schedule	-	-	3	-	5	3	5	
- Improper intervention	1	3	9	3	9	1	1	
- Change of Design	-	-	-	5	9	1	1	
- Lack of scope definition	-	-	-	5	9	-	1	
- Delay in obtaining site access	-	-	-	9	9	5	1	
- Breach of contract	-	-	-	-	9	3	-	
- Sudden bankruptcy	3	5	7	7	9	3	-	
- Inadequate project budget	3	3	5	3	9	3	3	
- Lack of project control	-	-	-	1	7	1	1	
Designers								15.63
- Defective Design	-	-	-	-	5	1	3	
- Deficiency in drawing	--	-	-	-	7	1	-	
- Changes in Design	-	-	-	3	7	1	-	
- Document not issued on Time	5	-	5	3	7	1	-	
- Ambiguities in Design and design changes	-	-	-	-	5	1	-	

Table 4.6 (cont'd) – Risk Exposure of Risk Events

Risk Item	Stages of a typical project life cycle							
	Invitation to Bid 1	Submission of Bid 2	Award of Contract 3	Mobilization to Site 4	Project Implementation/ Execution 5	Defects Liability Period 6	Handing Over/ Taking-Over 7	Integrated Risk Exposure (IREi)
Contractor								43.29
- Construction Accidents	-	-	-	1	7	1	-	
- Poor Quality	-	-	-	1	7	9	5	
- Low productivity	-	-	-	-	5	-	-	
- Technical problems in construction	-	-	-	1	7	1	-	
- Contractors incompetence	-	-	-	3	9	3	1	
- Lack or Departure of Qualified staff	-	-	-	3	7	3	1	
- Inadequate estimates	-	9	-	3	9	5	-	
- Financial difficulties	7	3	-	3	9	3	1	
- Poor Contract Management	3	3	-	3	7	3	3	
- Difficulty in controlling nom. Subcontractors	-	-	-	-	5	3	3	
Sub-Contractors								4.11
- Poor performance	-	-	-	1	5	3	3	
- Breach of contracts and disputes	-	-	-	-	5	3	3	
Suppliers								3.07
- Material Quality Problems	-	-	-	1	3	1	1	
- Delay of material supplied	-	-	-	3	5	1	-	

Table 4.6 (cont'd) – Risk Exposure of Risk Events

Risk Item	Stages of a typical project life cycle							
	Invitation to Bid 1	Submission of Bid 2	Award of Contract 3	Mobilization to Site 4	Project Implementation/ Execution 5	Defects Liability Period 6	Handing Over/ Taking-Over 7	Integrated Risk Exposure (IREi)
Political								33.94
- Threat of political instability	5	-	-	1	5	1	1	
- Labour strikes	3	1	-	3	5	1	-	
- Charges in laws and regulations	3	3	-	1	3	3	-	
- Corruption and Bribes	-	5	9	-	7	1	1	
- Delays in approval	5	-	7	-	7	1	-	
Economic								72.48
- Inflation	3	5	3	3	7	3	-	
- Currency Fluctuation	3	7	-	-	7	3	1	
- Shortage in material Availability	5	5	3	3	7	3	1	
- Shortage in manpower supply and availability	3	5	3	1	5	1	1	
- Shortage in Equipment Availability	3	3	3	1	5	1	1	
- Foreign currency exchange difficulties	5	3	-	1	5	3	1	
- Tax or capital movement restrictions	5	5	-	1	5	3	1	
- Increases in wages	5	5	5	1	5	1	-	
Natural								19.49
- Unexpected inclement weather	5	1	-	1	3	1	1	
- Unforeseen site condition	7	-	-	3	5	1	-	

- Force majeure	3	-	-	-	3	1	1	

Table 4.7 (cont'd) – Risk Exposure of Risk Events

Risk Item	Stages of a typical project life cycle							
	Invitation to Bid 1	Submission of Bid 2	Award of Contract 3	Mobilization to Site 4	Project Implementation/ Execution 5	Defects Liability Period 6	Handing Over/ Taking-Over 7	Integrated Risk Exposure (IREi)
Others								59.99
- Delays in resolving contractual issues	-	-	-	-	3	1	3	
- Delays in resolving litigation/disputes	-	-	-	-	5	3	3	
- Unfairness in tendering	3	5	7	-	-	-	-	
- Cost and time overrun	3	-	-	-	5	3	1	
- Difficulty in claiming insurance compensation	3	-	-	-	3	1	1	
- Delays of tendering and selection procedures	5	-	3	-	-	-	-	
- Poor communication between project parties	-	-	-	1	5	1	1	
- Termination of contract by contractor	5	5	5	-	7	3	1	
- Termination of contract by client	5	3	3	1	5	3	1	
- Health and safety on site issues	3	-	-	1	3	1	1	
- Geographically remove	5	3	-	3	3	1	1	
Sum	117	90	80	93	96	118	61	