RISK IDENTIFICATION AND ASSESSMENT IN HOUSING DEVELOPMENT PROJECTS USING ANALYTICAL HIERARCHICAL PROCESS

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OCTOBER, 2014

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BY

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A THESIS SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIAIN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OFMASTER OF SCIENCE DEGREE IN PROJECT MANAGEMENT

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OCTOBER, 2014

DECLARATION

I hereby declare that the work in this thesis titled "**Risk identification and assessment in housing development projects using analytical hierarchical process**" has been carried by me in the Department of Quantity Surveying, under the supervision of Dr. A. D. Ibrahim and Dr. Y. M. Ibrahim. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other Institution.

Yusuf GarbaBABA ....
Signature Date

CERTIFICATION

This project thesis entitled "**RISK IDENTIFICATION AND ASSESSMENT IN HOUSING DEVELOPMENT PROJECTS USING ANALYTICAL HIERARCHICAL PROCESS"by Yusuf Garba BABA** meets the regulations governing the award of the degree of M.Sc. Project Management of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This research work is dedicated to my beloved late father AbubakarAlhaji Musa on whose legacy I still thrive.

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ACKNOWLEDGEMENTS

This work could only have been possible with the encouragement and support from various quarters for which I am highly grateful.

I am highly grateful and remain deeply indebted to my supervisorsin the persons of Dr. A. D. Ibrahim and Dr. Y. M. Ibrahim, whose support have made it possible to achieve this work. I also appreciate the contributions of my internal examiner and other lecturers, especially the postgraduate coordinator in person of Dr. K.J. Adogbo, who provided an enabling friendly environment for me in the course of this research work.

It is imperative to acknowledge the singular contributions of my family members, who show great understanding and encouragement during my study period.

I remain grateful to all those, whose works were quoted, while undertaking this research work.

ABSTRACT

The construction industry and housing subsector is fraught with risks that have the potential of negatively impacting on the achievement of project objectives. The success or otherwise of most construction and housing projects depends to large extent on how well these risks have been managed. The aim of the study is to identify and assess risk associated with housing development projectswith a view toprioritisingthe identified risk factors to provide stakeholders with basis for sound decision. The study useda three-step identification framework (a literature review of documented past experience, experts' consultation and questionnaire based survey)to identify the potential key risk factors. The use of Analytical Hierarchical Process assessment methodology was employed to carry out relative prioritization assessment of the risk factors. The results show that 50 risk factors have relevant impact on housing development project objectives and 19 of these risk factors are of significant level. Similarly, based on the Analytic Hierarchical Process (AHP) relative-assessment ranking, at macro level, Economic risk and Land acquisition risk are found to have the highest level of impact while changes in demand for houses and interest rate fluctuation sub-factors have the highest ranking at micro level. The study concluded that a suitable identification framework and an efficient and flexible risk assessment methodology are keys to the identification and assessment of risks, and achievement of robust risk management system in housing development project. To this end, the study recommendsthe adoption and use of the combination of the multi-technique identification framework and AHP assessment methodology as a suitable model for management of risks in housing development project. In addition, the study drew attention to the need for focus on highly prioritised risk factors to reduce their chances of occurrence and impact on the achievement of project objectives.

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GLOSSARY OF ABBREVIATIONS

RM:	Risk Management
RMS:	Risk Management System
RMP:	Risk Management Process
PRAM:	Project Risk Analysis and Management
RAMP:	Risk Analysis and Management for Projects
PMI:	Project Management Institute
APM:	Association of Project Management
APMBoK:	Association of Project Management Body of Knowledge
PMBoK:	Project Management Body of Knowledge
BSI:	British Standard Institute
IRM:	Institute of Risk Management
RMA:	Risk Management Association
HRBS:	Hierarchical Risk Breakdown Structure
HDP:	Housing Development Project
AHP:	Analytic Hierarchical Process

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The Construction industry in Nigeria, although generally accepted as very active, is relatively small contributing only about 1.8% to 3% to the Nigeria's Gross Domestic Product (NBS, 2013). The industry provides employment opportunity to teeming millions of the country's workforce and produce wide variety of products ranging from housing; public facilities such as hospitals, schools, offices and other institutional buildings etc. in addition to other infrastructural, industrial and engineering fabrications. Massive demand for buildings and housing, in particular, across all sectors of the economy and the refocusing by the government on infrastructural development are some of the factors attributed to the growth in the construction and property sector. In recent years, there has been an increasing emphasis on the housing subsector by different tiers of government to ensuring adequate provision of decent houses to the teeming population, yet the adequate provision of this basic need is becoming more challenging to the construction industry. It is estimated that Nigeria's housing deficit falls around 18-20million Housing Units (HU) with the Federal Capital Territory, Abuja, alone having close to 3 million HU deficits (FMLHUD, 2006). The reaction of the construction industry to this finding is of mix feeling. The industry view it as an opportunity for a brighter feature for, at least, the housing subsector and also as a challenge for the industry to brace up, by equipping itself, for the handling of not only this present demand but also feature demands for more houses in the country.

The housing subsector accounts for virtually 30-40% of the construction industry's performance at the moment. However, studies on the performance of the industry have continued to point to the negative in terms of general performance of the industry(Odusami*et al*., 2010; Dantata,

2008).Dantata (2008) argued that the major challenge of the industry lies, among others, on lack of adequate skilled labour force to implement planned work and achieve objectives. On the other hand, Odusami*et al*. (2010) was pointed out the inadequacy of the industry in managing it objectives at both corporate and project levels to meet the challenges of its clientele. Although corporate management is important and improvement can be achieve with time, the project level management transformation is within the doorstep of the stakeholders in the industry. This can be conceived within the project management framework.

The Project Management Institute (PMI, 2008) in its guidance and standard manual - the Project Management Body of Knowledge (PMBok) has outlined key knowledge areas that are sacrosanct to the achievement of success in the management of project endeavours. These are cost, schedule, scope, human resource, and risk management. The first four components are all well familiar to most parties in the construction sector; it is the latter that stands out as a major obstacle to the realization of most projects. Recent study by Rezakhani (2012a) has shown that there is strong correlation between the industry's performance and its capability in managing project risks. The industry is characterized with high risk which has not always been dealt with adequately. The housing development (popularly known as housing estates) subsector is alsobedevilled with high uncertainty and risk due to the complex nature of the procurement arrangements and the influence of external forces on the housing development projects generally. This has often resulted in poor performance with increasing cost and time delays (Bashir, 2012).

To cope with this challenge and other recent industry challenges such as internal competitions; rapid technological changes; need for more prudency by clients (Egan, 1998; Latham, 1994) and overriding need for improved performance in the industry (Tah and Carr, 2001), the promoters of housing projects (developers) have developed series of rules of thumb that relies on intuition to analyse and assess risk (Bashir, 2012; Mustafa and Al-Bahar, 1991). However,

with increasing complexity and uncertainty, these rules of thumb have failed to effectively respond to the challenge and hence the need to deploy more robust, logical and systematic approach to risk management.

1.2 Statement of the Problem

Housing development projects, particularly of large scale sizes, like many other conventional construction projects are never free of risk. The nature of housing development projects, which involves multiple parties and processes all aimed at creating a valued products usually result in huge complexities and uncertainties to the developers. It therefore implies that management of risks forms an important and integral aspect of project management required for the realization of project objectives.The approach to risk management within the industry has been in two ways: the use of intuition and past experience as the only way (informal approach) and the deployment of robust systematic procedure in managing the risk complexities (the formal approach).

Recent studies (Bashir, 2012; Laryea and Hughes, 2009 and El-Sayegh, 2008) have found low usage of formal (systematic) risk management (RM) techniquesand greater reliance on informal approach among stakeholders in the construction industry.

The use of informal risk management approach, which entails subjective judgment and reliance on their experience and intuition, has been found not only to be ineffective in managing the complexities of construction and housing related projects risks but also costly in competitive business environment, where it makes products price models unrealistic (Tah and Carr, 2001).The informal approach has been criticized for lacking rational, straightforward approach that can combine all the facets of risk systematically into a prioritized manageable scheme.

On the other hand, the systematic risk management has set of procedures that must be followed and entails careful planning, risk identification, risk assessment and risk response. In the

systematic risk management field, a number of system approaches and models have been developed by both academia and practitioners (Mehdezadeh, 2012; PMI, 2004; Wang,et al., 2004; APM, 2004, Shen et al., 2001 and Tah and Carr, 2001)to guide project promoters to the achievement of project risk management objective.

In Nigeria, despite the growing challenges of risk and uncertainty in the housing development projects and the adverse effects to the attainment of project objectives caused by the use of informal approach vis-à-vis the potential benefits associated with successful deployment of risk managementsystem in project environment, no effort have been made to identify or assess the key risk factors bedevilling the subsector.

Two of the fundamental processes in systematic risk management are identification and assessment of risks.This study focus on the identification and assessment of the risks associated with housing development projects using system approach to risk management.

1.3 Significance of the Research

The presence of risks in a project has the potential of derailing the achievement of its objectives. Therefore, it is of paramount importance that all risks associated with project endeavours are systematically identified, assessed and responded to carefully in order to achieve any set of objectives (Salako, 2010). The study addresses some part of the challenges in the planning and implementation of systematic risk management in the housing development projects, particularly, risk identification framework formulation and risk assessment through the use of Analytical Hierarchy Process analysis and prioritization. Based on the identification framework used in the study, key risks associated with housing development projects are identified and the utilization of the AHP assessment ensures that the risks are prioritized. It is expected that the risk management process(RMP) framework proposed by the study would provide a better, simple and more practical means of risk identification and assessment which shall serve as

subsector benchmark for identification and assessment of risks in project endeavours and serves as one of the basic risk decision support tools for developers in the implementation of systematic project risk management for housing development projects. This will in turn go a long way in improving the project management deficit facing the nation.

1.4 Aim and Objectives

1.4.1 Aim

The aim of this research is to identify and assess risks associated with housing development projects using Analytical Hierarchical Process (AHP)methodology.

1.4.2 Objectives:

i. To identifyrisks associated with project environment generally
ii. To establish risks associated with housing development projects in particular.
iii. To measure the identified risks parameters such as risk probability and impact for assessment purpose.
iv. To determine the most critical risks and structure the risks in a consistent manner.
v. To carry out a prioritization assessment of the identified risks using AHP methodology.

1.5 Scope and limitations

Although, the lifecycle of housing project development covers all phases from inception to disposal and operation, the study is delimited to only the disposal phase and does not extend to operational phase of the project lifecycle. Similarly, the study work is restricted to mass housing development projects to provide a unique window into the risks associated with housing development projects and as such does not capture individual residential housing projects within

the study location. Due to the large number of housing development project developers within the Federal Capital Territory, Abuja operating under same project environment, the study area is confined within the Federal Capital Territory, Abuja the results of the study can be applicable nationwide. Additionally, risk generally is multi-perspective in nature; the study presents risks associated with the housing development projects based on developers' perspective.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Concept of Risk

It is generally acknowledged that every project, particularly construction, have inherent risk associated with it. What in essence does"risk" mean? It is only when the concept is understood that it would relate more meaning in the examination of the construction industry's approach to the issue of risk management, which have now turn to be wholly specialized subject. Efficient achievements of project objectives are some of the underlying benefits of risk management. Baker et al. (1999) asserts that with adequate assistance of risk management, two essential advantages will be captured, more confidence can be given to the estimated project cost and profits will be maximized.

2.2 Definition of Risk

There are undoubtedly, various perspectives on the meaning of the word "risk" just like the concept itself. There are many scholars, professionals' bodies, and standard institutes with various prospective towards the concept and definition of the term "risk". This has made it difficult to come out with a single united definition of the term "risk". However, despite the divergent perceptions, there is some essential elements in similarities with most of the definitions. Standard dictionaries have always connotes the term with negative and involves uncertainty. Bu-Qummaz (2007) submitted that the absence of consensus towards the definition of the term "risk" within the professional bodies and standard institutions is reflected in the presence of different phrases used to define risk in literature. Risk in relation to construction has been defined as an "exposure to economic loss or gain from involvement in the construction process" and "a consideration in the process of the construction project whose variation results in an uncertainty in the final cost, duration and quality of the project" (Kartamand Kartam, 2001). Similarly, within the business circle, risk has been defined both as "lack of predictability

about structure, outcomes, or consequences in a planning and decision situation" and "the probability of occurrence of some uncertain, unpredictable and even undesirable event(s) that would chance the prospects for the profitability on a given investment" (Nasir et al., 2003).

What is apparent in all these and similar definitions available is that the component of the term "risk" by definition can compose of three perspectives: either the term is (1) all negative (threat) (2) neutral (could be threat or opportunity) or (3) includes both negative and positive outcomes (threat and opportunities).

It is on these different perspectives of the term that various professional bodies and standard institutions proposed their definition of the term that reflect their members and corporate objectives. The Institution of Risk Management (IRM) surprisingly adopted the negative notion of the term, although, the IRM has no official definition of the term. Its document shows and refers to risk in phrases such on "change of bad consequences, or exposure to mischance". It adopted the traditional view that risk is wholly negative.

On the other hand, the United Kingdom (UK) Association of Project Management (APM) has neutral view of the term "risk". In its Project Risk Analysis and Management Guide (*PRAM Guide*) risk is defined as "an uncertain event or set of circumstances which, should it occur, will have an effect on achievement of objectives". In other words, the effect could include both positive and negative effects. The British Standard Institute (BSI, 2000) follows this same view of the word in its BS6079-3:2000, by submitting that, "risk is uncertainty…..that can affect the prospect of achieving……goals".

The recent trends in institutional definition took the third perspective that includes both negative and positive outcomes (threats and opportunities).The Project Management Institute (PMI, 2004) defines risk as in its *guide* to the Project Management Body of Knowledge (*PMBoK*) as "an uncertain event or condition that if it occurs, has a positive or negative effect on a project

objective". In a similar fashion, the Risk Analysis and Management for Project, guide (*RAMP Guide*) produced jointly by the Institute of Civil Engineering (ICE), the Faculty of Actuaries, and Institute of Actuaries defines risk as " a threat (or opportunity) which could affect adversely (or favourably) achievement of objectives". Table 2.1 presents some of the definitions based on some of the professional institutes.

Hillson and Murray-Websters (2007) submitted regarding the standard publications and professional bodies view on risk that until the late nineties, the vast majority of official published risk management standards exclusively used a negative definition. From the late nineties onward, two different views have emerged: either a neutral definition is presented or a wider definition that includes both threat and opportunities was adopted. From the present millennium the standard have regarded risk in explicit definition to include both threats and opportunities.

For the purpose of this study, the traditional definition of risk in terms of negative (threats) is adopted and would be used except where the circumstance call for explicit expression of different point of view.

Other Definitions

There are several other definitions of the term "risk" some of which includes "The exposure of possibility of economic or financial loss or gain, physical damage or injury, or delay, as a consequence of the uncertainty associated with pursuing a particular course of action" (Perry and Hayes, 1985; Chapman and Ward, 1997).Jaafari (2001) andKartam and Kartam (2001) also define it as "the probability of losses in a project".Baloi and Price (2003) consider risk as "the likelihood of a detrimental event occurring to the project" while Herzt and Thomas (1984) from business perspective look at risk as "a barrier to success".

Table 2.1 Definition of "Risk"

Negative Definitions	NeutralDefinitions	Broad Definitions
CAN/CSA-Q850-97: 'the chance of injury or loss'	AS/NZS:4360:2004 'the chance of something happening that will have an impact upon objectives'	PMBok 2004 'an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective'
IEEE 1540:2001 'the likelihood of an event, hazard, threat, or situation occurring and its undesirable consequences; a potential problem'	Bs6079-3:2000: 'Uncertainty… that can affect the process of achieving… goals'	IRM/ALARM/AIRMIC 2002: 'combination of the probability of an event and its consequence…consequence can range from positive to negative'
	IEC 62198:2001 'combination of the probability of an event occurring and its consequences for project objectives'	PRAM Guide 2004: 'an uncertain event or set of circumstances which should it occur, will have as effect on the achievement of objectives… either positively or negatively.
	JIS Q2001 (E) 'a combination of the probability of an event and its consequence'	

(Source: Raz and Hillson, 2005)

2.3 Risk and Uncertainty

Risk and uncertainty tends to be confusing with each other. Most definitions of risk include uncertainty either explicitly or implied as highlighted above. In attempt to distinguish two intertwined concepts, Jaafari (2001) submitted that "uncertainty is related to the probability of the occurrence of an event; an even is assumed to be certain if the probability of its occurrence is 100% or totally uncertain if the probability of the occurrence is 0% where among these boundaries the uncertainty varies quite wisely".

Flanagan and Norman(1993) defined uncertainty in relation to decision making situation as a "situation in which there are no historic data or previous history relating to the situation being considered by the decision-maker. In other words, it is 'one of a kind'. Whereas risk, which falls in between certainty and uncertainty, is considered in terms of decision as a "risk" when a decision-maker can assess, either intuitively or rationally, the probability of a particular event occurring".

Uncertainty has the potential of making it difficult to predict future events because of its intrinsic characteristics of ambiguity and variability. Hillson and Murray-Webster (2007) describes these two components of uncertainty as "variability describes the situation when a memorable factor can take one of a range of possible values while ambiguity is an uncertainty of meaning" in other words, ambiguity can be used when a particular event may or may not happen at all, and sometimes whether something else unexpected might take place.

Ward and Chapman (2003) in consideration of project life cycle argued that "risk" is usually viewed from a threat and event based perspective, uncertainty goes beyond that because it refers to a lack of knowledge about so many things at any stage of the project life cycle".

Risk, from all definition above, has two major characteristics: first it is associated with uncertainty and the impact of its consequences has effects on the objectives to be realized. Therefore, it can be argue in distinguishing the two concepts that risk is intrinsically linked with objectives by considering its consequences, whereas uncertainty doesn't consider any predefined objectives.

It is on the strength of this risk-objective relationship that the field of risk management importance is based.

2.4 Risk Attitude

It would be a daunting task and even inaccurate to investigate construction participants risk-based decision making behaviours without a good understanding of their risk attitudes.Participants to project environments, especially construction, are always confronted with enormous risk-based decision making problems. The decision makers usually perceive risk differently in various situations. Those subjective perceptions are usually guided and affected by several factors such as early experience, education background, personal belief, culture, etc. Those perceptions cause variations in decision making, making it impossible for people to make same decision in all the situations.

Researchers have studied these human behaviours and its effects onrisk-based decision making. Ward et al. (1991) submitted that "a partly general attitude towards risk refers to their preference for different risk/return trade-offs". On the other hand, Teo and Loosemore (2001) view human attitude from a broader perspective as purely based on individual's positive or negative evaluation of the consequences of a particular type of behaviour, as well as personal beliefs or knowledge about the consequences.What is then risk attitude? Hillson and Murray-Websters (2007) defined risk attitude as "chosen state of mind with regard to those uncertainties that could have a positive or negative effect on objectives". In a broader term, people's risk attitudes reflect their personal characteristics and experience, as well as the economic, policy and management environment which they belong to. Therefore, even in the same situation, various risk attitudes could be adopted, and these would lead to different actual behaviours and consequences. This forms the rationale why even in the same decision situations, different decision makers would make different, sometimes even conflicting judgment and decisions, or even some risks will mean different things to the same people at different times in their lifeor in different circumstance. Hillson and Murray-Webster (2006) presented the relationship between comfort level and response risk as depicted in figure 2.1 below. Wang and Yuan (2011)

concluded that the subjective judgment related to the human factors in the decision making plays an important role in decision making. Although, it is generally accepted that human factors contribute to the formation of people's risk attitude, those factors that have critical influence on risk-based decision maker's attitude in construction project have remains an unsolved problem. Many researches, (Han et al., 2005; Helliar et al., 2002; Harvey, 1988 etc.) have investigated the relationship between decision makers' risk attitude and behaviour. Furthermore, research efforts have also been devoted to studying the influence of risk attitude within the decision making process in construction projects. For instance, Au and Chan (2005) investigated the attitudes toward transferring a time-related risk while Han et al. (2005) investigated risk attitude and bid decision behaviour in the selection of internal project. On the other hand, Wang and Yuan (2011) investigated the factors influencing contractors' risk attitude in construction projects in China and concluded that experience, professional knowledge, educational background, scope of knowledge are some of the critical factors underlying contractors attitude.

In summary, because of the realized importance of decision making attitude within the decision making process more efforts have also been devoted to studying the influence of risk attitude and its consequences in risk management efforts particularly in construction and related projects.

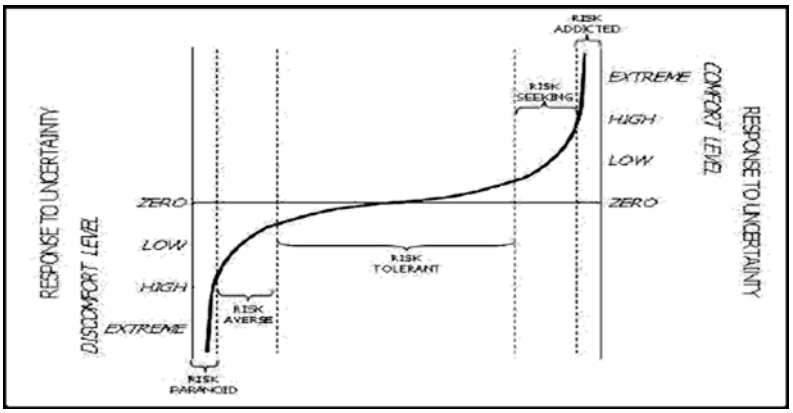


Fig 2.1 Risk Attitude Spectrum

(Source: Hillson and Murray-Webster, 2006)

2.5 Risk Management

2.5.1 Overview

Construction projects are increasingly becoming more complex and dynamic in their nature, and the introduction of new procurement methods means that parties to construction project have to rethink their approach to the way risks are treated within their projects and organization (Tahand Carr, 2001).

The desire to adequately manage risks inherent in project and organization is equally increasing. Risk exists because of people narrow knowledge of the future events clouded by uncertainty. Risk has also become relative not only to projects environment but also to many aspects of human existence (Health, economic performance of our economy, governance and strategy of our businesses etc.) it can be summarized that human beings are daily living to deal with risks and have incessantly seek to manage it proactively. Therefore, the concept of risk management is not new, nor does it entail employing some magical techniques. The knowledge of the importance of risk management has always been there in our society but few people take the time to analyse the risks in practice other than by using intuition and experience. However, the importance of a systematic analysis of risks, which usually identify quantity, build models and predict outcomes (results) that serve as a basis for a conscious decision making has never been undervalued in projects, organizations and even personal ways of lives. The central concerns of most people and organizations have always been on practically, cost effectiveness and realization in the management of risk. Hence, the current emphasis on the needs to have a risk management system that is not too complicated nor requires the collection of vast amount of data for the development of sophisticated super computers with requisite software and expertise to operate.

2.5.2 Historical

Historically, Baker et al. (1999) reported the use of the risk management concept as far back as 3200BC by the Asipu people living in Tigris-Euphrates. The Asipu according to Baker et al (1999) used a procedure that is highly comparable with the ones proposed by the recent methodical risk management guidelines. They tend to identify, propose alternative, and collect data on the likely outcomes. Then the most favourable actions would be selected and reported.

Ever since then, the practice of risk management has evolved with Bortkiewicz attempt in the 19^{th} century to apply probability analysis to a risk problem and later Hertz, in the mid-sixties of the twentieth century derive the probability distribution of the rate of return or the net present of value (NPV) of an investment project.

Risk management have long been acknowledged as an autonomy management discipline in business environment (with insurance and banking industries leading others) because of its importance handling the uncertainty associated with business and processes at all levels.

Unlike the business sector, the construction industry, despite been acknowledged as one of the most risky-prone industries have only embraced this formal management techniques as an integral process during the last few decades (Bu-Qammaz, 2007).

2.5.3 Definition of Risk Management

There is a common occurrence that risks at both corporate and project level need to be managed to among others, at least minimize its impact on success objectives. To have a depth understanding of the concept of risk management, one needs to understand what the concepts mean to the industry, stakeholders. For an individual in an informal setting, to manage risk may entails simply any procedures deployed to control the level of risk and mitigate its effects in the objectives. This procedure may be simply any procedure deployed to control the level of risk and mitigates its effect on the objectives. This procedure might be simply intuitive based on

previous history, record, experience or some subjective emotions. To individuals this might suffice but for organization and other project stakeholders the risk management process is more than intuition, it takes higher responsibility of being more systematic in approach to reflect corporate practice (Edwards and Bowen, 2009). Similarly, with more recent interest in the field of risk management, there is growing proliferation of more literature on guidance, manuals of practices etc. by more professional bodies and standards organizations.

There is at least a common concurrence that risk management from all perspectives and at both corporate and project level is essentially a means to manage inherent risks associated with organization, if not totally eliminated, at least minimize to the lowest level in order to, among others minimize its impact on successful achievement of objectives.

However, because of the divergent meaning attached to "risk" there is also very different meanings and approach to risk management.

Uher and Toakley (1999) described risk management "as a procedure to control the level of risk and mitigate its effects on the objectives". Whereas Wang et al (2004) defines risk management "as the formal and orderly process of systematically identifying, analysing and responding to risk throughout the life cycleof a project in order to obtain the optimum level of risk elimination, mitigation and control". This definition succinctly divides risk management into two broad categories: formal and informal process.

Within the realm of the informal approach, studies have shown that construction risks are mainly handled with experience, assumptions and human judgment (Baloi and Price, 2003). In the same vein, Mehdizadeh (2012) argued that since risks are highly situation specific, expert judgment provides just sufficient means of risk management, problems occurs when this expert knowledge is not documented -which is very common in the construction industry- and most times such knowledge is not transferable. Hartman (2000) submitted further on why

organizations resorts to informal approach that lack of an industry accepted model of risk management and analysis have forced many construction companies to form and test their own risk management models.

Mustafa and Al-Bahar (1991) also attributed the set back of the informal approach to lack of a rational, straight forward approach to combine all the facets of risk systematically into a prioritized manageable scheme.

The informal risk management approach view risk in a highly subjective manner and largely utilize experience, intuition judgment and use of contingency sums to cover any unknown/uncertainty that may arise in the management of projects and its associated risks (Dada, 2010; Smith et al., 2006;Akintoye and Macleod, 1997 and Shen, 1997).

The informal risk management approach has been a subject of much criticism because of its perceived lapses. The use of intuition and experience are usually found to be inadequate and fall short of dealing with risks that occur during project execution. This adversely affects the attainment of objectives either in terms of minimizing threats or maximizing opportunities that availed the projects (Kartam and Kartam, 2001).

Because of the adverse effect resulting from the informal approach and the potentials sign shown by the application of risk management in project environment, there have recently been a large number of researchers on the subject of risk management.However, most of the research efforts have focused on formal systematic approach, which has a set of procedures that must be followed in order to achieve objective (Smith et al., 2006).

Risk management within the formal/systematic approach, is acknowledged as an autonomous management discipline, in view of the fact that handling the uncertainty associated with business and projectsat all levels is credited to risk management. Therefore, the professional

bodies and standard institutions have been at the fore front of this approach and have proposed several risk management standards and guidelines to be adopted as a tool for dealing with risk that are either related to the organization business objectives or specific project objectives.

In this regard, the Project Management Institute (PMI, 2008) defines risk management "as a systematic process of identifying, assessing and responding to project risk." According to PMBok guide (PMI, 2008) project risk management is regarded to be one of the nine project manager's knowledge areas. Similarly, there are many guideline and standards by other several professional bodies as (outlined Table 2.2) intended for integrated approach to risk management which address risk across different levels within the organization.Hillson (2006) compiled the list and website address of several of the professional bodies engaged with risk management as contained in Table 2.3.

Bu-Qammaz (2007) on examination of available standards and guidelines discovered that they take on different scopes; while some implement the extensive perspective for risk management, others have limited scope and aimed for project based business and assist in handling project specific risk.

Table 2.2 Risk Management Standards and Guidelines

Reference/title	Standards body/publisher	Date
AS/NZS 4360:2004, Risk Management	Standards Australia, Homebush NSW 2140, Australia, and Standards New Zealand, Wellington 6001, New Zealand	2004
BS 6079-3:2000, Project Management – Part 3: Guide to the Management of Business-related Project Risk	British Standards Institution, London, UK	2000
BS 8444-3: 1996 (previously issued as 300-3-9:1995), Risk Management – Part 3: Guide to Risk Analysis of Technological Systems	British Standards Institution, London, UK	1996
CAN/CSA-Q850-97, Risk Management Guideline for Decision Makers	Canadian Standards Association, Ontario,Canada	1997
CP142 Operational Risk Systems and Controls	Financial Services Authority, London, UK	2002
IEEE 1540-2001, Standard for Software Life Cycle Processes – Risk Management	The Institute of Electrical and Electronic Engineers, Inc., USA	2001
ISO 14001: 2004, Environmental Management Systems – Requirements with Guidelines for Use	International Organization for Standardization, Geneva, Switzerland	2004
ISO/IEC 17799:2005, Information Technology – Security Techniques – Code of Practice for Information Security Management	International Organization for Standardization/International Electrotechnical Commission, Geneva, Switzerland	2005
IEC 62198:2001, Project Risk Management – Application Guidelines	International Electrotechnical Commission, Geneva, Switzerland	2001
JIS Q 2001:2001 (E), Guidelines for Development and Implementation of Risk Management System	Japanese Standards Association, Tokyo, Japan	2001
PAS 56:2003, Guide to Business Continuity Management	British Standards Institution, London, UK	2003
PD 6668:2000, Managing Risk for Corporate Governance	British Standards Institution, London, UK	2000
PD ISO/IEC Guide 73:2002, Risk Management – Vocabulary – Guidelines for Use in Standards	British Standards Institution, London, UK	2002
A Guide to the Project Management Body of Knowledge (PMBok®),	Project Management Institute, Philadelphia, PA, USA.	2004

3rd edn., ch.11 Project Risk Management		
A Risk Management Standard	Institute of Risk Management (IRM), Association of Insurance and Risk Managers (AIRMIC), and National Forum for Risk Management in the Public Sector (ALARM), London, U.K.	2002
Continuous Risk Management Guidebook	Software Engineering Institute (SEI), Carnegie Mellon University, USA	1996
Enterprise Risk Management – Integrated Framework	The Committee of Sponsoring Organizations of the Treadway Commission, USA	2004
Guidelines for Environmental Risk Assessment and Management	DETR, Environment Agency and IEH/ The Stationery Office, London, UK	2000
Guidelines on Risk Issues	The Engineering Council, London, UK	1995
Management of Risk – Guidance for Practitioners	UK Office of Government Commerce (OGC)/The Stationery Office, London, UK	2002
Project Risk Analysis & Management (PRAM) Guide, 2nd edn.	Association for Project Management / APM Publishing, High Wycombe, Bucks, UK	2004
Risk Analysis and Management for Projects (RAMP) 2nd edn.	Institution of Civil Engineers, Faculty of Actuaries and Institute of Actuaries/Thomas Telford, London, UK	2005

Source: (Hillson, 2006)

Table 2.3 Risk Management Professional Bodies

PROFESSIONAL BODY	WEB ADDRESS
Association for Project Management Risk Management Specific Interest Group (APM Risk SIG)	http://www.eurolog.co.uk/APMRiskSIG
Association of Insurance and Risk Managers (AIRMIC)	http://www.AIRMIC.com
European Institute of Risk Management (EIRM)	http://www.EIRM.com
Federation of European Risk Management Associations (FERMA)	http://www.ferma-asso.org
Global Association of Risk Professionals (GARP)	http://www.GARP.com
Institute of Risk Management (IRM)	http://www.theIRM.org
International Association of Contract and Commercial Managers (IACCM) Business Risk Working Group	http://www.IACCM.com/risk.php
International Council on Systems Engineering Risk Management Working Group (INCOSE RMWG)	http://www.INCOSE.org
Project Management Institute (PMI) Risk Management Specific Interest Group (PMI Risk SIG)	http://www.RiskSIG.com
Risk Management Association (RMA)	http://www.RMAhq.org
Society for Risk Analysis (SRA)	http://www.sra.org

Source: (Hillson, 2006)

2.6 Risk Management Process (RMP)

The essence of risk management is to eliminate or minimize the impact of unplanned incident on project objectives through systematic identification, analysis and response to potential risks before significant negative consequence occurs.

Nieto-Morote and Ruz-vila (2011) submitted that project risk management is beneficial if it is implemented in a systematic manner from planning stage through the project completion. In their opinion, the unsystematic and arbitrary risk management can endanger the success of the project since most of the risks are very dynamic throughout the project lifetime. Edwards (2001) also agrees with this position that risk management is a systematic approach to dealing with risk.

Bashir (2012) opined that there is no singular methodology for risk management in construction project but a number of professional bodies, standard institutes and academic writers have provided frameworks for formalized risk management procedures.Edwards and Bowen (2009) also,in concurrence with Bashir (2012),has similar opinion that there are many techniques that are available for each of these processes, the choice of techniques been influence by the nature of the risk involved and the amount of information available.

Flanagan and Norman (1993) considers risk management as a system which aims to identify and quantify all risks to which the business or project is expressed so that a conscious decision can be taken on how to manage the risks. Further, Flanagan and Norman (1993) submitted that the process of risk management system can be broken down into risk management subsystems (known as Risk Management Process – RMP) which can comprisethe following stages. Risk identification, risk classification, risk analysis and risk response.

Baker et al. (1999) submitted a framework of risk management lifecycle that includes risk identification, risk analysis, risk evaluation, risk response and risk monitoring which lead to controlled risk environment as depicted in Figure 2.2.

Several of the risk management schools and professional bodies did not only offer conceptual definitions of the risk management concept but also elaborate insight as to the framework in term of processes and techniques on how to achieve effective risk management objective.

Al-Bahar (1989) recognizes that the main task of risk management in a project can be appreciated systematically by breaking it down into the following three stages: risk identification, assessment and risk response and control. Similarly, Steele (1992) put forward that RM involves the identification, mitigation and evaluation of risks. However, Pipathanapiwong et al. (2003) asserts that the RMP provides a systematic and logical process for risk management including risk identification, risk structuring and risk analysis and response. The need of the different parties involved in a project and their objectives are incorporated in each process. Priorities based on significance of risks and objectives are considered. Al-Bahar and Crandall (1990) had argued that a conceptual framework which identifies the needs of the parties to a project in terms of risk identification and assessment can provide a basis for proactive rather than reactive risk management.

Other previous researches have similarly argued that for an effective stakeholder project risk management system, it should span the whole procurement process, incorporating pre-project planning and resource allocation; monitoring and control during operation activities, and post-project evaluation and feedback.

Edwards and Bowen (2003) opined further that the more serious the risk, the higher should be the level of management involved in the decision making which spawned it and in the subsequent processes for dealing with it.

The RMP provides a framework within which identification, assessing, mitigating and reporting the risk associated with projects can be carry out successfully. It provides a means of ensuring that risks are adequately assesses, and optimum value is achieved in the delivery of projects. Based on the foregoing, it can be submitted that risk management system includes risk identification, analysis, evaluation and control. Baker et al. (1999) however, submitted that even these steps can further be divided to include risk response and monitoring which in turns will result in obtaining a controlled risk environment.

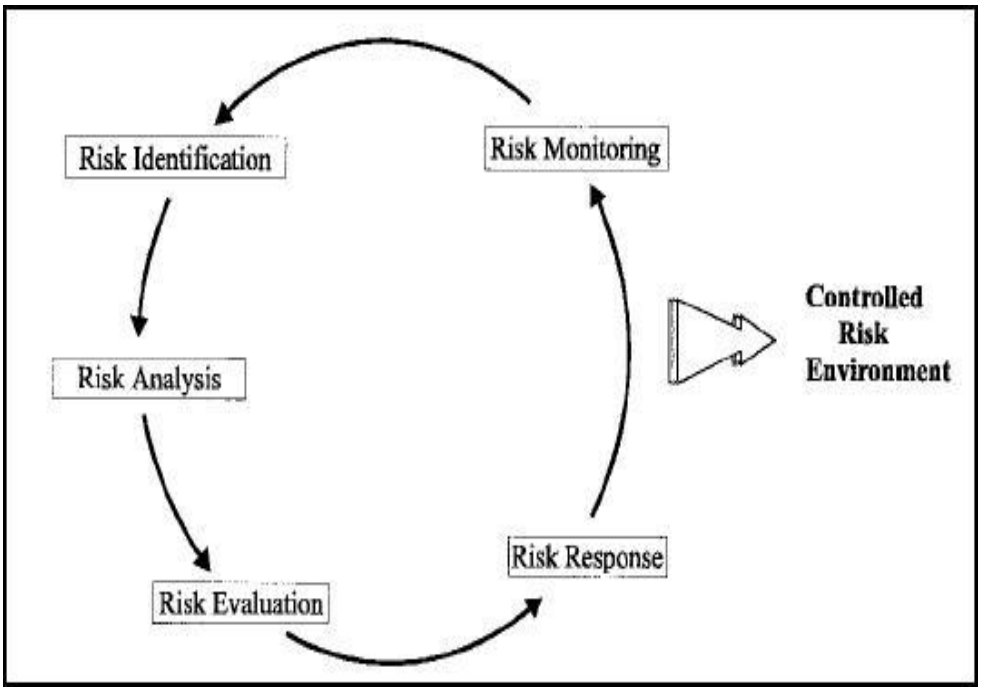


Fig. 2.2 Risk Management Lifecycle

Source: (Baker et al., 1999)

2.6.1 Institutional Perspective of Risk Management Framework

From the professional and institutional perspective, RMP goes beyond the identification-analysis and response approach. It is the establishment of an overall framework/strategy at the institutional level of how project/organizational risks should be addressed and managed. The strategic approach takes into account, among others, the organization's overall appetite for project risk vis-à-vis the expected reward. It incorporate policies, procedures and processes of identification, analysis, responds and other elements deemed practicable, all within a given framework.

Based on this approach, several risk management professional bodies and standards institutions have proposed RM standards and guidelines to be adopted as a tool for dealing with risk that are either relative to the organization business objectives or specific project objectives. Similarly, there are many guidelines that are intended for integrated risk management, as a framework, which address risk across different levels within an organization.

Bu-Qummaz (2007) after extensive examination of the available standard and guidelines submitted that they take on different scopes; while some implement the extensive perspective for risk management, others have limited scope and aimed for project-based business and assist in handling the project specific risks.

There are numerous standards and guidelines by professional bodies aim at providing guidance to practitioners for effective utilization of risk management practices. Raz and Hillson (2005) have undertaken a comparative review of nine major risk management standards; focused on their scope, process steps and specific emphasis. At the end Raz and Hillson (2005) discussed thesimilarities and differences to demonstrate how they harmonize each other in some areas. Accordingly, it was found that the major steps for applying risk management with regards to the nine different standards can be stated as

follow: planning, identification, analysis, treatment and control. Although, the use of terminology may be different from standard to another, yet the formation of the process is identical. For instance, there is alternative usage of the term "analysis" and "assessment"; while some standards have used the term "analysis" others have used "assessment". Similarly, in some standards "analysis" is divided into "estimation" (determining the probabilities and consequences of the risk events) and "evaluation" (prioritization of the risk events by determining their overall magnitude".

Table 2.4 and Table 2.5 present a brief on summarized work of Raz and Hillson (2005) on the review of the nine standards. In addition, the researchers have prepared a separate table (Table 2.6) which contained tools and techniques proposed by the different guidelines for identifying risk through the identification process.

Table 2.4: Risk Management Standards Reviewed

Title	Author	Year	Scope
National and international standards IEEE Standard 1540-2001: Standard for Software Life Cycle Processes – Risk Management	Institute of Electrical and Electronic Engineers, USA	2001	P/O
CEI/IEC 62198:2001: International Standard Project Risk Management: Application Guidelines, 1st edition, 2001-04	InternationalElectrotechnical Commission, Switzerland	2001	P
JIS Q2001:2001 (E): Guidelines for Development and Implementation of Risk Management System	Japanese Standards Association	2001	O
AS/NZS 4360:2004: Risk Management	Standards Australia/ Standards New Zealand	2004	O
BS 6079-3:2000: Project Management – Part 3: Guide to the Management of Business-related Project Risk	British Standards Institution (BSI)	2000	P
CAN/CSA-Q850-97: Risk Management: Guideline for Decision-Makers Professional standards	Canadian Standards Association (CSA)	1997	O

Risk Management Standard	Institute of Risk Management(IRM)/National Forum for Risk Management in the Public Sector (ALARM)/ Association of Insurance and Risk Managers(AIRMIC), UK	2002	O
Project Risk Analysis & Management (PRAM) Guide, 2nd edition	Association for Project Management (APM), UK		P
Guide to the Project Management Body of Knowledge (PMBok®): Chapter 11, Project Management, 3rd edition	Project Management Institute, USA	2004	P

Source: (Raz and Hillson, 2005)

Table 2.5 Element of Identification, Analysis and Treatment Steps

	Identification	Analysis	Treatment
IEEE 1540-2001	Risk identification	Risk estimation Risk evaluation	Perform risk treatment Selecting risk treatment Risk treatment planning and implementation
IEC 62198	Risk identification (consider the impact of risks upon all project objectives- cost, time, quality etc.)	Risk assessment Risk analysis (qualitative/quantitative) Risk limits and boundaries Dependences, Probabilities of occurrence; Impact on objectives Risk evaluation Risk level vs tolerability criteria; priorities for treating risk; Risk acceptance	Risk treatment
JIS Q 2001: 2001	Risk analysis - Risk Finding - Risk Identification	Risk analysis: Risk Estimation Risk Evaluation: Comparison to necessary risk criteria Risk Management targets	Selection of risk treatments: Establishment of risk management program; Implementation of risk management program; Additional considerations for emergencies and resumptions; Operative Control
AS/NZS 4360:2004	Risk Identification -What can happen -How and why it can happen	What analysis: Determine existing strategies and controls Consequences and probability; Types of analysis: qualitative; semi-quantitative analysis; quantitative analysis Sensitivity analysis Evaluation risks	Risk treatment; Identifying options for risk treatment; Assessing risk treatment options; Preparing and implementing treatment plans.
BS 6079-3; 2000	Risk identification and strategy Risk model clarification	Risk analysis Risk evaluation unacceptable; negligible and acceptable threat; Critical and desirable opportunity	Risk treatment Implementation

CAN/CSA-Q850-97	Preliminary analysis; Defining scope of definition(s); Identify hazards; Beginning stakeholder analysis; Strategy risk information library	Risk estimation: Defining methods for estimating frequency and consequences; Estimating frequency ; Estimating consequences; Refining stakeholder analysis; Risk evaluation; Estimating and integrating benefits and costs. Assessing acceptability of risk to stakeholders	Risk control Identifying feasible risk control options Evaluating risk control options Assessing stakeholder acceptance Risk financing Assessing stakeholder acceptance
IRM/ALARM /AIRMIC	Risk identification Risk description	Risk estimation; Probability and Consequence; both threats and opportunities Risk analysis methods and techniques Risk profile summarizes results of analysis, and provides a tool for prioritizing risks	
PRAM	Identify phase; search for sources of risk and responses; classify; characterize	Assesses phase Structure; Search/brainstorm/interview; Order risks and response for Ownership; Allocate responsibility; approve contractor allocation Estimate and Evaluate	Planning responses phase Plan risk event responses Plan project risk responses
PMBok®	Risk Identification	Qualitative risk analysis Quantitative risk analysis	Risk response planning

Source: (Raz and Hillson, 2005)

Table 2.6: Consolidated list of Tools and Techniques for Risk Identification

Assumption analysis	Fault tree analysis	Questionnaires
Benchmarking	Flow charts	Risk assessment workshops
Brainstorming	Hazard and opportunity studies (HAZOP)	Root cause analysis
Case and effect diagrams	Historical data	Scenario analysis
Checklists	Incident investigation	Stakeholder analysis
Constraints analysis	Influence diagrams	Structured interviews
Delphi technique	Interviewing	SWOT analysis
Diagramming techniques	Lessons learned	System engineering techniques
Documentation reviews	Nominal group technique	System analysis
Evaluation of other projects	Peer review	Taxonomies
Event tree analysis	Personal observation	Technology readiness level
Examination of past risk experience in similar organizations	Previous experience	Testing and modeling
Examination of past risk experience in the organization	Project monitoring	
Examination of vulnerabilities and weaknesses	Prompt lists	
Expert opinion	Prototyping	

Source: (Raz and Hillson, 2005)

Raz and Hillson (2005) also, after detailed comparison of the standards and guidelines have concluded that even when the scope of standards differs widely as they range between a limited scope which aims to be implemented within certain types of project or activities; or a much wider scope which can be utilize for any type of activity within the organization; no

fundamental differences were located between the two extremes with regards to the structure of the process or their contents. Raz and Hillson (2005) therefore have suggested that the best practices proposed by these standards are suitable to be implemented in projects or any other types of activity conducted within an organization. The consistency observed between the standard brace the fact that there is a general consensus among risk practitioners about the major components of risk management process.Tah and Carr (2001) present more robust model that consists of five steps as shown in Figure 2.3 below.

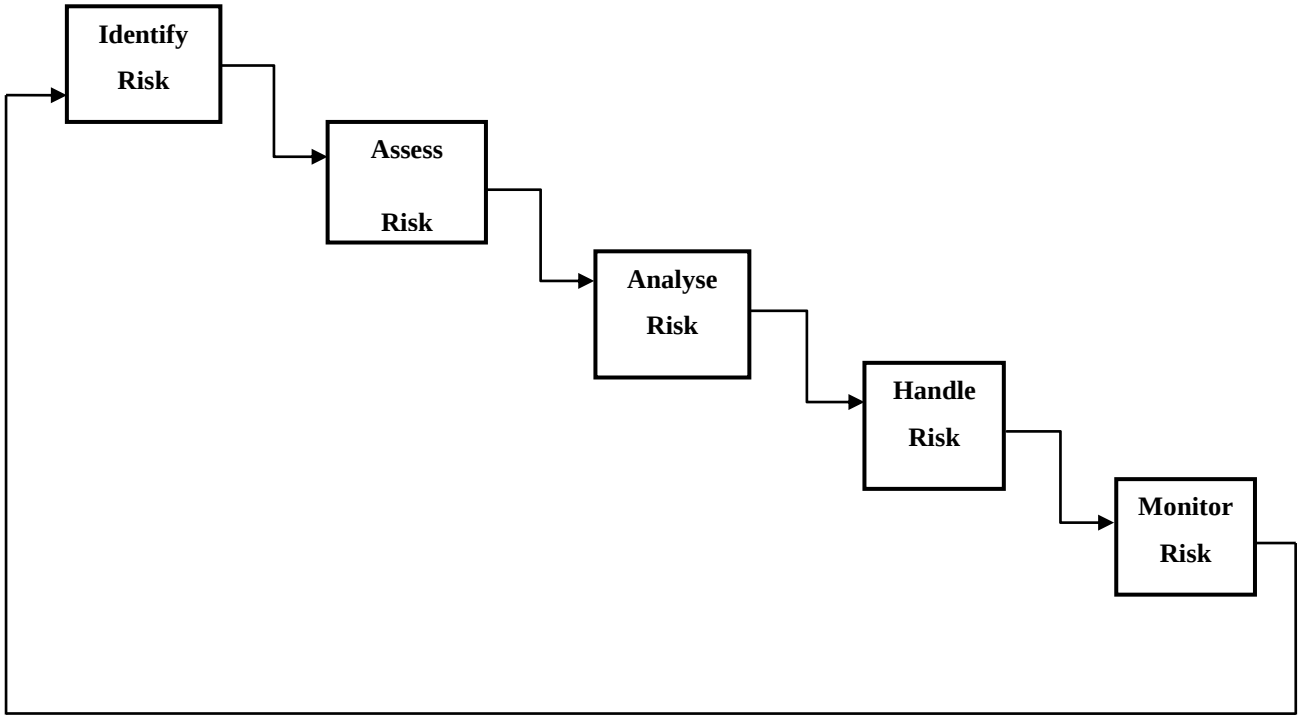


Figure2.3:Risk Management Process (RMP)

Source: (Tah and Carr, 2001).

2.6.2 Risk Management Models

Berkely et al. (1991) have suggested a simple, common and systematic approach to risk management with a model consisting of four distinct stages: (a) risk classification, (b) risk identification, (c) risk assessment, and (d) risk response. In the first stage, risks should be classified into groups with certain criteria in order to clarify the relationships between them.

The second stage entails the identification of the risks pertaining to risk management. The third stage is to assess and evaluate the effects of these risks. In the final stage, appropriate risk response policies should be developed to reduce and control the risks.

Flanagan and Norman (1993) also outlined a more elaborate system (as shown in Figure 2.4 below) compares to Berkely's model in which risk management is modelled to consist of five stages:

i.	Risk identification:	Identification the sources and type of risks
ii.	Risk classification:	Consider the type of risk and effect on the person and organization.
iii.	Risk analysis:	Evaluate the consequences associated with the type of risk, or combination of risks, by usinganalytical techniques. Assess the impact of risk by using various risk measurement techniques.
iv.	Risk attitude:	Any decision about risk will be affected by the attitude of the person or organization making decision.
v.	Risk response:	Consider how the risk should be managed by either transferring it to another party or retainingit.

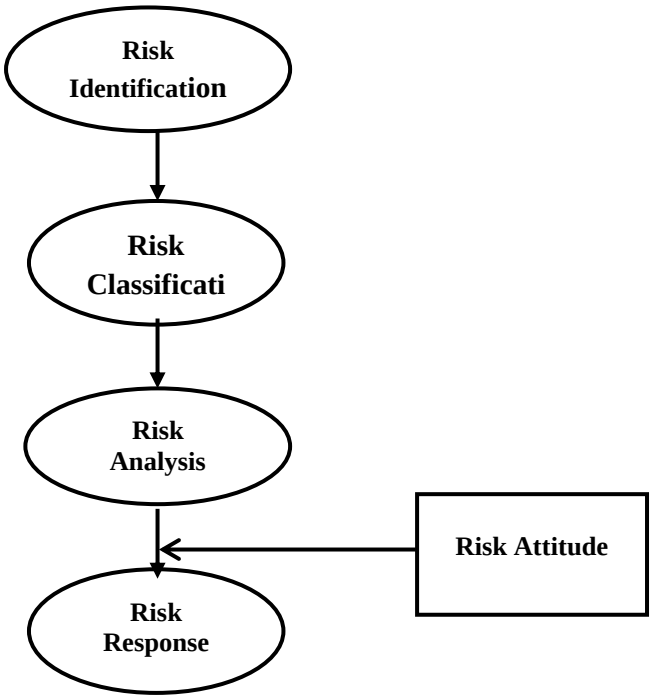


Fig 2.4 Risk Management Model
(source: Flanagan and Norman, 1993)

Tummala et al. (1994) proposed a more comprehensive and systematic approach consisting of five core elements as shown in Figure 2.5 and referred to as the RMP. The RMP begins with identifying the strategic importance of a project together with associated project mission, aims and objectives; the resulting strategy from the integration of all these elements, overall corporate, would constitute the driver of the RMP methodology. Tummalaet al. (1994) explained that the risk identification, risk measurement, and risk assessment together constitute the basic set of tools required to facilitate the identification of potential risk factors, enumeration of the associated consequences and their severity and the assessment of the likelihood of the occurrence of the consequences, as a step towards developing the corresponding risk profile that are necessary for the accomplishment of project objectives.

In the risk evaluation phase, the project managers/decision makers should be able to evaluate several decision alternatives based on the risk profiles generated by using risk identification, risk measurement and assessment phases and choose the most appropriate course of action to contain and control the identified risks. The final phase-risk control and monitoring- serves to enhance a review of project progress and correct any deviations relative to established targets.

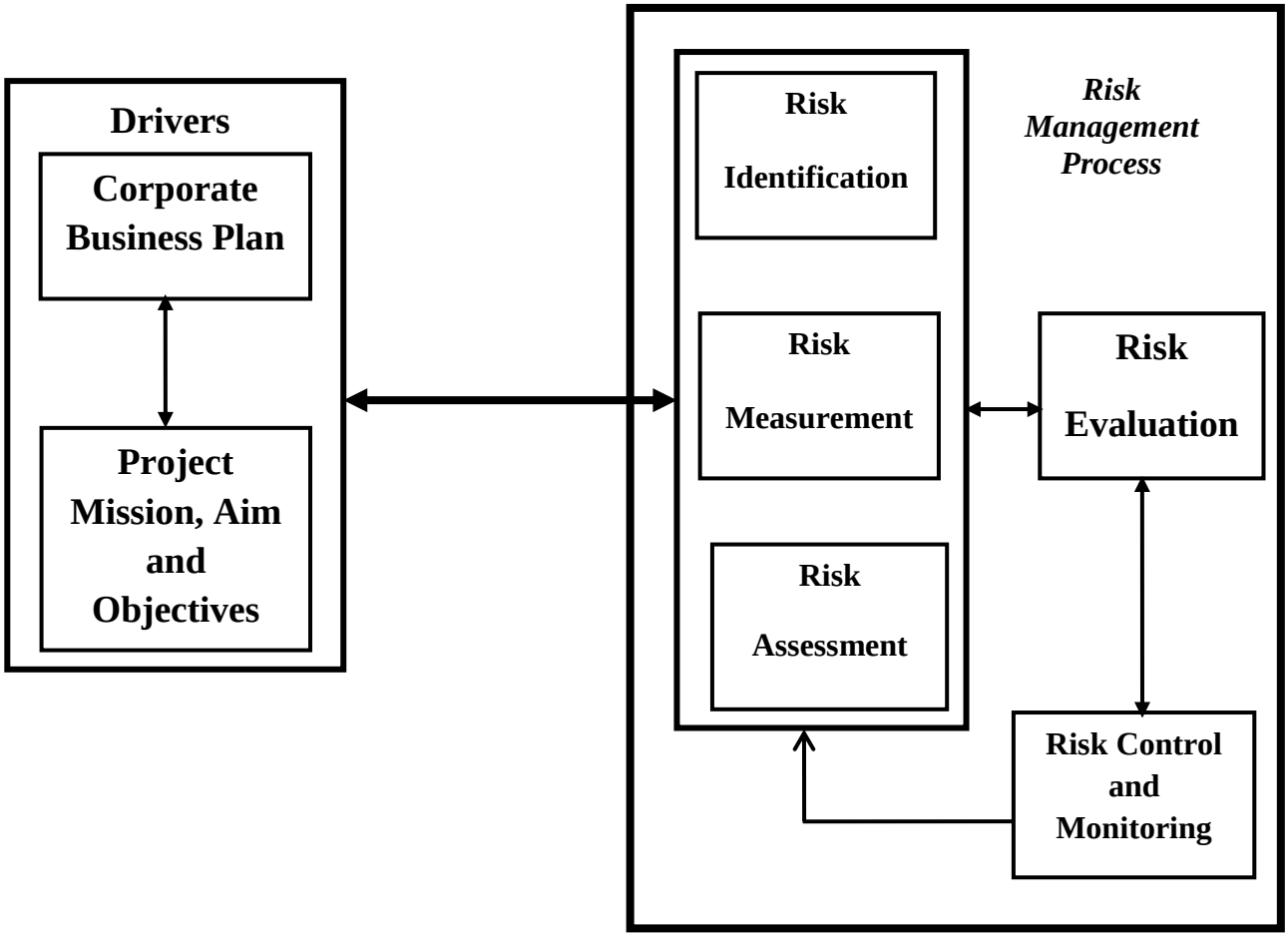


Figure 2.5 Risk Management Process (RMP) Model

Source: Tummalaet al. (1994)

From the institutional or professional perspective, just as previously highlighted, there are several framework/models proposed for use by practitioners. Based on the analysis and submission of Raz and Hillson (2005) studies, which shows that there is a general agreement among risk professionals on the major steps/processes for managing risk, it is essential to examine just one of the models put forward to give an insight on the industry's institutional perspective of risk management model. The Risk Analysis and Management for Projects (RAMP) put forward by the joint working group between the ICE and the faculty of Actuaries and institute of Actuaries which lean so much on construction project risk management process is examined.

The RAMP Processes

The RAMP is a process for analysing and responding to risk that can have an influence on the achievement of project objectives (Bu-Qummaz, 2007). The RAMP covers the whole project lifecycle from inception to disposal and essentially contains four activities (as shown in Figure 2.6 below):

i. Process launch
ii. Risk Review
iii. Risk Management
iv. Process Closed-Down

Hitchings and Wilson (2002) have examined the RAMP, based on the RAMP handbook and discussed the main issues regarding this process as follows:

The RAMP process consists of four activities; these activities are carried out at different stages of investment (project) life cycle, the activities together with the times into which they supposed to be conducted are indicated below:

i. Process launch: Conduct early in the invention life cycle.
ii. Risk Review: Conducted before key decisions or interval.
iii. Risk Management: Conducted continually between risk reviews
iv. Process Close-Down: Conducted at the end of the investment lifecycle or on premature termination.

A brief explanation of the RAMP process is outlined below

Process Launch

It is essentially a preparation/planning stage. Prior to the establishment of RAMP it is essential to collaborate the perspective from which the risk analysis and management is being

performed in addition to the identification of the key stakeholders according to whom the outcomes are evaluated.

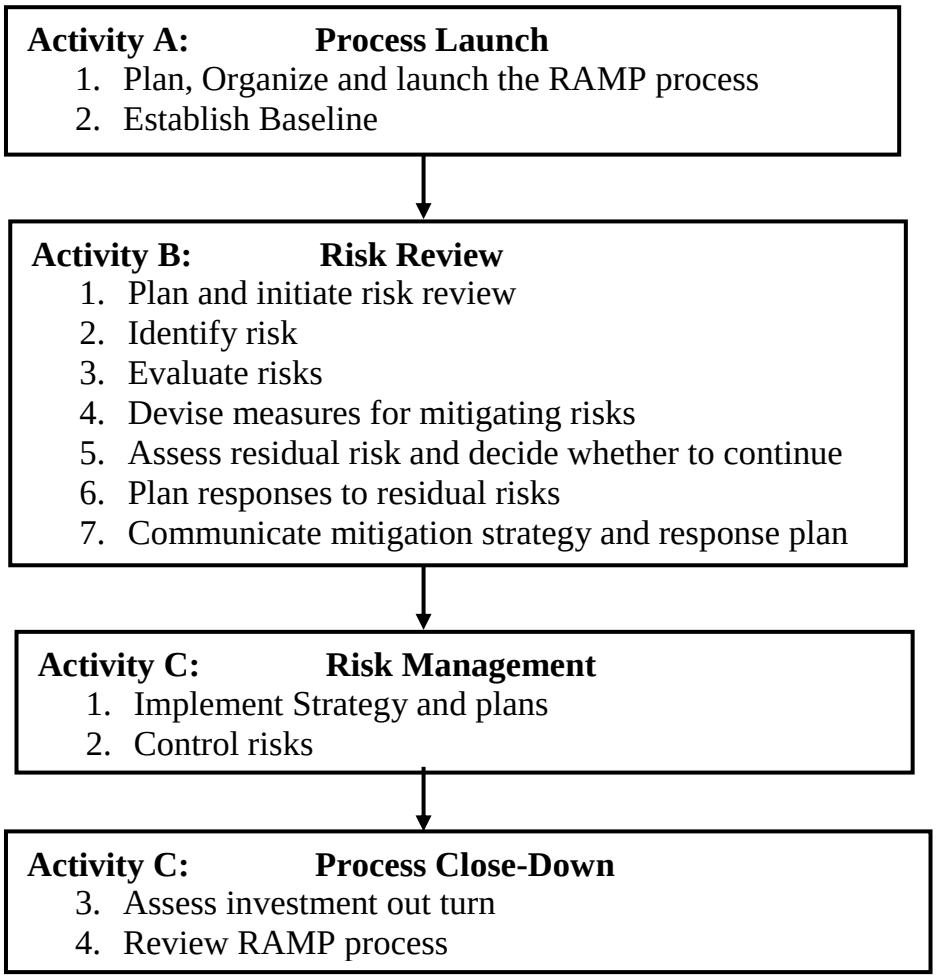


Figure 2.6: The RAMP Process

Source: (Hitching andWilson, 2002)

Risk Review

The risk review plan prepared at the launch includes the aims, scope, and level of the risk review. The aim usually is to discover all the significant types and sources of risks and uncertainty associated with the objectives of the project. It may also include the determination of the cause(s) of each risk, assess the interactions between risks, and how the risks should organized or clustered to be evaluated. Further, many mitigation options are

contemplated for dealing with the non-negligible risks. In essence, the risk review activity under RAMP contains several major phase which include: risk identification, risk analysis, risk mitigation, financial evaluation and the go/no-go decision.

Risk Management Activity

Hitching and Wilson (2002) submitted that through this activity the residual risk analysis, risk mitigation strategy and risk response plan are all implemented within the main stream investment, project and operating management phrases. Then, actions are monitored to ensure their timely and satisfactory completion; where any deviations from the planned actions are directly reported to the manager. Furthermore, throughout the project lifecycle the residual risk analysis, risk mitigation strategy, and risk response plan are reviewed and the contingency budget is utilized due to risk exposure. In the course of this activity risk review reports are submitted to the client's representative and stakeholders.

Process Close-Down Activity

At the end of the investment/project life cycle or on premature termination of the project, a revision is undertaken to determine the effectiveness of the implementation of RAMP process to the investment/project. A RAMP close-down report is developed using the result of this review. The report compares the performance of the investment/project with the original objectives. Furthermore, an assessment is performed for the risks and their actual impacts comparing them with those predicted. Finally, the report records the learnt lessons and suggested improvement for future project (RAMP, 2004).

In conclusion, careful examination for all the above highlighted risk management models, fromBarkely et al. (1991) to Flanagan and Norman (1993) toTummala et al. (1994) and the RAMP(2004)it is apparent that there is a general theme, within all the models, regarding the

concentration in the indispensable role for adequate identification and assessment of risks, risk events and their sources to ensure effective implementation of the models. More so, there is no fundamental difference found between the several models proposed by both scholars and practitioners regarding the structure for the process for managing risk in project/investment.Therefore, these two important stage/processes of risk identification and assessment are further examined.

2.7 Risk Identification

Al-Bahar and Crandall (1990) defined risk identification as "the process of systematically and continuously identifying, categorizing, and assessing the critical significance of risks associated with a construction project". The risk identification process is a diagnostic stage during which the uncertainties associated with the achievement of objectives are reduce, in descriptive terms. The identity and potential impact of the key variables that characterize risk in the problem situation under consideration are giving further consideration. In other words, risk identification entails capturing all possible range of risks that might affect the project at that stage of its development. The emphasis is to maximize the quantity of possible risks rather than their quality at this stage of the RMP by generating a large quantity imaginative risk scenarios, it is more likely that all possible scenarios will be covered. If a risk is not identified it cannot be controlled, transferred or otherwise managed. Risk identification is part of the iterative process of identification-mitigation-evaluation-control mechanisms that should be approach as an iterative process, and not in the discrete phases, continuously until a satisfactory position is reached (Chinyio and Fergusson, 2003).

Risk identification is a necessary first step before risks can be analysed and appropriate response can be determined. The risk identification process is important because it focuses the attention of project management on strategies for the control and detection of risk, as it

will highlight those areas where further consideration in design and development work is needed. It is a difficult and complex task because there is no unerring procedure which may be used to identify construction risks. It relies heavily in the experience and insight of the key project personnel (Bajaj et al., 1997). Karimiazari et al. (2011) submitted that risk identification is the first step which determines which risk components may adversely affect which project objectives and documents their characteristics.

For the purpose of this study, risk identification is a systematic procedure of identifying risk sources, classifying and grouping the risks based on some definite criteria and applying some structuring techniques to provide initial assessment of the risk. In this regards, identifying risks in projects follows the systematic pattern outlined in Figure 2.7 below

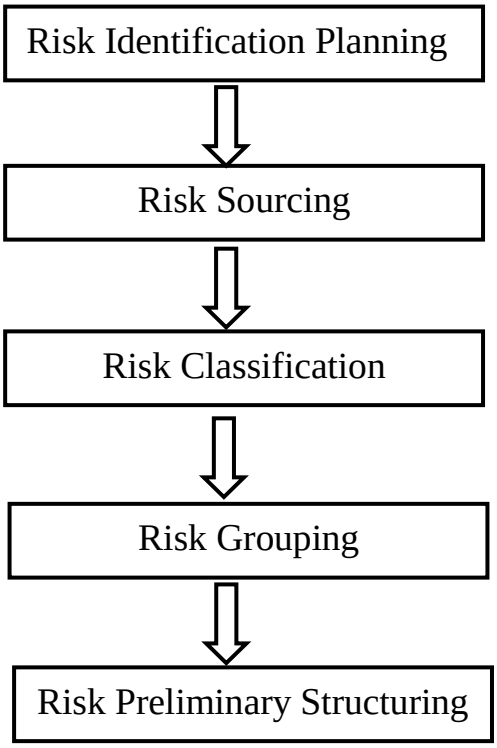


Figure 2.7: Risk identification framework

(Source: Author, 2014)

2.7.1 Risk Identification Planning

The first step in risk identification process is to actually define and agree on the process to be followed at the outset as part of the overall risk management plan. This may already be reasonably well defined where an established framework such as PRAM, RAMP etc. is being followed. This has clearly identified RM application, each having a particular purpose. Alternatively, in the case of organizations with no recognized approach, this would have to be defined from scratch. Aside from take off point for the RM process, it is necessary to identify roles and responsibilities of the parties involved, agree the method and approaches to be used and review and reporting frequency.

2.7.2 Sources of Risk

At this stage, the sources of all risk events and their potential effects on project objectives are identified. Flanagan and Norman (1993) cautioned that at this level all sources of risk and the effects of risk are not only identified but must also be clearly distinguished as in the sequence in Figure 2.8 below.



Figure 2.8 Risk sourcing sequence

Source: (Flanagan and Norman, 1993)

Flanagan and Norman (1993) further outlined, as presented in figure 2.9, that some risks are controllable, such as a lack of coordination between the mechanical engineering services specialist contractor and the suspended ceiling specialist control. Other risk, such as the risk caused by exceptional inclement weather, cannot be controlled. However, it is always difficult to think in terms of the source, the event, the effect but the structuring of which in a systematic manner has proved positive.

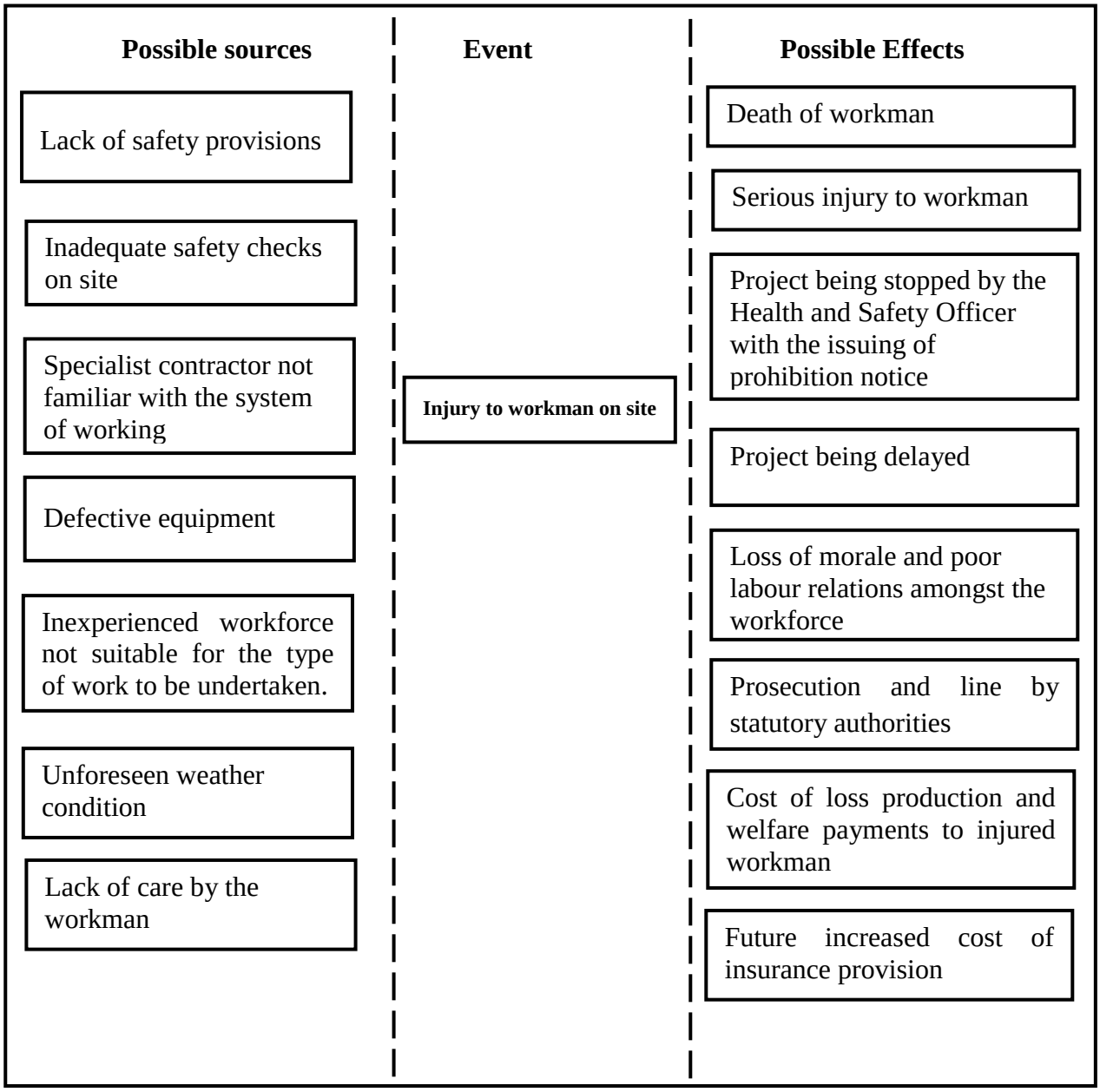


Figure 2.9: Example of source-event –effects iteration

Source: (Flanagan and Norman, 1993)

Al-Tabtabai and Diekmann (1992) stated that the primary basis for identifying risks is historical data, experience and insight. Similarly, Toakley and Ling (1991) reported that to aid in sourcing risk for risk identification purposes, many firms have compiled checklists, which are simple catalogue to help prevent risk overlooked.

Shehu and Sommerville (2006) outlined that the project team have a broad scope when attempting to identify potential sources of risk and thereby reducing the chance of overlooking important areas of risk. Similarly, Al-Tabtabai and Diekmann (1992) argued that the primary basis for identifying risks is historical data, however,Razand Hillson (2005) study has elaborated more avenues and provided a few dozens of tools and techniques employed in sourcing and identification of risk in project environment.

These risk sourcing techniques ranges from examination of past risk experience, brainstorming, expert opinion, checklists, root cause analysis, SWOT analysis, interventions and host of huge others.

The sourcing of project risks (sometimes terms as the sole identification) is very crucial because if the risks facing a project cannot be determined a priori then any or some of them can materialized at any time in the life of the project's objectives (Chinyio and Ferguson, 2003). They further suggested the need to deploying different ways and tools in order to capture the divergent and multiple of risks in project environment.

2.7.2.1 Common Risk Sourcing Technique

i. Interviews, Survey and Research

Jones (1998) observes that interviews, survey, and research can provide information on the number and nature of specific project risks. Interviewing the project personnel and stakeholders from every construction discipline who have experiences of similar projects ensures that corporate knowledge and experience and utilizes in the process of the identification.

ii. Checklists/registers

Checklists are cheap, simple and adaptable and allow for comparison to be made between different set of data. They can be generic or specific. This can provide a means of use of recorded information in the form of list which can help in the identification of risks. Uher and Toakeley (1999) submitted that checklists were the most frequently utilized technique by PRAM practitioners.

iii. External expert consultation

In some specialised project, experts are consulted when their knowledge is thought to aid the sourcing and identification process. The major setback to this approach is the resultant delay caused by the need for the external expert to fully understand a new setting in the project at hand and the difficulty of transfer of knowledge to project management team.

2.7.3 Risk classification (grouping)

The Project Management Institutes guidance document PMBok (version 2008) defines risk classification as a provider of a structure that ensures a comprehensive process of systematically identifying risks to consistent level of detail and contribute to the effectives and quality of the risk identification process. The risk classification process is vital because it tends to provide each identified risk source factor a specific characteristic that distinguish it with others and which can be used to associate it with similar types of risks when grouping and structuring the risk system. Rezkhani (2012) opined that risk classification is an important step in the risk management process, as it attempts to structure the diverse risks that may affect a project. In other words, the classification process provides the basis for subsequent structuring of risks by distinguishing each with characteristics feature.

For each identified risk, the following information is assigned according to Mehdezadeh (2012):

- The type, cause and description.
- The corresponding phase or task in project plan
- It state (latent, apparent, disappeared), the consequence (on cost, time, performance, etc. value, estimation technique
- Its detestability (consequences or cause, including precursor event)
- The probability of occurrence (qualitative-quantitative)
- Its allocation/responsible
- Risk response (avoid, transfer, mitigate) and needed resources
- Interdependencies with other risks and responses

This information isessential for setting up of a systematic hierarchical structure of risks or risk breakdown structure (RBS) as the case may be.

Accordingly, Oni (1996) classified construction risks into three groups, i.e. construction finance, construction time and construction design. Shen (1997) identified eight major risks accounting for project delay. Tah and Carr (2000) classified project risks by using the hierarchical risk breakdown structure (HRBS) into internal and external risks. Chapman (1997) grouped risks into form subsets: environment, industry, client and project. Dekmen et al. (2007) used influence diagrams to define the factor which have influence on project risks. Similarly, Zeng et al. (2007) classified risk factors as human, site, materials and equipment factors.

Flanagan and Norman (1993) outlined a classification of risks that considers both consequences and impact of risk to either pure risk (specific risk) or speculative (market risk) as presented in Figure 2.10 below.

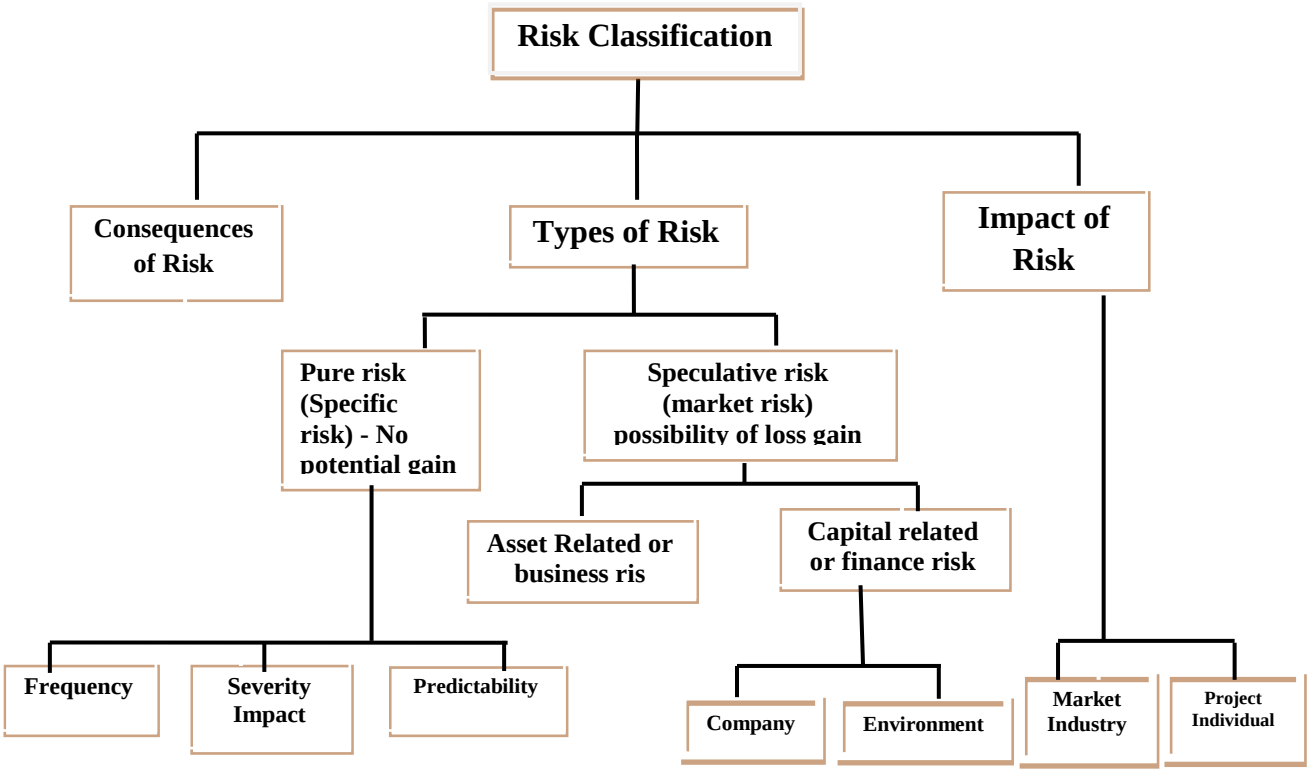


Figure 2.10: Risk Classification

Source: (Flanagan and Norman, 1993)

2.7.4 Risks Initial Structuring

The structuring of risks factors and events tend to create interrelationship between the risk variables in some definitive way. The risk structuring at the identification level is preliminary in nature. According to Mehdezadeh (2012) it is an attempt to link upthe interdependencies of identified risks with other based on some simple linear criteria and result in more perfect picture of the entire project risk. The structuring at this level without detailed analysis is just to enable and facilitate further risk identification and provide the foundation for subsequent analysis and full structuring.

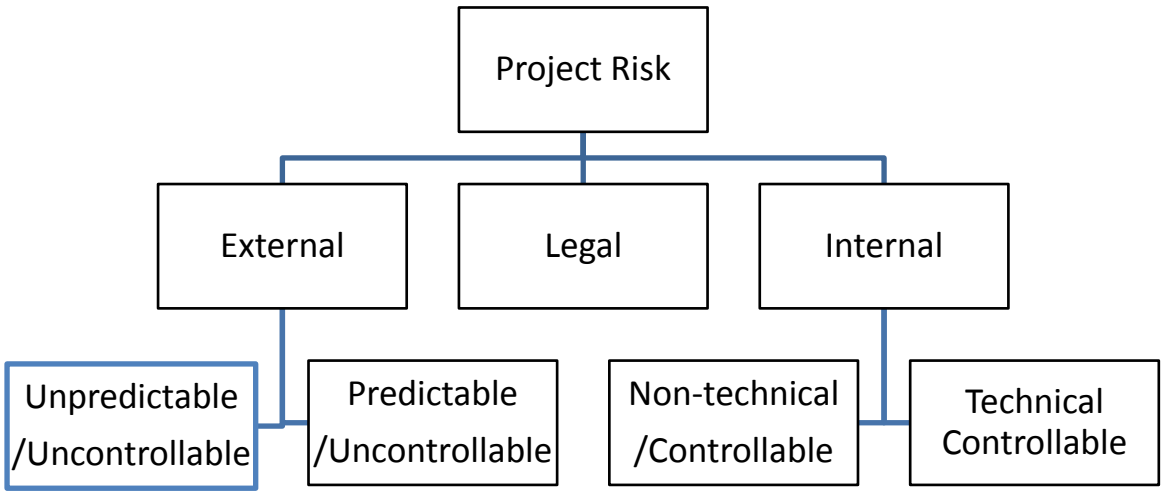


Figure 2.11 Typical Initial Structuring of Specific project risks

(source: Flanagan and Norman, 1993)

2.8 Risk Assessment

2.8.1 Assessment Approaches

The risk assessment process in a risk identification-assessment-response model of RMP is an integral project that composes of three subsets activities: measurements, analysis and evaluation. It is a vital link between systematic identification of risk and rational response/mitigation measure for the control of risks in a project. The risk assessment process aims to evaluate the consequence associated with risk by measuring the relative occurrence and impact of risk using measurement and analysis techniques. The process leads to structuring and prioritization of identified risks for further project management team actions.

Thomas et al (2006) submitted that in all the RMP, the risk assessment process is perhaps the most difficult tasks. It involves evaluation of the probability of occurrence of risk events and their impacts on projects, objectives such as time, cost, quality and safety.

It is not surprising, therefore, that there are so many approaches, methods and techniques that have been proposed and adopted for use in the assessment of risk involved in project environment. Decision analysis (Jeljeli and Russel, 1995; Ahmad, 1990; De Neufiville, 1990) Stochastic simulation(Holland et al., 1976; Hertz, 1964), Sensitivity analysis (Woodward 1995) and conceptual models/artificial intelligence (AI) analysis are the different approaches that have been used in probability-impact evaluation of project risks.

Tradition risk assessment for construction has been synonymous with the probabilistic analysis (Al-Bahar, 1990). Such approaches requires events to be mutually exclusive, exhaustive and continually independent. However, construction projects involve many variables, and it is often difficult to determine causality, dependence and correlations. As a result, subjective analytical methods that rely on historical information and experience of individuals and companies have been used to access the impact of constructive risk (Bajaj et al., 1997).Recently, a number of models/frameworks based on the above approaches have been proposed for project risk assessment. Table 2.7 presents some of these previous research works on risk assessment as submitted by Thomas et al. (2006).

Table 2.7: Review of Project Risk Assessment Models

Model Name/Utility	Basic Tool/Theory	Author/Researcher	Remarks
Cost impact assessment under varying risk allocation between owner and contractor	Decision analysis	Levitt et al. (1980)	Incorporate differing risk perceptions, incentive to perform, value of controllable risks and differing preferences towards accepting risk
Decision model for risky investment	Multi-attributable utility theory & Bayesian probability	Ibbs and Crandall (1982)	Complexity of the model increases with increase in number of attributes
Cost assessment framework for political risks in international construction	Influence line diagramming	Ashley and Bonner (1987)	Model facilitate for identification of primary political risk sources and their impact on three project cash flow elements; labour cost, material cost and overhead cost
Identification, goal description, risk allocation, risk evaluation and risk mitigation	Expert system-fuzzy set analysis	Kangari and Boyer (1989)	Microcomputer based model which accepts subjective data input from experts
Assessment of project risks during the bidding stage	Analytical hierarchy process (AHP)	Mustafa and Al-Bahar (1991)	Incorporate both subjective and objective inputs.
Bid mark up for construction risk	Fuzzy set theory	Peak et al. (1993)	Risk associated consequences are estimated as fuzzy numbers
Loss assessment model	Fuzzy sets and neural networks	Jablonowski (1994)	Neural network is trained using fuzzy risk profile for various risk scenarios and associated expert limit selections
Liability assessment model	Decision analysis,Influence diagrams and their combination	Jeljeli and Russell (1995)	Facility for incorporating subjective expert opinion. Demonstrated for liability assessment in environmental

			clean-up project.
Cost risk analysis	Influence diagramming and Monte Carlo simulation method	Diekman et al. (1996)	Modelled for internal and external risks. Influence diagramming for external risks and simulation for internal risks.
Evaluation of project life cycle risks	Fault tree and reliability graph analysis	Tsai et al. (1999)	Objective data is required for each risk factor as input. Sensitivity of risk management strategies can be evaluated.
Scheduled risk assessment model	Decision analysis in conjunction with a hypertext information system	Mulholland and Christian (1999)	Incorporate knowledge and experience from experts, project specific information,
Liability assessment model for project disputes	Monte Carlo simulation method	Winter (1999)	Developed by Baker and McKenzie, London
Project investment decision model for international projects	Risk-based normative decision theory, cross impact analysis	Han and Diekmann (2005)	Effective for describing conditional relationship between variables subjectively, Scenario and sensitivity analysis can be carried out for various decision options
Risk assessment for international projects (ICRAM-1)	Analytical hierarchy process (AHP)	Hastak and Shaked (2000)	Provide a structural approach evaluating country level, market level and project level risk indicators of international projects
Assessment of contraction project risks	Risk break down structure, fuzzy logic	Tah and Carr (2000)	Project risk exposure in terms of time, cost, quality and safety using linguistic inputs from experts
Infrastructure risk analysis model (IRAM)	Event tree and expedience probability	Ezell et al. (2000)	Developed for water distribution system but can be extended for other systems. Component

			vulnerability is subjectively assessed and scenario analysis was done through event tree approach.
Evaluation of investment decision in infrastructure project	Monte Carlo simulation method	Ye and Tiong (2000)	Decision criteria as NPV-at-Risk (measure of minimum expected return at a given confidence level) by combining weighted average cost of capital and duel risk return methods. Difficulty in obtaining input density functions.

Source: (Thomas et al. 2006)

The first step in the assessment process is the measurements which tend to first distinguish between risks as to having a "clearly significant" or "possible significant" consequence, or otherwise. The measurement tries to establish by ascribing qualitative or quantities characters features as to the likelihood/frequency of occurrence of risk factor/event per unit of time or some other convenient unit. The potential consequence of the occurrence is also determined. Similarly, the likely timing of the risk in relations to the project life cycle, in terms of both occurrence and impact may be of value in the analysis phase of the assessment process.

In this instance, these events and their consequences may sometimes be related to each other. For instance, where risk may be caused by the same source or the likelihood of one risk is affected by another; the related risk should be accessed jointly.

The main input to risk measurement and analysis is the identified risk from the risk identification process. The probability and impact of identified risk are two key variables in accessing the risk. The process can range from very simple qualitative analysis to complex quantitative analysis which is more sophisticated. The measurement depends in the type of analysis to be deployed.

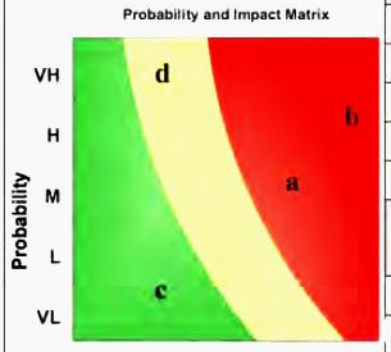
2.8.2 Risk Analysis

The essence of risk analysis according to Flanagan and Norman (1993) is to give an insight into what happens if the project does not proceed according to plan, that is, the likely outcome/effect of project if risk occurs. It attends to capture all feasible options and to analyse the various action of any decision.

Mehdizadeh (2012) outlined three approaches to risk analysis;

a) **QualitativeAnalysis**: it is an analysis which is based on a descriptive or normal scale to describe risk events and their consequences. This is, mainly used in the initial evaluation of risk or for a rapid assessment. It can also be used when there is little knowledge about probability and/or impact. This approach allows risk events to be identified individually with the most significant influence as high priority may be further analyse using quantitative risk analysis methods.
b) **Semi-Quantitative**: Extends the qualitative analysis process by assigning the numerical values to the descriptive scale.
c) **Quantitative Analysis:** Uses numerical values of probability of risk events (or variables and risk factors) and their consequences.

The qualitative approach tends to measure,analyseand evaluate characteristics of individual identified risks and prioritize these risks based on agreed-upon characteristics. The approach does not take the overall risks to project objectives that may arise due to combine effects of all risk and their potential interactions. The approach only categorise risk in descriptive term as either low, medium or high and does not give quantitative value for comparism. Figure 2.12 outlined the general pattern of the classification under this approach.



Probability (Likelihood)	Synonyms		[1]Approximate %
Very high	Almost certain	Very Sure	≥ 90%
High	Likely	Pretty Sure	80%
Medium	Possible	Maybe	50%
Low	Unlikely	Seldom	20%
Very Low	Rare	Improbable	≤ 10%
Consequence (Impact)	**Synonyms**		**[1]Approximate %**
Very high	Very Critical	Very Strong	≥ 10%
High	Critical	Strong	8%
Medium	Moderate	Average	4%
Low	Slight	Mild	2%
Very Low	Very Little	Very Mild	≤ 1%

Figure 2.12 Example of qualitative description of risk

Source: (Mehdizadeh, 2012)

On the other hand, quantitative analysis seeks to quantify the combined effects of risk on project objectives by ascribing or translating quantitative descriptions to numerical values, using the appropriate parameters and deploying appropriate techniques and methods. According to Thomas et al. (2006) sensitivity Analysis, Decisions Trees, Fault Tree, Risk Breakdown Structures, Delphi-Analytical Hierarchical Process and Fuzzy-AHP are some of the methods used for this approach. The approach involves building in models of the whole project or key elements, reflecting identified risk into the model, analysing the combined effects on project outcome (Hillson, 2002).

2.8.3 Prioritization/Structuring of Risk

The analysis of project risk activity leads to prioritization of the identified risk. The analysis of risk, which usually considered the frequency and severity of impact of individual risk variable, results in a combined rating of the risk. The analysis deploys some logical and reliable method/technique that facilitate the result been prioritized in a consistence manner. This prioritized risk provides the basis for the deployment or remedial proactive management procedure that serves as mitigatorymeasure (Zayed et al 2008).

The risk index (R-index) model which is usually the result of rigorous analysis of some of the assessment models characterizes the various source of risk in a project and assesses their effects on such project in order to be able to take the remedial measures.The prioritization of identified risks base on risks index (R-index) provides the basis for final structuring of risks for final management consideration.Various techniques have been used in the prioritization and structuring of risks in the project environment. Risk Breakdown Structure (Mehdizadeh, 2012; Dikmen, 2006; Boloi and Price, 2003; Hillson, 2002; Tah and Carr, 2001etc.); Analytical Hierarchical Process (Li and Zou, 2010; Zayed et al., 2008; Zhang and Zou, 2007; Wang et al., 2007); Decision and Fault tree (Thomas et al., 2006;Dey, 2001), etc.

Each of these techniques provides a hierarchically organized depiction of the identified project risks arranged in some order that show the various areas and causes of potential risk (PMI, 2008) as outlined in Figure 2.13 and Figure 2.14. It tends to represent the overall project and organization risk factors and events organized by group and categories. It usually provides a simple and adequate decision support tool for management action.

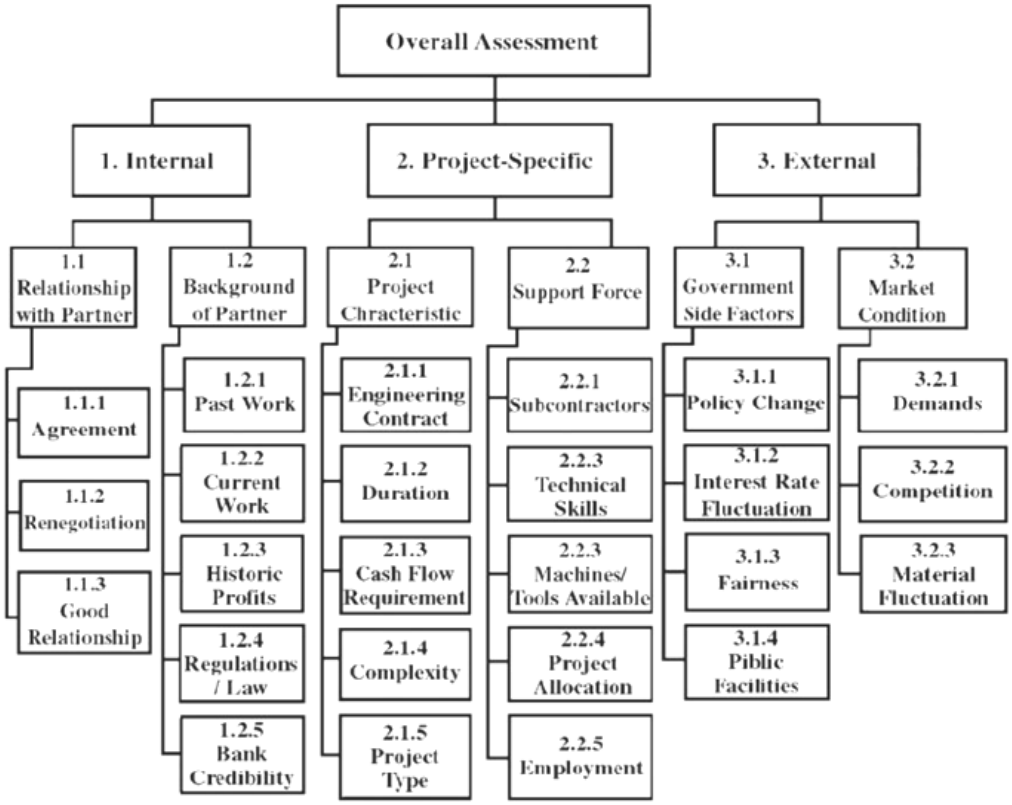


Figure 2.13 Hierarchical Structuring of risk

Source: Thomas et al. (2006)

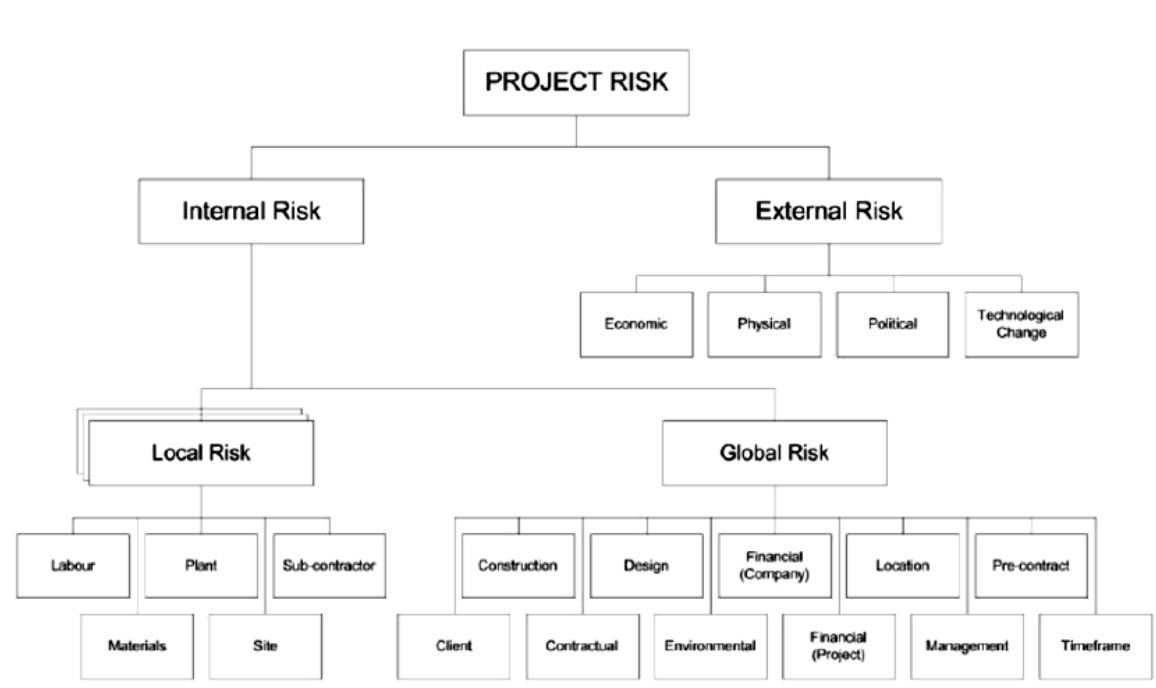


Figure 2.14 Example of the Risk Breakdown Structure

Source: Tah and Carr (2001)

2.9 Risk Response

The next process after the risk identification and assessment is to develop options and determine convenient actions, focusing on most significant risks, in order to shift odds in favour of project success and to minimize the negative impacts of threats on project objectives (Mehdizadeh,2012).

The risk response/mitigation process is in brief a stage where action is taking to control the risk analysed in the first two processes (identification and assessment). In addition, monitoring mechanisms are also incorporated to ensure that any deviation is detected and corrected early. The general mitigatory responses are categorized into four, namely: risk retention reduction, risk transfer and risk elimination (Chinyio and Ferguson,2003). The detail discussion of these outlined strategies, although generally part of risk management process is outside the scope of this study.

2.10 Risk Management as an Iterative Process

Projects are usually considered as long time endeavours which during their life cycle are encountered with so much risk. During project progress the level of available information usually increases, whereby decreasing the uncertainty associated with the project feature. Some predicted risk events occurs while others will not, new unpredicted risk event may also surfaced or maybe identified, and the characteristics of those already identified may change. Therefore the risk management and RMP needs to be approach in similar fashion, as a dynamic and iterative process (Mehdizadeh, 2012;Chinyio and Ferguson, 2010; PMI, 2008;Tah and Carr, 2001).

2.11 Housing Development Project Risk Identification and Assessment

2.11.1 The Housing Development Project Concept

The housing sub-sector is part of the larger construction sector of the economy and recently, the most active sub-sector of the construction industry. The contribution of this sub-sector is estimate to range between 50 - 65% of the gross capital formation in the economy.

The housing development business is a multifaceted and complex endeavour that involves huge array of professionals, various components of works that culminate the development of new building or improvement of existing buildings. The primary investors, the developers, are the coordinators of the activities and the final profit takers of the schemes. It is a little bit distinct from general construction in the sense that mostly the developers don't essentially build themselves but usually engage the services of other professionals in both conception and development of the project (although in recent times, many developers also construct in some ways).

Essentially, in housing development business, which is usually quite huge investment, the developer acquires land, (either freehold or lease), source, structure and agree on financing with the financiers (usually a bank mortgage loan or others), commission experts team (or use internal personnel) to conduct feasibility study and design of the scheme - with clear conception, processes, controls and mode of execution of the scheme. The team usually comprises of construction experts such as project managers, architects, quantity surveyors, engineers, planners, surveyors, General and subcontractors. In addition, other non – construction professionals are usually engaged to provide supporting services. A legal counsel, structure the agreements and sometimes facilitate government approvals. The development process requires the skills of each and every member of the team. The construction professionals to plan, design and supervise the execution of the infrastructural

components while the non – construction professionals provide specialized services, such as legal, marketing, facility management and financial services.

The development usually see to light the construction of vital infrastructural facilities such as buildings (houses) roads, electrification, water system and sanitary facilities, telecommunication network and other facility maintenance components such as security post, administrative and commercial facilities etc.

For the development to achieve it main objectives the developer needs to interrelate not only with the financiers of the scheme, but also arrays of others stakeholders such as the local communities, consumer associations, local developers association and the public authorities whose influence over the project is by for inestimable. Aside from the granting of land title and ownership, the public authorities usually directly influence development approvals and provide laws and policies regulating the environment of the scheme.

The housing development project is a complex arrangement that involve many parties and substantial number of construction and non-construction activities that the developer is expected to coordinate effectively and efficient if the objectives are to be achieved. Figure 2.15 shows a typical project organization arrangement of a housing development project.

Like many of the Public-Private Partnership (PPP)procurement arrangements where the motives of the developing SPV (special project vehicle) company is making maximum returns to the promoting stakeholders, the housing development project developers goal is also, mostly, to make maximum return to their investment (except for some few public agencies developers whose mission may include other non-profit objective).

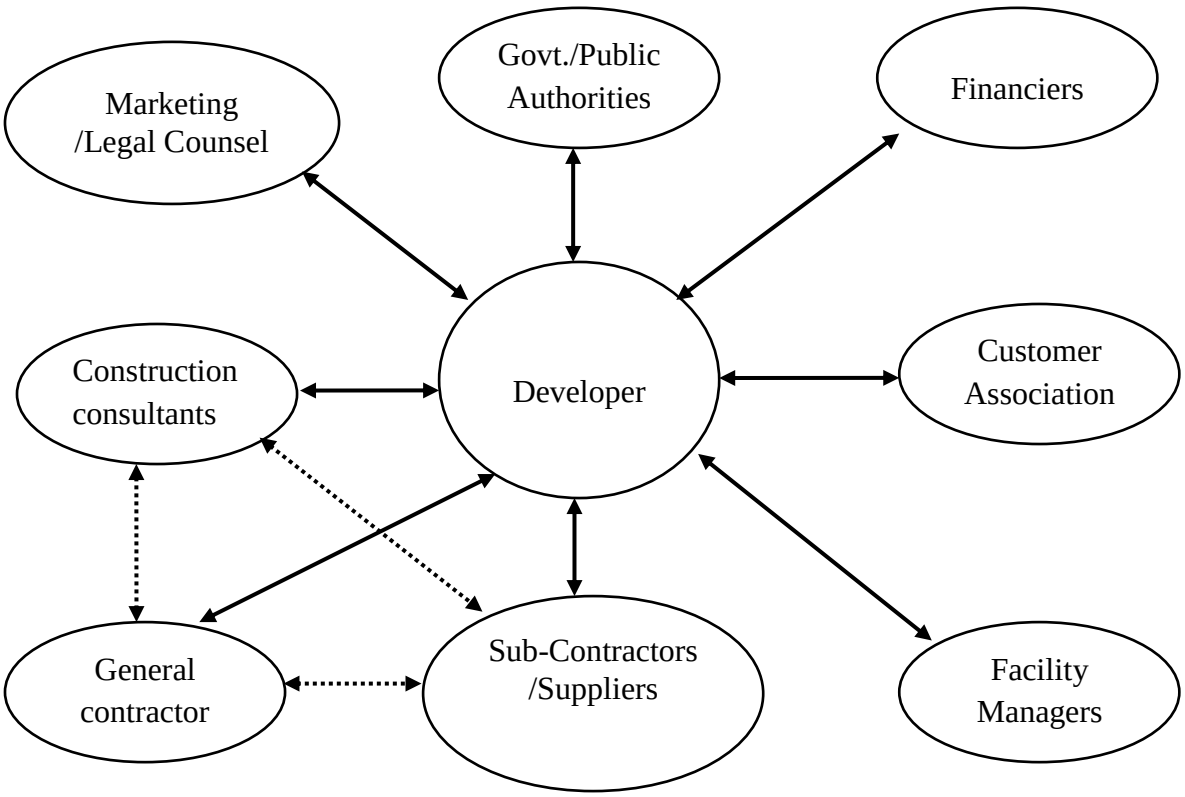


Figure 2.15 Project organizational relationship of a typical Housing Development Project (Source: Author, 2014)

Therefore, the need for the developer to assemble the requisite professionals to address physical, economic, environmental and political risks inherent in a typical complex housing development project environment is very critical. A developer's success depends greatly on the ability of developer and the team to coordinate and manage the completion of a series of interrelated activities, without things going so wrong, effectively and efficiently. In addition, the commercial orientation of the scheme, usually, put more burdens on the developer for more prudency, efficiency in the implementation of the scheme.In other words, the developer need to manage not only the daily production challenges of the scheme but also the enormous risks associated with the scheme which arises as a result of complexity of the scheme, the huge investment deployed and the profit-motive of the developer.

Efficient and effective risk management is critical to the success of such project (Salako, 2010). Appropriate tools and techniques needs to be deployed to assist in achieving the

objective of the scheme. The role of risk identification and the deployment of appropriate risk assessment techniques and tools cannot be overemphasised insuch endeavours.

2.11.2 Risk Identification Framework for Housing Project

Project Risk Management (PRM) is a systematic process of identifying, assessing and responding to project risk. The overall goal of the RMP is to minimize, or completely eliminate the negative threats and consequences of risk thereby maximizing the opportunities inherent in such project.

The indispensable role of adequate identification of risk associated with construction projects, such as housing schemes has been outlined earlier. Similarly, the need for in depth assessment of the inherent risks in whole or in part to provide basis for decision by project management team have been discussed earlier.

As outlined above, there is a general consensus among both scholars and practitioner as to the indispensable role and acceptance as the first critical process of RMP, of the risk identification phase. Various sources cited above regarding their scopes of RM encompass risk identification as primary step before analysing the risk associated with the activity under consideration. The need to identify risk sources at the outset is emphasized by all approaches to risk management (Flanagan and Norman, 1993; Bu-Qummaz, 2007). According to Tahand Carr (2001) this would include determining what risk may be present and categorizing them properly for further assessment.

Although, risk identification is recognized as essential phase/process by most scholars, there is still sharp variation as to the content, extend and procedure usually deployed in carrying out the risk identification process. Whereas some scholars view it is just an essential step of sourcing that recognizing the risk factors associated with project (Flanagan and Norman,

1993; Edwards, 1995) others consider risk identification to be beyond that and includes such stages as risk classification and coding, initial structuring and analysis.

This study adopted the broader definition of risk identification to include sourcing, classification (grouping), preliminary analysis and structuring (the sourcing-classification-structuring framework) as depicted in Figure 2.16below. It is best suited for housing projects because of the multiparty and multi-components nature of housing project.

2.11.3 Risk Identification Process

2.11.3.1 Risk Sourcing

Risk sourcing simply meansidentifying the sources, factors and events that constitutesriskboth within and without project environment/organization. It is one of the steps in project risk identification process which culminated, usually, to the production of risk checklist and risk register (which serves a data base for the project and organization. It is important according to Flanagan and Norman (1993) to distinguish between sources of risks and the effects of risk when undertaking the risk sourcing evaluation.

There are equally various methods/avenues through which an organization can carry out risks sourcing (Edwards, 1995) some of this channels have been discussed in paragraph 2.7.2.1However, for the purpose of sourcing of risks in housing development project, as a new or improvement strategy, a combination of three distinct methods is adopted. This includes literature review, experts' consultation and field survey.

i. Risks Sourcing Through Literature Review

Literature research is a common means of acquires into some risks associated with housing projects. Literature sources provide a wide range of valuable, organized and vetted sources of information for project undertaken. It greatly help by bringing the experiences of multiple of

researches globally on similar kind of undertaken. It captures some special peculiarities which the in-house team may not taught of in runny the project.

ii. Risk sourcing through consultation of experts

Sometimes, the in-house expertise needed to assess certain risks may be unavailable or inadequate. In such circumstances, outside assistance should be sought (Chinyio and Ferguson, 2003). It is sometimes impossible within project team structure to have all the needed expertise for a project internally. Consulting experts in the process of risk sourcing, identification and even assessment is like an extension of the use of experience. According to Chinyio and Ferguson (2003) different experts specialize in different subjects and have the built-up experience that goes with their vocation. By engaging consultant, the project team acknowledges it deficiency in that respect and engaged the external expert to assist, this usually result into a better identification and clears more uncertainly.

iii. Risk sourcing through survey

Surveys and interviews with project in-house team provide a handy means of enquiry into some risks associated with projects. It gives near reality of information based on the perception of the project team. Information solicited through field survey provides more broader-based judgment and reliable because of its practicability. In-house team members although sometimes may not be able to give good judgment on future aspects of work phases which are yet to be executed, their judgment on phases that they witnessed are usually factual reliable and apt. Housing development projects have this circular process (from scheme to scheme) therefore the information from project team members is reliable and first hand. This can provide vital input to the RM model build up.

2.11.3.2 Risk Factors Associated with Housing Projects

There are wide range of sources and risk factors associated with housing project investment. Generally, these risks factors can be conveniently be categorized based on their sources and effect on project objectives into two broad categories: general risks (comprising both country factors and industry risk) and specific risks (project specific risk factor). Some of the risk factors are briefly outlined below. It should be noted, however the list of risks associated is by fact inexhaustible.

General Risks

This refers to the range of risk factors that operates/influence the achievement of project objectives at both country and industry level. Key among the general risks is political risk, legal risk, economic risk and natural events. General risks usually have no direct bearing on the running of project but influence the project environment. In other words, these are risks outside the control of the project parties which Flanagan and Norman (1993) described as "uncontrollable risk". They concern changes in broad economic conditions, the political atmosphere in the project environment as while as social issues and natural phenomena's. This group of risk cannot completely be avoided and they are considered to be diversifiable. For instance, the legal risk comes about when new laws and regulations are passed with negative consequences on the project environment (tenancy bill, Housing mortgage act, pension act procuring acts,etc.).

Political forces such as insecurity, government restructuring and changes in government have serious adverse consequences on the investments environment. Similarly, natural phenomena's such as disasters, inclement weather, strike, conflict and war (usually grouped as force majeure) have strong effect on investment level and project running. On the other hand, the general economic parameters in the country have indirect influence on the running and product of the project. The project funding available and adequacy depends so much on

the banking regulations, interest and inflation rates as while as tax regulations. This in turn has effect on the housing unit price in addition to its effects on the demand for the housing unit from prospective house owners.The effects of laws and policies are also enormous. Changes in laws relating to mortgage system, environments protection or event pension scheme have global effects on the industry performance. Closely, related are natural event such as inclement weather condition, earthquake community resistance theft and vandalism can have a negative consequence on the project environment.

Specific Project Risks

These refer to the risks inherent in the project itself. In other word, risks that have direct influence on the running of the project and usually falls within the control of the project parties. These range from design and documentation issues to the financing and constructability of the project. It also includes human resources management and health and safety issues.

2.11.3.3Risk Classification (Grouping)

Various approaches have been suggested and used in both literature and practice for classifying risks. Perry and Hayes (1985) after thorough examination give an extensive list of factors assembled from several sources, and classified in terms of parties to the project as risk retainable by contractors, consultants and clients. Cooper and Chapman (1987) classify risks according to their nature and magnitude, grouping risks into two major groups of primary and secondary risks. Tah et al. (1993) use a risk breakdown structure to classify risks according to their origin and to the location of their impact in the project. Wirba et al (1996) adopted a combination of approaches of Tah et al.(1993) and that of cooper and Chapman (1987) and produced a classification for both general risks and segregated risks into further primary and secondary risks. Tah and Carr (2000) and Mehdizadeh (2012) classified project risks by using hierarchical risk breakdown structure (HRBS) and classified them into internal and external

risks. Chapman (2001) grouped risk into four subjects: environment, industry, client and project.

Shen (2001) categorized risks into six groups in accordance with the nature of the risks, i.e. financial, legal, management, market, policy and political. Dikmen et al (2007) use influence diagrams to define the factors which have influence on project risks. Zen et al. (2007) classified risk factors as human, site, material and equipment factors while Li and Zou (2010) adopted the classification based on lifecycle of the project.

Zou et al (2007) noted that the aim of risks classification is to structure the various risks influencing project objects in a systematic manner. Therefore, the initial structuring of risks which seeks to decomposed risks into 'father-son' relationship is part of the classification activity and identification process.

2.11.3.4Risk (initial) Structuring

It is a scenario modelling of the identified risks which enable clear structuring of risk patterns by depicting risk categories, their relationship, and their occurrence structure. The probability assessment of a higher-level complex risk event is more easily made with greater confidence if a model that relates the final event to underlying variable is constructed (Spetzler and Holstein, 1975).

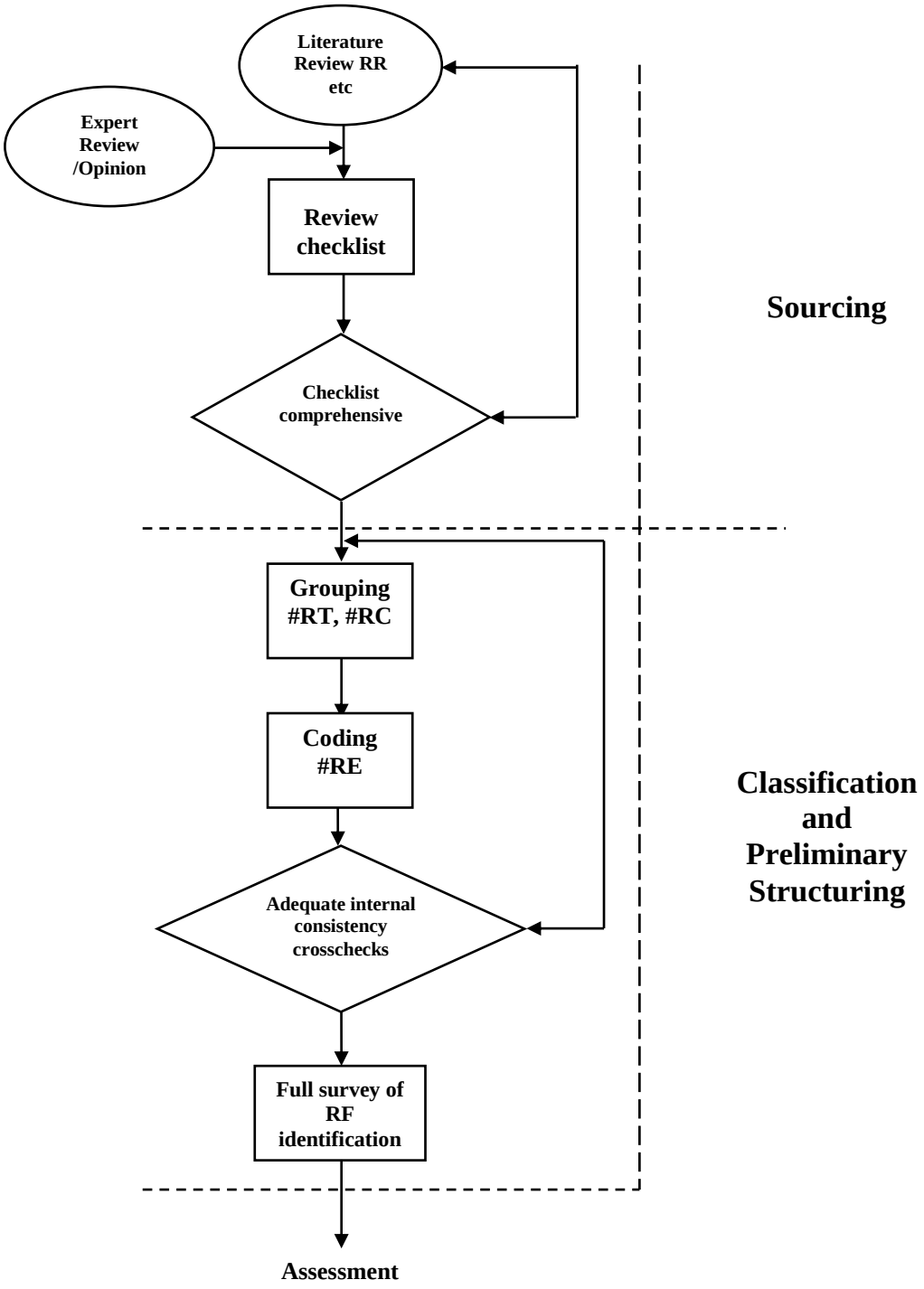


Figure 2.16 *Risk identification flowchart*

(Source: Author, 2014)

According to Thomas et al. (2006) in the structuring, the complex risk events (RE_1, RE_2,….) are further decomposed into risk factors. The risk factors, which lead to the occurrence of complex risk events, are modelled as component events (CE_1, $CE_{2…}$), and then as terminal events (TE_1, TE_2) in a fault tree like, the events for which further decomposition is not

possible are treated as terminal events. The lower level events (component and terminal events) in the risk structure are characterized with their probability of occurrence.

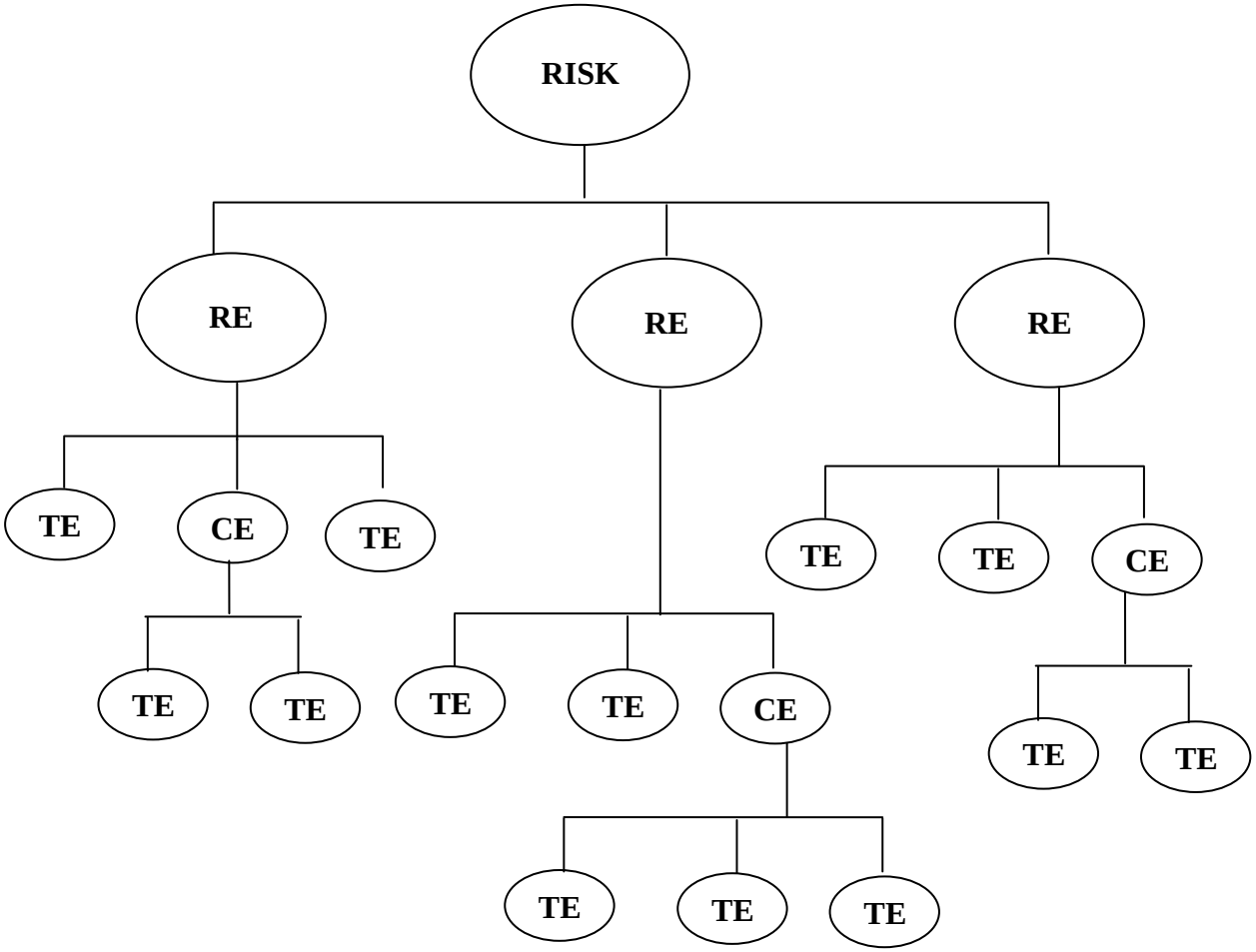


Figure 2.17 Generic Hierarchical structuring of risk

Source: (Thomas et al.,2006)

2.11.4 Risk Assessment in Housing Project

Risk assessment, as outlined above, is essentially an important stage in the RM system where historical data and other similar information obtained from risk identification process are subjected systematically to empirical measurement, analyse and prioritized to serve as a basis for sound management decision. It therefore involves thorough and systematic measurement of key variables that tends to define risk within project environment. Basically within the housing development project, it entails having first-hand information from the professionals working on the project and the management team, regarding risks and its effect on project.

Risk assessment according to Thomas et al (2006) is the most difficult task in RM, because it involves evaluation of the probability of occurrence of risk events and their impact on project objectives such as time, cost and performance.

Based on this objective, to evaluate the impact of risk on project objectives, many approaches have been developed essentially differentiated based on the technique use in analysing the risk data obtained from measurement. The analysesrange from qualitative to quantitative. Similarly, within the realm of the quantitative assessment various techniques such as Fault tree analysis, Event Tree Analysis (ETA), Probability and Impact Grids, Sensitivity Analysis, estimation of system reliability, failure mode and effect analysis among others, which has statistical variables have been used widely.

However, the inadequacy of high quality data in housing and construction project and the difficulties in analysing statistical data have hampered the use of most of these statistical techniques for risk assessment in housing and construction projects. Recently, because of the complexity, unanticipated nature of information and multi-criteria situation occasioned in housing, construction and similar project endeavours, more analytical techniques are favoured. The techniques that use unstructured or partly structured data obtained from identification phase of RMP by structuring and organizing to provide a standard presentation of risk which facilitates understanding, communication and management are more prevalent (Hillson, 2003). The structuring of risks factors and events is an essential strategy to ensure formal generation and understanding of the information. To this end, the Analytical Hierarchical Process (AHP) technique which tends to decompose project risks into a hierarchical representation, thereby defining the total risk exposure of the project, is more suitable and adequate for risk assessment of housing project. It is a risk source-oriented grouping of risk associated the project that tends to define the total risk of the project by

decomposing the risks into descending levels with each level representing an increasingly detailed definition of the sources of risk (Hillson, 2003).

2.12 The Fuzzy-Based Analytical Hierarchical Process (AHP) Risk Assessment

2.12.1 The AHP Concept

The Analytical Hierarchical Process (AHP) first introduced by Saaty in 1980 is a robust and flexible multi-criteria decision analysis methodology. The AHP concept is based on three general principles (Saaty, 2005)

- Hierarchy representation and decomposition: breaking down the problem into separate elements
- Priority discrimination and synthesis: ranking the elements by relative importance, and
- Logical consistency: ensuring that elements are grouped logically and ranked consistently according to a logical criterion.

According to Saaty (1980), the first principle of AHP concept involves construction of a functional hierarchy to decompose complex systems into their constituent parts according to their essential relationships. The elements in the hierarchy compose of clusters of system objectives, decision criteria, the attributes of criteria and alternative solution. Each set of elements in a functional hierarchy occupies a level of the hierarchy. The top level of the hierarchy is the focus, consists of only one element i.e. the broad, overall system objective. Subsequent levels may each have several elements and because the elements in one level are to be compared with one another against a criterion in the next higher level, the elements in each level must be of the same order of magnitude. Thus, when the elements of a level cannot be readily compared, a new level with finer distinction must be created. The second level of

the hierarchy usually lost the decision criteria, which are linked to their attributes in level three of the hierarchy (Saaty, 2001). To further examine the decision attributes, various levels of sub-attributes need to be inserted in the hierarchy, thus expanding the level of hierarchy. Forming the last level of the hierarchy are the alternative solutions. The alternative solutions are linked to the decision attributes, based on which the alternative will be judged (Russell and Taylor, 2000). A typical functional hierarchy used in AHP concepts is presented in Figure 2.18 below.

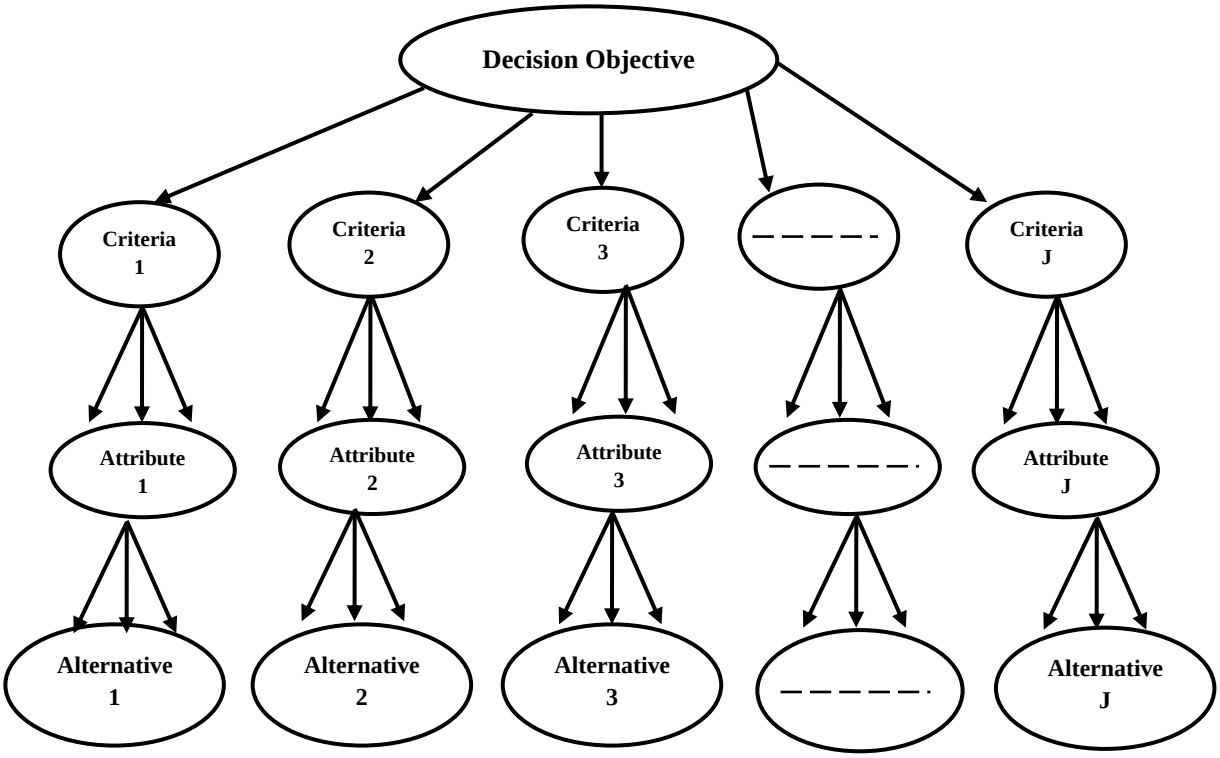


Figure 2.18 AHP Functional Hierarchy

Source: (Ahmed et al., 2005)

Having constructed the system hierarchy, the AHP concepts are used to analyse the priorities of elements in the hierarchy in terms of their contribution to the focus of the hierarchy (system objective). The element priority analysis begins by making pair wise comparison, that is, to compare the elements in pairs against a given criterion in a matrix format. The pair

wise comparison process starts at the top of the hierarchy (system objective) that will be used for making the first comparison. Then from the level immediately below, take the elements to be compared [criteria(1)….. criteria ('i')]. To populate pair wise comparison matrix, the process of judgment of the relative important (RI) of one element over another with respect to the property is utilized. The judgments are usually present on a fuzzy scale (1-9) according to Saaty (2001).

In this risk assessment approach, usually the expert judgment are defined in linguistic scales such as "low probability", 'serious impact', or 'high risk' etc. These terms are vague. According to Wang et al. (2007) these crisp judgment is not easy task to assess because of the imprecise information and the uncertainty nature of risks. In order to address this problem Fuzzy inference (derived from Fuzzy set theory) is incorporated to convert these imprecise judgments to numerical values for easy computation.

2.13 Computer-based Analytical Hierarchy Process (AHP) Risk Assessment

2.13.1 The System

Saaty and Niemira (2006) submitted that the Analytical Hierarchy Process (AHP) is one of the solution options for Multi-Criteria Decision –Making (MCDM) problem in which a "decision hierarchy containing a goal or mission statement, objective or criteria, and alternatives of choice is evaluated by deriving ratio scale priorities from pairwise judgment". In the AHP model the problem is structured as a hierarchy, and then a process of prioritization is executed. Prioritization entails seeking judgments in the form of experts' response to questions about the dominance of one element of the hierarchy over another when compared with respect to a specific criterion. In other words, the judgements reflect the relative influence of one of two elements over the other in a pairwise comparison process on a third element in the system, with respect to underlying control criterion (Saaty, 2005).

The idea and methodology of AHP as developed by Saaty has received global acceptance in application to many fields of endeavours including management, insurance, banking, strategy and computer applications to mention but few.

In a similar manner, the growth of the method to a reboots system has also been complemented with its adoption into computer software, both off the shelves and customized, that deploys AHP method in resolution and analysis of multi-criteria and multi objective decision scenarios. Common software application such as EXPERT CHOICE, ANALYTICA, AHP-DRASTIC and SUPER DECISION are off-the-shelve products that can be utilized in the assessment of risk decision environment. Similarly customized application developed strictly for some particular risk related (Rating) problems situation are also available. Example includes: ICRAM – 1 (Hastak and shaked, 2000), ICRM (Bu – Qammaz, 2007); GERMA (Mehdizadeh, 2012) etc.

The study used*SuperDecisions* software in the assessment of risks associated with housing development project as it will be used in analysing the research data. The *SuperDecisions* software was strictly developed based on Saaty's idea and methodology for the implementation of both Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) methods. The *SuperDecisions* software is use for decision making with dependence and feedback. It implements the AHP, using the same fundamental prioritization process based on deriving priorities by making judgments on pairs of elements or obtaining priorities by normalizing direct measurements. The decision elements are arranged in a hierarchic decision structure from the goal to the criteria to the alternatives of choice.

The AHP model consists essentially of two parts. The first part consists of a control hierarchy of criteria and sub criteria that controls the interactions in the considered system. The second component of the system is a network of influences among the elements and clusters. The

network is dependent on the criterion, as for each criterion the network of influence is different, and a supermatrix of limiting influences is computed for each control criterion. Then, each of these supermatrices is weighted by the priority of its control criterion and the results are synthesized through addition of all the control criteria (Saaty, 2003).

CHAPTER THREE

RESEARCH METHODS

3.1 Research Design

The study focuses on two processes of risk management: identification and assessment of risks associated with the conception and implementation of housing development projects. The study explored three broad approaches: first approach involves a systematic review of literature within the field of risk management in project environment and narrowed down specifically to identification and assessment processes in housing development projects. Secondly, the study also involves eliciting data from field using designed questionnaires. Lastly, the study assesses the data obtained in order to both establish the risks factors associated with housing development project and prioritize the identified risks to provide a basis for project decision.

3.2 The Study Population and Sample

The first step in obtaining a sample is to define the population. It is essential to identify characteristics which members of the universe have in common and which will identify each unit as being a member of a particular group (Osuola, 2005). Sampling entails taking any portion of a population or universe as representative of that population or universe. It's on the basis of the sample that generalizations can be made to the population it is drawn from. The population for this study consist of the entire housing/real estate developers operating in Nigeria.

3.3 Sampling Design Method

A sample is a limited number of observations from a population. Usually the sample is drawn because it is impossible to coverall observations in the population on ground of time, scope, greater accuracy or other resources. According to Patton (2002), sampling of research participants can be done through a purposive approach which means there is far less emphasis on generalizing from sample to population but greater attention to a sample "purposely" selected for its potentials to yield insight from its illuminative and rich information sources.

Although the targeted population for this study is the entire population of housing/real estate developers operating within the construction sector of the Nigerian economy, the study was conducted within Federal Capital Territory, Abuja because of the relative number of operators (compare to the entire population of developers nationwide) in housing development projects. Therefore purposive sampling representing a group of non-probability sampling technique was employed as sampling method.

3.4 The Sampling Size

The logical and/or statistical determination of the size and type of sample to be used to select research participants or subjects from whom data for the study would be elucidated is very paramount to research. A good sample must be as nearly as representative of the entire population as possible. The sample should be fairly homogenous and share critical similarities related to the research question(McCracken and West, 1998). Using the purposive sampling adopted for this study, a researcher may have a specific group in mind, it may not be usually possible to specify the population as they would not all be known and access could sometimes be difficult, the researcher attempts to zero in on the target group interviewing whoever is available as the sample is a subset of the larger population.

In this study, due to the nature of the information that was required, housing development firms (developers) were chosen as the target respondents for the survey while Federal Capital Territory, Abuja was chosen as the study area. Consequently, a list and plot locations of Mass Housing developers was obtained from the Mass Housing Department of the Federal Capital development Authority, an agency of the Federal Capital Territory administration vested with the responsibility of supervising the development of mass housing projects within the Federal Capital Territory, Abuja. Additionally, a list of registered developers was obtained from the local branch of the Real Estate Developers Association of Nigeria (REDAN) which shows a registered number of sixty-seven (67) developers operating within the territory.

The lists obtainedcontained sufficient number of the potential developers and has served as the basis for selection of the sample respondents. The sample size for the study could not be calculated using any defined formula because of the absence of any unified register for all developers operating in the country. Rather, a sample size of 40 was set as minimum based on the Leedey (1997) assertion that 'a minimal sample size of 30 was regarded as sufficiently large to provide effective normal approximation as a general rule of thumb, regardless of the shape of the population frequency distribution'. Additionally, purposive sampling method was adopted for the selection of the assessment team to provide the requisite pairwise judgments for the assessment of the identified risk factors.

3.5 Research Instrument

This research employed combination of research instruments basedon the research approach to achieve the objectives. Basically, there are a number of tools and techniques deployed in identifying risks, for instance, brainstorming, expert opinion, structured interviews, questionnaire, checklist review, historical data, previous experience, evaluation etc. This study employed three-stage framework of literature review of documented past projects of

similar nature to source the risk factors, experts' consultation and questionnaire survey in identifying and establishing risks factors associated with housing development projects. Similarly, both questionnaire survey and Focus Group (the Assessment Team) were employed in eliciting (pairwise comparison judgment) data for risk assessment to ensure more reliability of data. The team experts are drawn based on four basic criteria: requisite working experience in housing project for a minimum of 20years; adequate understanding of risk matrix assessment system after briefing; membership of top management in organization and possession of highest educational qualification (PhD and above).

3.6 Data Collection

To generate data from respondents, several methods can be used to collect primary data. According to Chen (2009) the choice of a method depends upon the purpose of the study and the resources available. The most common methods for data generation are observation techniques, personal interviews, questionnaire based survey, etc.

Data collected for this research were obtained from two-stage field surveysconducted using questionnaires. The questionnaires were structured and contained questions that allowed the respondents to identify the potential risk factors, their chances of occurrence and the potential severity (impact) levels of the risks. Additionally, the impact of each risk factor in relation to the other risk factors (pairwise) in impacting on the overall project goal is measured by the selected Assessment Team (Focus Group).

3.7 Data Analysis

The data collected from the study were subjected to quantitative analysis. Two approaches were adopted for the analysis of the data; these are:

3.7.1 Identification of risks data analysis

Based on the approach adopted for the study and in conformity with PMBok (PMI, 2006), quantitative risk analysis isadopted for the identification stage of the study analysis in order to establish the risk factors, provide the needed prioritization and create the structure for further assessment actions. Similarly, quantitative analysis was further employed to compute the relative Significance Index (sometimes also referred to as Relative Importance Index) of each risk factor.

Likertscale (a two dimensional) of 1-5 was used to measure the likelihood of occurrence and impact of the risk factors. Respondents were requested to score using natural linguistic terms as contained in Table 3.1 (for likelihood) and Table 3.2 (for impact) below.

Table 3.1 Likelihood of Risk Events Scaling

Score	Descriptor	Explanation
1	Rare	Not expected to happen
2	Unlikely	Small likelihood but could well happen
3	Possible	50 – 50 chance
4	Likely	More than 50 – 50 chance
5	Most likely	Almost certain that it will happen

Table 3.2 Impact of risk Events Scaling

Score	**Very low 1**	**Low 2**	**Moderate 3**	**High 4**	**Very High 5**
Cost	Insignificant cost increase	< 5% cost increase	5 – 10% cost increase	10-20% cost increase	>20% cost increase
Time/Schedule	Insignificant schedule slippage	Schedule slippage less than 5%	Overall project slip 5-10%	Overall project slippage 10-20%	Overall schedule slips >20%
Scope	Scope decrease barely noticeable	Minor area of scope affected	Major area of scope affected	Scope reduction unacceptable to the developer	Project end product is effectively useless
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires developers approval	Quality reduction unacceptable to the client	Project end product effectively unusable

Using the Shen et al.'(2001) Significance Index formula given by the Equation 3.1 below the criticality of each of the identified risk factors based on the respondents' scorings was calculated for both the likelihood of occurrence and the impact of the risk factor.The risk factors were, accordingly, ranked based on Wang et al.'s (2004) criticality ranking method which uses Mean Scale value.

The Shen et al.'s Significant Index is given by the formula

$$RS^i = \frac{\sum_{i=1}^{n} S_j^1}{n} \quad - - - - - - \quad \text{Equation 3.1}$$

Where:

$$S_j^1 = \propto_j^i \beta_j^i$$

RS^i = Significant Index of risk i

$\propto_j^i$=the likelihood of risk i occurrence assessed by respondent j (in scale weight =1, 2, 3, 4 or 5)

β_j^i =the degree of impact of risk i occurrence assessed by respondent j (in scale weight =1, 2, 3, 4 or 5)

n= number of risks in the assessment.

S_j^1 = Signifcant score assessed by respondent j for risk i

Further, the results of the significance indexing, in terms of both likelihood of occurrence and impact, was used to determine the most significant risks for further structuring and final assessment.

3.7.2 Assessment of risk data analysis

The significant risks identified and analysed based on the above analysiswere arranged in hierarchy structure and subjected to final assessment that involvedAssessment Team judgment. In order to achieve more precision with weighting of the risk factors a more robust methodology that involves scaling and measuring the respondents perceptions using natural linguistic terms and fuzzified computation that fit into analytic hierarchy process method was employed. The final assessment was carried out using computer software ***SuperDecision version 2.2*** to determine the relative priority index (weight) of each risk factor and risk cluster.

The***SuperDesicion*** software, developed in consonant with the principles of Analytic Hierarchy Process (AHP) model postulated by Thomas Saaty (1980) uses natural linguistic terms such as high, low, medium, etc. to measure the respondents' inputs (perceptions) and convert these inputs to numerical values in line with the fuzzy arithmetic computations as outlined by Takacs and Edit(2012). The AHP methodology developed by Saaty (1980) involves pairwise comparison of each of the identified risk factors with respect to the objective by each of the Assessment Team members and computing each risk impact/contribution on the system objective. The ***SuperDecision*** software implements the

AHP, using the same fundamental prioritization process based on deriving priorities by making judgments on pairs of elements or obtaining priorities by normalizing direct measurements.

The natural (default) scaling of the software as presented in Table 3.3 was used to obtain the respondents subjective perception by scoring against each risk factor and these responses obtained from the questionnaires are inputtedinto the questionnaire input mode of the software after structuring the problem.

Table 3.3 The Fundamental Scale for making judgment

1	Equal
2	Between Equal and Moderate
3	Moderate
4	Between Moderate and Strong
5	Strong
6	Between Strong and Very Strong
7	Very Strong
8	Between Very Strong and Extreme
9	Extreme

After structuring the problem and inputting the responses obtained from the questionnaire, the data is synthesised to obtain the relative priorities of each risk factor and risk cluster.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Data Presentation and Analysis

This section presents the results of the two field surveys conducted to identify and assess the relevant risk factors associated with housing development projects, which includes initial impact assessment of the risk factors before the detailed assessment. The identification survey results are followed by computer based AHP –pair wise assessment of the significant risk factors in order to establish the relative weights (priorities) of each of the significant risk factors.

In the risk identification general survey, a total of 120 questionnaires were distributed to selected housing development organizations that are involved in some housing development projects within the Mass Housing precinct of the Federal Capital Territory, Abuja. Forty-two(42) questionnaires out of the 120 distributed were returned duly completed and all were used in the analysis of the relevancy of the risk factors and significant risks determination. Whereas, for the AHP-based assessment survey a five (5) man Assessment Team were selected out of the respondents pool established from the identification survey. The analysis and discussion of the results are outline based on the survey type and subdivided under several headings based on the objectives of the study.

4.2 Results of the Risk Identification Survey

4.2.1 General information of the respondents

The general information (section A) part of the questionnaire sought to know the responding profession, academic qualification, working experience, age group and type of organization

the respondent works for, as this has strong bearing on their risk attitude and judgements. The findings are presented in Tables 4.1-4.4.

4.2.1.1 Profession of the respondents.

On the profession of the respondents, out of the 42 respondents, 26% (11) were project managers, 21% (9) were architects, 17% (7) were engineers while 29% (12) and 7% (3) were quantity surveyors and builders respectively. Table 4.1 shows the profession of the respondents surveyed.

Table 4.1: Profession of the respondents

Profession	**Number of the respondents**	**Percentage (%)**
Project manager	**11**	**26**
Architect	**9**	**21**
Engineer	**7**	**17**
Quantity surveyors	**12**	**29**
Builder	**3**	**7**
Others	**Nil**	**Nil**

4.2.1.2 Working Experience.

Based on the returned questionnaires, the respondents' years of working experience shows that 19% (8) were between 1-5 years, 17% (7) were between 6-10 years, 34% (14) were between 11 -16 years whereas 11% (5) and 19% (8) were between 15-20 years and above 20 years working experience. This is presented in Table 4.2

Table 4.2 Respondents' Working Experience

Working experience(years)	**Numbers of respondents**	**Percentage (%)**	**Cumulative percentage (%)**
1-5	8	19	19
6-10	7	17	36
11-15	14	34	70
16-20	5	11	81
Above 20	8	19	100

4.2.1.3 Academic qualification of the respondents

Concerning the academic attainment of the respondents, Table 4.3 shows the breakdown with 12% (5) Ph.D. degree holders, 36% (15) were M.Sc. holders, 24% (10) were B.Sc. holders, 21% (9) were HND holders while 4% (2) and 2% (1) of the respondent were ND holders and other none listed qualification.

Table 4.3: Academic qualification of the respondents

Qualification	**Number of respondents**	**Percentage (%)**
Ph.D.	5	12
M.Sc.	15	36
B.Sc.	10	24
HND	9	21
ND	2	4
Others	1	2

4.2.1.4 Age Group

On the age group of the respondents, the breakdown of the respondents' ages is presented in Table 4.4. The distribution shows that 17% (7) of the respondent were between the ages of 1-30 years, 19% (8) were between the ages of 31-40 years, 40% of the respondents are age

between 41-50 years whereas 17% (7) and 7% (3) were between the ages of 51-60 years and above 60 years respectively.

Table 4.4: Age Group of the Respondents

Ages	**Number of respondents**	**Percentage**
<30	7	17
31-40	8	19
41-50	17	40
51-60	7	17
Above 60	3	7

4.2.1.5 Type of Organization

On the specific type of the organization where the respondents were employed in the project organization, 41% (17) of the respondents were directly engaged with the main developer, 24% (10) were working for consultancy firm (consultants) whereas 31% were public officials (government agencies). Table 4.5 present the respondent's organizational attachment.

Tables 4.5: Types of Respondent's Organization

Types of organization	**Number of respondents**	**Percentage**
Housing Developer	17	41
Consultant	10	24
Contractor/supplier	13	31
Government agencies	2	4
Others	Nil	Nil

4.2.2 Relevance of Potential Risk Factors

The respondents were asked to confirm or otherwise (Yes/No) the relevancy of all the 50 listed potential risk factors to the housing development project in their locality. The finding shows that 100% of the respondents agreed that all the risk factors sourced and presented to

them are relevant in housing development context. Table 4.5 shows the respondent's responses to the relevancy of the risk factor

Table 4.6: Relevance of Risk Factors

Confirmation/otherwise	**Number of respondents**	**Percentage**
Yes	42	100
No	0	0

The potential risk factors were drawn from literature which were further vetted by risk and project experts as part of the risk identification framework proposed by the researcher.

4.2.3 Likelihood of Occurrence of the Risk Factors

In order to carry out an initial assessment of the potential risk factors identifiedthe study sought information on the likelihood of occurrence (probability of occurrence) of the identified risk factors from the respondents. The relative significant index of each of the risk factors was calculated based on the respondents' judgments and used to determine the significance or otherwise of the risk factors for further assessment. Table 4.6 shows the mean and standard deviation scored by each of the potential risk factors as submitted by the respondents.

Table 4.7: Likelihood of Occurrence Risk Factors

S/No	Risk ID#	Potential Risk Factor	Mean score	Standard deviation	Variance
1	B07	Delay in approval of design	4.30952	0.6803	0.462834
2	A06	Inflation in the economy	4.04762	0.9358	0.87573
3	A05	Exchange rate fluctuation	3.80952	0.9432	0.88966
4	B14	Scheduling overrun	3.80952	0.9687	0.93844
5	B26	Cash flow challenges	3.73810	1.0136	1.02729
6	B25	Cost overrun	3.71429	0.9183	0.84321
7	B18	Site condition variation	3.71429	1.0658	1.13589
8	B23	Delay in payment to suppliers	3.61905	1.0348	1.07085
9	B06	Changes in design	3.59524	1.0606	1.12486
10	A08	Interest rate fluctuation	3.59524	1.0606	1.12486
11	B02	Illegal encroachment on land	3.42857	1.0625	1.12892
12	A03	Corruption in the system	3.38095	1.2088	1.46109
13	B01	Delay in land acquisition	3.33333	1.0515	1.10569
14	A18	Theft and vandalism	3.26190	1.1699	1.36876
15	B16	Productivity challenges	3.07143	0.9472	0.89721
16	A17	Community resistance	2.78571	1.0250	1.05052
17	B19	Quality system inadequacy	2.76190	1.2457	1.55168
18	A16	Outbreak of war and conflict	2.73810	0.9892	0.97851
19	A11	Changes in demand for houses	2.70732	1.1455	1.31220
20	B17	Raw material and equipment non-availability	2.69048	1.1994	1.43844
21	A15	Industrial strike	2.6667	1.0041	1.00813
22	A07	Lending policy changes	2.64286	1.0551	1.11324
23	B27	Claims and variation	2.59524	0.9122	0.83217
24	A01	General insecurity in the economy	2.57143	1.08540	1.1777
25	B15	Health and safety inadequacies	2.38095	0.8540	0.72938
26	A10	Tax changes	2.89095	1.0581	1.11963
27	B21	Variation in scope	2.30902	1.074	1.14576
28	A14	Inclement weather condition	2.11905	1.2138	1.473287
29	B20	Technology changes	2.09524	1.1347	0.91754
30	A09	Price control system	2.07143	1,1974	1.28746
31	B05	Defective design	2.07143	1.1974	1.43380
32	A12	Changes in law and regulation	2.04762	1.0110	1.02209
33	B04	Illegal title to land	2.02381	0.9750	0.95064
34	B32	Project stakeholders challenges	1.97619	1.1580	1.34088
35	B22	Damage to work	1.97619	0.9236	0.85308
36	A02	Lack of policy control	1.92838	1.7252	1.26597
37	B28	Project fear selection challenges	1.92857	0.8083	7.65331
38	B03	Inaccessibility to land	1.92857	0.9974	.099477
39	B08	Inadequate specificant	1.88095	0.9678	0.93670
40	A04	Inefficient in government	1.85714	1.0493	1.10105
41	A13	Inefficient legal proceed	1.76190	0.8782	0.77120
42	B11	Adoption of wrong procurement system	1.69048	0.8111	0.65796
43	B24	Bankruptcy of suppliers	1.69048	0.7153	0.51161

44	B31	Technical and managerial complexity	1.69048	0.81111	0.651956
45	B29	Project execution strategy Challenges	1.66667	0.7544	0.569106
46	B13	Unenforceability of contract	1.64286	0.7908	0.62544
47	B30	Decision challenges	1.64286	0.7908	0.62544
48	B12	Inappropriate documentation	1.57143	0.8074	0.8146
49	B09	Failure in bidding system	1.52381	0.8334	0.69454
50	B10	Failure in negotiation	1.45238	0.6325	0.40012

Based on the mean score of the likelihood of the occurrence of the risk factors, respondents submitted that delay in the approval of designs by public supervising agencies (RID#B07) has the highest likelihood of occurrence (with mean score of 4.31), followed closely by inflation in the economy (RID#A05) as second. Similarly, risk factors such as claims and variation by work contractors (RID#B27), industrial strike (RID#A15)and general insecurity in the economy (RID#A01)have mean occurrence score that are moderate.

However, least on the likelihood of occurrence are risk factorsFailure in negotiation during the procurement process (RID#B10) ranked fiftieth (50^{th}), Failure in building system (RID#B09) ranked forty-ninth (49^{th}) and Inappropriate documentation (RID#B12) ranked forty-eightieth (48^{th}) with mean score of 1.57.

4.2.4 Impact of the Risk Factors on Project

The second component of the initial quantitative risk assessment is the measurement and determination of the impact of potential risk factors on developers' project, otherwise known as the potential impact on project objectives (cost, time, quality, scope etc.,) which under this study is aggregated and expressed as a single objective.

Based on the responses on the impact of potential risk factors on developers, the results as shown in Table 4.7 revealed that Schedule (time) overrun (Risk ID# B14) with mean score of 3.69 ranked highest. This is followed by Interest rate fluctuation (RID# A08) and Outbreak of

war and conflict (RID# A16) with mean scores of 3.64 and 3.57 respectively rank as second and third. Risk factors such as Community resistance (RID# A17), Inflation in economy (RID# A06) and Price control system in the economy (RID# A09) with mean score of 2.59, 2.43 and 2.43 are moderately ranked in terms of impact on the objectives of projects by the respondents.

Least ranked in terms of impact on the objectives among the risk factors ranked are Technical and managerial complexity (RID# B31) with mean score of 1.31, rank as fiftieth (50^{th}) Failure in bidding system (RID# B09) with mean score of 1.41 rank as forty-ninth (49^{th}) as while as Failure in negotiation during the procurement process (RID# B10) with mean score of 1.4 rank forty-eightieth (48^{th}). Table 4.7 shows the ranking of the respondents judgments on the impact of the potential risk factors on the project objectives based on mean score by each of the potential risk factors

Table 4.8: Impact of Risk Factors on project objectives

S/No	Risk ID	Potential Risk Factor	Mean score	Standard deviation	Variance
1	B14	Scheduling (time) overrun	3.69048	0.89692	0.75552
2	A08	Interest rate fluctuation	3.64286	1.0078	1.01568
3	A16	Outbreak of war and conflict	3.57143	0.9145	1.83624
4	A11	Demand for houses changes	3.47619	1.3835	1.01405
5	B07	Delay in design approval	3.38095	1.0110	1.02207
6	B24	Bankruptcy of suppliers	3.21429	1.1161	1.24565
7	A05	Exchange rate fluctuation	2.904761	0.9579	0.91754
8	A17	Community resistance	2.59524	1.1275	1.27120
9	A06	In fluctuation in the economy	2.4285	0.9913	0.98258
10	A09	Price control system	2.4285	0.9913	0.98258
11	A15	Industrial strike	2.21429	0.7982	0.6371
12	A10	Tax changes	2.1667	0.8530	1.09930
13	A14	Inclement weather	2.166	1.0515	1.10569
14	B23	Delay in payment to suppliers	2.1667	0.8530	0.72764
15	A01	General in security in the economy	2.09524	0.8500	0.72242
16	B17	Raw material and equipment non-availability	2.04762	0.8250	0.680604
17	B16	Productivity challenges	2.0000	0.7651	0.58537
18	B21	Variation in score	1.95238	0.8540	0.72242
19	B13	Unenforceability of contract	1.90476	0.9579	0.91754
20	B18	Site condition variation	1.90476	0.9055	0.81998
21	A12	Changes in law and regulations	1.88095	0.9423	0.88792
22	B04	Illegal title to land	1.88095	0.8323	0.69280
23	B22	Damage to work	1.88095	0.9678	0.93670
24	A07	Lending policy changes	1.85714	0.7513	0.564460
25	B27	Claims and variations	1.85714	0.85715	0.75958
26	B11	Adoption of wrong procurement	1.80952	0.9432	0.88966
27	A04	Instability in govt	1.73810	0.8571	0.73461

28	B01	Delay in land acquisition	1.71429	0.7345	0.53949
29	A02	Lack of policy continuity	1.71429	0.7420	0.50174
30	B25	Cost overrun	1.71429	0.7083	0.50174
31	B28	Project team selection challenges	1.71429	0.8050	0.64808
32	A03	Corruption in the system	1.66667	0.7213	0.52303
33	A18	Theft and vandalism	1.66667	0.6867	0.47155
34	B26	Cash-flow Challenges	1.66667	0.8165	0.66667
35	B03	Inaccessibility to land	1.66667	0.7544	0.56911
36	B05	Defective design	1.66667	0.7213	0.52033
37	B20	Technological changes	1.61905	0.6608	0.43670
38	B12	Inappropriate documentation	1.61905	0.8540	0.72938
39	B15	Health and safety inadequacies	1.61905	0.6228	0.387921
40	B19	Quality system inadequacies	1.61905	0.7309	0.53426
41	B29	Project execution strategy challenges	1.59524	0.7345	0.53949
42	B02	Illegal encroachment on land	1.57143	0.6678	0.44599
43	B32	Project stakeholders challenges	1.54762	0.8612	0.74158
44	A13	Inefficient legal procedure	1.52381	0.7067	0.49942
45	B06	Changes in design	1.52381	0.6339	0.40186
46	B08	Inadequate specification	1.52381	0.7067	0.49942
47	B30	Decision challenges	1.45238	0.5501	0.30256
48	B10	Failure in negotiation	1.42857	0.5903	0.34843
49	B09	Failure in bidding system	1.40476	0.5868	0.34437
50	B31	Technical and managerial complexity	1.30952	0.5174	0.26771

4.2.5 Initial Risk Severity Assessment

After potential risk factors have been identified, and as part of risk identification process, it is imperative to carry out an initial severity assessment of the identified risk factors in order to determine and filter significant risk factors that have potentials to severely affect project

objective from the insignificant ones, so that effort can be focused on significant risks in the final assessment as opined by Choi and Mahadeven (2008) and Dallas (2006).

In determining the degree of severity of risk in the study, the likelihood of occurrence and the impact of the potential risk factors assessed by the respondents are used to determine the risk significance index as outlined by Shen (2008). Table 4.8 shows the outcome of the calculations of the relative Significance Index and the categorization of each of the risk factors based on scales averaging technique.

Table 4.9: Severity ranking of identified risk factors

S/No.	Risk ID#	Risk Factor	Significant Index	Remark
1	A11	Changes in demand for houses	15.7381	Significant
2	A08	Interest rate fluctuation	14.7857	Significant
3	A16	Outbreak of war and conflict	12.7381	Significant
4	A05	Exchange rate fluctuation	12.8810	Significant
5	B07	Delay in design approval	12.3333	Significant
6	A01	General insecurity in the economy	12.1429	Significant
7	B25	Cost overrun	10.4047	Significant
8	A15	Industrial strike	9.3095	Significant
9	A17	Community resistance	8.8095	Significant
10	B14	Scheduling (time)overrun	8.4528	Significant
11	A06	Inflation in the economy	7.9286	Significant
12	A02	Lack of policy continuity	7.4762	Significant
13	B05	Defective design	7.1905	Significant
14	B18	Site condition variation	6.9524	Significant
15	A04	Instability in government	6.5476	Significant
16	B04	Illegal title to land	5.7143	Significant
17	B26	Cash-flow challenges	5.5000	Significant
18	B24	Bankruptcy of suppliers	5.3571	Significant
19	B01	Delay in land acquisition	5.1904	Significant
20	B11	Adoption of wrong procurement system	4.9781	Insignificant
21	A14	Inclement weather	4.9524	Insignificant
22	A18	Theft and Vandalism	4.9286	Insignificant
23	A07	Lending Policy Changes	4.9286	Insignificant
24	A13	Inefficient Legal Procedure	4.7857	Insignificant
25	B17	Raw Material and Equipment Non-Availability	4.5000	Insignificant
26	B03	Inaccessibility to Land	4.4524	Insignificant
27	B16	Productivity Challenges	4.1191	Insignificant
28	B13	Unenforceability of contract	3.6667	Insignificant
29	B08	Inadequate Specification	3.6429	Insignificant
30	A12	Changes in-law and regular	3.5000	Insignificant
31	A09	Price Control System	3.4286	Insignificant

32	B12	Inappropriate documentation	3.3810	Insignificant
33	B15	Health and safety inadequacies	3.3095	Insignificant
34	B21	Variation in Scope	3.2857	Insignificant
35	B23	Delay in Payment to supplies	3.2619	Insignificant
36	B10	Failure in Negotiation	3.2381	Insignificant
37	B20	Technology Changes	3.1905	Insignificant
38	B19	Quality System inadequacies	3.0714	Insignificant
39	B20	Technology Changes	3.0714	Insignificant
40	B06	Changes in design	2.9762	Insignificant
41	B27	Claims and variations	2.8333	Insignificant
42	B29	Project execution strategy challenge	2.5714	Insignificant
43	B22	Damage to Work	2.5714	Insignificant
44	B09	Failure in Biding System	2.5476	Insignificant
45	B02	Illegal Encroachment in Land	2.5476	Insignificant
46	B28	Project team selection challenges	2.4762	Insignificant
47	B03	Inaccessibility to land	2.4534	Insignificant
48	B32	Project stationers challenges	2.3333	Insignificant
49	B30	Decision challenges	2.22381	Insignificant
50	B31	Technical and managerial complex	1.9048	Insignificant

*Arithmetic Mean Scales Value = 5.0

Based on the severity calculations and ranking as presented in Table 4.8, 19 out of the 50 identified potential risk factors were found to have relative significance index of 5.0 and above whereas the remaining 31 of the 50 potential risk factors identified have significance index value below 5.0 threshold and therefore classified as insignificant.

4.2.6 Review of Project Risk Structure

Based on the computations of the severity of the potential risk factors and the subsequence categorization, as significant or insignificant, the reviewed project risk structure of the significant risks is presented in Table 4.9.

The result of this restructuring shows a remarkable reduction in the number of both macro-level risk factors, which dropped from 10 to 7 and the micro-level sub-factors which reduced from 50 to 19. This, among others, ensures that the final assessment is handy and focused on significant risk factors.

Table 4.10 Reviewed Risk Hierarchy structure

Risk ID#	Risk Factor
L0101	**Political**
A01	General insecurity in the economy
A02	Lack of policy continuity of government
A04	Instability in government
L102	**Economic**
A05	Exchange rate fluctuation
A06	Inflation in the economy
A08	Interest rate fluctuation
A11	Demand for house change
L104	**Force Majeure**
A15	Industrial strike
A16	Outbreak of war and conflict
A17	Community resistance
L105	**Land Acquisition**
B01	Delay in land acquisition
B04	Illegal title of land
L106	**Design**
B05	Defective design
B07	Delay in design approval
L108	**Construction**
B14	Scheduling (time) overrun
B18	Site condition variation
L109	**Financial**
B24	Bankruptcy of suppliers
B25	Cost overrun
B26	Cash-flow challenges

4.3 Results of the Risk Assessment Survey

The risk assessment survey was carried out among selected respondents measure and determine the relative weight (priority) of each of the identified significant risk factors in line

with the Analytical Hierarchical Process (AHP) procedure which demand pair-wise comparison among the identified significant risk factor. The evaluation of the assessment data was carried out using computer-based AHP-structure software – *Superdecision*. The software uses the eigenvalue method of AHP in analysing the pair-wise comparison matrices collected from the respondents to calculate relative weight vector for each matrix.

4.3.1 General Information of the Assessment Team

The general information part of the questionnaire captured the respondents' profession, working experience, academic qualification, and respondents' organization type as while as position in the organization. The summarised details of the Assessment Team' general information backgrounds are presented in Table 4.10.

Table 4.11:General Information of the Assessment Team

S/N	Profession	Working experience (years)	Academic qualification	Organization type	Position in organization	Remark
1	PM	Above 20	Ph.D.	Consultant	Senior Mgt	Respondents A
2	Engineer	Above 20	Ph.D.	Consultant	Senior Mgt	Respondents B
3	Builder	16-20	Ph.D.	Developer	Senior Mgt	Respondents C
4	PM	16-20	Ph.D.	Developer	Senior Mgt	Respondents D
5	PM	Above 20	Ph.D.	Contractor	Senior Mgt	Respondents E

In summary, three (3) of the respondents are project managers, while the other two are one (1) engineer and one (1) builder Two of the respondents (B and C) have working experience of 16-20 years while the other three have all above 20 years working in housing and construction field. All the five respondents have Ph.D. degree and are in senior and management positions in their respective organizations. Lastly, two of respondents are working as consultants whereas the other two are developers (two) and the last is a contractor.

4.3.2. Priorities of Significant Risk Factors

4.3.2.1 Macro Level Risk Factors

Presented in Table 4.11 is the result of the findings of the relative priorities (weights) of the macro-level risk factors based on respondents' judgments in pair-wise comparison matrix. It also shows the consistency ratio as computed by the *Superdecision* software. The respondents were asked to make pair-wise comparison judgement between the seven (7) identified significant macro-level risk factors with respect to the main goal (Housing Development Project Risk). The responses were inputted into the structured problem platform in the *Superdecision* software using the matrix input mode. The responses were synthesised and the relative weights (priorities) were read from the Unweighted matrix displayed.

Table 4.12: Pair-Wise Comparison priorities of Macro-Level Risk Factors

S/N	**Risk ID#**	**Risk factors**	**Priorities by respondents**					**Average weight**
			A	**B**	**C**	**D**	**E**	
1	L102	Economic	0.3845	0.3905	0.4128	0.4371	0.3816	0.4013
2	L105	Land acquisition	0.2602	0.218	0.2549	0.2765	0.2418	0.2502
3	L106	Design	0.0973	0.1821	0.1682	0.0890	0.0734	0.1220
4	L109	Financial	0.1031	0.0784	0.1386	0.1246	0.1056	0.1101
5	L108	Construction	0.0798	0.0596	0.0512	0.0604	0.0557	0.0613
6	L101	Political	0.0403	0.0515	0.0428	0.0386	0.0470	0.0440
7	L104	Force Majeure	0.0109	0.0357	0.0414	0.0092	0.0091	0.0211
Consistency Ratio(CR)			0.0414	0.051	0.0313	0.0159	0.0258	

Based on the results the relative priorities of the macro-level risk factor, economic risks group (RID# L102) with an average weight value of 0.4013 has the highest ranking as submitted by the respondents. This is followed by land acquisition risk (RID# L105) and design risk (RID#L106) with weight (priority) values of 0.2502 and 0.1220 respectively.

Least in the ranking among the macro-level risk group is the Force Majeure (natural disaster) (RID#L104) with average weight value of 0.0211 and political risk (RID#L101) with average weight value of 0.0440.

The consistency ratios (CR) among the respondents indicated on Table 4.11 are all below the indicative recommended value of 0.10 by the *Superdecision* system.

4.3.2.2 Micro-level Risk Factors

The Assessment Team members were each giving a questionnaire (the assessment questionnaire as contained in Appendix II of this thesis) and required to make pair-wise comparison judgments on the impact of each of the significant micro-level risk factors on their project with respect to main goal (housing development project risk level). Table 4.12 presents summary of the results in terms of the derived ratio scale priorities (weight values) and the consistency ratios of the matrices based on the data inputted into and subsequently synthesized by the *Superdecision* software.

Table 4.13: Pair-wise Comparison priorities of Micro-level Risk Factors

S/N	Risk ID#	Risk factors	Weights (Priorities) by respondent					Average weight	Coefficient of variation
			A	B	C	D	E		
1	A01	General insecurity in the economy	0.0328	0.0996	0.0525	0.0236	0.0324	0.0482	0.000937
2	A02	Lack of policy continuity in the system	0.0118	0.0069	0.0151	0.0097	0.0091	0.0105	0.000096
3	A04	Instability in govt	0.0523	0.0492	0.0310	0.0320	0.0291	0.0387	0.000123
4	A05	Exchange rate fluctuation	0.0079	0.0133	0.0122	0.0073	0.0249	0.0131	0.000050
5	A06	Inflation in the economy	0.0731	0.0211	0.0311	0.0415	0.0289	0.0391	0.000414
6	A08	Interest rate fluctuation	0.1183	0.1283	01008	0.1580	0.1458	0.1302	0.000507
7	A11	Changes in demand for houses	0.2328	0.1894	0.1718	0.2379	0.1775	0.2019	0.000978
8	A15	Industrial strike	0.0157	0.0295	0.0182	0.0026	0.0195	0.0171	0.000093
9	A16	Outbreak of war and conflict	0.0506	0.0417	0.0703	0.0511	0.0402	0.0508	0.000144
10	A17	Community resistance	0.0142	0.0229	0.0131	0.0114	0.0003	0.0124	0.0000653
11	B01	Delay in land acquisition	0.0253	0.0470	0.0529	0.0263	0.0358	0.0375	0.0001511
12	B04	Illegal title to land	0.0478	0.0467	0.0703	0.0502	0.1082	0.0647	0.0006852
13	B05	Defective design	0.0021	0.0107	0.0015	0.0047	0.0453	0.0111	0.000368
14	B07	Delay in design approval	0.0703	0.0802	0.0533	0.0402	0.0302	0.0548	0.0004267
15	B14	Scheduling(time) overrun	0.0579	0.1078	0.1024	0.0804	0.0795	0.0856	0.0004023
16	B18	Site condition variation	0.0275	0.0110	0.0117	0.0313	0.0133	0.0190	0.0000933
17	B24	Bankruptcy of suppliers	0.0232	0.0253	0.0032	0.0021	0.0001	0.0110	0.0001481
18	B25	Cost overrun	0.0753	0.1398	0.0963	0.1308	0.1117	0.1108	0.000678
19	B26	Cash-flow challenges	0.0503	0.0618	0.0229	0.0412	0.0408	0.0434	0.000204
	Consistency Ratio(CR)		0.0346	0.0675	0.0513	0.0482	0.0611		

The result after synthesis of the data shows significant variations in the weightings between each risk factor. The highest average weight score by the risk factors is 0.2019 (RID#A11) while the lowest is 0.0105 (RID#A02). Other risk factors average scores ranges from 0.1308 (RID#A08) to 0.0110 (RID#B24).

Similarly, there are variations in responses from the respondents in terms of both judgment scores, measured as a Consistency Ratio (CR) and scoring of each of the respective risk factor, measured as coefficient of variation (CV). The consistency ratios (CR) show that respondent (B) has the highest inconsistency value of 0.0675 while the lowest is respondent (A) with 0.0346 CR value. Laterally, there is also variation in judgments between respondents on each of the risk factors measured. The highest variation recorded is on risk factor (RID#A11) which recorded 0.00098 while the lowest with respondents' scoring variation is risk factor RID# A02 –lack of policy continuity in system.

4.4 Ranking of Risk Factors

4.4.1 Macro-level risk factors

To prioritise the risk factors, the risks are compared based on their respective weights scorings. Table 4.14 shows the priority ranking of the macro-level risk factors. Housing development project is an investment oriented project that produces tangible housing products which are usually subjected to market forces of demand and supply. The investment and its products are sensitive to the demand of the product by its consumers – the housing owners. The scoring of economic risk as the highest macro-level risks may not be unconnected with that situation. It is, therefore, not surprising that all experts agreed that economic risk is highest in the housing development projects. The economic factor not only affect the cost of funds – the interest rate, inflation rate and exchange rate – but also the demand of the housing products.

Table 4.14 Ranked Macro-level Risk Factors

S/No.	Risk ID#	Risk Factor	Average weight value	Ranking
1	L102	Economic	0.4013	1st
2	L105	Land acquisition	0.2502	2nd
3	L106	Design	0.1220	3rd
4	L109	Financial	0.1101	4th
5	L108	Construction	0.0613	5th
6	L101	Political	0.0440	6th
7	L104	Force Majeure	0.0211	7th

Land acquisition (RID#L102) and design (RID#L106) macro-level risks are adjudged as the second and third respectively as the most highly risk events. The high ranking given to land with the survey area may not be unconnected with the government reform policies in land ownership in the territory. Similarly, the design risk, which encompasses the authority's design approval before proceeding with project execution, is highly risky due to the reform efforts of public authorities within the study location. Financial and construction macro-level risks are ranked by experts as moderate due to the developers' day to day control over such risks factors. Least ranked among the macro-level risk factors are political risk and risk due to Force Majeure (natural disasters) which are mostly outside human control and also have less likelihood of occurrence.

4.4.2 Micro-level risk factors

On a similar note, to prioritise the micro-level risk factors, their respective weight scorings are compared and ranked accordingly. The priority ranking of the micro-level risk factors is presented in Table 4.14 below.

Table 4.15: Ranked Micro-level Risk Factors

S/No.	Risk ID#	Risk Factor	Average weight value	Ranking
1	A11	Changes in demand for houses	0.2019	1st
2	A08	Interest rate fluctuation	0.1303	2nd
3	B25	Cost overrun	0.1108	3rd
4	B14	Scheduling (time) overrun	0.0856	4th
5	B04	Illegal title to land	0.0647	5th
6	B07	Delay in design approval	0.0548	6th
7	A16	Outbreak of war and conflict	0.0508	7th
8	A01	General insecurity in the economy	0.0482	8th
9	B26	Cash-flow challenges	0.0434	9th
10	A06	Inflation in the economy	0.0391	10th
11	A04	Instability in government	0.0387	11th
12	B01	Delay in land acquisition	.0.0375	12th
13	B18	Site condition variation	0.0190	13th
14	A15	Industrial strike	0.0171	14th
15	A05	Exchange rate fluctuation	0.0131	15th
16	A17	Community resistance	0.0124	16th
17	B05	Defective design	0.0111	17th
18	B24	Bankruptcy of suppliers	0.0110	18th
19	A02	Lack of policy continuity in govt.	0.0105	19th

Top on the highest ranking is an economic risk factor – changes in demand for houses (RID#A11). The demand for houses, which is invariably influenced by the purchasing power of the consumers, available mortgage system and government housing policies among others, has been fluctuating in Nigeria over recent years. Many of the housing products are have stocks piled up without commensurate buyers. The ranking of this risk factor by experts as the highest risk may not be unconnected with this situation. The second ranked risk factor by experts is another economic risk group element – the interest rate fluctuation (RID#A08). The interest rate invariably affects borrowing rate and cost of funds for the entire investment. Placed third (3rd) and fourth (4th) are two construction risk factors that are so regular in construction management: Cost overrun (RID#B25) and scheduling (time) overrun (RID#B14). Despite the enormous efforts and time usually sacrificed in planning and management of capital project's cost and time, thetwo tasks remain major risk factors in

project implementation as submitted by the experts' opinions. Land acquisition risk factor – illegal title to land (RID#B04) is considered by the experts as also high with average weighting value of 0.065.

On the moderate scale are wide ranges of risk factors with variant degree of weighting values such as inflation in the economy (RID#A06), instability in government (RID#A04), delay in land acquisition (RID#B01), Site condition variation (RID#B18), general insecurity in the economy (RID#A01) and industrial strike (RID#A15). These risk factors which have average weightings of 0.40 – 0.015 are regarded by experts as moderate risk factors.

Least ranked, among the lowest of the 19 risk factors are defective design (RID#B05), bankruptcy of suppliers (RID#B24) and lack of policy continuity (RID#A02) probably due to prototype nature of housing development projects which allows defect in design to be corrected easily. Experts consider these risk factors are fairly stable and as such ranked them low. Similarly, the rolling over of project management team which allows same parties to move along from project to project makes evaluation of the insolvency of suppliers usually a routine task and may not constitute high risk to developers. Lack of policy continuity is ranked also lowest by experts probably due to fairly consistent policy environment enjoyed in Nigeria of recent. Therefore, lack of policy continuity (RID#A02) with it low chance of occurrence and impact is regarded as the lowest ranked risk factor.

4.5 Discussion on the results of the study

The essence of risk identification and assessment within any risk management framework is to clearly identify those major risks that are relevant and can have impact on the achievement of project objectives and outline the most critical ones, in an orderly manner, based on some rational assessment method. The results of this study are distinctively clear as to the risks that are significant and relevant to housing project development in Nigeria. The results show that

each risk factor and sub-factor can distinctively be identified and assessed in both direct and relative (by weight) to other risk factors and sub-factors in order to provide a prioritised risk ranking that can serve as a basis for sound mitigatory decision. This approach is quite distinct to the practice of including lump sum as a cover for all kind of risk events as practiced in the informal risk management environment.

The study results show that the most critical risk event is the Economic event (RID#L102). Economic risk is one of the general risk events that affect the industry as a whole and not tight to specific project and which can only be addressed by the industry stakeholders together through combined efforts. The most critical risk factor that contribute more to the high exposure of housing development projects to economic risk is the demand for housing (RID#A11) during the study period as shown in the micro-level prioritization assessment result. The demand for housing, which in this study refers to the quantity of housing stock/assets that consumers are willing and able to buy, is not only influenced by the price of housing assets alone, but a number of other factors such as the financial resources (income) of the housing consumers; the consumers' taste (offered by various types and designs of houses); the number of consumers in the housing market; the consumers' expectations and price of other related products and services (Pozdena, 1988).

Consequently, although the assessment of risk in this study has pointed to the most critical risk event and risk factor (in Economic event and demand for housing) the mitigatory response by project promoters needs to consider deeply into the other underlying factors that affect the demand for housing, and possibly carry out further assessment in line with this study methodology, in order to take appropriate mitigatory decision and measures. The responses can range from accepting the status quo, rejecting the risk or even transferring the risk to another party that is willing to bear it.Conclusively, the results of the study have revealed some amazing paradox: hunger in the mist of plenty! Whereas the Nigeria people

and government are busy crying of inadequate housing units (FMLHUD, 2006), the housing developers are worrisome about the demand for housing products!

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

A brief summary of the findings from the study are as follows:

a.) In order to adequately capture all the significant risks associated with housing development project, the study proposed an identification framework that consists of three integrated techniques that involves review of documented past experiences on similar projects as contained in literature, experts' consultation and questionnaire based survey. The framework has proved successful in identifying key risks associated with housing development projects.

b.) Additionally, the study extends the scope of the traditionalidentification process to include initial assessment and structuring sub-processes that enables significant risk elements to be filtered among the identified risk factors which has helped in focusing the final assessment on the most significant risk elements.

c.) The study also proposed a prioritization risk assessment methodology (the Analytic Hierarchical Process technique) that incorporates fuzzy-based methodology so as to capture the subjective risk information using natural linguistic terms that ensures easy and greater participation among thee surveyed respondents. This has yielded the required results.

d.) Based on the risk identification framework proposed, 50 potential risk factors were identified to have some influence on house development project objectives. These factors were classified under ten (10) macro-level groups.

e.) The study, as part of the preliminary assessment and structuring of the risk factors, measured and evaluated the risk severity variables (the likelihood of occurrence and

estimation of impact) to determine the significance of each risk factors. The results of the findings shows that 19 risk factors out of the 50 identified risk factors are significant and therefore qualified for in-depth prioritization assessment.

f.) The results of the assessment findings show that the risk exposure of housing development project with respect to macro-level economic risk (RID#L102) and land acquisition risk (RID#L105) are very high while political (RID#101) and Force Majeure (RID#L104) risks are low. Similarly, at the micro-level risk factors such as Changes to demand for houses risk (RID#A11), interest rate fluctuation risk (RID#A08) and Cost overrun risk (RID#B25) are very high risks to developers while Lack of policy continuity (RID#A02), Bankruptcy of suppliers (RID#B24) and Defective design (RID#B05) are low risk factors.

5.2 Conclusions

The need for the deployment of robust and systematic risk management system in housing development projects is becoming increasingly imperative not only because of the need to improve the working system in developers' organizations but also to adverse the consequences of risk on the success of project undertaken.

The findings of the study have revealed and underscored the importance of the two strategic processes of identification and assessment towards achieving a robust systematic risk management system. A sound identification framework and an efficient and flexible risk assessment methodology are keys to the achievement of robust risk management system. The study was able to properly identify and adequately assessed the risks associated with housing development project using computer-based AHP prioritization assessment technique.

5.3 Recommendations

The following recommendations are proffered on the account of the research findings:

i. The planning and selection of methods, techniques and tools appropriate for risk management system to be deployed in any project undertaken should be given high emphasis as this usually have serious influence on the outcome of the risk management efforts put in place.

ii. Risk identification strategy should, as a matter of priority, includes an initial assessment which has the potentials of enabling project management team to focus only on high priority risks at the final assessment stage thereby minimising the cost and efforts required in the final assessment and mitigatory processes.

iii. Risks prioritization should be at the heart of every risk assessment process because of its potentials to reduce efforts, cost and actions required in the plan risk responses which in turn may result in project performance improvement.

iv. Efforts should be intensified to discourage or atleast minimise the use of informal techniques such as the use of lump sum to cover effects of risk factors (as a rule-of-thumb) through appropriate enlightenment and education of project stakeholders. Avenues such as symposium, conferences, exhibition, etc. should be considered for this purpose.

v. Although the study was able to establish high and low priority risks, it is by no means an end in itself. Risk management should be approached in a dynamic way, because risks have the potentials of mutating at a given time.

5.4 Major Contribution to Knowledge

i. The study has shown that Economic risk and land Acquisition risk at macro-level were found to have the highest risk priority while Changes

in demand for houses risk and Interest rate fluctuation risk were found to have similar highest risk ranking at micro-level in housing development projects in Nigeria.

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APPENDIX I

QUESTIONAIRE

Department of Quantity Surveying

Faculty of Environmental Design

Ahmadu Bello University,

Zaria, Nigeria.

Dear Sir/Madam,

RISK IDENTIFICATION AND ASSESSMENT IN HOUSING DEVELOPMENT PROJECTS USING ANALYTICAL HIERARCHIAL PROCESS

This questionnaire is part of an on-going research work for an M.Sc. (Project Management) degree in the department of Quantity Surveyors, Ahmadu Bello University, Zaria. It is designed to obtain relevant information on the above subject research topic.

This research work seeks to identify risks associated with housing development projects and assess the risks using Analytical Hierarchical process (AHP). techniques for the purpose of prioritization. This among others includes identification of risk sources, measurement and pair – wise assessment of risk impact for the purpose of prioritization assessment using AHP methodology.

Therefore, your contribution through the completion of the questionnaire attached herewith would be very valuable to the success of this study.

Please feel free to complete the questionnaire. I assure you that all information collected from this survey will be treated with utmost confidentiality and will not be used for any other purpose other than what is herein stated.

Yours faithfully,

Baba, Yusuf Garba

SECTION A

GENERAL INFORMATION

1. **Profession**: Project Manager [ ] Builder [ ] Quantity Surveyor [ ] Engineer [ ] Architect [ ] Others [ ] specify……

2. **Working Experience** (years):
   1-5 [ ] 6 – 10 [ ] 11-15 [ ] 15 – 20 [ ] Above 20 [ ]

3. **Academic Qualification**:
   PhD [ ] M.Sc [ ] B.Sc. [ ] HND [ ] ND [ ] others[ ]

4. **Age group** (years)**:** 1- 30 [ ] 31 – 40 [ ] 41 – 50 [ ] 51 – 60 [ ] above 60 [ ]

5. **Type of Organization:** Housing Developer [ ] Consultant [ ] Contractor [ ] Govt. Agency [ ] Others [ ] specify…….

SECTION B

1. RISK FACTORS IDENTIFICATION

Listed below are potential risks factors associated with housing development project sourced from various means.

Risk ID	**Risk Factor**
A01	General Insecurity in the Economy
A02	Lack of policy continuity of government
A03	Corruption in the system
A04	Instability in government
A05	Exchange rate fluctuation
A06	Inflation in the economy
A07	Lending policy
A08	Interest rate
A09	Price Control system
A10	Tax changes
A11	Changes in Demand for Houses
A12	Changes in laws and regulations

A13	Inefficient legal procedure
A14	Inclement Weather condition
A15	Industrial strike
A16	Outbreak of War and conflict
A17	Community resistance
A18	Theft and vandalism
B01	Delay in land acquisition
B02	Illegal encroachment on land
B03	Inaccessibility to land
B04	Illegal title to land
B05	Defective design
B06	Changes in design
B07	Delay in approval
B08	Inadequate specification
B09	Failure in bidding system
B10	Failure in negotiation during the procurement process
B11	Adoption of wrong procurement system
B12	Inappropriate documentation
B13	Unenforceability of contract
B14	Scheduling (time) overrun
B15	Health and safety inadequacies
B16	Productivity challenges
B17	Raw material and equipment non-availability
B18	Site condition variation
B19	Quality system inadequacies
B20	Technology changes

B21	Variation in scope
B22	Damage to work
B23	Delay in payment to suppliers
B24	Bankruptcy of suppliers
B25	Cost overrun
B26	Cash-flow challenges
B27	Claims and variations
B28	Project team selection challenges
B29	Project Execution Strategy challenges
B30	Decision challenges
B31	Technical and managerial complexity
B32	Project stakeholders challenges

Do you consider the factors as relevant, in terms of influencing the achievement of any objective, in the development of housing project in your locality? **Yes** [ ] **No** [ ]

2. RISK FACTORS AND THEIR LIKELIHOOD OF OCCURRENCE

Listed below are risks factors associated with housing project development in Nigeria. Please tick appropriately the likelihood of occurrence of each of the risks factors.
Key: using the following scale: Rare (not expecting to happen), Unlikely (small likelihood but could well happen), Possible (having 50-50 chance), Likely (more than 50 – 50chance), Almost certain (almost certain it will happen)

Risk ID	**Risk Factors**	LIKELIHOOD OF OCCURRENCE				
		Almost certain	**Likely**	**Possible**	**Unlikely**	**Rare**
A01	General Insecurity in the Economy					
A02	Lack of policy continuity of government					
A03	Corruption in the system					
A04	Instability in government					

A05	Exchange rate fluctuation					
A06	Inflation in the economy					
A07	Lending policy					
A08	Interest rate					
A09	Price Control system					
A10	Tax changes					
A11	Changes in demand for Houses					
A12	Changes in laws and regulations					
A13	Inefficient legal procedure					
A14	Inclement Weather condition					
A15	Industrial strike					
A16	Outbreak of War and conflict					
A17	Community resistance					
A18	Theft and vandalism					
B01	Delay in land acquisition					
B02	Illegal encroachment on land					
B03	Inaccessibility to land					
B04	Illegal title to land					
B05	Defective design					
B06	Changes in design					
B07	Delay in approval					
B08	Inadequate specification					
B09	Failure in bidding system					

B10	Failure in negotiation during the procurement process					
B11	Adoption of wrong procurement system					
B12	Inappropriate documentation					
B13	Unenforceability of contract					
B14	Scheduling (time) overrun					
B15	Health and safety inadequacies					
B16	Productivity challenges					
B17	Raw material and equipment non-availability					
B18	Site condition variation					
B19	Quality system inadequacies					
B20	Technology changes					
B21	Variation in scope					
B22	Damage to work					
B23	Delay in payment to suppliers					
B24	Bankruptcy of suppliers					
B25	Cost overrun					
B26	Cash-flow challenges					
B27	Claims and variations					
B28	Project team selection challenges					
B29	Project Execution Strategy challenges					
B30	Decision challenges					
B31	Technical and managerial complexity					
B32	Project stakeholders challenges					

3. IMPACT OF RISK FACTORS ON DEVELOPER

Listed below are risks factors associated with housing project development in Nigeria. Please tick appropriately the likely Impact of each of the risks factors.

Key: using the following scale: Very low impact (negligible effect), Low impact (small/slight effect), Moderate impact (reasonable effects), High impact (serious threat), Very high impact (the impact is totally unacceptable)

Risk ID	**Risk Factors**	IMPACT LEVEL				
		Very High	**High**	**Moderate**	**Low**	**Very Low**
A01	General Insecurity in the Economy					
A02	Lack of policy continuity of government					
A03	Corruption in the system					
A04	Instability in government					
A05	Exchange rate fluctuation					
A06	Inflation in the economy					
A07	Lending policy					
A08	Interest rate					
A09	Price Control system					
A10	Tax changes					
A11	Changes in demand for Houses					
A12	Changes in laws and regulations					
A13	Inefficient legal procedure					
A14	Inclement Weather condition					
A15	Industrial strike					
A16	Outbreak of War and conflict					
A17	Community resistance					

A18	Theft and vandalism					
B01	Delay in land acquisition					
B02	Illegal encroachment on land					
B03	Inaccessibility to land					
B04	Illegal title to land					
B05	Defective design					
B06	Changes in design					
B07	Delay in approval					
B08	Inadequate specification					
B09	Failure in bidding system					
B10	Failure in negotiation during the procurement process					
B11	Adoption of wrong procurement system					
B12	Inappropriate documentation					
B13	Unenforceability of contract					
B14	Scheduling (time) overrun					
B15	Health and safety inadequacies					
B16	Productivity challenges					
B17	Raw material and equipment non-availability					
B18	Site condition variation					
B19	Quality system inadequacies					
B20	Technology changes					
B21	Variation in scope					
B22	Damage to work					
B23	Delay in payment to suppliers					

B24	Bankruptcy of suppliers					
B25	Cost overrun					
B26	Cash-flow challenges					
B27	Claims and variations					
B28	Project team selection challenges					
B29	Project Execution Strategy challenges					
B30	Decision challenges					
B31	Technical and managerial complexity					
B32	Project stakeholders challenges					

APPENDIX II

QUESTIONAIRE

Department of Quantity Surveying

Faculty of Environmental Design

Ahmadu Bello University,

Zaria, Nigeria.

Dear Sir/Madam,

RISK IDENTIFICATION AND ASSESSMENT IN HOUSING DEVELOPMENT PROJECTS USING ANALYTICAL HIERARCHIAL PROCESS

This questionnaire is part of an on-going research work for an M.Sc (Project Management) degree in the department of Quantity Surveyors, Ahmadu Bello University, Zaria. It is designed to obtain relevant information on the above subject research topic.

This research work seeks to identify risks associated with housing development projects and assess the risks using Analytical Hierarchical process (AHP). techniques for the purpose of prioritization. This among others includes identification of risk sources, measurement and pair – wise assessment of risk impact for the purpose of prioritization assessment using AHP methodology.

Therefore, your contribution through the completion of the questionnaire attached herewith would be very valuable to the success of this study.

Please feel free to complete the questionnaire. I assure you that all information collected from this survey will be treated with utmost confidentiality and will not be used for any other purpose other than what is herein stated.

Yours faithfully,

Baba, Yusuf Garba

SECTION A

GENERAL INFORMATION

6. **Profession**: Project Manager [ ] Builder [ ] Quantity Surveyor [ ] Engineer [ ] Architect [ ] Others [ ] specify……

7. **Working Experience** (years):
   1-5 [ ] 6 – 10 [ ] 11-15 [ ] 15 – 20 [ ] Above 20 [ ]

8. **Academic Qualification**:
   Ph.D. [ ] M.Sc. [ ] B.Sc. [ ] HND [ ] ND [ ] others[ ]

9. **Type of Organization:** Housing Developer [ ] Consultant [ ] Contractor [ ] Govt. Agency [ ] Others [ ] specify…….

10. **Position in the Organization:** Senior Management [ ] Middle level Staff [ ] Junior Staff [ ] Others [ ] specify…….

SECTION B

BACKGROUND INFORMATION

Listed below in Table 1 are potential risks factors and sub-factors identified from survey of risks associated with housing development project and structured for guidance.

Table 1: Identified Risk factors

Risk ID	**Risk Factor**
L101	**Political**
A01	General Insecurity in the Economy
A02	Lack of policy continuity of government
A03	Corruption in the system
A04	Instability in government
L102	**Economic**
A05	Exchange rate fluctuation
A06	Inflation in the economy
A07	Lending policy change

A08	Interest rate fluctuation
A09	Price Control system
A10	Tax changes
A11	Changes in the demand for houses
L103	**Legal**
A12	Changes in laws and regulations
A13	Inefficient legal procedure
L104	**Force Majeure**
A14	Inclement Weather condition
A15	Industrial strike
A16	Outbreak of War and conflict
A17	Community resistance
A18	Theft and vandalism
L105	**Land acquisition**
B01	Delay in land acquisition
B02	Illegal encroachment on land
B03	Inaccessibility to land
B04	Illegal title to land
L106	**Design**
B05	Defective design
B06	Changes in design
B07	Delay in approval
B08	Inadequate specification
L107	**Contract**
B09	Failure in bidding system
B10	Failure in negotiation during the procurement process

B11	Adoption of wrong procurement system
B12	Inappropriate documentation
B13	Unenforceability of contract
L108	**Construction**
B14	Scheduling (time) overrun
B15	Health and safety inadequacies
B16	Productivity challenges
B17	Raw material and equipment non-availability
B18	Site condition variation
B19	Quality system inadequacies
B20	Technology changes
B21	Variation in scope
B22	Damage to work
L109	**Financial**
B23	Delay in payment to suppliers
B24	Bankruptcy of suppliers
B25	Cost overrun
B26	Cash-flow challenges
B27	Claims and variations
L110	**Project Management**
B28	Project team selection challenges
B29	Project Execution Strategy challenges
B30	Decision challenges
B31	Technical and managerial complexity
B32	Project stakeholders challenges

B.) Listedin Table 2 below also same potential risks factors and sub-factors but identified and found to have significant influence to the achievement of project objectives in housing development project and structured for guidance.

Listed in Table 2 Identified significant risk factors

Risk ID	**Risk Factor**
L101	**Political**
A01	General Insecurity in the Economy
A02	Lack of policy continuity of government
A04	Instability in government
L102	**Economic**
A05	Exchange rate fluctuation
A06	Inflation in the economy
A10	Tax changes
A11	Changes in the demand for houses
L104	**Force Majeure**
A15	Industrial strike
A16	Outbreak of War and conflict
A17	Community resistance
L105	**Land acquisition**
B01	Delay in land acquisition
B04	Illegal title to land
L106	**Design**
B05	Defective design
B07	Delay in approval
L108	**Construction**
B14	Scheduling (time) overrun
B18	Site condition variation

L109	Financial
B24	Bankruptcy of suppliers
B25	Cost overrun
B26	Cash-flow challenges

PAIR-WISE RISK COMPARISON

Contained in the Tables 4 and 5 below are pair-wise comparism matrices for the identified risk factors that were found to have significant influence on housing development project objectives. Please circle the relevant arrows and tick appropriate likely dominance (in terms of contributing to the severity of impact of the main node) for each pair of the risk factors.

Key: using the following scale: 1(equal), 2(Between equal and moderate), 3(moderate), 4(between moderate and strong), 5(strong), 6(between strong and very strong), 7 (very strong), 8(between strong and extreme) and 9(extreme).
The symbol ← indicate the judgment is in favour of the Risk Factor indicated to the left, whereas the symbol ↑ indicates the judgment is in favour of the Risk Factor indicated to the top (right).

Note: Self compared and inverse (INV) elements can be ignored for convenience as this can be computed from the system.

A. Macro-level risk factors with respect to the main Goal (HDP Risk) (7x7 matrix)

S/N	Main Node	Risk# (Left) vs Risk# (Top)	In favour of Risk# to the Left ←	In favour of Risk# to the Top ↑	Comparative Dominance level								
					1	2	3	4	5	6	7	8	9
1	Goal	L101 v L101	-	-	-								
2		L101v L102											
3		L101 v L104											
4		L101 v L105											
5		L101 v L106											

6		L101 v L108											
7		L101 v L109											
8		L102 v L101	INV	INV									
9		L102 v L102	-	-	-								
10		L102 v L104											
11		L102 v L105											
12		L102 v L106											
13		L102 v L108											
14		L102 v L109											
15		L104 v L101	INV	INV									
16		L104 v L102	INV	INV									
17		L104 v L104	-	-									
18		L104 v L105											
19		L104 v L106											
20		L104 v L108											
21		L104 v L109											
22		L105 v L101	INV	INV									
23		L105 v L102	INV	INV									
24		L105 v L104	INV	INV									
25		L105 v L105	-	-									
26		L105 v L106											
27		L105 v L108											
28		L105 v L109											
29		L106 v L101	INV	INV									

30		L106 v L102	INV	INV									
31		L106 v L104	INV	INV									
32		L106 v L105	INV	INV									
33		L106 v L106	-	-									
34		L106 v L108											
35		L106 v L109											
36		L108 v L101	INV	INV									
37		L108 v L102	INV	INV									
38		L108 v L104	INV	INV									
39		L108 v L105	INV	INV									
40		L108 v L106	INV	INV									
41		L108 v L108	-	-									
42		L108 v L109											
43		L109 v L101	INV	INV									
44		L109 v L102	INV	INV									
45		L109 v L104	INV	INV									
46		L109 v L105	INV	INV									
47		L109 v L106	INV	INV									
48		L109 v L108	INV	INV									
49		L109 v L109	-	-									

B. Micro-level risk factors with respect to the main Goal (HDP Risk)

(19x19 matrix)

S/N	**Main Node**	**Risk# (Left) vs Risk# (Top)**	**In favour of Risk# to the Left** ←	**In favour of Risk# to the Top** ↑	**Comparative Dominance level**								
					1	2	3	4	5	6	7	8	9
1	Goal	A01 v A01	-	-	-								
2		A01v A02											
3		A01 v A04											
4		A01 v A05											
5		A01 v A06											
6		A01 v A08											
7		A01 v A11											
8		A01 v A15											
9		A01 v A16											
10		A01 v A17											
11		A01 v B01											
12		A01 v B04											
13		A01 v B05											
14		A01 v B07											
15		A01 v B14											
16		A01 v B18											
17		A01 v B24											
18		A01 v B25											
19		A01 v B26											
20	Goal	A02 v A01	INV	INV									

21		A02 v A02	-	-									
22		A02 v A04											
23		A02 v A05											
24		A02 v A06											
25		A02 v A08											
26		A02 v A11											
27		A02 v A15											
28		A02 v A16											
29		A02 v A17											
30		A02 v B01											
31		A02 v B04											
32		A02 v B05											
33		A02 v B07											
34		A02 v B14											
35		A02 v B18											
36		A02 v B24											
37		A02 v B25											
38		A02 v B26											
39	Goal	A04 v A01	INV	INV									
40		A04 v A02	INV	INV									
41		A04 v A04	-	-									
42		A04 v A05											
43		A04 v A06											
44		A04 v A08											
45		A04 v A11											
46		A04 v A15											

47		A04 v A16											
48		A04 v A17											
49		A04 v B01											
50		A04 v B04											
51		A04 v B05											
52		A04 v B07											
53		A04 v B14											
54		A04 v B18											
55		A04 v B24											
56		A04 v B25											
57		A04 v B26											
58	Goal	A05 v A01	INV	INV	-								
59		A05v A02	INV	INV									
60		A05 v A04	INV	INV									
61		A05 v A05	-	-									
62		A05 v A06											
63		A05 v A08											
64		A05 v A11											
65		A05 v A15											
66		A05 v A16											
67		A05 v A17											
68		A05 v B01											
69		A05 v B04											
70		A05 v B05											
71		A05 v B07											
72		A05 v B14											

73		A05 v B18											
74		A05 v B24											
75		A05 v B25											
76		A05 v B26											
77	Goal	A06 v A01	INV	INV									
78		A06v A02	INV	INV									
79		A06 v A04	INV	INV									
80		A06 v A05	INV	INV									
81		A06 v A06	-	-	-								
82		A06 v A08											
83		A06 v A11											
84		A06 v A15											
85		A06 v A16											
86		A06 v A17											
87		A06 v B01											
88		A06 v B04											
89		A06 v B05											
90		A06 v B07											
91		A06 v B14											
92		A06 v B18											
93		A06 v B24											
94		A06 v B25											
95		A06 v B26											

96	Goal	A08 v A01	INV	INV									
97		A08v A02	INV	INV									
98		A08 v A04	INV	INV									
99		A08 v A05	INV	INV									
100		A08 v A06	INV	INV									
101		A08 v A08	-	-	-								
102		A08 v A11											
103		A08 v A15											
104		A08 v A16											
105		A08 v A17											
106		A08 v B01											
107		A08 v B04											
108		A08 v B05											
109		A08 v B07											
110		A08 v B14											
111		A08 v B18											
112		A08 v B24											
113		A08 v B25											
114		A08 v B26											
115	Goal	A11 v A01	INV	INV									
116		A11v A02	INV	INV									
117		A11 v A04	INV	INV									

118		A11 v A05	INV	INV									
119		A11 v A06	INV	INV									
120		A11 v A08	INV	INV									
121		A11 v A11	-	-	-								
122		A11 v A15											
123		A11 v A16											
124		A11 v A17											
125		A11 v B01											
126		A11 v B04											
127		A11 v B05											
128		A11 v B07											
129		A11 v B14											
130		A11 v B18											
131		A11 v B24											
132		A11 v B25											
133		A11 v B26											
134	Goal	A15 v A01	INV	INV									
135		A15v A02	INV	INV									
136		A15 v A04	INV	INV									
137		A15 v A05	INV	INV									
138		A15 v A06	INV	INV									
139		A15 v A08	INV	INV									
140		A15 v A11	INV	INV									

141		A15 v A15	-	-	-								
142		A15 v A16											
143		A15 v A17											
144		A15 v B01											
145		A15 v B04											
146		A15 v B05											
147		A15 v B07											
148		A15 v B14											
149		A15 v B18											
150		A15 v B24											
151		A15 v B25											
152		A15 v B26											
153	Goal	A16 v A01	INV	INV									
154		A16v A02	INV	INV									
155		A16 v A04	INV	INV									
156		A16 v A05	INV	INV									
157		A16 v A06	INV	INV									
158		A16 v A08	INV	INV									
159		A16 v A11	INV	INV									
160		A16 v A15	INV	INV									
161		A16 v A16	-	-	-								
162		A16 v A17											
163		A16 v B01											
164		A16 v B04											
165		A16 v B05											
166		A16 v B07											

167		A16 v B14											
168		A16 v B18											
169		A16 v B24											
170		A16 v B25											
171		A16 v B26											
172	Goal	A17 v A01	INV	INV									
173		A17 v A02	INV	INV									
174		A17 v A04	INV	INV									
175		A17 v A05	INV	INV									
176		A17 v A06	INV	INV									
177		A17 v A08	INV	INV									
178		A17 v A11	INV	INV									
179		A17 v A15	INV	INV									
180		A17 v A16	INV	INV									
181		A17 v A17	-	-	-								
182		A17 v B01											
183		A17 v B04											
184		A17 v B05											
185		A17 v B07											
186		A17 v B14											
187		A17 v B18											
188		A17 v B24											
189		A17 v B25											
190		A17 v B26											
191	Goal	B01 v A01	INV	INV									
192		B01v A02	INV	INV									

193		B01 v A04	INV	INV									
194		B01 v A05	INV	INV									
195		B01 v A06	INV	INV									
196		B01 v A08	INV	INV									
197		B01 v A11	INV	INV									
198		B01 v A15	INV	INV									
199		B01 v A16	INV	INV									
200		B01 v A17	INV	INV									
201		B01 v B01	-	-	-								
202		B01 v B04											
203		B01 v B05											
204		B01 v B07											
205		B01 v B14											
206		B01 v B18											
207		B01 v B24											
208		B01 v B25											
209		B01 v B26											
210	Goal	B04 v A01	INV	INV									
211		B04 v A02	INV	INV									
212		B04 v A04	INV	INV									
213		B04 v A05	INV	INV									
214		B04 v A06	INV	INV									
215		B04 v A08	INV	INV									
216		B04 v A11	INV	INV									

217		B04 v A15	INV	INV									
218		B04 v A16	INV	INV									
219		B04 v A17	INV	INV									
220		B04 v B01	INV	INV									
221		B04 v B04	-	-	-								
222		B04 v B05											
223		B04 v B07											
224		B04 v B14											
225		B04 v B18											
226		B04 v B24											
227		B04 v B25											
228		B04 v B26											
229	Goal	B05 v A01	INV	INV									
230		B05v A02	INV	INV									
231		B05 v A04	INV	INV									
232		B05 v A05	INV	INV									
233		B05 v A06	INV	INV									
234		B05 v A08	INV	INV									
235		B05 v A11	INV	INV									
236		B05 v A15	INV	INV									
237		B05 v A16	INV	INV									
238		B05 v A17	INV	INV									
239		B05 v B01	INV	INV									
240		B05 v B04	INV	INV									

241		B05 v B05	-	-	-								
242		B05 v B07											
243		B05 v B14											
244		B05 v B18											
245		B05 v B24											
246		B05 v B25											
247		B05 v B26											
248	Goal	B07 v A01	INV	INV									
249		B07v A02	INV	INV									
250		B07 v A04	INV	INV									
251		B07 v A05	INV	INV									
252		B07 v A06	INV	INV									
253		B07 v A08	INV	INV									
254		B07 v A11	INV	INV									
255		B07 v A15	INV	INV									
256		B07 v A16	INV	INV									
257		B07 v A17	INV	INV									
258		B07 v B01	INV	INV									
259		B07 v B04	INV	INV									
260		B07 v B05	INV	INV									
261		B07 v B07	-	-	-								
262		B07 v B14											
263		B07 v B18											
264		B07 v B24											

265		B07 v B25											
266		B07 v B26											
267	Goal	B14 v A01	INV	INV									
268		B14v A02	INV	INV									
269		B14 v A04	INV	INV									
270		B14 v A05	INV	INV									
271		B14 v A06	INV	INV									
272		B14 v A08	INV	INV									
273		B14 v A11	INV	INV									
274		B14 v A15	INV	INV									
275		B14 v A16	INV	INV									
276		B14 v A17	INV	INV									
277		B14 v B01	INV	INV									
278		B14 v B04	INV	INV									
279		B14 v B05	INV	INV									
280		B14 v B07	INV	INV									
281		B14 v B14	-	-	-								
282		B14 v B18											
283		B14 v B24											
284		B14 v B25											
285		B14 v B26											
286	Goal	B18 v A01	INV	INV									
287		B18 v A02	INV	INV									
288		B18 v A04	INV	INV									

289		B18 v A05	INV	INV									
290		B18 v A06	INV	INV									
291		B18 v A08	INV	INV									
292		B18 v A11	INV	INV									
293		B18 v A15	INV	INV									
294		B18 v A16	INV	INV									
295		B18 v A17	INV	INV									
296		B18 v B01	INV	INV									
297		B18 v B04	INV	INV									
298		B18 v B05	INV	INV									
299		B18 v B07	INV	INV									
300		B18 v B14	INV	INV									
301		B18 v B18	-	-	-								
302		B18 v B24											
303		B18 v B25											
304		B18 v B26											
305	Goal	B24 v A01	INV	INV									
306		B24v A02	INV	INV									
307		B24 v A04	INV	INV									
308		B24 v A05	INV	INV									
309		B24 v A06	INV	INV									
310		B24 v A08	INV	INV									
311		B24 v A11	INV	INV									
312		B24 v A15	INV	INV									

313		B24 v A16	INV	INV									
314		B24 v A17	INV	INV									
315		B24 v B01	INV	INV									
316		B24 v B04	INV	INV									
317		B24 v B05	INV	INV									
318		B24 v B07	INV	INV									
319		B24 v B14	INV	INV									
320		B24 v B18	INV	INV									
321		B24 v B24	-	-	-								
322		B24 v B25											
323		B24 v B26											
324	Goal	B25 v A01	INV	INV									
325		B25v A02	INV	INV									
326		B25 v A04	INV	INV									
327		B25 v A05	INV	INV									
328		B25 v A06	INV	INV									
329		B25 v A08	INV	INV									
330		B25 v A11	INV	INV									
331		B25 v A15	INV	INV									
332		B25 v A16	INV	INV									
333		B25 v A17	INV	INV									
334		B25 v B01	INV	INV									
335		B25 v B04	INV	INV									
336		B25 v B05	INV	INV									

337		B25 v B07	INV	INV									
338		B25 v B14	INV	INV									
339		B25 v B18	INV	INV									
340		B25 v B24	INV	INV									
341		B25 v B25	-	-	-								
342		B25 v B26											
343	Goal	B26 v A01	INV	INV									
344		B26v A02	INV	INV									
345		B26 v A04	INV	INV									
346		B26 v A05	INV	INV									
347		B26 v A06	INV	INV									
348		B26 v A08	INV	INV									
349		B26 v A11	INV	INV									
350		B26 v A15	INV	INV									
351		B26 v A16	INV	INV									
352		B26 v A17	INV	INV									
353		B26 v B01	INV	INV									
354		B26 v B04	INV	INV									
355		B26 v B05	INV	INV									
356		B26 v B07	INV	INV									
357		B26 v B14	INV	INV									
358		B26 v B18	INV	INV									
359		B26 v B24	INV	INV									
360		B26 v B25	INV	INV									
361		B26 v B26	-	-	-								