UNIVERSITY OF KWAZULU-NATAL

IDENTIFICATION, QUANTIFICATION AND CLASSIFICATION OF RISKS PERTAINING TO BUILDING CONTRACTORS IN THE JBCC (PRINCIPAL BUILDING AGREEMENT)

Nishani Harinarain

A Dissertation submitted in partial fulfillment of the requirements for the degree of a Master in Construction Project Management in the School of Civil Engineering Surveying and Construction, Faculty of Engineering
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DEDICATION

I dedicate this dissertation to the following special people:

To my husband Niresh, for his patience, encouragement and support,

My mother, my sister Aruna, brother Rivesh for their constant support and encouragement,

To all my friends for always standing by me,

and especially to my DAD, for all the love, support and words of wisdom,

Thank You.

Nishani Harinarain

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I would firstly like to acknowledge God, Almighty, without who I would not have been able to complete this research.

I am also grateful to all those who have assisted me in the preparation of this document.

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The Staff at the EG Malherbe and Barry Biermann Architecture Libraries, Howard College Campus,

And lastly to all the respondents of the questionnaires and interviews.

Thank You.

Nishani Harinarain

DECLARATION OF ORIGINALITY

I, Nishani Harinarain, hereby state that this dissertation represents the original work of myself the author, and is submitted for the Masters in Construction Project Management at the University of KwaZulu-Natal, Durban. Where the works of other authors have been used, they have been duly acknowledged and referenced.

This research has not been submitted before for any degree or examination to any other university.

N. Harinarain The 9th day of January 2008

ABSTRACT

Risks are present in every aspect of business. As one of the biggest industries worldwide, the construction industry is plagued with risks. Being such a large industry, there are hundreds of contracts signed every day. These contracts range from new construction, refurbishment to maintenance. Some projects are simple and worth few thousands of dollars where others are complex and may cost hundreds of millions. Irrespective of how simple or complex the project is, all projects are exposed to risk and can go wrong (Edwards and Bowen, 2005).

Construction is governed by complicated contracts and involves complex relationships in several tiers (Abdou, 1996). According to Sawczuk (1996) as soon as the employer and the contractor have signed a contract they have taken on board risks. Their awareness of the risk and the steps to be taken to manage their share of the risk, will determine the likelihood of problems occurring. Construction projects have an abundance of risk, contractors cope with it and owners pay for it. The construction industry is subject to more risk than any other industries. Taking a project from initial investment appraisal to completion and into use is a complex and time-consuming design and construction process. It requires a multitude of people with different skills and a great deal of effort to co-ordinate a wide ranges of disparate, yet interrelated, activities. Inevitably, this complex process is compounded by many unexpected events that may cause loss to the client and other involved parties (Shen, 1999; Flanagan and Norman, 1993).

According to Carter et al. (1997) the construction industry is facing a more challenging environment than any time in the past. Client expectations have grown higher and they call for better quality and service. Smith (1998) highlighted that for years the South African building industry had a very poor reputation in managing construction risks. These risks could be prevented or reduced if management takes action at early stages of the project life cycle. In order to overcome these limitations and improve the image of the South African construction industry, this research aims to develop an innovative framework to enable construction contractors to identify, quantify and classify the risks associated with the Joint Building Contracts Committee (JBCC) Principal Building Agreement (PBA). This will help making decisions on informed bases. In addition, it will enable contractors develop particular course of actions to mitigate the effects of these risks. The research methodology designed to achieve this aim consisted of literature review, questionnaire and interview. Firstly, the literature review was used to review risk management in construction, construction contracts,

contractors' potential risks and different classification of risks in construction. Secondly, survey questionnaires were used to assess the developed framework and gain the industry feedback to improve the developed framework. Finally, the interviews were used to apply the framework on the different clauses of the JBCC (PBA).

Findings of this research showed that there is inadequate risk identification, quantification and classification by construction professionals in the South African construction industry. In addition the South African construction industry recognises the need for the developed framework to aid in managing project risks.

It is recommended that construction contractors adopt the Identification Quantification and Classification framework developed in this research to aid in their risk management plans and that further research could be conducted by adding additional aspects such as quality, health and safety and cost to the framework.

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ACRONYMS

HIPO	-	Hierarchy Plus Input Process Output.
ICAM	-	Integrated Computer Aided Manufacturing.
ICOM	-	Input (I), Controls (C), Outputs (O), Mechanisms (M).
IDEF	-	Integrated Definition.
IQC	-	Identification Quantification and Classification.
IQCF	-	Identification Quantification and Classification Framework.
JBCC (PBA)	-	Joint Building Contractors Committee (Principal Building Agreement) Series 2000.
JBCC	-	Joint Building Contractors Committee.
PDSA	-	Plan, Do, Study and Act.
RII	-	Relative Importance Index.
RMS	-	Risk Management System.
SADT	-	Structured Analysis and Design Technique.
SARIMA	-	South African Risk and Insurance Management Association.
SSADM	-	Structured Systems Analysis and Design Method.
SWOT	-	Strengths, Weakness, Opportunities and Threats.
UML	-	Unified Modelling Language.

GLOSSARY OF TERMS

Agent: means the person or entity named in the schedule or appointed by the employer to deal with specific aspects of the works. The employer warrants that the agent has full authority and obligation to act in terms of the agreement.

Agreement: means the JBCC Principal Building Agreement and other contract documents which together form the contract between the employer and contractor.

Applied research: research of direct and immediate relevance to practitioners that addresses issues they see as important and is presented in ways they can understand and act upon.

Arbitrator: means the person appointed to decide any dispute arising in terms of this agreement in terms of the Arbitration Act of 1965.

Bills of Quantities: the document in which is set out the description and quantity of the work included in the contract sum.

Building contract: The term used for the contract between client/ employer and contractor to construct the building.

Client / employer: Person or organisation which commissions (contracts with) consultants and contractor for design and construction.

Closed question: question that provides a number of alternative answers from which the respondent is instructed to choose.

Cluster sampling: probability sampling procedure in which the population is divided into discrete groups or clusters prior to sampling. A random sample (systematic or simple) of these clusters is then drawn.

Coding frame: the systematic order of codes in a content analysis.

Coding: The process whereby raw data are transformed into standardised form suitable for machine processing and analysis.

Consultant: Person or organisation commissioned by the client to carry out professional services in connection with the design of a building.

Contractor: Person or organisation which takes total responsibility for the construction, or the design and construction, of a building project. While retaining such responsibility, it does sublet part of the work to subcontractors.

Data analysis: Any approach, qualitative or quantitative, to reduce the complexity in the data material, and to come to a coherent interpretation of what is and what is not the case.

Deming cycle (Plan, Do, Study, Act): A scientific method for learning how to make improvements.

Design team: The term used to describe the consultants commissioned by the client to design or contribute professional services for the project.

External validity: The degree to which the results of a study can be generalised to other participants, settings, and times.

Focus group: Group interview, composed of a small number of participants, facilitated by a 'moderator', in which discussion is focused on aspects of a given theme or topic.

Hypothesis: A testable prediction about the relationship between two or more variables.

Internal validity: The degree to which a study establishes that a factor causes a difference in behaviour.

Interview: A data-collection encounter in which one person (an interviewer) asks questions of another (a respondent). Interviews may be conducted face-to-face or by telephone.

Likert scale: A composite measure developed by Rensis Likert in an attempt to improve the levels of measurement in social research through the use of standardised response categories in survey questionnaires. Likert items are those using such response categories as strongly agree, agree, disagree, and strongly disagree.

Mean: The average value calculated by adding up the values of each case for a variable and dividing by the total number of cases.

Median: The middle value when all the values of a variable are arranged in rank order.

Methodology: The theory of how research should be undertaken, including the theoretical and philosophical assumptions upon which research is based and the implications of these for the method or methods adopted.

Open question: Questions allowing respondents to give answers in their own way.

PDSA (Plan, Do, Study, Act) cycle: A systematic method to learn and to improve, as described by Deming.

Population: The complete collection of items or persons who are the target of statistical inference based on random sampling. A population is defined for practical purposes by a sampling frame

Primary data: Data collected specifically for the research project being undertaken.

Probability sampling: Selection of sampling techniques in which the chance, or probability, of each case being selected from the population is known and is not zero.

Qualitative analysis: The non-numerical examination and interpretation of unstructured data, e.g. transcripts of open interviews, field notes, photographs, documents or other records, for the purpose of discovering underlying meanings and patterns of relationships.

Questionnaire: A document containing questions and other types of items designed to solicit information appropriate to analysis. Questionnaires are used primarily in survey research and also in experiments, field research, and other modes of observation.

Reliability: A general term referring to the degree to which a participant would get the same score if retested.

Research ethics: The appropriateness of the researcher's behaviour in relation to the rights of those who become the subject of a research project, or who are affected by it.

Respondent: A person who provides data for analysis by responding to a survey questionnaire.

Risk: all uncertainties (threats and opportunities). A condition in which loss or losses are possible.

Risk Analysis: attempts to capture all feasible options and to analyse the various outcomes of any decision.

Risk Analysis Technique: the technique used to analyse, the risks associated with a project

Risk Attitude: the willingness of decision-makers to take chances or to gamble on investments of uncertain outcome

Risk Averse: where decision-makers prefer a sure cash payment to a risky venture with a known expected value greater than the sure cash payment

Risk Control: implementation of a risk management plan

Risk Exposure: the probability of investing in a project whose economic outcome is less favourable than what is economically acceptable

Risk Management: all steps associated with managing risks: risk analysis, risk response and risk control

Risk Management Plan: list of actions to eliminate or reduce the probability of a threat occurring

Risk Neutral: where decision-makers are indifferent between a sure cash payment and a risky venture with an expected value equal to the sure cash payment and therefore accept a fair gamble

Risk Response: third phase of risk management, developing a risk management plan

Risk Seeker: where decision-makers prefer a risky venture with a known expected value to a sure cash payment equal to the expected value

Sample size: An indicator of quality of quantitative social research. The power of a statistical inference depends on the sample size among other things.

Sampling frame: The list or quasi-list of units composing a population from which a sample is selected. If the sample is to be representative of the population, it is essential that the sampling frame include all (or nearly all) members of the population.

Sampling: Selecting randomly units of analysis from a sampling frame, so that estimates of the population are obtained with known margins of error.

Secondary data: Data used for a research project that were originally collected for some other purpose. See also documentary secondary data, multiple source secondary data, survey-based secondary data.

Simple random sample: A type of probability sample in which the units composing a population are assigned numbers, a set of random numbers is then generated, and the units having those numbers are included in the sample.

Snowball sample: A non-probability sampling method often employed in field research. Each person interviewed may be asked to suggest additional people for interviewing.

Stratified random sampling: Probability sampling procedure in which the population is divided into two or more relevant strata and a random sample (systematic or simple) is drawn from each of the strata.

Structured interview: An interview in which all respondents are asked a standard list of questions in a standard order.

Systematic sample: A type of probability sample in which every nth unit in a list is selected for inclusion in the sample.

Threats: uncertain events that reduce the probability that the desired outcome will happen

Triangulation: The use of two or more independent sources of data or data collection methods within one study in order to help ensure that it is valid.

Uncertainty: the total range of events that may happen and produce risks affecting a project. An event that cannot be precisely predicted.

Validity: The extent to which data collection method or methods accurately measure what they were intended to measure.

CHAPTER 1

INTRODUCTION

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INTRODUCTION

Key to success isn't much good until one discovers the right lock to insert it in.

(Hart, 1988, p.153).

1.1 Introduction

This chapter introduces the research background and problem statement and hypothesis. In addition, it explains the research aims and objectives, the research methodology as well as the research originality and achievement. Furthermore, this chapter identifies the limitations of the research. Finally, research recommendations and a guide to the dissertation is explained.

1.2 Research Background and Problem Statement

The future is largely unknown and making a decision based on assumptions, expectations, estimates and forecasts involves taking risks (Raftey, 1994). Papageorge (1988) and Flanagan and Norman (1993) state that risks are present in every aspect of doing business, from the most obvious and simple problems to highly complex situations.

According to Smith (1999), Finley *et al.* (1994), Flanagan and Norman (1993) and Papageorge (1988), risk is a natural part of any construction project mainly because construction is a multifaceted process that has a wide variety of complex situations. In addition, construction projects involve hundreds if not thousands of interacting activities. Each activity has time, cost, quality and sequencing problems. These problems inevitably bring about the risks of inflation, cost overruns, natural or physical damage on site, potential harm and/or loss to people and/or property, or other losses like loss of reputation or loss of business and reduction in qualified personnel and bankruptcy.

Construction is a risky business and it is highly unlikely that a complex construction project will be planned and executed without risk. Risk can only be managed, minimised, shared, transferred or accepted but it cannot be ignored (Grinfeld and Simpson, 1998).

Berkeley *et al.* (1991) state that a reduction of loss of profit can be attributed to risk events that occur during the execution of a project. Most risks that arise in building projects could be prevented or reduced if management takes action at an earlier stage (e.g. during inception or planning stage).

Flanagan and Norman (1993) state that risk management is a system which aims to identify and quantify all risks to which the project is exposed so that a decision can be taken on how to manage these risks. Although risk management does not specifically eliminate risks, it gives managers the opportunity to foresee potential problems and to identify methods of avoiding them.

Earlier and continuous identification of risk throughout the project life cycle is essential for adopting better management decisions. Once risk has been identified, risk analysis plays an important role in capturing all feasible options and to analyse the various outcomes of any decision (Laxtons, 1996). In addition, risk analysis quantifies the effect of each risk based on the probability and severity of occurrence. Based on risk identification and analysis, a suitable risk response has to be adopted. This ranges from risk avoidance, risk transfer, risk reduction and residual retention and risk retention (Edwards and Bowen, 2005; Smith, 1998; Laxtons, 1996; Flanagan and Norman, 1993).

As one of the biggest industries worldwide, the construction industry is plagued with risks. Being such a large industry, there are hundreds of contracts signed every day.

A building contract is an agreement between two parties, the contractor who agrees to erect a building and the employer who agrees to pay for it. The contractor has the obligation to erect the building and the right to be paid for it, while on the other hand the employer has the right to have the building erected and the obligation to pay for it. A contract comes into existence on the acceptance of an offer (Finsen, 1991).

According to Clough (1975) the time for a careful reading of all contract articles is before rather than after the contract is signed. After execution of the contract, the contractor is bound by all its provisions, whether one has read them or not.

According to Carter *et al.* (1997) the construction industry is facing a more challenging environment than any time in the past. Client expectations have grown higher and they are demanding that multi-million rand projects are delivered within fixed-price budgets and tight time-scales. Eventually, all of these factors will lead to risk. The nature of risk or what risk is perceived to be by the role players in the construction industry determines how it is treated or managed.

The Joint Building Contracts Committee (JBCC), representing the construction industry was established in 1984. It was assigned the task of drafting a new contract agreement. The contract was completed in 1991 and the committee had published the JBCC Principal Building Agreement and associated documents. The JBCC (PBA) document records the terms of the agreement between the employer and the contractor, in which the employer is represented by a principal agent, on whom nearly all of the employer's rights and obligations devolve. The document commences with a comprehensive list of definitions and concludes with a schedule of variables, containing information specific to a particular contract (Finsen, 1999).

Consultants in Risk Management (2001) states that construction professionals need to know how to balance the contingencies of risk with their specific contractual, financial, operational and organisational requirements. In order to achieve this balance, proper risk identification and risk management is required which entails identifying construction risks and exposures, and formulating an effective risk management strategy to mitigate the potential for loss.

Contracts are often delayed and cost more than the tender price and fail to perform to clients' expectations. The conventional approach is to recognise that many contracts will deviate from their tender price by 5% either way by the time the final account is reached, and to make allowances in the form of contingency sums and the padding of programmes to allow for slippages, with possible compromises in quality (Grinfeld and Simpson, 1998).

Edwards and Bowen (2005) and Flanagan and Norman (1993) state that building sectors in a number of countries are undergoing many changes. Various building sector stakeholders are facing new construction methods, procedures, new materials and new types of buildings. As a result of these changes, project stakeholders are facing high risks of achieving high quality products. It is therefore important to plan and make the right decisions, which will reduce risk on quality, time and cost of the building projects.

Smith (1998) states that for years the South African construction industry had a very poor reputation due to the lack of application of risk management. Today, a contractor is often given a mass of information and data at the time of bidding, which may or may not be well coordinated and organised. The contractor is expected to assimilate all the information in a relatively short period of time and to provide the client with a profitable bid.

The rationale of this research stems from the importance of improving the image of the South African construction industry. In addition, the research obtains its significance from the necessity to assist contractors understand and manage risks associated with the JBCC(PBA).

1.3 Research Question

How can contractors identify, quantify and classify risk in the JBCC (PBA)?

1.4 Research Hypothesis

An Identification, Quantification and Classification Framework will assist contractors in understanding and managing risks associated with the JBCC (PBA).

1.5 Research Aims and Objectives

This research aims to investigate the risks associated with the JBCC (PBA) from the contractor's perspective in order to develop a framework that will assist them in identifying, quantifying and classifying risk in the JBCC (PBA).

In order to achieve this aim the following objectives have to be accomplished:

1) Establishing a clear understanding of the nature of risk and risk management in the construction industry, construction contracts (JBCC (PBA) in particular), investigate how building contractors identify, quantify and classify risks in terms of the JBCC (PBA), understanding the IDEF-0 and Plan-Do-Study-Act cycle.
2) Developing the Identification, Quantification and Classification framework that will assist contractors in identifying, quantifying and classifying risk in the JBCC (PBA).
3) Evaluating the developed framework via a questionnaire.
4) Applying the developed framework to identify, quantify and classify the risks associated with the JBCC (PBA) to test it appropriateness and suitability to the South African construction industry..
5) Developing the correlation matrix of risk sources to the contractor that will assist contractors in identifying which party poses a risk to them in terms of each clause in the JBCC (PBA).

1.6 An Overview of the Research Methodology

The above mentioned aim and objectives called for a research methodology that could gather data sufficiently rich to investigate the risks associated with the JBCC (PBA) from the contractors perspective.

The different phases of research methodology and the Plan, Do, Study and Act (PDSA) cycle was used in this research as an effective tool to design the research methodology. The PDSA Cycle is simply a wheel divided into four quadrants – Plan, Do, Study and Act. Table 1.1. shows the activities carried out in each phase.

Table 1.1. Activities of the PDSA cycle.

Phase	Activities
PLAN	❖ Identifying the problem statement. ❖ Establishing aims and objectives. ❖ Developing a framework for the identification, quantification and classification of risks.
DO	❖ Identifying all risks that affect the building contractors from various literary sources (books, journals, construction magazines and conference proceedings as well as the Internet). ❖ Comparing the identified risks from literary sources to the JBCC contract, clause by clause to ensure that the risks associated with the clauses are covered, refer to Appendix (A). ❖ Evaluating the IQCF through compiling a questionnaire so that feedback from the contractor's about the framework could be collected. ❖ Adjusting the IQCF according to the feedback that was received. ❖ Applying the developed framework using an interview process. ❖ Developing the risk source correlation matrix.
STUDY	❖ Analysing the data collected from the questionnaires and interviews.
ACT	❖ Summarising the research findings and recommendations. ❖ Enriching the body of knowledge through the compilation of two research papers (Appendix B and C). ❖ Recommending the use of the IQCF. ❖ Recommending the use of the correlation matrix. ❖ Recommending research application in industry and for further research.

During the course of this research different methods were used for data collection and data analysis.

The following processes were used for data collection:

- Literature review was used for identifying all the risks facing construction contractors, and to obtain a better understanding of the JBCC (PBA) contract.
- A survey questionnaire was used in two stages, firstly to evaluate the IQCF and secondly to evaluate the risk source correlation matrix.
- Interviews was utilised in two stages, firstly to apply the IQCF and secondly to evaluate the risk source correlation matrix.

The following steps were used for data analysis:

- The Central Tendency measures were used to get an overview of the typical value for each variable by calculating the mean, median and mode.
- The Relative Importance Index was also used as all the clauses in the JBCC (PBA) do not have the same risk to the contractor.

Because of their importance, the issue of reliability and validity are discussed in this research. The researcher eliminated as much bias as possible when conducting the interviews and in structuring the questionnaires by looking at three factors: sampling frame bias, researcher bias and non-response bias.

1.7 The Research Originality and Achievement

The identification, quantification and classification framework developed by this research represents a genuine contribution to the original body of knowledge and the construction industry. This is because the developed framework was not previously produced.

The IQCF aids the contractor in identifying, quantifying and classifying framework risk associated with the JBCC (PBA) and provides an innovative tool for risk management. The development of the IQCF is an accomplishment not previously carried out in respect of the South African Construction Contractors and will aid in risk management and in improving the image of the South African construction industry. In addition, it provides a foundation in terms of risk and the JBCC (PBA) contract that was not researched in the past.

The most note worthy achievement of this research is the development of an Identification, Quantification and Classification Framework (IQCF) that will assist construction contractor's to identify, quantify and classify risks in the JBCC (PBA). On the whole this research is innovative, unique and adds to the greater body of knowledge by covering an area that is original and not previously studied.

The research also produced a correlation matrix that will assist contractors in identifying which party poses a risk in terms of each clause in the JBCC (PBA).

1.8 Research Limitations

This research is limited to the following factors:

- Formal construction companies in central Durban, KwaZulu-Natal, South Africa will only be utilised.
- Only companies listed / registered with the Master Builders Association will be considered.
- Only risks in the JBCC (PBA) form of contract will be considered and not any other form of contract.

1.9 Research Recommendations

1.9.1 Research Recommendations for the Industry

- The construction industry is advised to adopt the IQCF developed through this research, to assist in their risk management procedures.
- The construction industry is advised to adopt the risk source correlation matrix developed through this research, to assist in their risk management procedures.
- Escalating contractor awareness to better manage project risk.

1.9.2 Recommendations for Further Research

Further in-depth research needs to be conducted into:

- Applying the developed framework to other forms of contracts in South Africa.
- Develop the framework in an electronic software or on-line format.
- Further research could be conducted by adding additional aspects such as quality, health and safety and cost to the framework.
- Further research could be conducted into incorporating all the risks identified from literary sources in Appendix (A) into the JBCC (PBA).

1.9 A Guide to the Dissertation

This research is broken down as shown in Figure 1.1.

Chapter 1: Introduction

This chapter presents a summary of the dissertation by discussing the background and rationale to the research, the aims and objectives as well as the research methodology. In addition the research originality, achievement and limitations were explained. The research findings, recommendations and a guide to the dissertation is provided.

Chapter 2: Literature review

This chapter explores the concept of risk with particular emphasis on the construction industry. It also describes the various types of risk during construction and the different ways in which risk is allocated. This chapter will also elaborate on the purpose and fundamental concepts of contracts in general and then the JBCC (PBA) in particular. The JBCC (PBA) contract is discussed in terms of the parties to a contract and the obligations of various parties. A letter was sent out to the Joint Building Contracts Committee in order to obtain approval for reproducing aspects of the contract.

Chapter 3: Research Methodology

This chapter discusses the research methodology designed to achieve the research aims and objectives. The research process and approach is explained. In addition, both qualitative and quantitative methods, interviews and questionnaires, were used in order to obtain triangulation. The design of the research methodology is also discussed. This chapter describes the Plan, Do, Study and Act cycle and goes on to explain the data collection and analysis methods. The respondents were selected via purposive sampling from a sampling frame from the members of the Master Builders Association (MBA). Further more,. The sampling methodology is illustrated and the data analysis is also explained. The chapter concludes by discussing reliability, validity and research ethics.

Chapter 4: The Identification, Quantification and Classification Framework

This chapter explains the identification, quantification and classification framework (IQCF) developed by this research. The importance, aim, objectives and the conceptual description of the IQCF is provided. The description of models and the modelling process as well as various modelling tools is explained in order to describe the functional representation of the IQCF. The application and benefits of the framework are also discussed. This chapter concludes by describing the limitations of the IQCF.

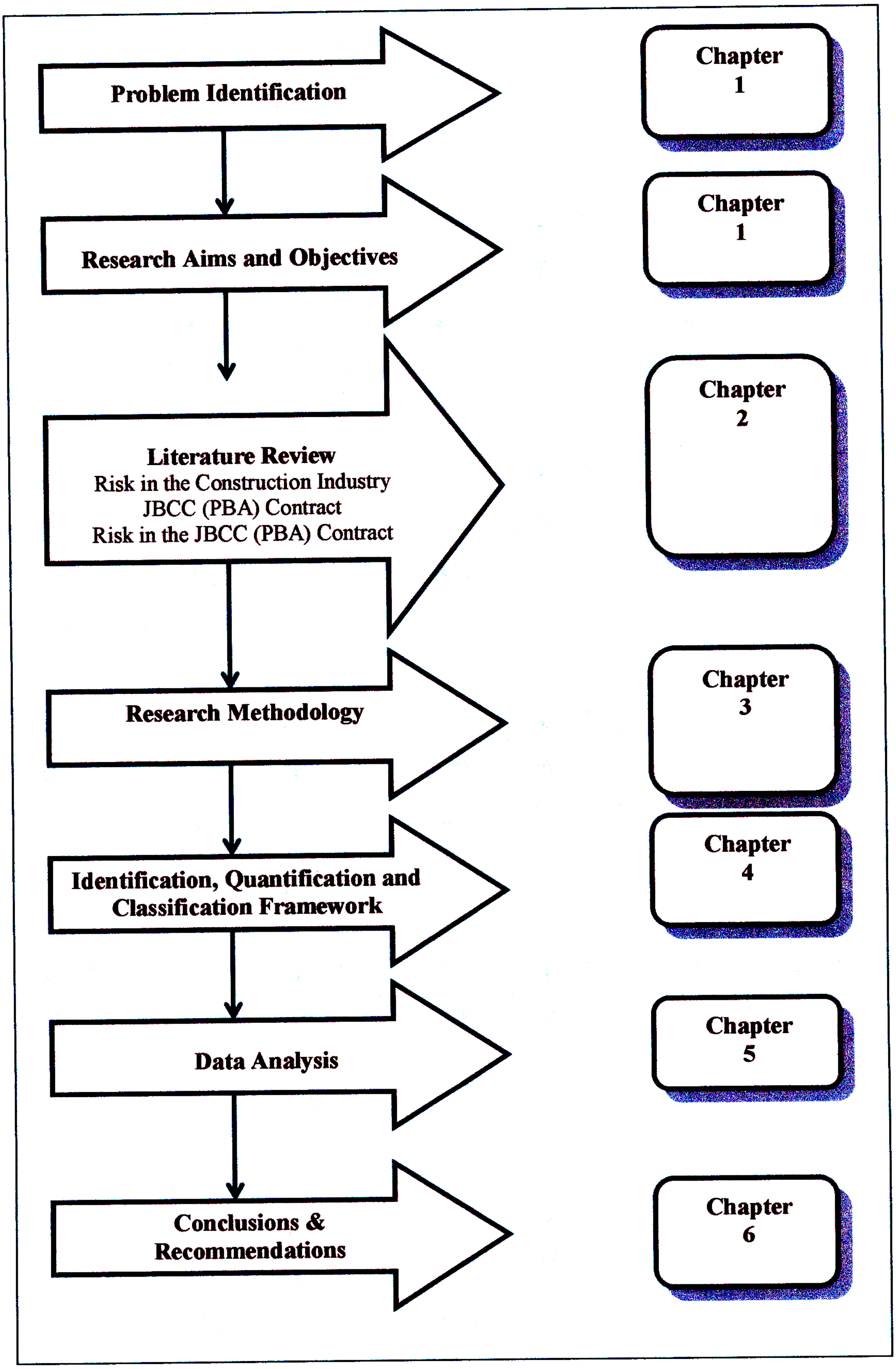


Figure 1.1. The Research Structure

Chapter 5: Data Analysis

This chapter analyses the data collected from the questionnaires and the structured interviews. Answers were categorised, totals were added, and patterns were discovered so that the responses could be expressed in statistical terms. All of this was accomplished with the aid of Microsoft Excel. Both the questionnaire and the interview are broken down into questions and each question contains 3 sections. The first part states the question, the second part discusses the objective of the question and the third part analyses the response and in certain cases provides a graphical presentation of the analysis. The questions in both the questionnaire and the interview were constructed with a great amount of care in order to aid in data collection and analysis.

Chapter 6: Conclusions and Recommendations

This chapter draws conclusions and provides appropriate recommendations both to industry and recommendations for further research. It concludes the research carried out to develop an IQCF to analyse the JBCC (PBA) contract clause by clause from the contractor's perspective. It also provides a positive contribution to the existing body of knowledge.

1.10 Conclusion

This chapter discussed the background and rationale to the research. The research outcome is the development of an Identification, Quantification and Classification Framework (IQCF) that will assist construction contractors to identify, quantify and classify risks in the JBCC (PBA). The aims and objectives, methodology, originality and achievement were also explained. In addition the limitations of the research as well as the research findings were explained. This chapter concluded by providing recommendations and a guide to the research. The next chapter explains the research methodology.

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2

LITERATURE REVIEW

'To try to eliminate risk in business enterprise is futile. Risk is inherent in the commitment of present resources to future expectations. Indeed, economic progress can be defined as the ability to take greater risk.'

(Hertz and Thomas, 1984, pg.58)

2.1 Introduction

This chapter outlines the theory of risk in the construction industry and explains risk awareness. Uncertaininty and the various attitudes to risk as well as risk management are explained. In addition, this chapter outlines the way risk is identified, quantified and classified and the manner in which risk is responded to and mitigated. Contracts in the construction industry and the JBCC (PBA) in particular are explained together with the fundamental concepts of contracts. The JBCC (PBA) contract is discussed in terms of the parties to a contract and the obligations of various parties. The chapter concludes by discussing the identification of contractor's risk.

2.2 Risk and the Construction Industry

The construction industry is one of the biggest industries worldwide. Being such a large industry there are contracts signed every day for some building work, be it a new building, refurbishment or maintenance. Some projects are simple, others complex; some may involve just two organisations; others may involve hundreds of suppliers, subcontractors and consultants. No matter how small or simple a project may be it still has something in common with the larger complex projects in that it still can go wrong (Edwards and Bowen, 2005).

According to Sawczuk (1996) as soon as two parties, the employer and the contractor, have signed a contract they have taken on board risks. Their awareness of the risk, and the steps they have taken to minimise their share of the risk, will determine the likelihood of a problem occurring.

Laxtons (1996) is concerned with the fact that for too long, construction projects have failed to achieve the time, cost and quality targets that clients' and their consultants aim for. It is widely acknowledged that there are and always will be difficulties in meeting every project objective and some degree of compromise is nearly always inevitable. Gold taps cost money, innovative construction techniques and materials can take time whilst budget constraints reduce overall quality. Time, cost and quality are pulling in opposite directions and any change in any of them invariably impacts on one or both of the others as shown in Figure 2.1.

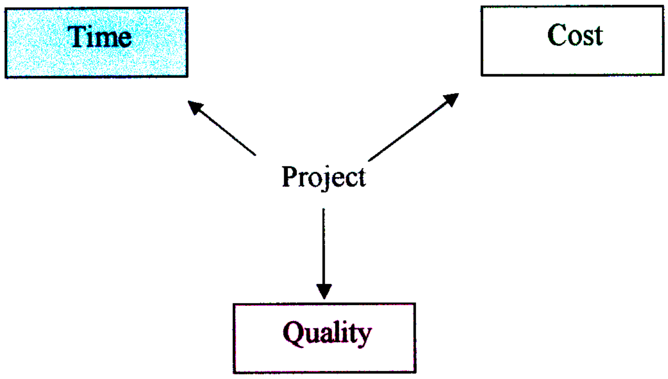


Figure 2.1. Time, cost and quality trade-off. (Laxtons, 1996, pg.1).

The three objectives of cost, time and quality are in a trade-off position with each other. For example:

- Higher quality will normally cost more and might take longer to complete.
- Faster completion may cost more, depending on whether additional net resources are required.
- To achieve lower cost, it may entail quality being defined at a lower level (Lavender, 1996; Laxtons, 1996)

Construction projects have an abundance of risk, contractors cope with it and owners pay for it. The construction industry is subject to more risk and uncertainty than many other industries. This is because the process of taking a project from initial investment appraisal to completion and into use is complex and entails time-consuming design and production processes. It requires a multitude of people with different skills and interests and the co-ordination of a wide range of disparate, yet interrelated, activities. Such complexity is also compounded by many external and uncontrollable factors (Flanagan and Norman, 1993).

According to Flanagan and Norman (1993), many organisations see risk as a four letter word and they try to insulate themselves from risk. They position themselves to unload unexpected costs onto others. Increased costs are passed onto consumers by raising prices. Sub-contractors are played off against each other to gain the cheapest price and although this approach may well have worked in the past, it can be a recipe for disaster. Shifting financial risk onto sub-contractors does not encourage high levels of trust and commitment. Risk now needs to be identified, analysed and apportioned much more openly and professionally.

The nature of risk and its perception by the role players in the construction industry determines how it is treated or managed. For the great majority of project stakeholders, risk is important to their continuing survival and success to be ignored or dealt with inappropriately. Modern society's expectations of corporate behaviour and public accountability demand that organisations give due regard to the risks they face or which they create for others (Edwards and Bowen, 2005).

2.3 Risk Awareness

"Risk is a universal experience and inescapable."
(Edwards and Bowen, 2005, p.1)

According to Edwards and Bowen (2005) risk is faced by all people, some more frequently and more willingly than others. While some worry constantly about risk, others cheerfully seek it out. This treatment of risk can be seen in every area of our lives.

Attention to risk is vital to ensure good performance of a company or project and peace of mind. Papageorge (1988) and Flanagan and Norman (1993) state that risks are present in every aspect of doing business, from the most obvious and simple of problems to highly complex situations and although some risks are unavoidable elements of certain business services others are completely self inflicted, which effects the potential earnings of an investment.

Risk arises in the context of a situation that exists or is likely to occur at some point in the future. Edwards and Bowen (2005) state that the situations which most give rise to risks are those which involve us in engaging in activities, carrying out tasks, making commitments or entering into obligations. Risk arises out of individual or organisational decision-making. Any exploration of project risks therefore needs to consider not only the tasks, commitments and objectives of the project, but also the decision-making processes associated with the organisational structures through which projects are procured.

The construction industry, unlike the manufacturing industry, is not repetitive in nature. Construction differs from the manufacturing industry because each project:

- Is highly individualised,

- ❖ Is highly complex and interdependent, requiring expertise and a coordinated effort from numerous disciplines, craftsmen, manufacturers and suppliers,
- ❖ Is subject to variable weather and site condition, and
- ❖ Have variable conditions for controlling quality, quantity, time and money (Papageorge, 1988).

According to Smith (1999); Finley *et al.* (1994); Flanagan and Norman (1993) and Papageorge (1988), risk is a natural part of any construction mainly because construction is a multifaceted process that has a wide variety of complex situations. In addition, construction projects involve hundreds if not thousands of interacting activities each with a time, cost, quality and sequencing problems which inevitably brings about the risks of inflation, cost overruns as well as natural or physical damage on site, potential harm and/or loss to people and/or property, or other losses like loss of reputation or loss of business and reduction in qualified personnel and bankruptcy. Building projects need simple techniques according to Grey (1998) to allow individuals to assess the risks they face, and help them make reliable decisions about commitments and targets.

2.3.1 Conditions likely to make a project risky

Smith (1999) and Cooper and Chapman (1987) state that a risky project might be one in which any of these conditions exist. The 'risky' conditions are:

- ❖ Large capital outlays are involved,
- ❖ Unbalanced cash flows are likely to occur,
- ❖ There are substantial requirements for new technology,
- ❖ Novel or unusual procurement arrangements are contemplated,
- ❖ Novel operational requirements are intended by the client,
- ❖ The project is extremely large,
- ❖ The project is highly complex,
- ❖ Severe time constraints exist,
- ❖ Some or all of the stakeholders are inexperienced,
- ❖ The client's business is highly sensitive to the performance and/or quality of the project,
- ❖ Stringent, inconsistent, or changing regulatory requirements are encountered,
- ❖ Environmental or ecological sensitivity is encountered,
- ❖ Political and/or cultural sensitivities are significant,
- ❖ Situational turbulence is encountered (e.g. projects in developing or politically unstable countries) and lastly,
- ❖ The effectiveness of the stakeholders' risk management.

Ineffective or non-existent risk management could exacerbate the impacts of many of the above risks as well as increase the likelihood of occurrence for some risks, their consequence, or the period of exposure. Few of the above conditions can be measured accurately; therefore they should always be considered (Edwards and Bowen, 2005).

2.4 Uncertainty and Risk

2.4.1 Uncertainty

The greatest degree of uncertainty about the future is encountered early in the life of a new project. Decisions taken during the appraisal stage have a very large impact on final cost, duration and benefits (Smith, 1999). Uncertainty is defined by Valsamakis, *et al.* (1999) as being a condition that results from an inability to foresee future events.

2.4.2 Risk

Risk exists whenever the future is unknown. It is inherent in all human activities and especially in business enterprise. There is no universally accepted definition of risk. Risk can mean many different things; it has different definitions and can be dealt with in many ways.

Risk is seen to exist by Smith (1998) when a decision is expressed in terms of a range of possible outcomes and when known probabilities can be attached to the outcomes. A risk is any potential problem which might result in loss or harm to people, property, or other interests according to Papageorge (1988).

Whichever definition is preferred is must be remembered, that when dealing with risk, the following four aspects should be considered:

- The probability that an event will occur,
- The event and its nature,
- The consequences of that event, and
- The period of exposure to the event (Edwards and Bowen, 2005).

There is confusion over risk and uncertainty because the difference between risk and uncertainty is not easily defined. Some authors attempt at making a distinction between the two and others treat them as synonymous terms. In a literal sense the concepts of risk and uncertainty are regarded as interrelated. Uncertainty gives rise to risk. This is because where the outcome of events are subjected to, or surrounded by, uncertainty, risk will be present

(Edwards and Bowen, 2005; Cloete, 2001; Valsamakis, *et al.*, 1999; Smith, 1999; Doherty, 1985).

In this research risk and uncertainty are treated as synonymous terms.

2.5 Risk Attitude

The main 'developers' are property companies, financial institutions, public sector agencies and occupiers. Some of these developers are more inclined than others to accept uncertainty, or 'take a risk'. Typically, property development companies are thought to be the greatest risk takers but the extent to which they feel comfortable with risk varies (Bryne, 1996; Flanagan and Norman, 1993).

There is much evidence of people who are more reluctant to undertake uncertain projects than certain ones. According to Flanagan and Norman (1993) there are three types of people/organisations:

- Risk loving – are people willing to take additional risks on the expectation of a higher return.
- Risk averse – people willing to sacrifice the possibility of a higher return even for a relatively small risk.
- Risk neutral – people who are indifferent to return except if it can be calculated to be worth the risk. A risk neutral person is one who treats risk and reward on an equal basis.

2.6 The Classification of Risk

Classifying risks enables construction professionals to consider them within a more coherent framework. It provides construction professionals with a more uniform risk language, particularly in fields where risk needs to be communicated to a wide variety of project stakeholders. It allows one to establish a common understanding of different risks, and provides an essential basis for effective knowledge transfer, within an organisation and from one project to another (Edwards and Bowen, 2005).

- Doherty (1985) identifies four types of risks: marketing risk, financial risk, resource management risk and environmental risk.

- Greene and Serbein (1983) classify risks along similar lines, namely: property and personnel, marketing, finance, personnel and production and the environment.

- Smith (1998) classifies risks according to: financial, legal, political, social, environmental, communicational, geographical, geo-technical, constructional, technological and demand risks.

- Valsamakis, *et al.* (1999) and Sawczuk (1996) considers three types of risk:
  - Internal risks. These are risks which can be identified and are within the control of the contractor's organisation.
  - External risks. Are risks which emerge from outside the contractor's organisation (e.g. natural risks such as weather, political risk, vandalism, inflation and availability of materials).
  - Contractual risks. This is a combination of internal and external risks together with the quality of the building team and the potential for claims arising during the course of the project with the chosen procurement route.

Edwards and Bowen (2005) describe two primary categories:

- Natural risks arise from systems whose existence is beyond human agency. The sub-categories of natural risks are weather systems, geological systems, biological systems, physiological systems, ecological systems and extraterrestrial systems.
- Risks arising out of human systems are more difficult to categorise than natural risks, due to the inter-relational characteristics of many humanly devised systems. The sub-categories of human risks comprise of social risk, technical risk, political risks, cultural risks, health risks, legal risks, economic and financial risk and managerial risks.

This research classifies risks that affect the contractor as internal risks and external risks. Internal risks reduce a company's strength and increase a company's weakness, while, external risks reduce a company's opportunities and increases a company's threats. This is in accordance with the SWOT (Strengths, Weaknesses, Opportunities and Threats) Analysis which is a systematic way used for corporate analysis. It is a means of combining the organisation to its working environment.

2.7 Risk Management

Flanagan and Norman (1993) argued that there are four ways to tackle risk in the construction industry:

- 'the *umbrella approach*' where you must allow for every possible eventuality by adding a large risk premium to the price;
- 'the *ostrich approach*' where you bury your head in the sand and assume everything will be alright, that somehow you will muddle through;
- 'the *intuitive approach*' that says don't trust all the fancy analysis, trust your intuition and gut feel;
- 'the *brute force approach*' that focuses on the uncontrollable risk and says we can force things to be controlled, which of course they cannot.

A more realistic approach would be to eventually adopt a risk management approach.

Greene and Serbein (1983) define risk management as the process for conserving the earning power and assets of the firm by minimising the financial effect of accidental losses. According to Flanagan and Norman (1993) once a risk is identified and defined, it ceases to be a risk, it becomes a management problem and therefore the aim of risk management is to ensure that the project objectives are achieved. Risk management according to Papageorge (1988) is a control system similar to a time or cost control system which must be integrated into every aspect of doing business and offering services.

Valsamakis, *et al.* (1999), states that risk management is a managerial function aimed at protecting the organisation, its people, assets, and profits, against the physical and financial consequences of event risk. It involves planning, coordinating and directing the risk control and the risk financing activities in the organisation. This definition firstly emphasises

- The managerial nature of the function by explicitly stating that risk management involves the planning, coordinating and directing of the risk control and risk financing activities.
- Being a management function, the risk manager will be involved in strategic decision-making.
- It also meets the requirement that people and processes should be involved by specifically referring to the protection of people, assets and profits in the definition.
- The last requirement for an integrated approach is that the process be proactive.

Most managers control only the obvious risks. They seldom use risk management as an ongoing system to minimise or eliminate both obvious and subtle risks. However, to manage all risks, the risk management system must touch every function within a company. Papageorge (1988) sees risk management as a monitoring system to be understood, appreciated, implemented, and maintained by an organisation throughout its life. With a comprehensive integrated risk management system, managers can minimise risk, producing a better product and ensuring a more successful business venture.

The successful adoption of risk management is dependent upon the stage of the project at which it is introduced. Much of the ethics behind risk management is the identification of risks before they materialise, followed by the implementation of mitigation strategies and contingency plans. Clearly, if risk management techniques are not put into use until late in a project's development then their effectiveness in ensuring project success is greatly diminished. It is essential that at the project briefing stage consideration is given to a risk analysis and management strategy (Laxtons, 1996).

In South Africa, risk management started to develop in the 1970's. The first organisations to practice risk management were companies such as Price Forbes Group. In 1986 South Africa's major companies formed the South African Risk and Insurance Management Association (SARIMA) of which membership was on a corporate basis. Risk management originated as insurance buying activity and a security function. It has developed into a fully fledged management function which is beginning to move into areas which were originally considered unrelated, like the building industry (Valsamakis *et al.*, 1999).

2.7.1 Importance of risk management

Risk management according to Patching and Chapman (1998) is the most important focus of effective management, as it allows decision making to be more systematic and less subjective. Risk management also assists in deciding which risks require urgent attention and which can be dealt with later.

Boothroyd (1994) states that risk management is important because it allows the client to better understand the project and gives them more confidence in the achievability of cost, time and quality objectives and in terms of the professional team, it enables team members to be involved in problem solving and increases their commitment to the project.

Valsamakis *et al.* (1999) emphasises that risk management is an ongoing process, not a single event. Risk management can be used highly successfully to plan ahead in order to reduce adverse effects on company profitability.

Effective risk management provides

- An increased awareness of the consequences of risks
- A focus for a more structured approach to risk management
- More effective centralised management control
- Better risk information transfer between those concerned with and those responsible for such matters and, most importantly,
- Reduced long-term loss expenditure and hence corresponding increased profits (Edwards, 1995).

According to Laxtons (1996) and Papageorge (1988) risk problems seldom, if ever, resolve themselves. In fact, the majority of risk impacts occur simply because managers do not identify problems early enough or they procrastinate about resolving them. In order to effectively manage risks, all company employees must fully understand how to identify and control risks. This can only be done by establishing an ongoing risk management system, to be maintained and refined throughout the life of an organisation, cutting across all business and operational functions.

2.7.2 Risk Management System

A risk management system must be practical, realistic and must be cost effective. Risk management need not be complicated nor require the collection of vast amounts of data. It is a matter of common sense, analysis, judgement, intuition, experience, gut feel and a willingness to operate a disciplined approach to one of the most critical features of any business or project in which risk is generated (Flanagan and Norman (1993).

Laxtons (1996) states that whilst every project undertaken is different, the approach to the management of risk is similar. The stages of the risk management system are:

- Risk Identification
- Risk Analysis
- Risk Response and Mitigation

2.7.2.1 Risk Identification

Risks exist from the very outset of a project. The construction industry can be subject to an exceptionally broad range of risk and uncertainty. Procuring a building from inception to commissioning may involve a great number of people all with vastly different specialist skills and responsibilities. Each new project entails unique design and construction problems. Without identifying what the potential risks are we cannot ascertain:

- If they will arise
- What effect they might have if they do arise, and
- What measures need to be taken to prevent their occurrence (Valsamakis, *et al.*, 1999; Laxtons, 1996).

A. Importance of Risk Identification

If risk management is seen as part of the overall decision making process and the identification of risks is perhaps the most important element of risk management, then this action must be taken early in a project's life. Many of the major decisions that have the greatest impact on the project are made during its early feasibility and design development stages. During this stage changes can be made with the least disruption. In addition the information, upon which such decisions are made, is most likely to be incomplete or inaccurate. Therefore to ensure that the right decisions are made, all the important risks and then sources must be identified and assessed at the earliest possible point in the project's life cycle (Valsamakis, *et al.*, 1999; Laxtons, 1996).

Laxtons (1996) considers the identification of risks as the most important stage in the risk management process. Every risk management programme must be put in motion by the process of risk identification. A risk will not be managed if it is not identified. Hence this process must be viewed as the single most important function of the risk management programme and should be approached in as systematic a manner as possible (Valsamakis, *et al.*, 1999). The main aim is to seek out and identify all possible risks in order to allow management to take decisions made on an informed basis.

B. Risk Identification Principles

The following are risk identification principles.

- Identify all potential risks as early as possible.
- Do not allow any problem to go unnoticed or unresolved.
- Identify all levels of problems, ranging from internal business functions and project services to external forces affecting the organisation.
- Closely evaluate the company's ability to perform.
- Evaluate team members' abilities to perform and work with others. This includes owners, contractors, architects, subcontractors, consultants, and suppliers.
- Evaluate contractual conditions and obligations.

- Make sure that contracts are comprehensive, precise, and fair.
- Evaluate existing project conditions.
- Identify project restraints that might result in loss or harm to the organisation.
- Provide and implement a systematic company procedure for identifying risk problems (Valsamakis, *et al.*, 1999; Laxtons, 1996; Papageorge, 1988).

C. Risk Identification Tools

According to Valsamakis, *et al.* (1999); Laxtons (1996) and Papageorge (1988) risk identification may be approached by a combination of the following methods:

- **Use of experienced intuitive management**; parties or building practitioners see risks arising based on their own specialisation and background experiences.
- **Use of experts in departments;** they can aid in problem solving due to their vast knowledge.
- **Standard questionnaires and checklists;** These are useful but not an effective way of stimulating the identification of risks. They are however good aids to memory. Questionnaires can be a very important tool in risk management if used or updated properly. They can also be an effective method of extracting risks and capturing corporate experience during their preparation and their subsequent use by others.
- **Structured interviews;** Structure of the interview should be prepared in advance. During the interviews it is very important to record all concerns and risks expressed so that they can be analysed to determine their importance.
- **Use of expert computer-based systems;** The major benefits of expert systems have been found in areas where the range of risks has been identified over many similar projects and the company's experts and practitioners have considerable experience to draw on.
- **Use of outside specialists;** These bring additional experience into the building project concerned.
- **Brainstorming sessions;** Brainstorming is an extremely effective method for identifying risks and their mitigation strategies.
- **Delphi technique;** attempts to produce objective results from subjective discussions. The main advantage of this method is that all participants act independently, there are neither stronger personalities to dominate nor any peer pressure.
- **Combined approach;** In reality it is recommended that an approach combining a number of identification techniques is adopted. By combining techniques the various disadvantages of one method may be offset by the advantages of others to produce a more meaningful exercise.

2.7.2.2 Risk Analysis

Risk analysis is used to evaluate risks and ascertain the importance of each risk to the project, based on an assessment of the probability of occurrence (Likelihood) and the possible consequence of its occurrence (Severity). Risk = Likelihood X Severity (Raftery, 1994). Risk analysis assesses both the effects of individual risks, and the combined consequences of all risks on the project objectives. According to Raftery (1994) situations where there is little, no or unreliable data are not ones where it is not possible to carry out the analysis, they are situations where the analysis is more, not less, important.

A. Importance of Risk Analysis

The main purpose of a risk management system according to Laxtons (1996) is to assist business to take the right decisions. An integral part of the system is risk analysis. The wider and more efficient use of computers is likely to encourage more rigorous analysis of risks. The time has now arrived when the more significant risks can be evaluated with economic advantages.

Risk analysis enables decision makers to improve the quality of their judgments by providing more realistic information on which to base decisions. This is clearly summarised by Tony Ryan, Chairman of Guinness Peat Aviation Ltd, as quoted in Raftery (1994, pg.3) "*This is not a speculative game at all. Our objective is not to avoid risk but to recognise it, price it and sell it.*"

B. Risk Analysis Principles

The following are risk analysis principles:

- Analyse all the risks identified, which results in the overall reduction in risk exposure;
- Pre-planning should lead to the use of pre-evaluated and prompt responses to any risks which do materialise;
- More explicit decision making on the project is needed;
- Clearer definition of specific risks associated with particular projects are needed;
- Full use should be made of the skill and experience of projects personnel;
- Good documentation is needed to ensure that corporate knowledge of project risks accumulates over time and does not remain with individuals (Raftery, 1994).

C. Risk Analysis Tools

There are two techniques used in the risk analysis. Firstly, quantitative risk analysis which requires numerical data input and carrying out of some calculations. It provides some numerical results, which will allow the project team makes informed decisions. Secondly, qualitative risk analysis which involves subjective assessment based on experiences and intuition of the project team, which may be used to determine risk impacts. Lack of information and lack of demand for more detailed approach, and absence of numerical data related to risk identification are the main reasons that compel risk analysts to use the qualitative technique. This does not mean that the quantitative risk techniques are not used. Both techniques are used according to the importance of the project and the availability of information. There are many techniques used for risk analysis. They are: sensitivity analysis, probability analysis, simulation techniques, risk premium, expected monetary value (EMV), expected net present value (ENPV), EMV using a Delphi peer group, risk-adjusted discount rate (RADR), detailed analysis and simulation, and stochastic dominance (Raftery, 1994; Shen, 1999; Smith, 1999).

2.7.2.3 Risk Response and Mitigation

Risk response and mitigation is the action that is required to reduce, eradicate or avoid the potential impact of risks on a project. The main aim of any response and mitigation strategy is to initiate and implement appropriate action to prevent risks from occurring or, at minimum, limit the potential damage they may cause. This should ensure that the overall project objectives of time, cost and quality are not jeopardised. The information gained from the identification and analysis of the risks gives an understanding of their likely impact on the project if they are realised. This, in turn, enables an appropriate response to be chosen (Laxtons, 1996).

Unfortunately, when firms are bidding for work in competition, as is the case in most tendered construction contracts, there may be a tendency to understate the risk or its effects or even an unwillingness to raise the possibility or risk so as to gain an advantage over other tenderers. According to Raftery (1994) it is of much greater benefit to be able to respond to risks rather than having to deal with their consequences when they materialise unexpectedly.

The purpose of the identification and the analysis is to enable the decision maker to make a considered response in advance of the problem occurring. The general guiding principle of risk response is that the parties to the project should seek a collaborative and mutually beneficial distribution of risk. The starting point for the distribution of risk is the contract (Raftery, 1994).

Furthermore, risks need to be allocated to those parties best placed to influence both the likelihood of the risk occurring and its potential impact should it occur. Prior to the allocation of risks to the various project participants it is necessary to consider a number of factors:

- who is best placed to influence the events that may lead to the risk materialising,
- who is best placed to control and manage the risk when it does materialise,
- is the risk one which lies within the project's control,
- the timing of risk allocation,
- what secondary or resultant risks arise as a result of the action taken,
- is the cost of mitigating the risk acceptable when compared to the potential impact of the risk itself?

It should be appreciated that the allocation of a risk to the wrong person for the wrong reasons and at the wrong time can have almost as adverse an outcome as not identifying and responding to the risk in the first place. (Laxtons, 1996; Flanagan and Norman, 1993).

The method used to handle risk depends upon its nature and the circumstances of the person or firm exposed to it. One or more of the following methods may be used with regard to a particular risk:

- **Risk avoidance.** Avoiding a risk means deliberately taking another course of action so that it cannot arise in the new circumstances for that project. The ultimate form of risk avoidance is not to proceed with the project at all, which is seldom adopted. Flanagan and Norman (1993) states that risk avoidance is synonymous with the refusal to accept risks. Risk avoidance is rarely a straightforward or easy response measure. Because it is highly effective in the right circumstances, however, it should always be considered first among the possible options available to a stakeholder (Edwards and Bowen, 2005). Risk avoidance may include a review of the overall project objectives leading to a reappraisal of the project as a whole (Laxtons, 1996).

- **Risk transfer.** A project organisation is seeking to shift the burden of a particular risk to another stakeholder. Typically, a client will transfer risks to a contractor, who in turn will transfer them to sub-contractors or suppliers. Every risk transfer has a cost. This is usually reflected in the price the transferee charges for accepting the risk e.g. the premium payable to an insurance company, the fee set by a bonding agent, or the commission charged by the bank. Transfer of liability for the consequences of risks events may be achieved, but accountability often remains in some degree (Edwards and Bowen, 2005). In some cases, transfer can significantly increase risk because the party to whom it is being transferred, may not be aware of the risk they are being asked to absorb.

- **Risk reduction and residual retention.** Once all the avenues for response and mitigation have been explored a number of risks will remain. No risk should be avoided, transferred or retained without first checking to see if it is possible to reduce it and then retain the residual risk. Edwards and Bowen (2005) emphasis that all dimensions of the risk should be examined, since it may be possible to reduce the probability of occurrence, the impact consequences, or the duration of exposure to the risk. According to Smith (1998) risk can be reduced by obtaining additional information; performing additional tests/simulations; allocating additional resources; and improving communication and managing organisational interfaces. Laxtons (1996) emphasises that retained risks should not simply be ignored, they should be subject to effective monitoring, control and management.

- **Risk retention.** Retaining risks without mitigating them presumes that the decision is an informed one and based upon analysis which indicates that any reduction treatment has a negative cost/benefit ratio. Risks that produce individually small, repetitive losses are those most suited to retention. Retention may also occur when you are unaware of a risk to which you are exposed (Smith, 1998; Laxtons, 1996). In some situations the only option available is to retain a risk. The party that is holding a risk might be the only one that can manage the risk or accept the consequences, should the risk materialise. It is normal according to Smith (1998) for the client to be left with some risks.

- **Combination of two or more of these responses to risk.** Often the wisest course of action is to concurrently use more than one method of handling a risk. Combinations of retention, reduction and transfer responses to risk are possible. Since risk avoidance aims to change the circumstances through which a particular risk arises, this response cannot be used in combination with others. Probably the most common example of combination risk response is the transfer of risk through insurance, while at the same time retaining a small amount of the impact by accepting liability for a fixed excess sum in the insurance policy agreement (Edwards and Bowen, 2005; Doherty, 2000; Smith, 1998; Laxtons, 1996; Athearn and Pritchett, 1984).

2.8 Contracts in the Construction Industry

2.8.1 Definition of Contracts

A contract is an agreement enforceable at law. To be a legally enforceable contract, an agreement must meet the following requirements:

- Its purpose must be legal.

- There must be an offer and acceptance.
- There must be a consideration.
- The parties to the contract must be competent.
- It must be in legal form (Athearn and Pritchett, 1984).

A contract is an agreement between two parties, one of whom, the building contractor, agrees to erect a building, and the other, the employer, agrees to pay for it. Personal rights and obligations are created by the agreement, and the right of one party is the obligation of the other. A contract comes into existence on the acceptance of an offer. There is a meeting of minds, a consensus that is an essential element of a contract (Finsen, 1999).

Contractual documents are tools for managing risks (Uff, 1995). Flanagan and Norman (1993) state that the purpose of the contract is to establish the rights, duties, obligations, and responsibilities of the various contracting parties in order to allocate risk. A building contract is a trade off between the contractor's price for undertaking the work and his willingness to accept both controllable and uncontrollable risks. Controllable risks reflect, for example, variations in human performance, such as management and operative performance. Uncontrollable risks include such factors as inclement weather, the effects of inflation or ground conditions on a particular site. The price for doing the work partly reflects the contractor's perception of the risk involved.

The vital parameters requiring definition in the construction contract are what the client has to do, what the contractor has to do, by what dates these various tasks each have to be carried out, pre-defined mechanisms for payment. The emphasis must be on using the contract documents to reduce uncertainty or provide mechanisms for action when particular uncertainties eventuate into reality (Uff, 1995).

The means by which the contractor is identified, the form of contract between owner and contractor, and the scope of duties assumed by the contractor are highly variable with each individual case. The contractor may be selected according to Clough (1975) on the basis of competitive bidding of one sort or another, the owner may negotiate a contract with a selected contractor, or perhaps a combination of the two may be used. The entire project may be included within a single general contract, or separate prime contracts for specific portions of the job may be used. The contract may include project design as well as construction, or the contractor's responsibility may be primarily managerial in nature.

2.9 The JBCC Building Agreement

In 1984 the Joint Building Contracts Committee (JBCC) was established, to draft an agreement for the construction industry. In 1991 the committee published the JBCC Principal Building Agreement and associated documents.

The Department of Public Works in the documents considered adopting the JBCC documents for its own use, but required that the document be brought into line with the state's requirements and policy, which led to an intensive re-examination and re-drafting of the documents, and in 1998 the new documents, designated JBCC Series 2000, were published (Finsen, 1999).

The JBCC is a committee which represents the variety of interests in the construction industry. It has six constituent member organisations which are: the Association of South African Quantity Surveyors; the Institute of South African Architects; the South African Association of Consulting Engineers; the South African Property Owners' Association; the Specialist Engineering Contractors Committee, and the Building Industries Federation of South Africa (BIFSA). The drafting of specialist clauses in the documents have had the assistance for instance of the South African Insurance Association and the South African Insurance Brokers Association; the SA Banks Technical Committee (construction guarantee clauses); and the Association of Arbitrators (dispute resolution clauses). The documents have taken some 10 years to produce. These documents represent a delicate balance of the interests of the various participants in the construction industry, arrived at through a process of negotiation over this very long period of time (Van Deventer, 1993).

The JBCC Series 2000 is a suite of documents that comprises the Principal Building Agreement, the Nominated/Selected Subcontract Agreement and the Preliminaries, which together constitute the terms and conditions of the agreement between the parties. In addition there are sundry ancillary documents that do not add to the rights and obligations of the parties but merely facilitate the administration of the contract. These include the Contract Price Adjustment Provisions, the Construction Guarantee, the Payment Guarantee, the Payment Certificate, the Completion Certificate, etc. These documents are intended to be used in conjunction with each other (Finsen, 1999).

2.9.1 The Principal Building Agreement

The document records the terms of the agreement between the employer and the contractor, in which the employer is represented by a principal agent, on whom nearly all of the employer's rights and obligations devolve. Other agents may be appointed to whom some of the principal agent's duties may be delegated. The document commences with a comprehensive list of definitions. The document concludes with a schedule of variables containing information specific to a particular contract. A letter was sent out to the Joint Building Contracts Committee in order to obtain approval for reproducing aspects of the contract.

2.10 Fundamental Concepts of Contracts

Since the contract is an agreement, both parties agree about what should be done, how and when it should be done, and what should happen if it is not done. Agreement is the basis of the contract and absence of agreement on any fundamental aspect would be fatal to the contract and would render performance and enforcement impossible (Finsen, 1999).

The agreement must be freely made; an agreement which has been induced by compulsion, threats or fear is not a true agreement; the courts will generally hold such contracts void. A contract that has as its purpose some illegal objective will also be unenforceable, not because of any defect in the agreement, but because, as a matter of policy, the courts will not assist in an illegal dealing (Athearn and Pritchett, 1984; Uff, 1981).

Finsen (1999), Murdoch (1996), Flanagan, Norman (1993) and Uff (1981) highlight the following areas in contracts:

- **Contractual capacity**

Anyone who has reached the age of 21 has contractual capacity, and therefore has the capacity to enter into a valid contract. Excluded are persons of unsound mind, women who are married in community of property and un-rehabilitated insolvents. The power to enter into a contract is not limited to a natural person. A juristic person, such as a company, a close corporation or a university can enter into a contract but the act is performed by a natural person duly authorised acting on its behalf.

Variation of the terms of the contract

The parties by consent can vary any aspect of the agreement. Some contracts prudently contain a provision that no variation to the contract shall have a binding effect unless it is in writing and signed by the parties. Unless this has been stipulated, subsequent oral variation to a contract, oral or written, will have a binding effect.

The lawful termination of contracts

Just as a contract may be entered into the mutual agreement, so, by mutual agreement, the parties can agree to bring a contract to an end. The most natural way in which a contract may come to an end is by the performance by each party of all his obligations under the contract. There remains nothing to be done, nothing to enforce, and the contract becomes a spent force and expires. When each party still has obligations to discharge, a contract will terminate when the parties mutually agree to bring it to an end. A contract may also come to an end when one of the parties, who no longer wishes to perform his obligations and enjoy his benefits under the contract, finds someone else to step into his shoes who will take over both his rights and obligations. Where this happens, the original contract terminates and a new contract arises, but all the original terms persist unless otherwise decided by the parties.

Breach of contract

Contracts impose various obligations on the parties. If one of the parties does not carry out any particular obligation, he or she is said to be in breach of contract. The remedies available to the innocent party prejudiced by such breach may be cancellation of the contract and a claim for damages, or he or she may elect to uphold the contract and claim specific performance together with damages.

Penalties and damages

Time is frequently stated in the tender documents as being the essence of the contract. If the building is completed later than the contracted completion date, the employer will have lost the use of it for a while, which would probably represent the loss of rents, but thereafter he will derive the same benefit from it that he would have enjoyed if it had been completed on time. An employer who suffers financial loss as a consequence of late completion of the works is entitled to the usual contractual remedy of damages. He is entitled to such recompense from the contractor as would put him in the position in which he would have been had the works been timeously completed. To overcome this difficulty it is common practice for the parties, in their agreement, to stipulate that the contractor shall pay to the employer a penalty in lieu of damages for late completion. The penalties do not have to be an accurate pre-assessment of the damages likely to be suffered, nor even are they limited to a consideration of the financial loss likely to be sustained by the employer. The courts do have the power; however, to reduce the amount of the penalty if it appears to be excessive, although they appear to be somewhat reluctant to interfere in the right of the parties to contract on whatever terms they wish.

- **Extensions of time**

Most building contracts contain express provisions under which the period allowed for the contractor to undertake and complete the works can be extended. These provisions cater for delays which are neither the fault nor the responsibility of the contractor. Such provisions obviously benefit the contractor, who will not be liable to pay damages for delay during the period for which time is validly extended. The importance of losing the fixed date is that a contractor who has caused part of the delay is still liable to pay general damages for delay.

- **Dispute-resolution**

All parties to a building contract will start off with the best intentions to get the work both completed satisfactorily in the agreed time and at the least expense to the owner, whilst ensuring that the general contractor and all the other specialist works contractors and suppliers make a reasonable profit. Somewhere between the beginning and the end, disagreements, disputes, disruption and delays arise which can destroy the best of intentions.

The reasons for disputes are the fact that the scale of building projects has increased enormously in recent years, and their design and construction has grown in complexity. Such projects require an ever-increasing number of specialist subcontractors. The pressure has been on the construction industry to build more and more in less and less time.

2.11 Parties to a Building Contract

It is a universal practice in construction for the contract to be formalised by a written document. The basic purpose of a written contract is to define exactly and explicitly the rights and obligations of each party thereto. The complex nature of construction dictates a form of contract that is relatively lengthy, sacrificing brevity in order to describe precisely the legal, financial, and technical provisions. Construction contracts are substantially different from the usual commercial variety. The commodity concerned is not a standard one but a structure that is unique in its nature and whose realisation involves considerable time, cost, and hazard. The usual construction contract consists of a number of different documents such as general conditions, supplementary conditions, drawings, bills of quantities and addendums.

Collectively all the foregoing documents constitute the construction contract (Finsen, 1991; Clough, 1975).

It is general practice to interpret the contract to the letter where possible and feasible under the law. "*It is presumed that those who enter into contracts know what they want, say what they mean, and understand what they have said. It is an accepted rule of law that a person has a duty to read and understand a contract before executing it, and his failure to do so will not excuse his ignorance of its contents*" (Clough, 1975, p.114).

During the bidding period, the contractor must evaluate each clause with regard to its possible or probable contribution to the cost of construction. On becoming the successful bidder, he must again examine the contract, but with a different purpose in mind. Many provisions require specific actions on the part of the contractor during the life of the contract (Finsen, 1991; Clough, 1975).

The parties to a building contract are, on the one hand, the person who wishes to have a building built for himself and who employs a builder to do so, and who is generally referred to in building contracts as the employer, and, on the other hand, the builder who carries out the work and who is generally referred to as the contractor. Architects, quantity surveyors, engineering consultants, etc. are not parties to a contract in that they do not acquire legal rights or obligations, but they are nevertheless charged with many duties as agents of the employer (Finsen, 1999). Agency is a broad term describing the relationship between two parties whereby one, the agent, acts on behalf of the other, the principal. An agency may arise under a contract, whereby the agent is appointed by his principal to carry out certain duties (Uff, 1981).

Finsen (1999). Murdoch (1996), (Van Deventer, 1993) briefly describes the parties to a contract as mentioned in Figure 2.2.

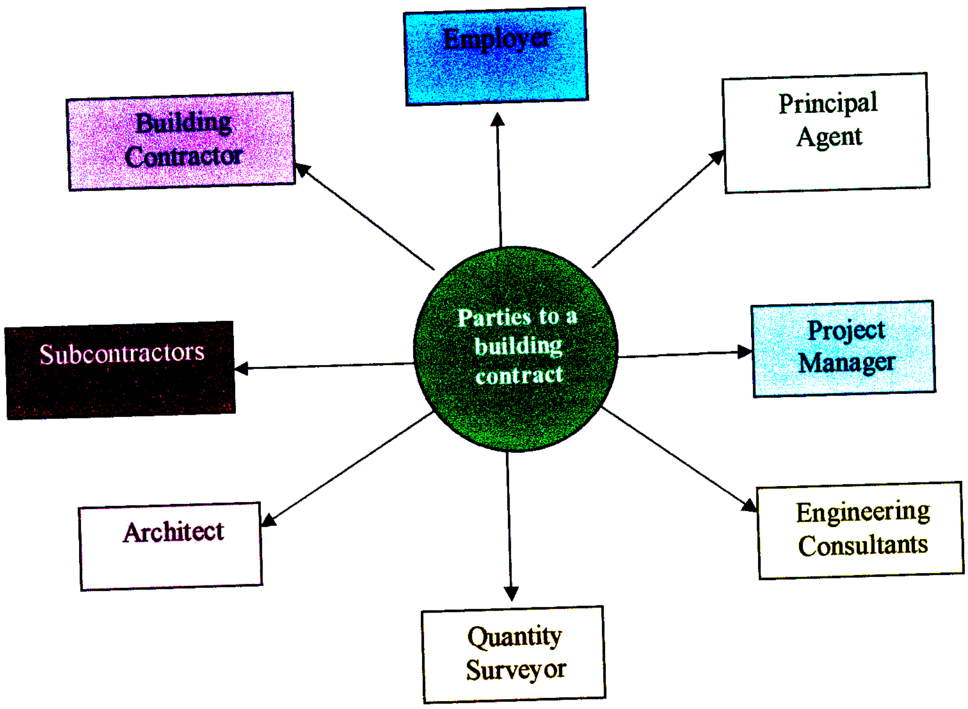


Figure 2.2. Parties to a building contract.

2.11.1 The Employer

Employers may be divided into two categories:

- those who erect buildings for their own ownership and use, whether they intend to inhabit and use the buildings themselves or let them to others, and
- those whose intention is to sell the buildings as soon as they can, possibly even during the construction phase, so that they can recoup their capital, with a profit, and embark on further building projects.

This latter type of employer is generally referred to as a property developer. Most of the major employers with large ongoing building programmes are members of the South African Property Owners' Association (SAPOA) which was formed to co-ordinate their views and to provide a representative body for negotiating with other representative bodies in the building industry.

2.11.2 The Building Contractor

A building contractor usually undertakes to build the entire project, moving onto a vacant site at the inception of the contract and at its completion, delivering a building that is complete in all respects and ready for occupation and use by the employer. In certain trades, for example electrical and plumbing, tradesmen have to be registered before they can carry out work.

Many building contractors are members of their local Master Builders Association, but membership of such associations is no guarantee of competence or integrity. Contractors are co-ordinated by the Building Industries Federation South Africa (BIFSA) which is a representative body that negotiates strongly on behalf of its constituent members. At one time building contractors employed most, if not all, of the tradesmen that might be required for any particular project. With the growing complexity of building techniques and installations, however, there has been very rapid growth of the subcontracting industry and there are now numerous subcontractors specialising in various aspects of building construction and installations.

2.11.3 Subcontractors

Essentially the typical standard form subcontract is designed to achieve a mirror image of the main contractual provisions. The reason for this is that the contractor and the employer want the subcontractor to execute work of the same quantity, quality and value as the work under the in contract. In some contracts, nearly all the work is carried out under subcontracts, the principal contractor confining himself to managing and controlling the process. As the trend towards subcontracting developed, employers saw the opportunity of getting the best of both worlds, and the nominated subcontract was introduced which enabled the employer to have the benefit of a principal contractor to control the entire building operation while yet being able themselves to choose specific subcontractors to undertake specific work, as they had previously been able to do.

2.11.4 The Architect

An architect is a person who designs buildings and superintends their erection. He is both advisor to, and agent of his client. Only persons registered as an architect in terms of the Architects' Act 1970 may hold himself out as an architect. An architect is required to be familiar with all the statutory or other legal requirements or limitations on the design of his client's building and to ensure that his design complies with them.

It is in the discharge of the duty of inspecting the work in progress and satisfying himself that it complies with the terms of the contract that the architect is at greatest risk. He is not expected to carry out continuous supervision, and any defect in the work which he does not detect is nevertheless the liability of the contractor rather than his ; his inspections are for the benefit of the employer, not the contractor, and do not relieve the latter of any of his contractual obligations. Most architects carry professional indemnity insurance not only to cover any successful claims that may be made against them, but also to meet the cost of defending them.

2.11.5 The Quantity Surveyor

The quantity surveyor is a person who calculates the quantity of labour and materials that are required to erect the building and compiles this information in a document known as a bill of quantities, which is used by tenderers as a basis for estimating the cost of the project and formulating their tenders. As an agent of the client, the quantity surveyor prepares preliminary estimates of cost, advises on the value of interim payment certificates, evaluates claims for extras and determines the proper value of the final account. The profession of quantity surveying is governed by the South African Council for Quantity Surveyors, a statutory body established in terms of the Quantity Surveyors' Act 1970, which supervises the education of quantity surveyors, administers their registration and deals with infringements of the rules of professional conduct.

2.11.6 The Engineering Consultants

The structural design of contemporary buildings, and the design of their mechanical and electrical installations, has become so sophisticated and complex that it is beyond the technical knowledge and experience of architects, and is therefore undertaken by engineers trained and experienced in this type of work. Like the other members of the professional team, the engineer is normally engaged by the employer of the building and is liable to his client for any negligence in the execution of his professional duties.

2.11.7 The Project Manager

A project manager performs functions that usually are additional to the functions of the architect, quantity surveyor and the other consultants, although he sometimes performs some of their functions. The project manager is involved in a number of highly specialised professional disciplines and activities in complex projects where there is a need for someone to co-ordinate these disciplines in order to ensure the timeous and harmonious completion of the project. The prime responsibility of project managers is to see that neither the programme nor the budget is exceeded. In so doing the project manager often becomes the principal agent in the building contract, with the responsibility for the contract administration duties that would otherwise devolve upon the architect.

2.11.8 The Principal Agent

In the JBCC Series 2000 edition no mention is made either of the architect or of the quantity surveyor or any of the engineers, instead there is a principal agent who assumes all these roles. He may be an architect or anyone else, even a project manager. He is not expected to fulfil all of these roles as provision is made for the employer to appoint other agents as appropriate, and so the architect, the quantity surveyor and the engineers will continue to play their traditional roles. However, it is only the principal agent who can issue instructions, receive notices on behalf of the employer and bind the employer, although he can delegate certain of his authority to the other agents. The principal agent is not a party to the contract and does not acquire any contractual rights and obligations. He acts on behalf of the employer in respect of a great number of his obligations which, for lack of training and expertise, the employer cannot perform himself. The duties of the principal agent and the other agents to the employer under a construction contract are, first, to carry out their duties with reasonable skill and care, independently exercising reasonable professional judgment, and, secondly, to protect the employer's interests.

2.12 Obligations of the Employer and Contractor

2.12.1 Obligations of the Employer under the Principal Agreement

The prime obligations of the employer under the contract according to Finsen (1999), Edwards (1995) and Van Deventer (1993) are to:

- **Appoint Agents.**

The employer surrenders many of his contractual rights to his principal agent: inter alia, the right to approve work, to order additional work, to determine the value of variations, to extend the construction, and to determine the amounts of payments to be made under an interim or final payment certificate. The principal agent is expected to act even-handedly, without bias towards either party, and the employer may not influence him in the execution of these duties.

- **Hand over the site to the contractor.**

At the commencement of the construction period, the site is required to be 'handed over' to the contractor to enable him to carry out the contract. The contractor is put in possession of the site, but ownership of the site remains with the employer.

- **Make payments in accordance with the agreement.**

- **Provide a payment guarantee** if required.

An employer is obliged to provide a payment guarantee within 21 calendar days of a request by the contractor to do so.

- **To provide drawings and instructions.**

The contractor has undertaken to carry out the work in accordance with the drawings and instructions issued, from time to time, by the principal agent and is entitled to receive whatever information, whether in the form of drawings or otherwise, that he may need to fulfil his contractual obligations.

- **Interim payments.**

In a building contract, the common law does not oblige the second party, the employer, to perform his obligation until the first party, the contractor, has completed his performance. The contractor must complete the works in all respects before the employer is required to pay. No contractor has the financial resources to finance the construction of a project from start to finish, and it has become the invariable custom that the contractor is paid at regular intervals, usually monthly, an amount which represents the value of work done since the previous payment. It must be appreciated, however, that the right to such payment is contractual, and that in the absence of such provision in the agreement, the contractor has no common-law right to such interim payments.

- **Final account and final payment.**

The final account, which represents the contract value at the time that the contractor has finally discharged his contractual obligations, is required to be prepared by the principal agent and submitted to the contractor within 90 working days from the date of practical completion. The contractor is required to co-operate and assist in the preparation of the final account by providing all necessary documents and information that may be requested. The principal agent may not, however, issue the final payment certificate before the works are complete in all respects and he has issued the certificate of final completion.

2.12.2 Obligations of the Contractor under the Principal Agreement

- **Submission of priced bills of quantities or lump-sum document.** The bills of quantities will be used primarily for valuing variations, but also for valuing work in progress for interim payment certificates.
- **Furnishing of security.** Clause 14.0 provides for three alternative forms of security for the due performance of the contract to be furnished by the contractor, and the choice rests with the contractor, who is required to indicate his choice in his tender. In the event that the contractor fails to provide a security, the employer may either accept the default form of security provided or cancel the agreement.

- **Furnishing waiver of lien.** Where the contractor is required to waive his lien, he shall do so, using the JBCC Waiver of Contractor's Lien form, within seven calendar days of receiving a payment guarantee from the employer.
- **To appoint a site representative.** Clause 6.0 requires the contractor to have on site at all times a competent representative to administer and control the works with whom the principal agent could discuss the progress of the works and to whom he could give instructions.
- **To prepare a construction programme.** The common-law position is that the contractor, having contracted to carry out certain work within an agreed time, is free to carry it out in whatever manner he wishes.
- **To carry out and complete the work by the agreed date.** The contractor's first and most obvious obligation is to carry out the agreed work, and to do so by the agreed date. Failure to complete the works by the agreed date renders him liable to penalties for non-completion
- **Materials and workmanship to be satisfactory.** The contractor is deemed to be an expert in building, and is expected to ensure that the materials that he acquires for the works are not defective. As an expert in building, he also warrants, by a term implied by law, that the materials that he uses will be fit for their purpose, and if they turn out to be unsuitable, he is obliged to replace them with suitable materials or to be liable for damages.
- **Contractor's obligations to subcontractors.** The contractor stands in the same relationship to a subcontractor under a Subcontract Agreement as the employer does to him under the Principal Agreement, to give the subcontractor access to the portion of works necessary for the execution of the subcontract, to make payments, to furnish a payment guarantee, and to provide drawings and instructions.
- **Limitation to liability for latent defects**. The contractor's obligation is to complete the works free of patent defects. Latent defects may become apparent some time after final completion, and if they were due to some breach of the contract, the contractor would be liable for their rectification. In the JBCC Agreements, as a matter of policy, the contractor's liability for latent defects is contractually limited to five years.
- **Liability for design**. Where the design is prepared by an architect or engineer, the contractor's contractual obligation is to build in strict accordance with that design, and any deviation from it would amount to breach of contract.
- **Suspension of the works.** The contractor is not entitled to suspend the works for any reason whatsoever.
- **Contract instructions.** The employer has the unilateral right to vary the extent and nature of the performance to be rendered by the other party. The other party, the

contractor, cannot refuse to carry out the varied obligation, and his only remedies are an adjustment of the price he is entitled to be paid for the performance, and, in appropriate circumstances, an extension of the time in which to make such performance.

2.13 Conclusion

This chapter outlined the theory of risk and construction contracts. Risk awareness and uncertaininty as well as the various attitudes to risk were discussed. In addition the risk management and the way risk is identified, quantified, classified and the manner in which risk is responded to and mitigated were discussed. The purpose and fundamental concepts of contracts in general and then the JBCC (PBA) in particular were explained. The JBCC (PBA) contract was discussed in terms of the parties to a contract and the obligations of various parties. The chapter concluded by discussing the identification of contractor's risk.

The next chapter explains the Identification, Quantification and Classification Framework.

CHAPTER 3

RESEARCH METHODOLOGY

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology designed to achieve the research aim and objectives. The research process and approach are explained. In addition, both qualitative and quantitative methods, interviews and questionnaires, were used in order to obtain triangulation. The design of the research methodology is also discussed. The respondents were selected via purposive sampling from a sampling frame. Further more, this chapter describes the Plan, Do, Study and Act cycle and goes on to explain the data collection methods. The sampling methodology is illustrated and the data analysis is also explained. The chapter concludes by discussing reliability, validity and ethics of this research.

3.2 Research and the Research Process

3.2.1 Definition of Research

The South African Pocket Oxford English Dictionary (2001, pg. 820) defines research as the systematic investigation into the study of materials or sources in order to establish facts and reach new conclusions.

Different authors define research in different ways.

- According to Cohen and Manion (1994 cited in Walliman, 2001), research is a combination of both experience and reasoning and must be regarded as the most successful approach to the discovery of truth.
- Johnson (1994 cited in White, 2002) defines research as a systematic enquiry that going beyond generally available knowledge to acquire specialised and detailed information, providing a basis for analysis and comment on the topic of enquiry.
- According to Leedy (2005) research is a systematic process of collecting, analysing, and interpreting information.

The above mentioned definitions mean that:

- Research is a systematic process.
- Research has objectives or purpose.
- Research aims to increase human knowledge.
- Research allows one to collect information and evaluate it before making a final decision.

3.2.2 Research Characteristics

Although research projects vary in complexity and duration, research according to Leedy (2005), typically entails eight distinct characteristics:

- Research originates with a question or problem.
- Research requires a clear articulation of a goal.
- Research requires a specific plan for proceeding.
- Research usually divides the principal problem into more manageable sub-problems.
- It is guided by the specific research problem, question, or hypothesis.
- Research accepts certain critical assumptions.
- Research requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research.
- Research is by its very nature, cyclical.

3.2.3 The Research Process

Fellows and Lui (1997) describe the research process as one that is dynamic and flexible and allows for changes throughout the research process.

There are different approaches to the different types of research. Although, different approaches suggest different steps, most seem to follow a similar process as follows:

(1) Research problem formulation.
(2) Focus project or area of interest within a theory.
(3) Design a study.
(4) Collect data.
(5) Analyse the data.
(6) Interpret findings and draw conclusion.
(7) Inform others in a report.

The seven steps simplify the research process and represent the necessary activities to be undertaken. Researchers rarely wait for one step to finish before they start the next one. Rather, the steps blend into each other. Often a later step stimulates reconsideration of a previous one. In addition, the research process does not end when one comes to the end of step seven. Research is an ongoing process. Each research project builds on prior research and contributes to a large body of knowledge (Neuman, 1994; Nachmias and Nachmias, 1996).

3.3 Research Methodology and Methods

3.3.1 Definition

The approach a researcher uses to investigate a subject is termed the methodology which is referred to by Leedy (2005) and White (2002) as the philosophical basis on which the research is founded.

Amongst others, White (2002) and Silverman (2005) distinguish two main areas in methodology: quantitative research and qualitative research. The particular techniques used to collect data and information are termed methods. These include quantitative methods, like closed ended questions, as well as qualitative techniques like open ended questions.

3.3.2 Quantitative Research

Quantitative research originates from science and therefore is sometimes referred to as the 'scientific method' or the positivist method. White (2002) states that it is based on the collection of facts and observable phenomena, and scientists use these to deduce laws and establish relationships. In particular, it examines cause-and-effect relationships. The diagnostic feature is that the techniques used always generate numerical data which is then analysed. Leedy (2005) and Tashakkori (1998) describe the process of quantitative studies as a representation of the mainstream approach to research; with carefully structured guidelines. The analysis can be simple in mathematical terms involving the production of tables, charts and diagrams (e.g. pie chart, bar chart, etc.). This type of interpretation is referred to as descriptive statistics.

The purpose of quantitative researchers according to Leedy (2005) is to seek explanations and predictions that will generalise to other persons and places. The intent is to establish, confirm, or validate relationships and to develop generalisations that contribute to theory.

3.3.3 Qualitative Research

The researcher doing qualitative research attempts to obtain an inside view of the research, getting as close as possible to the subject of the research in order to collect resonant and fertile data. Qualitative research is typically used to answer questions about the complex nature of phenomena, often with the purpose of describing and understanding the phenomena from the participants' point of view (White, 2002; Walliman, 2001). This type of research is sometimes called relativist or phenomenalist, interpretative, constructivist, or post-positivist approach (Leedy, 2005).

Qualitative data is usually collected in the form of descriptions for example, interviews, observation, diaries, case studies and action research. Qualitative researchers generally use non-mathematical procedures when interpreting and explaining their research which often generates lots of material (White 2002).

Leedy (2005) states that the purpose of qualitative researchers is to seek a better understanding of complex situations, with researchers entering the setting with open minds, prepared to immerse themselves in the complexity of the situation and interact with their participants.

3.3.4 Triangulation

Triangulation according to (Tashakkori, 1998) refers to the use of multiple methods to cross-check and verify the reliability of a particular research tool and the validity of the data collected. The term originated from land surveying, and means simply that you get a better view of things by looking at them from more than one direction.

Use of triangulation techniques include triangulation of sources (e.g., interviews and observations), of methods (e.g., quantitative and qualitative), of investigators, of data and theoretical triangulation (McNeil and Chapman, 2005; White, 2002; Tashakkori, 1998; Gorden, 1980).

Each method, tool or technique has its unique strengths and weaknesses. There is an inevitable relationship between the data collection method employed and the results obtained. In short, the results will be affected by the method used. The problem here is that it is impossible to ascertain the nature of that effect. Since different methods will have different effects, it is best to use different methods to cancel out the effects, which will lead to greater confidence being placed in the conclusion (Saunders *et al.*, 2003).

Within this research both qualitative and quantitative research was used to obtain triangulation. Questionnaires were sent out to nineteen construction managers via faxes and email. Four interviews were also conducted. Both the interview and the questionnaire were used as complementary instruments to collect related data

The following steps were followed in developing the methodology:

- Selecting the method of interviewing: individual, group or a combination of the two and sending out of questionnaires
- Designing a strategy for the selection of respondents.
- Conducting the interviews.
- Transcribing the interviews.
- Analysing the text corpus.

3.4 Designing the Research Methodology

The research aims to improve the image of the South African construction industry and help contractors identify, quantify and classify risks associated with the JBCC (PBA).

This necessitates collecting data from different sources using different methods to review and identify the research problem and establish the research aim and objectives.

In addition, the research nature requires gaining the feed from the South African construction professionals regarding their evaluation of the developed framework and then applying the framework to the JBCC (PBA) clauses.

By comparing the research aim, objectives and nature with the different research approaches mentioned above, this research adopts the applied research.

In addition, the research methodology of this research is based both on quantitative and qualitative research. Qualitative and quantitative research was used to obtain triangulation. Both the interview and the questionnaire were used as complementary instruments to collect related data.

The steps of the applied approach could be summarised in the four steps of Planning, carrying out the research, analysing the data and then taking the action required. These steps are in harmony with the Deming cycle of Plan-Do-Study-Act (PDSA).

- Plan - involves describing a study to be conducted.
- Do - the plan is implemented and the progress is monitored.
- Study - results of the "do" phase are compared to predictions made during the planning phase.
- Act - the team decides what actions are appropriate, given the results of the three previous phases.

In addition to the harmony between the applied research and the PDSA, this cycle meets the research aims to improve the performance of the risk management of the South African construction industry as the PDSA is also a quality improvement tool.

3.5 Plan-Do-Study-Act (PDSA) Cycle

The Deming cycle is a simple methodology for improvement that was strongly promoted by W. Edwards Deming. It was originally called the Shewhart cycle after its original founder, Walter A. Shewhart, but was renamed the Deming cycle by the Japanese in 1950. The Deming cycle is composed of four stages: Plan, Do, Study and Act (PDSA) as illustrated in Figure 2.1. (Evans and Lindsay, 2005; OmniLingua, 2004; Bergman and Klefsjo, 1994). It is in essence, a never-ending process very reflective of the continuous journey of continuous quality improvement. Most firms actively engaged in continuous improvement train their work teams to use the plan-do-study-act cycle for problem solving.

The PDSA cycle provides managers with a scientific method for learning how to make improvements. Repeated use of the PDSA cycle is a method for systematically developing knowledge of the cause and effect relationships that exist in systems and processes, and for developing and testing new products and new methods of doing work. When the PDSA cycle is applied as a methodology for learning within a system of improvement, the probability of improvement is increased beyond what would occur by relying on chance (Bergman and Klefsjo, 1994, Bounds, *et al.*, 1994).

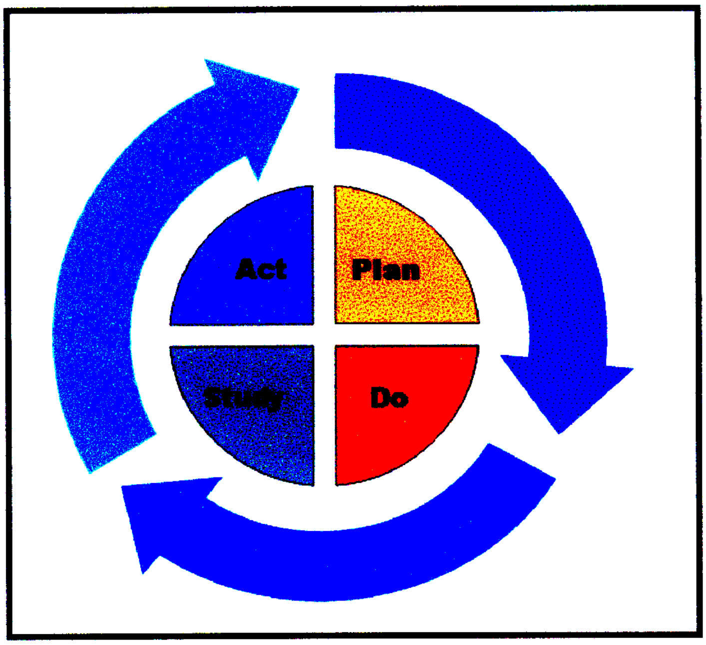


Figure 3.1. The PDSA Cycle is a continuous and continuing cycle (OmniLingua, 2004)

The PDSA cycle was used in this research as an effective tool for enhancing the image of the South African construction industry and to improve the performance of contractors towards managing risks associated with the JBCC (PBA). The continuous application of the PDSA model helps identify causes of poor quality or areas that can be further enhanced.

3.5.1 Implementation of the PDSA Cycle

This research used the PDSA tool in order to design the research methodology as shown in Figure 2.2. The cycle comprises the following steps:

3.5.1.1 The Plan Phase

The planning phase involves describing a study to be conducted, a test of a process change, or an experiment that will be carried out in the next phase of the cycle. The plan includes a list of all the steps required to conduct the study or test including who will carry out each step, when each step will be carried out and what data and other records will be recorded (Bounds, *et al.*, 1994). After assessing the benefits and costs of the alternatives, the team develops a plan with quantifiable goals for improvement as well as their means of achievement. A plan is then developed (Kranjewski and Ritzman, 2002; Bergman and Klefsjo, 1994).

In this research the plan phase involved:

- Identifying the problem statement.

- Establishing aims and objectives.
- Developing a framework for the identification, quantification and classification of risks.

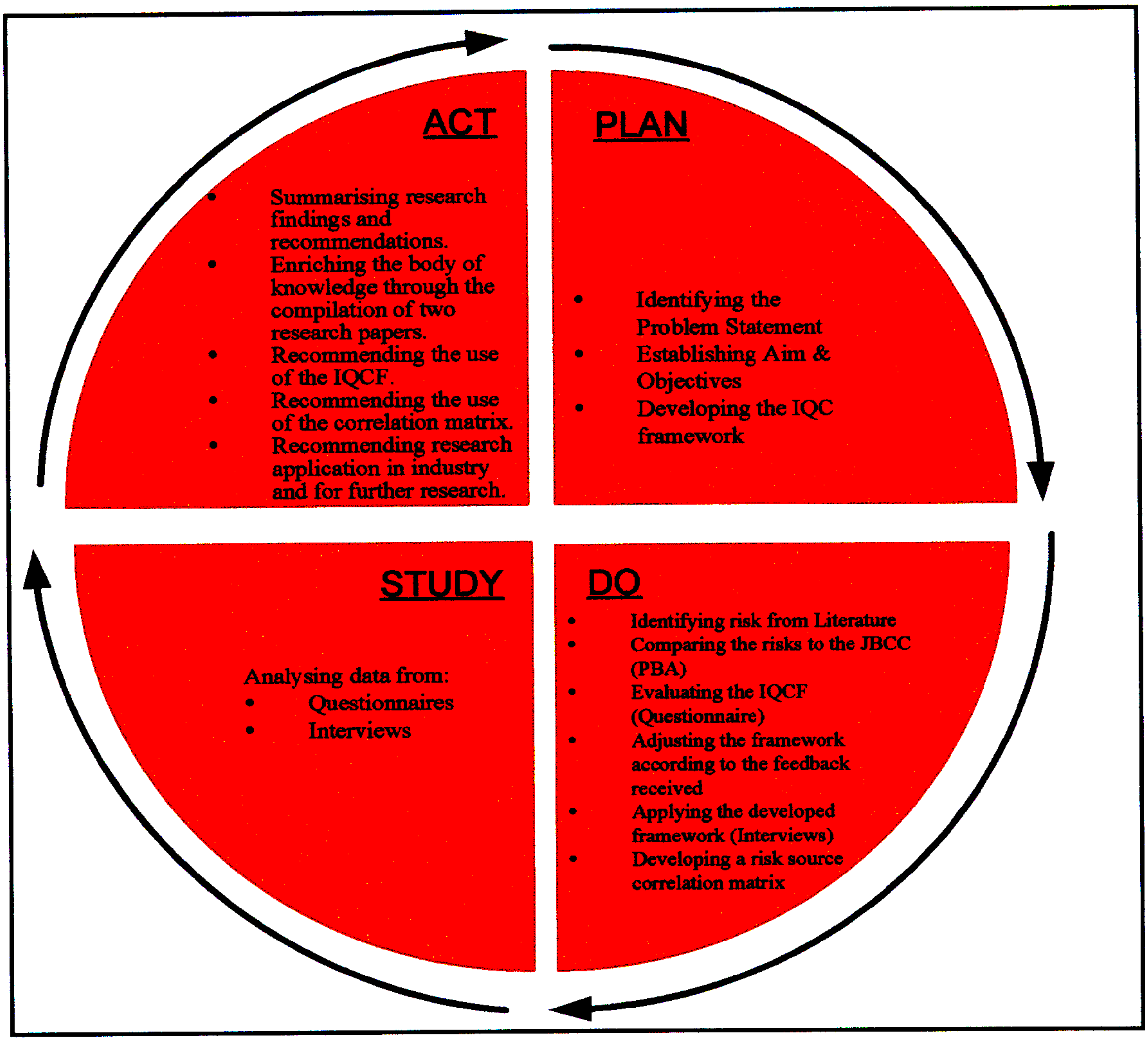


Figure 3.2. The PDSA utilised for this research design.

3.5.1.2 The Do Phase

In the do phase, the plan is implemented and the progress is monitored. Data from the experiment are collected and documented. Data is collected continuously to measure the improvements in the process. Any changes in the process are documented, and further revisions are made as needed. Any failures to follow the plan are recorded for use in the analysis (Kranjewski and Ritaman, 2002; Bergman and Klefsjo, 1994).

Within this research the 'Do Phase' was carried out in following stages:

- ❖ All risks that affect the building contractors were identified from various literary sources (books, journals, construction magazines and conference proceedings as well as the Internet) refer to Appendix (A).
- ❖ The identified risks from literary sources were compared to the JBCC contract, clause by clause to ensure that the risks associated with the clauses are covered, refer to Appendix (A).
- ❖ The IQCF was evaluated through compiling a questionnaire so that feedback from the contractor's about the framework could be collected. The questionnaire was sent out to nineteen respondents as explained in sampling below.
- ❖ The feedback that was received was taken into consideration and the IQCF was adjusted accordingly. The feedback received was to try to reduce the length and make it easier to read.
- ❖ The developed framework was applied using an interview process.
- ❖ The final process entailed developing a risk source correlation matrix.

3.5.1.3 The Study Phase

Results of the "do" phase are compared to predictions made during the planning phase. If the results do not agree with what was predicted, the theory laid out during the planning phase may be revised. If the results agree with the prediction, the team determines how the conditions of the study might differ from conditions that might be seen in the process or system in the future. These differences may require further testing to extend the range of conditions under which the theory can be expected (Kranjewski and Ritaman, 2002; Bergman and Klefsjo, 1994).

The 'study' phase in this research involved the analysis of the data collected from the questionnaires and interviews.

3.5.1.4 The Act Phase

During the act phase of the cycle, the team decides what actions are appropriate, given the results of the three previous phases. Action may consist of change to the process or system under study, or the team may determine that further testing is required before making any substantial changes. The "act" phase also includes deciding what should be the focus of the next cycle. The results of a successful process are documented so that it becomes a standard procedure for all who may use it (Evans, and Lindsay, 2005; Kranjewski and Ritaman, 2002; Bounds, *et al.*, 1994).

In the 'act' phase of this research:

- The research findings and recommendations were summarised.

- It enriched the body of knowledge through the compilation of two research papers (Appendix B and C).
- The IQCF was recommend for use.
- The correlation matrix was recommend for use.
- Research application in industry and for further research was recommended.

Practice of the PDSA cycle provides a discipline for systematically learning and using the knowledge gained to make changes for improvement. (Bounds, et al., 1994)

3.6 Data Collection Method

Leedy (2005) and Walliman (2001) draw a distinction between primary and secondary data. This distinction is based on the source from which the data is derived.

Primary sources are those from which the researcher can gain data by direct, detached observation or measurement of phenomena in the real world undisturbed by any intermediary interpreter. Data from primary sources can be in the inanimate form of instrumental readings, results of measuring, physical artifacts, or in the animate form such as reports of direct observations, interviews or recordings of experiences by those involved (Walliman, 2001; Bauer, *et. al.*, 2000; Sharp, 1996).

Where data have been subjected to interpretation they are referred to as coming from secondary sources. The most common form of secondary source is books, newspaper reports, articles and other publications. Secondary sources cannot be described as original and do not have a direct physical relationship to the event being studied, either because of the presence of intermediaries or because of the period of time between the recording and the event (Leedy, 2005; Walliman, 2001).

The data collection methods utilised in this research are the literature review, the questionnaire and the interview.

3.6.1 The Literature Review

Holt (1998) defines the literature review as the collection and incorporation of as much information as can be discovered with respect to a given topic that allows the researcher to understand and develop a theoretical background to the research. In this way the literature review helps generate ideas and identify key variables impacting the research.

The literature review was used during this research to:

- Establishing a clear understanding of the nature of risk and risk management in the construction industry, construction contracts (JBCC (PBA) in particular), investigate how building contractors identify, quantify and classify risks in terms of the JBCC (PBA), understanding the IDEF-0 and Plan-Do-Study-Act cycle.
- Analyse construction contracts the JBCC (PBA) in particular.
- Investigate how building contractors identify, quantify and classify risks in terms of the JBCC (PBA).
- Understanding the IDEF-0 and Plan-Do-Study-Act cycle.

A critical review and analysis of textbooks, academic journals, professional magazines, conference proceedings and internet websites were utilised to meet the objectives.

3.6.2 Questionnaire

A questionnaire is defined as a form containing a set of questions; submitted to people to gain statistical information. One of the main features of a questionnaire is its impersonality. The questions are fixed, that is they do not change according to how the replies develop, and they are the same for each respondent. The responses can be completely anonymous. Another feature is that there is no geographical limitation with regard to the location of the respondents: they can be anywhere in the world as long as they can be reached by email. Questionnaires can be a relatively economic method, in terms cost and time, of soliciting data from a large number of people (McNeil and Chapman, 2005; Sharp, 1996; Babbies, 1992).

The methods of delivering questionnaires according to Walliman (2001) are personally, by post, fax and email. The advantages of personal delivery are that respondents can be helped to overcome difficulties with the questions, and that personal persuasion and reminders by the researcher can ensure a high response rate. The reasons why some people refuse to answer the questionnaire can also be established, and there is a possibility of checking on responses if they seem odd or incomplete. There are however problems in both time and geographical location which limit the scope and extent to which this method of delivery can be used (McNeil and Chapman, 2005; Sharp, 1996).

In this research the questionnaire was used at two stages. At stage one it was used to evaluate the developed IQCF. It was sent to a selected number of contractors to seek their feedback on the framework before applying it the JBCC (PBA) clauses. A copy of the questionnaire-1 (Framework Evaluation) is attached in Appendix (D). Stage two of the questionnaire was used to obtain information for the risk source correlation matrix. A copy of questinnaire-2 (Correlation Matrix of Risk Sources) is attached in Appendix (F). Due to the time constraints the respondents are currently facing in the busy construction sector, the questionnaire was designed to be simple to read and easy to understand and answer. As a data collection method, questionnaires were selected because they generate data in a very systematic and ordered fashion and the responses to the questions can easily be quantified, categorised and subjected to statistical analysis. Due to the poor response rate the researcher telephonically contacted all the respondents in order to ensure that the questionnaires were returned. Both closed and open questions were used in order to obtain a broader understanding of the respondent's answers. The closed questions were coded in so that data analysis will be easier and with fewer mistakes. Open questions were utilised because they allow respondents to express themselves in words, indicates respondent's level of information, indicates what is salient in the respondents mind and they do not suggest answers to respondents.

Closed questions allowed the respondents to answer questions so that answers could be meaningfully compared, produces less variable answers, produces answers that are much easier to computerise and analyse and respondents find closed questions easier to answer (Gillham, 2000; Tashakkori, 1998; Fellows and Liu, 1997; Foddy, 1993)

3.6.3 Interview

Interviews are a social process, an interaction or cooperative venture, in which words are the main medium of exchange. It is not merely a one-way process of information passing from one (the interviewer) to another (the interviewee), but an interaction, an exchange of ideas and meanings, in which various realities and perceptions are explored and developed. To this extent both the respondent(s) and the interviewer are in different ways involved in the production of knowledge (Leedy, 2005; Bauer *et al.*, 2000; Gillham, 2000; Sharp, 1996; Gorden, 1980).

Qualitative interviewing is a widely used method for data collection. Bauer *et al.* (2000) and Gaskell (2000) mentioned that it is a technique or method for discovering that there are other perspectives or viewpoints on events other than those of the interviewer. Interviewing is conceptualised by Glesne and Peshkin (1992) as the process of getting words to fly.

The structured or formal interview was utilised in this research. The structured interview involves the researcher working through a series of standardised questions known as an interview schedule or questionnaire. This type of interview is likely to be composed mostly of closed questions. Structured interviews are regarded highly by positivist researchers because, like questionnaires, they are standardised, respondents are exposed to the same questions or stimulus and data is usually quantifiable. Moreover, such interviews are capable of producing the same result when given to similar individuals. In other words, they are verifiable and therefore seen as a highly reliable methodological tool. Furthermore, they provide a large amount of straightforward factual and comparative information relatively cheap (McNeil and Chapman, 2005; White 2002; Gillham, 2000 and Gorden, 1980).

The structured interview was used at two stages. At stage one it was used to apply the IQCF to the Clauses of the JBCC (PBA) and in stage two it was used to obtain information for the risk source correlation matrix. A copy of the interview-1 (Framework Application) is attached in Appendix (E) and interview-2 (Correlation Matrix of Risk Sources) is attached in Appendix (F). The interviewer thereby had full control on the questionnaire throughout the entire process of the interview. This also seemed the appropriate choice because there is generally little room for variation in response except where a few open-ended questions were used. The interview was composed of questions that were open and closed ended. The interviewer found the structured interview with the combination of open and closed questions as the most appropriate method because answers can be explored by finding out 'why' the particular answer was given. The structured interview process not only helped to clarify ambiguous terms but also allowed for face to face interaction so that the questions and background to the problem could be clearly understood leading to data that can be appropriately analysed.

3.7 Sampling Methodology

Balnaves and Caputi (2001) define sampling as a technique for selecting a subset of units for analysis from a population. The aim of sampling was to select a representative and non-biased sample to allow for valid and reliable findings. This was achieved by the purposive sample methodology as only contractors in the Durban area that utilise the JBCC (PBA) were required to respond to the questionnaire and interview.

Purposive sampling is where the sample is selected with a *purpose* in mind. There is usually one or more specific predefined groups the researcher is seeking. The researcher obtained subjects to participate in the study based on identified variables under consideration. It is used when the population for study is highly unique. The uses for purposive sampling include the validation of a test or instrument with a known population, the collection of exploratory data from an unusual population and the use in qualitative studies to study the experience of a specific population. With a purposive sample the number of people interviewed is less important than the criteria used to select them (Trochim, 2006; National Statistics, 2005; Northern Arizona University, 1997).

3.7.1 Selecting the Questionnaire and Interview Sample

Having selected a suitable sampling method, the remaining problem is to determine the sample size. According to Walliman (2001) there is no easy answer to this problem. One false belief is that a sample must be large or it is not representative. This is however untrue because if the population is homogeneous then a small sample will give a fairly representative view of the whole (Cooper and Schindler, 1995; Babbies, 1992).

The sampling frame is the list of elements from which the sample is actually drawn (Cooper and Schindler, 1995). A particular issue in sampling is determination of the size of the sample. The four main properties to be considered according to Fellows and Lui (1997) are consistent, unbiased, efficient and sufficient.

Selecting the sample for this research was seen as very important and great care was taken when choosing the type of sample design. The researcher had to ensure that the characteristics of the sample are the same as its population and act as representative of the population as a whole.

- In order select an appropriate sample the researcher obtained a list of all the contractors that are listed in the Master Builders Association website, which totaled 120. Figure 2.3. shows the Master Builders Association website.

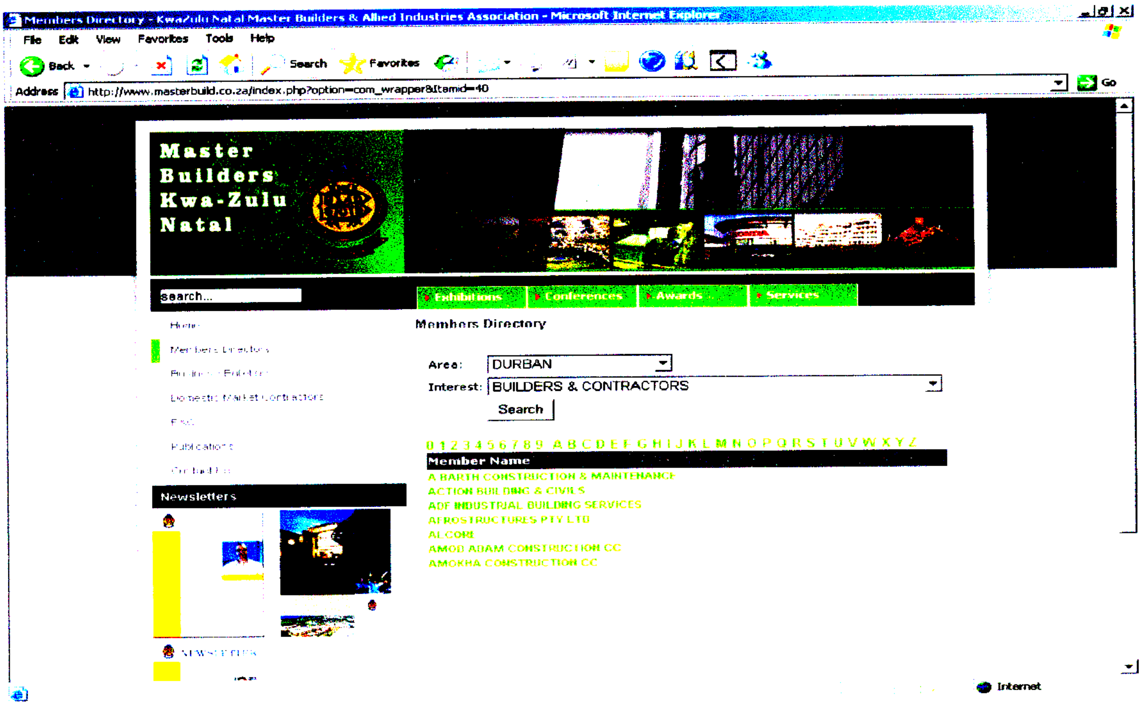


Figure 3.3. Master Builder Association members directory

- In order to limit the sample size to one that was more manageable, the researcher then contacted all the companies with the telephone numbers beginning with the code (031) in the Durban central area as only companies based in central Durban were selected. This resulted in a sample size of sixty-two.

- The researcher then telephonically contacted all the listed contractors in the Durban area to enquire if they utilise the JBCC (PBA) so that the questionnaire could be sent to them. The researcher chose to telephonically contact the contractors as the details of the appropriate person in each company could be obtained to help ensure an increase in the number of respondents. The person identified was then contacted by telephone and the study was briefly explained. The respondents were advised of the confidentiality both during the telephonic conversation and in writing in the formal letter attached to the questionnaire.

- Out of the 62 contractors contacted, 23 respondents mentioned that they do in fact use the JBCC (PBA). The researcher tried to contact all 23 companies but 4 of the companies were totally unreachable/incorporative due to incorrect details been posted on the website or that the company was out of business or that they were too busy to assist. The questionnaire was thus faxed to 15 companies and this proved useful as 'transmission verification reports' were received for every fax. Four other companies requested emails which were also sent out. Thus a total of 19 questionnaires were sent out.

- Out of the nineteen questionnaires that were sent out only 47% (nine) of the respondents to the questionnaire replied.

- It was initially intended to interview all nine respondents, however due to the unavailability, time constraints and work commitments of Commercial Managers only four interviews could be conducted.

- After completion of the first interview and upon further research and investigation, the researcher developed a risk source matrix to identify sources of risk to the contractor and used this as a basis for a second questionnaire and interview. Due to the fact that this was a shorter questionnaire and interview and it was conducted separately, the researcher managed to secure nine respondents.

- The questionnaire and the interviews were structured so that is was carried out in a free and unbiased manner. Confidentiality was assured so that the interviewees were allowed to express their opinion and attitudes toward the research without fear.

Because of the importance of eliminating sampling bias, the researcher eliminated as much bias as possible by looking at three factors and responding to it.

- ***Sampling frame bias*** was avoided by ensuring an up to date list of contractors were obtained within the acceptable sampling frame.
- ***Researcher bias*** was avoided by utilising both open and closed questions so that the questions were not too narrow, thus giving the respondents in the interview an opportunity to express themselves fully. The researcher also used the structured interview so that the same questions could be asked in the same order and thereby reducing bias.
- ***Non-response bias*** could not be completely avoided, but the researcher tried to reduce it by telephonically contacting all the respondents and explaining the research.

3.8 Data Analysis

Data analysis is concerned with analysing data from the questionnaire and interview. Once data has been collected, one has to be ready to analyse the results to determine the direction of the study. Researchers gather a lot of information. Therefore, it is expected that one gives a summary of the data which highlights main trends and differences in the most appropriate manner.

3.8.1 Quantitative Data Analysis

Quantitative data is numerical data that can easily be quantified (i.e. measured). Before analysing quantitative data, the type of data needs to be considered, the format of inputting, the data coding requirements, weighting requirements and error checking methods.

A two stage approach was utilised for quantitative data analysis in this research. The first stage involved the measure of the central tendency of the questionnaire and the interview responses. The measure of central tendency was used to get an overview of the typical value for each variable by calculating the mean, median and mode. The second stage involved the use of the Relative Importance Index (RII) as all the clauses in the JBCC (PBA) do not have the same risk to the contractor.

3.8.2 Qualitative Data Analysis

Qualitative data is based on meanings expressed through words and is usually non-standardised and requires categorisation. Qualitative data deals with subjective opinions and viewpoints that are presented in descriptive formats.

According to Miles and Huberman (1994) there are three concurrent flows of activity: data reduction, data display and conclusion drawing/verification, are used to define qualitative analysis, the method adopted in this research.

- **Data Reduction:** is the process of selecting, focusing, simplifying, and transforming the data that appear in notes or transcriptions.
- **Data Display:** is an organised, assembly of information that permits conclusion drawing and action. It permits the researcher to see an edited set of data as a basis for thinking about its meaning.
- **Conclusion drawing and verification:** the qualitative analyst decides right from the start of data collection what meanings can be drawn from the data. The analyst seeks for

irregularities, patterns, explanations, possible configurations, etc. The competent researcher maintains openness and skepticism, and views the conclusion vaguely at first and then increasing in explicitness and groundedness. Verification means that the meanings emerging from the data have to be tested for their plausibility, their sturdiness, conformability and validity.

3.9 Reliability and Validity

The central aim of any data gathering methodology is to improve both the reliability and validity of the information obtained (Bauer, *et. al*., 2000; Gaskell, 2000; Tashakkori, 1998; Gorden, 1980).

3.9.1 Reliability

Reliability refers to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions. For reliability to be calculated it is incumbent on the scientific investigators to document their procedure and to demonstrate that categories have been used consistently as a measure is only reliable to the degree that it supplies consistent results (Silverman, 2005; Hall and Hall, 1996; Babbies, 1992).

If a method of collecting evidence is reliable, it means that anybody else, using this method, or the same person using it at another time, would come up with the same results. The research could be repeated, and the same results would be obtained (Tashakkori, 1998; Cooper and Schindler, 1995; Kidder, 1981).

Reliability can be assessed by posing the following three questions:

- Will the measures yield the same results on other occasions?
- Is there transparency in how sense was made from the raw data?
- Will similar observations be reached by other observers? (Saunders *et al,* 2003).

There may be four threats to reliability.

- The first of these is subject or participant error.
- There may be subject or participant bias. Interviewees may have been saying what they thought their bosses wanted them to say.

- Third, there may have been observer error. Introducing a high degree of structure to the interview schedule will lessen this threat to reliability.
- Finally, there may have been observer bias (Saunders *et al.*, 2003),

3.9.2 Validity

Hammersley (1992) defined validity as another word for truth. It refers to the correctness or credibility of a description, conclusion, explanation, interpretation or other sort of account. Hall and Hall (1996) mentioned that validity means the extent to which a test, questionnaire or other method is really measuring what it is intended to measure. Validity also refers to the problem of whether the data collected is a true picture of what is being studied. The problem arises particularly when the data collected seems to be a product of the research method used rather than of what is being studied (Silverman, 2005; Tashakkori, 1998).

The threats to validity include history, inappropriate testing, instrumentation, mortality and maturation (Saunders, 2003).

3.9.3 Reliability and Validity of this research

Because of their importance, the reliability and validity of the framework will be escalated through (1) increasing the reliability and validity of the research methods and (2) escalating the reliability and validity of the findings of the research.

In order to increase the reliability and validity of the questionnaire and interview:

- Content validity was ensured by guaranteeing that the questionnaire and interview represents the underlying concept of the study topic.
- Contacting the construction industry specialists to assess and evaluate the developed framework.
- Selecting a representative and non-biased sample.
- Designing the questions to be easy to read, understand and answer.
- Reliability was also ensured by coding all closed questions and checking all open questions for themes and patterns before summarising the responses.

In order to increase the reliability and validity of the literature review:

- Depending on more than one data source including text books, journals, construction magazines and conference proceedings as well as the Internet.
- Carrying out detailed and critical review of the literature.

Increasing the reliability and validity of the research findings:

- Was concerned with how a measure appears, which is known as Face Validity. Face validity was ensured by adequacy of samples, representatives of samples, adequacy of data processing, correct data analysis, appropriate interpretation and justifiable conclusions. Validity was also ensured during the questionnaires and interview process by ensuring there are no basis and confidentiality if information.
- The research findings were triangulated with other sources.
- The research findings were reviewed by academics and specialists to seek their comments and feedback.
- Two papers were produced on which the academic community could comment.
- The developed framework was tested by potential users in the industry.

3.10 Research Ethics

According to Churchill (1995 cited in White, 2002) ethics is defined as moral principles and values governing the way an individual or group conducts its activities.

Research can have a very powerful impact on people's lives. The researcher must always think very carefully about the impact of the research and how he/she ought to behave, so that no harm comes to the subject of the research or to society in general. Ethics or moral principles must guide research and requires the following:

- Informed consent - people should know research is being carried out upon them and how the results will be used so that they can make an intelligent choice as to whether they want to take part.
- The information must not be kept from those taking part in the research and researchers must not lie about the purpose of the research.
- The privacy of research subjects should be safeguarded as much as possible.
- Confidentiality means that the information an individual gives to the researcher cannot be traced back to that individual. If people know they cannot be identified, they may be more willing to reveal all sorts of personal and private matters. In other words, confidentiality and anonymity may increase the validity of the data collected.
- Research participants should be protected from any sort of physical harm.

- Finally, researchers need to think about legality and immorality, especially those that are involved in covert forms of research (White, 2002; Tashakkori, 1998).

All the above ethical issues were considered during this research. It is important to mention that if people do not trust researchers, the validity of the data collected by the researchers will not reflect what respondents are truly thinking or doing. The researcher both verbally and telephonically assured all questionnaire respondents and interviewees that confidentiality will be maintained through this research and their privacy and any confidential information will be regarded with the strictest confidence.

3.11 Conclusion

This chapter introduced the research methodology designed to achieve the research aims and objectives. Research definitions were provided and various approaches to research have been examined - notably qualitative and quantitative together with their combination through 'triangulation'. Research styles were also considered. The Plan, Do, Study and Act (PDSA) cycle was considered the most appropriate method to design this research.

The data collection methods were explained. They were the literature review, the questionnaire and the interview. The purposive sampling methodology was utilised. Nineteen questionnaires were sent out, four interviews were conducted in the first interview and 9 interviews were conducted in the second interview. Open and closed questions were used and care was taken to ensure that the results were valid and reliable. The ethical issues, such as informed consent of the respondent, invasion of privacy and confidentiality were also carefully taken into account.

Finally, the data analysis process for this study was discussed. Quantitative and qualitative processes will be used to analyse the data. Where possible, answers will be coded and similar themes grouped together. The findings will be discussed in chapter 5 and compared to the literature review in order to gain a deeper understanding of the results. Similar themes and ideas will be recognised and reported on. Thereafter, conclusion will be drawn and recommendations made. Chapter 3 explains risk in the construction industry and the JBCC (PBA) contract.

CHAPTER 4

THE IDENTIFICATION, QUANTIFICATION AND CLASSIFICATION FRAMEWORK (IQCF)

Chapter 4

The Identification, Quantification and Classification Framework (IQCF)

4.1 Introduction

This chapter presents the identification, quantification and classification framework (IQCF) to enable contractors to identify, quantify and classify risks in the JBCC (PBA). The importance, aims and objectives and the conceptual description of the IQCF is provided. The description of models and the modelling process as well as various modelling tools are explained in order to describe the functional representation of the IQCF. The application and benefits of the framework are also discussed. This chapter concludes by describing the limitations of the IQC framework.

4.2 The Identification, Quantification and Classification Framework (IQCF)

A framework is defined as the basic and logical structure for classifying and organising complex information (FEAF, 1999). It is a system of rules, ideas or principles that is used to plan and make a decision (Abdou, 2006). The Identification, Quantification and Classification Framework (IQCF) (hereinafter referred as "the framework" or the IQCF is the set of functions, activities, procedures as well as the tools and techniques required to assist construction contractors better understand the risks associated with the clauses of the JBCC (PBA). It is a decision making tool designed to enable contractors to identify, quantify and classify the risks of the JBCC (PBA) clauses. The IQCF will help the contractors draw the appropriate risk management plan to mitigate the adverse effects of these risks (Harinarain and Othman, 2007a).

4.3 The Importance of the Identification, Quantification and Classification Framework (IQCF)

The construction industry is one of the biggest and most booming industries in South Africa. Been one of the biggest industries, the construction industry involves hundreds of consultants, contractors and suppliers. There are hundreds of contracts either for new work, alterations or maintenance signed each and every day, especially since the rise in construction work for the 2010 Wold Cup. Some projects are simple and cost a few thousands of Rands while others are unique and costs hundreds of millions.

Due to the fact the every phase of the construction project faces an amount of risk, it is important that the contractor investigates the risks associated with contract clauses in order to adopt the appropriate risk management plan.

Because of the poor reputation of the application of risk management in South Africa this research developed the Identification, Quantification and Classification framework as an innovative decision making tool that aims to enhance the image of the South African construction industry and enables the contractors to identify, quantify and classify the risks associated with the JBCC (PBA) contract.

In addition, the developed framework will help the contractors meet the deadlines and achieve the client objectives and satisfaction.

Furthermore, implementing the IQCF will enable the contractors to make decisions on an informed basis and thus allowing them to develop an appropriate risk management plan to mitigate the effects of these risks.

4.4 Aims and Objectives of the Identification, Quantification and Classification Framework

Because of the uncertainty of the future, most business decisions are based on expectations and forecasts. Inevitably, making decisions on this basis involves risks. If not managed, these risks will affect the project success and lead to disputes and adversarial relationships. Therefore, contractors have to be aware of their obligations and the risks associated with their contracts (Smith, 1998). The aim of this framework is to enable contractors to identify, quantify and classify the risks associated with the Joint Building Contractors Committee Principal Building Agreement Series 2000 (JBCC PBA).

The above aims can be achieved by accomplishing the following objectives:

1) Identifying the risks associated with the JBCC (PBA) contract clauses from the contractor's perspective.
2) Quantifying the identified risks to draw a complete picture of the most serious risks.
3) Classifying the identified and quantified risks to collect them in groups in order to allow contractors to distinguish those risks that originate from within the contractor's organisation and those that are external to the contractor's organisation.

4.5 The Conceptual Description of the Identification, Quantification and Classification Framework

The IQCF was developed in a systematic process consisting of three steps: identification, quantification and classification of the risks associated with JBCC (PBA).

4.5.1 Identification of the JBCC (PBA) Risks

Since the framework adopts the contractor's perspective, the first step of risk identification was to identify all potential risks that could possibly affect the contractor. This entailed carrying out in depth literature review based on textbooks, academic journals, professional magazines, conference proceedings, seminars, dissertations and theses, organisation and government publications as well as Internet and related web sites.

According to Harinarain and Othman (2007a) the literature review resulted in identifying (270) risks. The second step of risk identification was the revision and refinement of risks identified. The work was reviewed and refined on a regular basis in order to omit repeated risks and merge similar ones. The end result was (136) risks, refer to Appendix (A). These risks were then compared with the clauses of the JBCC (PBA) in order to ensure that the most important risks were covered in the JBCC (PBA). The final step of risk identification was the establishment of the criteria that will be used to state the risks associated with JBCC (PBA) clauses. In order to establish these criteria, it is essential to initiate a link between the identified risks and the factors that lead to organisation success or failure. Corporate analysis shows that every organisation has internal and external environments. Each one of them has its effect on the success or failure of the organisation. Internal environment consists of Strength factors and Weakness factors, where external environment consists of Opportunities factors and Threat factors. The Strengths, Weakness, Opportunities and Threats are adopted to design the criteria for identifying the risks associated with the clauses of the JBCC (PBA).

4.5.1.1 SWOT Analysis for designing criteria for risk identification

SWOT Analysis, is a strategic planning tool used to evaluate the ***S***trengths, ***W***eaknesses, ***O***pportunities, and ***T***hreats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective. The technique is credited to Albert Humphrey, who led a research project at Stanford University in the 1960s and 1970s using data from Fortune 500 companies (Wikipedia, 2007a)

The SWOT analysis is an extremely useful tool for understanding and decision-making for all sorts of situations in business and organisations. SWOT analysis provides a good framework for reviewing strategy, position and direction of a company. A SWOT analysis is a subjective assessment of data which is organised by the SWOT format into a logical order that helps understanding, presentation, discussion and decision-making (Chapman, 1995).

It is a means of combining the organisation to its working environment. SWOT is the first stage of planning and focusing on key issues. Contractors who regularly run a SWOT analysis of their companies ensure that they stay on track to succeed.

Businesses of all sizes and types run SWOT analyses, which examine the internal working environment of a company and the external market in which that company operates. Strengths and weaknesses are internal factors, while opportunities and threats are external factors (Shutt, 2007).

Within this research, the criteria established to identify the risks associated with the JBCC (PBA) from the contractor's perspective are:

- Reducing Organisations Strengths
- Increasing Organisations Weakness
- Reducing Organisations Opportunities
- Increasing Organisation Threats (Refer to Figure 4.1.) (Harinarain and Othman, 2007a).

By understanding these four aspects of its situation, a firm can better escalate its strengths, overcome its weaknesses, exploit business opportunities, and deter potentially devastating threats (Internet Center for Management and Business Administration, Inc. 2002).

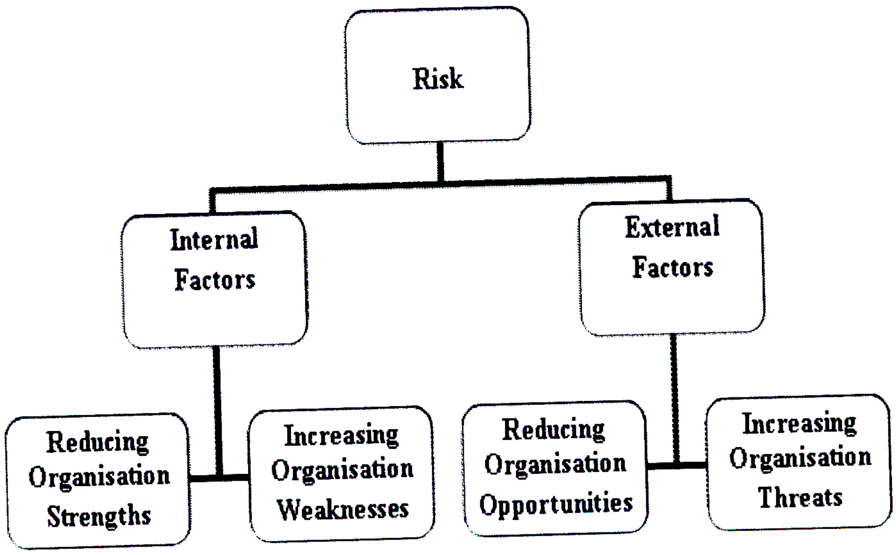


Figure 4.1. The criteria for identifying the risks associated with JBCC (PBA) (Harinarain and Othman, 2007a).

4.5.2 Quantification of the JBCC (PBA) Risks

After the identification criteria are established, the next step of the framework development is to quantify the risk associated with the JBCC (PBA) clauses from the contractor's perspective to identify the most influential ones. Risks will be quantified based on the probability of occurrence (P) and its severity (S), where the result is (R= P * S). This quantification was carried out through an interview with a selected number of managers of construction companies. The Likert scale of 1 to 5 was used to quantify the probability and severity of these risks. The numerical scores from the interview will provide an indication of the varying degree of influence that each risk has on the contractor. To further investigate the data, a relative importance index (RII) was used to rank the risks according to their influences (Olomolaiye et. al 1987).

4.5.2.1 The Likert Scale

Scaling is a procedure for the assignment of numbers to a property of objects in order to impart some of the characteristics of numbers to the properties in question. (Cooper and Schindler, 1995) In scale construction, response patterns across several items are scored. By this definition, the measurement method developed by Rensis Likert in 1932, called Likert scale, representing a systematic and refined means for constructing indexes from questionnaire data.
The respondent is presented with a statement in the questionnaire and is asked to indicate his response on a response scales consisting of 5 options (Tashakkori *et. al.*, 1998; Babbies, 1992).

The Likert format also lends itself to a rather straightforward method of index construction. Because identical response categories are used for several items intended to measure a given variable, each such item can be scored in a uniform manner. It should be noted that the uniform scoring of Likert-item response categories assumes that each item has about the same intensity as the rest (Mcneil & Chapman, 2005; Saunders *et. al.*, 2003; Naoum, 1998; Babbies, 1992).

A Likert Scale is often used in survey design to get around the problem of obtaining meaningful quantitative answers to restricted closed questions. The Likert technique presents a set of attitude statements. Respondents are asked to express their opinion on a five-point scale. Each degree of agreement is given a numerical value from one to five. Thus a total numerical value can be calculated from all the responses. Using a Likert Scale with closed ended questions generates statistical measurements of people's attitudes and opinions (Wikipedia, 2007b; Bernard, 2000). The Likert scale was chosen for this research as it is simple to construct and understand according to Baker (1997) and by allowing the use of latent attitudes; it produces a highly reliable scale.

4.5.2.2 The Relative Importance Index (RII)

To further investigate the data, a relative importance index (RII) was used to rank the risks according to their influences (Olomolaiye, et al, 1987; Shash, 1993). The calculation was carried out using the following formula:

$$\text{Relative Importance Index (RII)} = \frac{\sum w}{AN}$$

Where

w = weighting given to each clause by the respondents and range from 1 to 5, where 1 = very low probability or severity and 5 = very high influence.

A = highest weight (five in this case) and

N = total number of the sample (Kometa and Olomolaiye, 1997).

The RII ranges from zero to one. The full list of RIIs and ranking of clauses is provided in table 5.3, which shows that some clauses have very high influences of risk to the contractor while others do not. Due to the fact that some clauses have similar RIIs, for example clauses 25 and 27, a sequential ranking had to be presented as numbers in brackets in the "rank" column.

4.5.3 Classification of the JBCC (PBA) Risks

The last step of the framework development is the classification of the risks identified and quantified. Classifying risks enables the contractor to consider them within a more coherent framework. It provides the construction professionals generally and the contractor in particular with a more uniform risk language, specifically in fields where risk needs to be communicated to a wide variety of project stakeholders. It allows one to establish a common understanding of different risks, and provides an essential basis for effective knowledge transfer, within an organisation and from one project to another (Edwards and Bowen, 2005).

In order to be in line with the internal and external perspective adopted in developing the criteria for risk identification, this research classifies risks that affect the contractor as: internal risks and external risks.

- **Internal risks** are the ones which emerge from within the contractor's organisation or those risks that are within the control of the team members, and
- **External risks** are the ones which emerge from outside the contractor's organisation, or those risks that are out of the control of the contractor.

Table 4.1. shows the overall format of the IQCF that hosts all the information gleaned in the previous steps.

Table 4.1. The risk identification, quantification and classification framework (Harinarain and Othman, 2007a).

JBCC (PBA) Clause	Risk Identification Criteria				Risk Quantification			Risk Classification	
	Reducing Strength	Increasing Weakness	Reducing Opportunities	Increasing Threats	Probability (P)	Severity (S)	Result - (PxS)	Internal risk	External risk

The developed framework was sent out to the contractors for approval in the form of a questionnaire. Contactors feedback was sought out to improve the framework and ensure its compatibility with the industry requirements. Their feedback was then considered and the criteria revised. The updated criteria were then used in an interview process to apply the framework.

4.6 Models and the Modelling Process

Noran (2005) explains that a model is basically a simplified abstract view of the complex reality. A model according to Dilworth (1992) is an abstract representation of some real world process, system, or subsystem. Models are used in all aspects of life for example when constructing a paragraph to describe something, a model is been produced of the aspects or features that are pertinent and that needs to be conveyed.

A model is defined by Cooper and Schindler (1995) as a representation of a system that is constructed to study some aspect of that system or the system as a whole. Models differ from theories in that a theory's role is explanation whereas a model's role is representation.

Description, explication, and simulation are the three major functions of modelling. Each of these functions is appropriate for applied research or theory building.

- **Descriptive models** seek to describe the behaviour of elements in a system where theory is inadequate or nonexistent.
- **Explicative models** are used to extend the application of well-developed theories or improve our understanding of their key concepts.
- **Simulation models** go beyond the goal of clarifying the structural relations of concepts and attempt to reveal the process relations among them. Monte Carlo simulation models are examples of static simulations that represent a system at one point in time. They simulate probabilistic processes using random numbers. Simulations that represent the evolution of a system over time are called dynamic. Redistribution of market share, brand switching, and prediction of future values are examples that benefit from dynamic modelling (Cooper and Schindler, 1995).

Models belong to three general categories that are useful in analyzing and understanding real-world situations. They are:

- **Schematic Models** is a representation in the form of lines and colours, usually on some flat surface that provides an image of real-world situation for example graphs, maps, and charts.
- **Physical Models** are usually three dimensional representations of other objects. Examples include a globe; scale models and ionic models.
- **Mathematical Models**. Mathematical models use arrangements of symbols to depict the process system being modelled, for example equations or mathematical expressions (Dilworth, 1992).

The purpose of a model is to provide an argumentative framework for applying logic and mathematics that can be independently evaluated (for example by testing) and that can be applied for reasoning in a range of situations (Wikipedia, 2007c).

Models are developed when the need for a decision is recognised and when one seeks to understand how the real world works. Models can be used to describe what a system is (descriptive model), what it does (functional model), or what it works on (data model) (Chung, 1989). Other types of models which describe a particular view of a system are summarised below:

Data Model

It is an abstract model that describes how data is represented and used. Data modelling is the act of exploring data-oriented structures. Data models can be used for a variety of purposes, from high-level conceptual models to physical data models (Scott, 2003). A data model has three main components:

- The *structural* part: a collection of data structures used to create databases.
- The *integrity* part: a collection of rules governing the constraints placed on these data structures to ensure structural integrity.
- The *manipulation* part: a collection of operators which can be applied to the data structures, to update and query the data contained in the database (Wikipedia, 2007d).

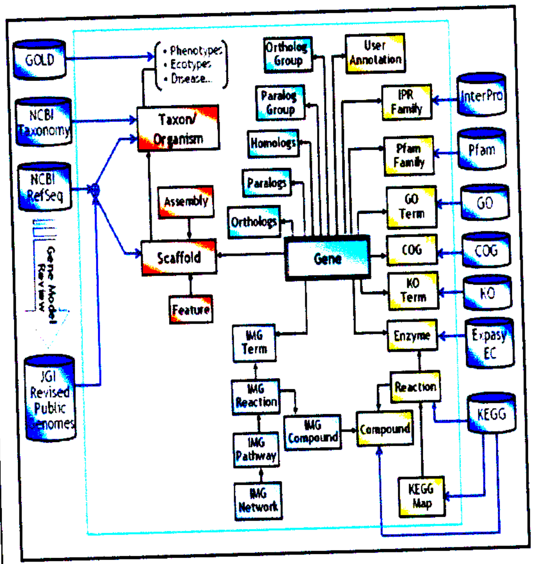


Figure 4.2. Data Model (The Regents of the university of California, 2007).

Information model

It is an abstract but formal representation of entities including their properties, relationships and the operations that can be performed on them. The entities being modeled may be real-world, such as devices on a network, or they may be abstract, such as the entities used in a billing system. Typically, though, they are used to model a constrained domain that can be completely described by a closed set of entities, properties, relationships and operations. The main driving force behind the definition of an information model is to provide formalism to the description of a problem domain without constraining how that description is mapped to an actual implementation in software (Wikipedia, 2007e).

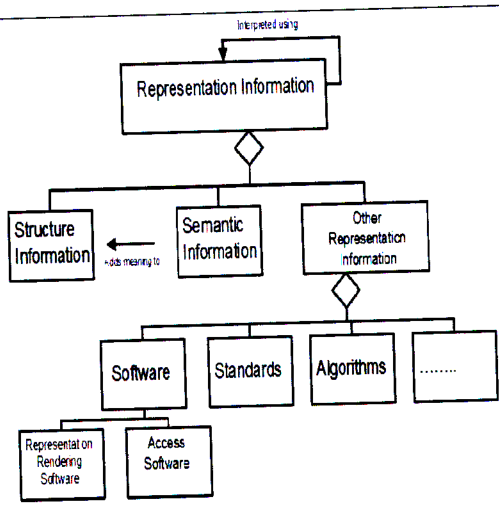


Figure 4.3. Information Model (Giaretta, 2005).

Conceptual model

The conceptual model is concerned with the real world view and understanding of data. A conceptual model may include a few significant attributes to augment the definition and visualisation of entities (Applied Information Science, 1997). People receive information, process this information, and respond accordingly many times each day. This sort of processing of information is essentially a conceptual model (or mental model) of how things in our surrounding environment work (MacKay, 2007).

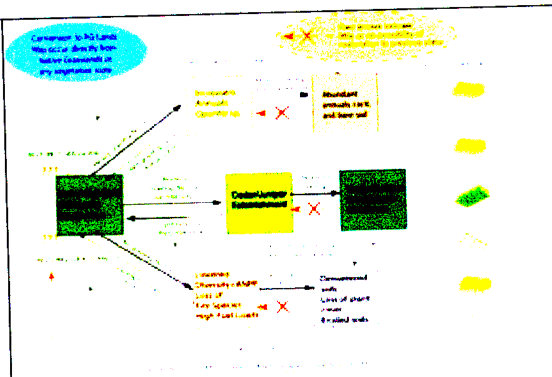


Figure 4.4. Conceptual Model (National Park Service-U.S. Department of the Interior, 2006).

Object-Orientated models

Are models in which the informational content of the model is localised around objects and/or systems of objects, In other words object-oriented models allow us to focus on individual objects and interactions and/or interrelationships among objects (The Object Agency, 2004)

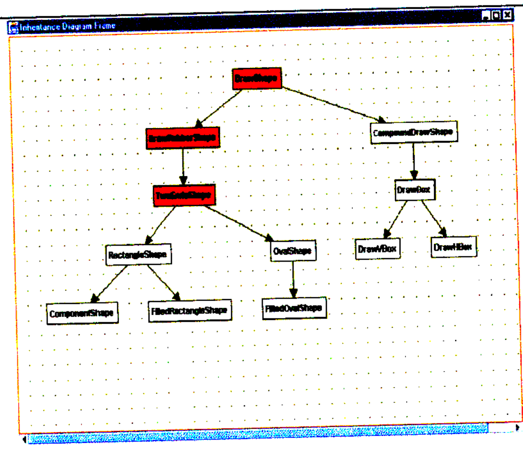


Figure 4.5. Object-Orientated model (Asija, 2007).

Physical Model

Is used in various contexts to mean a physical representation of a single item or object or a large system. The geometry of the model and the object it represents are often similar in the sense that one is a rescaling of the other; in such cases the scale is an important characteristic. Physical models in science and technology allow us to simulate or visualise something about the thing it represents. A model in this sense is a physical object such as an architectural model of a projected building or an existing one. Possible technical uses of an architectural model are to facilitate visualisation of internal relationships within the structure or external relationships of the structure to the environment (Wikipedia, 2007f).

Figure 4.6. Physical Model (Drainage Services Department, 2007).

Product model

The representation of data elements that define a product completely for all applications over its life cycle, and facilitates the transfer of data. Advanced modeling techniques are necessary to cope with configurable products where changing a small part of a product can have multiple impacts on other product structure models (Wikipedia, 2007g).

Figure 4.7. Product Model (Slant-Fin Corporation, 2007).

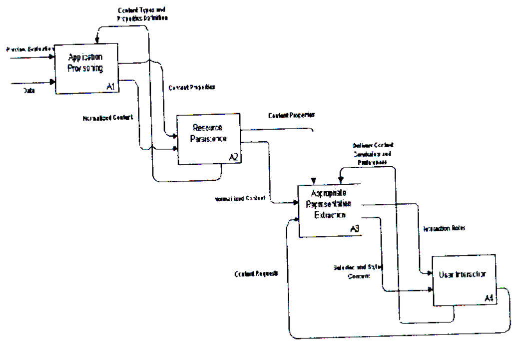
<table>
<tr><th colspan="2">Process model</th></tr>
<tr><td>A process model involves a series of events, or a set of consecutive steps or activities with an end product or service being delivered (Wikipedia, 2007h).</td><td>

Figure 4.8. Process Model (Boyera, 2002).</td></tr>
</table>

Models are developed when the need for a decision is recognised and when one seeks to understand how the real world works. Three interrelated steps form the modelling process: abstraction and model construction, validation and application. A model needs to be planned and developed and once developed, it is then tested to see if it is adequate for the intended use. It may be improved by the abstraction of additional features of the real world until the model is considered valid. Validation of a model means gaining confidence that the information it provides about the real world is accurate for its intended purposes. The model is applied once it appears to be a valid representation of the real world (Dilworth, 1992).

Based on the aim, objectives and characteristics of the IQCF the process model was the appropriate model for representing the functions and activities that are being designed to assist contractors identify, quantify and classify risks associated with the JBCC (PBA) clauses. Figure 4.2. shows the consecutive steps undertaken in choosing a model and the appropriate modelling tool.

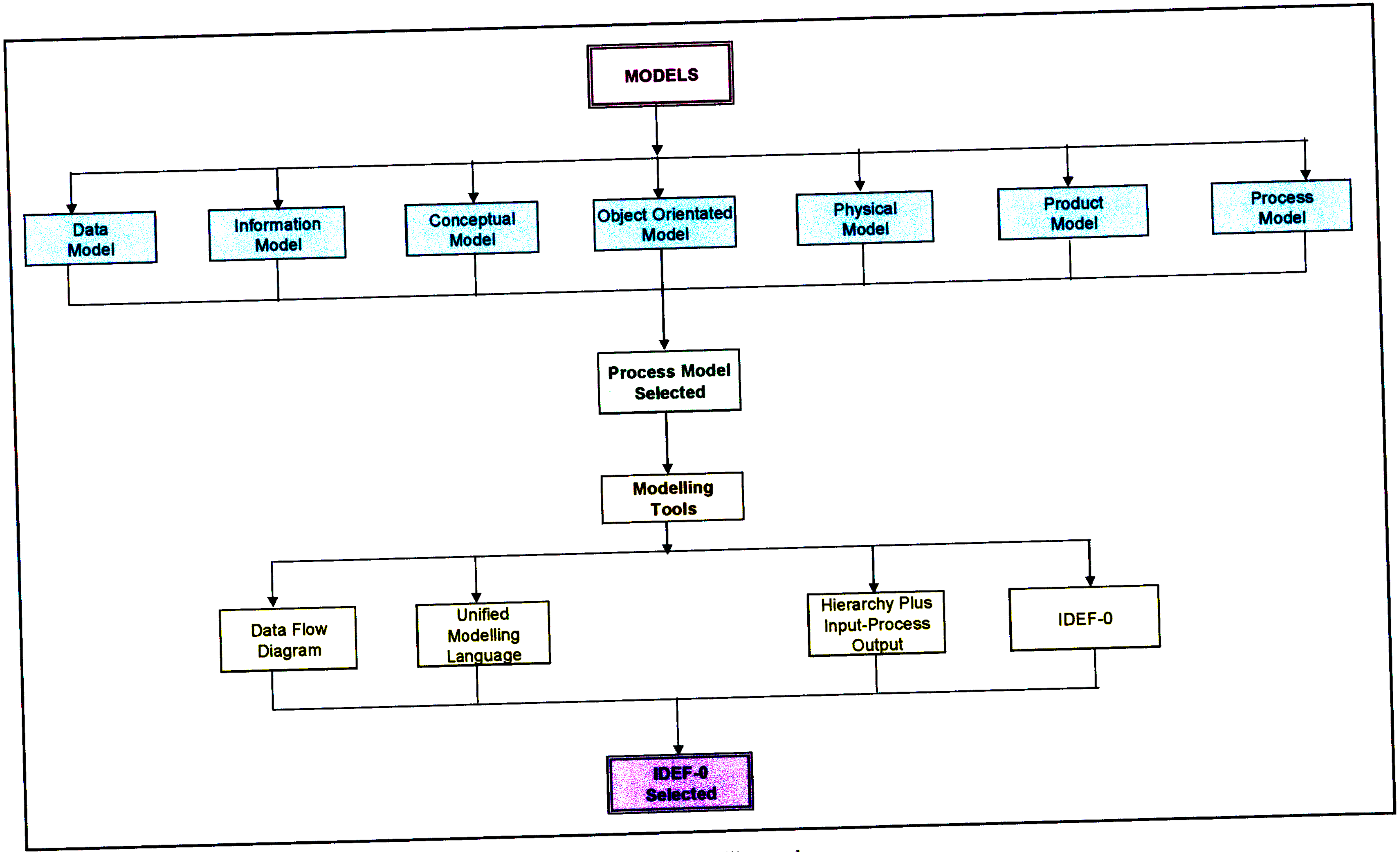


Figure 4.9. Diagrammatic representation of the selection of the model and modelling tools.

4.6.1 Modelling the Identification, Quantification and Classification Framework (IQCF)

According to Marca, and McGowan (1988) the word "modelling" is the act of developing an accurate description of a system. As technology grows, accurate system description becomes more vital. Modelling helps to regulate the unplanned day to day administrative procedures and it is therefore a powerful framework for solving problems. A well defined model will aid in contractual resolutions and in improving work routines, operations, reducing employees' frustration and increasing their confidence in management (Dilworth, 1992).

The IQCF is designed to be performed in a series of interrelated steps in order to enable building constructors to adopt the appropriate risk management strategy when utilising the JBCC (PBA). If the procedures to identify, quantify and classify risk cannot be reduced to the activities of a simple model then they could lead to complications. In general, modelling the IQCF will facilitate effective management and risk identification, quantification and classification, diminish confusion, enhance building contractors' reputation, maintain focus on project completion and achieve better decisions. Modelling requires determining the sequence of event and their relationship to each other so that this information can be presented in a network (Othman, 2005). Based on the properties of the IQCF, the process model was decided to be the appropriate model to represent the activities of the IQCF because it is concerned with representing consecutive steps or activities with the delivery of an end product or service.

4.6.2 Reviewing the Modelling Tools

An assortment of modelling tools needs to be evaluated in order to find a suitable tool to represent the Identification, Quantification and Classification framework as a distinctive tool for risk in the JBCC (PBA). It is important to review modelling tools because it helps find the most appropriate tool that can deal with function and activity modelling, that is comprehensive and generic, concise and flexible. (National Institute of Standards and Technology, 1993)

Chung (1989) list the following set of criteria for the selection of a modelling methodology:

- The ability to adequately represent the intended functions and interrelationship,
- Ease of use and understanding,
- Availability of methodology (including associated software tools),
- Applicability (with respect of how it has been used in the past),
- Robustness and Standardisation.

The criteria for representing the Identification, Quantification and Classification Framework include:

1. Analysis of each clause of the JBCC (PBA) in terms of risk identification, quantification and classification
2. Ease of use and understanding particularly for the contractors.
3. Applicability and relevance for the contractors.

The following section will investigate the existing process modelling methodologies.

4.6.2.1 Unified Modeling Language (UML)

In the field of software engineering, the Unified Modeling Language is a standardised specification language for object modeling. UML is a general-purpose modeling language that includes a graphical notation used to create an abstract model of a system, referred to as a UML model. By establishing an industry consensus on a graphic notation to represent common concepts like classes, components, generalisation, aggregation, and behaviours, UML has allowed software developers to concentrate more on design and architecture (Wikipedia, 2007i). UML is a modelling language. As such, it contains a set of symbols (the notation) and a group of rules (semantics) that manage the language. UML is still in its infancy; and is not widely used in the construction industry (Noran, 2005).

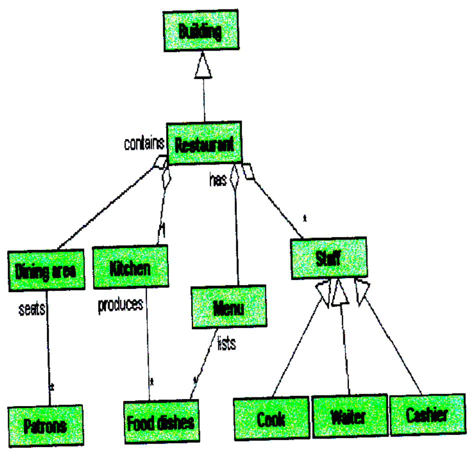


Figure 4.10. UML Diagram (Science Fair Project Encyclopaedia, 2007).

4.6.2.2 Data Flow Diagrams (DFD)

Data flow diagrams present the logical flow of information through a system in graphical or pictorial form. Data flow diagrams were invented by Larry Constantine, the original developer of structured design in the 1970's. DFD's are one of the three essential perspectives of Structured Systems Analysis and Design Method (SSADM). With a dataflow diagram, users are able to visualise how the system will operate, what the system will accomplish, and how the system will be implemented (Wikipedia, 2005d; Scott, 2003). The model generally starts with a context diagram showing the system as a single process flowchart connected to external entities outside of the system boundary. The system is decomposed into a set of processes, data stores, and the data flows between these processes and data stores. Each process is then decomposed into an even lower level diagram containing its sub-processes until the required level has been reached (Hendon, 1997). Data Flow Diagrams was not used in this research because it is not versatile enough for the modelling of the IDEF as it is mainly used to show the movement of data within a system.

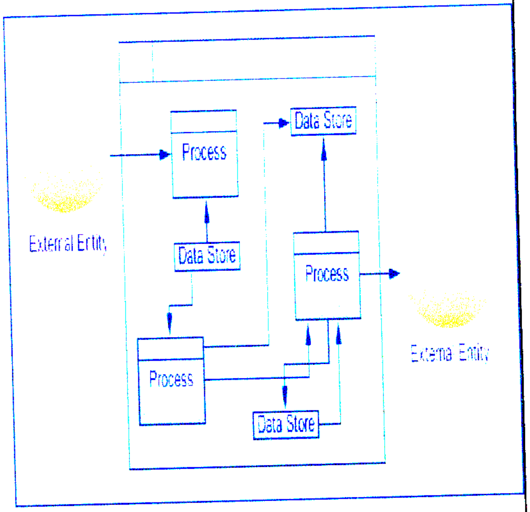


Figure 4.11. Data Flow Diagram (Hendon, 1997).

4.6.2.3 Hierarchy plus Input-Process-Output (HIPO)

It is a flow-charting technique that provides a graphical method for designing and documenting programs. Diagrams are used to describe inputs, outputs, and functions of a system. Major functions are shown in an overview diagram and detailed diagrams describe specific functions. HIPO has been used in software development for documenting system structure and the design and analysis of systems. This methodology considered to be limited in its ability to show detailed information about a system (Chung, 1989).

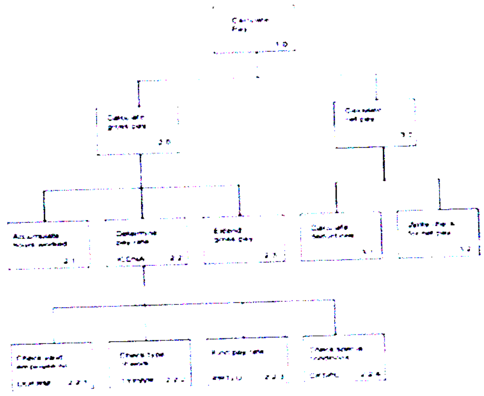


Figure 4.12. HIPO Diagram (Standish, 2005).

4.6.2.4 Integrated DEFinition (IDEF-0)

The IDEF-0 method is a requirements specification tool based on the concept of system modelling. It uses natural and graphic languages to convey meaning about a system. This methodology defines functions and their interfaces and facilitates hierarchy decomposition of detail in a system. It is used for developing system description. In addition, it is used widely in construction and is becoming a standard for process modelling of the building process (Chung, 1989).

The result of applying IDEF-0 to a system is a model that consists of a hierarchical series of diagrams, text, and glossary cross-referenced to each other. The two primary modelling components are functions (represented on a diagram by boxes) and the data and objects that inter-relate those functions (represented by arrows) (National Institute of Standards and Technology, 1993).

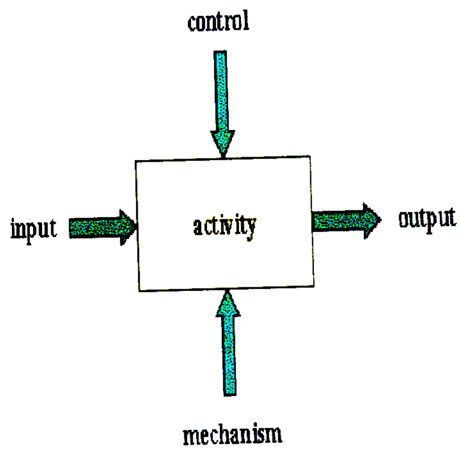


Figure 4.13. IDEF-0 Diagram (Renssen 2, 2001).

IDEF-0 was chosen as the most appropriate methodology to represent the IQCF because:

- It uses function and activity modelling which is ideal to model the IQCF by describing its functions and activities step by step.
- It is comprehensive (due to the elaborated information required),
- It is generic (for analysis of systems and subject areas of varying purpose, scope and complexity);
- It is rigorous and precise (for production of correct, usable models);
- It is concise (to facilitate identifying, quantifying and classifying risks in the JBCC (PBA));
- It is conceptual (for representation of functional requirements independent of physical or organisational implementations);
- If allows for decomposition of a function into a number of smaller sub-functions.
- It is flexible (to support several phases of the life cycle of a project) (National Institute of Standards and Technology, 1993).

4.7 The Functional Representation of the Identification, Quantification and Classification Framework

Prior to presenting the functional representation of the IQCF, the selected modelling methodology, IDEF-0 notation will be described.

4.7.1 IDEF-0 Notation

4.7.1.1 The IDEF Family of Methods

Sixteen methods, from IDEF-0 to IDEF-14 (and including IDEF-1X), are each designed to capture a particular type of information through modelling processes. IDEF methods are used to create graphical representations of various systems, analyse the model, create a model of a desired version of the system, and to aid in the transition from one to the other (TechTarget, 2001). Table 4.2 lists the different IDEFs and their area of application.

Table 4.2. Suite of IDEF Methods (TechTarget, 2001; Hanrahan, 1999; National Institute of Standards and Technology, 1993)

IDEF METHODS	
IDEF 0	Function Modelling
IDEF 1	Information Modelling
IDEF 1X	Data Modelling
IDEF 2	Simulation Model Design
IDEF 3	Process Description Capture
IDEF 4	Object-Oriented Design
IDEF 5	Ontology Description Capture
IDEF 6	Design Rationale Capture
IDEF 7	Information System Auditing
IDEF 8	User Interface Modelling
IDEF 9	Scenario-Driven IS Design
IDEF 10	Implementation Architecture Modelling
IDEF 11	Information Artefact Modelling
IDEF 12	Organization Modelling
IDEF 13	Three Schema Mapping Design
IDEF 14	Network Design

IDEF-0 is a method designed to model the decisions, actions, and activities of an organisation or system. IDEF-0 was derived from a well-established graphical language, the Structured Analysis and Design Technique (SADT). SADT is a graphical approach to system description, introduced by Douglas T. Ross in the early 1970s. In 1981, the United States Air Force Program for Integrated Computer-Aided Manufacturing (ICAM) standardised and made public a subset of SADT, called IDEF (Integrated DEFinition) (Klingler, 2007; EDrawSoft Inc, 2004)

IDEF-0 is a modelling technique based on combined graphics and text that are presented in an organised and systematic way to gain understanding, support analysis, provide logic for potential changes, specify requirements, or support systems level design and integration activities. An IDEF-0 model is composed of a hierarchical series of diagrams that gradually display increasing levels of detail describing functions and their interfaces within the context of a system. There are three types of diagrams: graphic, text, and glossary. The graphic diagrams define functions and functional relationships via box and arrow syntax and semantics, refer to Figure 4.14. (Kamara *et al.*, 2000).

IDEF-0 was originally used to apply structured methods to better understand how to improve manufacturing productivity. An IDEF-0 activity diagram contains one level of decomposition of a process. Boxes within a diagram show the sub-processes of the parent process named by the diagram. Arrows between the boxes show the flow of products between processes (Klingler, 2007).

IDEF-0 is an engineering technique for performing and managing needs analysis, benefits analysis, requirements definition, functional analysis, systems design, maintenance, and baselines for continuous improvement. IDEF-0 models provide a "blueprint" of functions and their interfaces that must be captured and understood in order to make systems engineering decisions that are logical, affordable and achievable. One of the most important features of IDEF-0 as a modelling concept is that it gradually introduces greater and greater levels of detail through the diagram structure comprising the model. In this way, according to National Institute of Standards and Technology (1993) communication is enhanced by providing the reader with a well-bounded topic with a manageable amount of detail to learn from each diagram.

Effective IDEF-0 models help to organise the analysis of a system and to promote good communication between the analyst and the customer. IDEF-0 is useful in establishing the scope of an analysis, especially for a functional analysis. As a communication tool, IDEF-0 enhances domain expert involvement and consensus decision-making through simplified graphical devices. As an analysis tool, IDEF-0 assists the modeller in identifying what functions are performed, what is needed to perform those functions, what the current system does right, and what the current system does wrong. Thus, IDEF-0 models are often created as one of the first tasks of a system development effort (Knowledge Based Systems Inc, 2006).

The main strength of IDEF-0 is its simplicity, as it uses only one notational construct, called the ICOM (Input-Control-Output-Mechanism) (EDrawSoft Inc, 2004; The Improvement Encyclopdia, 2002).

4.7.1.2 Characteristics of the IDEF-0

- It is comprehensive and expressive, capable of graphically representing a wide variety of business, manufacturing and other types of enterprise operations to any level of detail.
- It is a coherent and simple language, providing for rigorous and precise expression, and promoting consistency of usage and interpretation.

- It enhances communication between systems analysts, developers and users through ease of learning and its emphasis on hierarchical exposition of detail (MicroAfrica, 2007).

4.7.1.3 The benefits of using IDEF-0:

- Understanding - modelling helps discover the nature of the business being modelled;
- Communication - once understanding has been reached, the nature of the processes can be documented and these documents easily communicated.
- Enlightenment - modelling helps uncover anomalies, redundancies deficiencies and inefficiencies in the existing business process.
- Improvement - a model allows you to select deficient areas of the business and its processes and improve them.
- Redesign - a model provides a tangible basis for redesigning the process, performing simulations of the redesigned business process as defined by the strategy. This means that strategies can be tested before implementation takes place.
- An IDEF-0 diagram breaks a process down into sub-processes and product flows.
- IDEF-0 is a well documented robust standard technique.
- Many tools are available to support IDEF modelling.
- IDEF-0 specifies a formal methodology for naming processes, diagrams and for providing feedback on diagrams.
- IDEF-0 focuses on the value of the output of a process to ensure that the design is purposive (Klingler, 2007; Knowledge Based Systems Inc, 2006; Pieterse, 2006).

The above benefits become apparent when modelling the IQCF. IDEF-0 made understanding and communicating the framework easy to understand and present. IDEF-0 allows for re-design so that the optimum option could be used and breaking the process down into sub-processes also allowed greater understanding and process definition. The naming of processes and diagrams reduced confusion.

4.7.1.4 The weaknesses of using IDEF-0

- IDEF-0 models are so concise that they are understandable only if the reader is a domain expert or has participated in the model development.
- Sometimes it is difficult to integrate different IDEF techniques
- The top level diagrams in IDEF-0 can easily get confusing and complex.
- Like all graphical presentations IDEF-0 is limited in the number of nodes allowed per page.

- IDEF-0 requires consistency between different levels of modelling which is sometimes difficult to maintain. (Klingler, 2007; Knowledge Based Systems Inc, 2006; Pieterse, 2006).

Within this research the above weaknesses were overcome in the following manner:

- The entire IDEF-0 model and history was explained and the model was written in plain, simple language so that it could be understandable to any reader not just domain experts.
- Only IDEF-0 was used therefore integration of different techniques was not a problem.
- Top level diagrams were kept simple and properly labelled to minimise confusion.
- The IQCF model was designed to be simple and easy to understand and therefore did not need to be extended to more than one page.
- Due to the above it was easy to maintain consistency between the different levels of modelling.

4.7.1.5 Description of the IDEF-0 model

An IDEF-0 diagram contains boxes and arrows. The boxes on an IDEF-0 diagram are rectangles representing a function or an active part of a system, so boxes are named with verbs or verb phrases. The boxes represent activities of the system being modelled. Arrows connect boxes together and represent interconnections between the boxes (Figure 4.5.). A diagram is named with a title, placed in the bottom centre portion of the diagram with standard identification information, e.g. author, project, date, etc. Also, IDEF-0 requires that no fewer than three and no more than six boxes appear on anyone diagram. These limits keep the complexity of diagrams and models from going beyond the ability of people to read, understand and use them (Kamara *et al.*, 2000; Marca, and McGowan, 1988).

The top-level diagram in the model provides the most general description of the subject and is followed by a series of child diagrams providing more detail about the subject. Arrows describe the things (i.e. data and objects) that constitute the system using nouns or noun phrases. The kinds of arrows used in IDEF-O, and their relationship within a box, are illustrated in Figure 4.14. These include: input, control, output, mechanism (ICOM), mechanism call, tunnelled, internal, and boundary arrows (Kamara *et al.*, 2000)

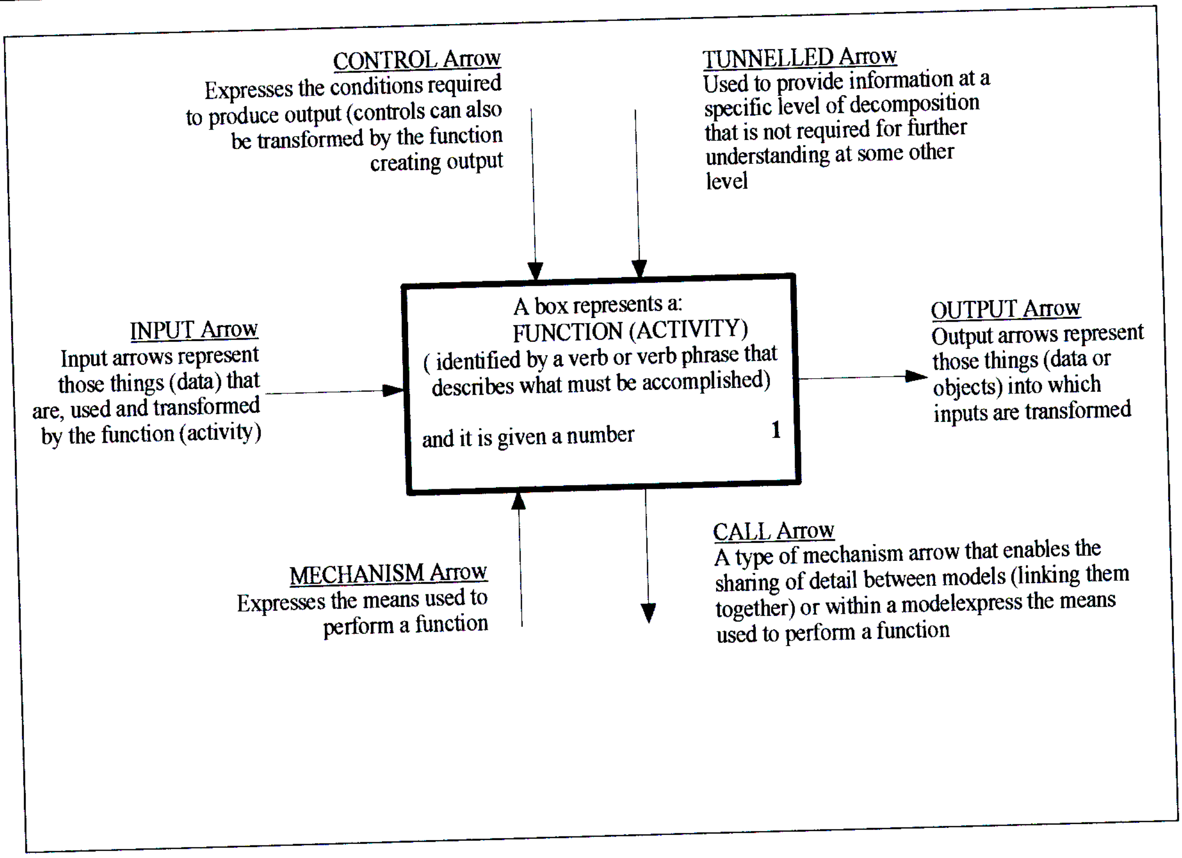


Figure 4.14. Basic concepts of the IDEF-0 method (Kamara *et al.*, 2000).

Each side of an IDEF-0 box has a specific and special meaning. The left side of a box is reserved for inputs, the top side is reserved for controls, the right side is reserved for outputs, and the bottom is reserved for mechanisms. This notation represents certain system principles: inputs are transformed into outputs; controls constrain or dictate under what conditions transformations occur, and mechanisms describe how the function is accomplished. Input arrows represent those things used and transformed by activities. Control arrows represent the things that constrain activities. Output arrows represent those things into which inputs are transformed. Mechanism arrows represent, at least in part, how activities (i.e., the functions of the system) are realised (National Institute of Standards and Technology, 1993; Marca, and McGowan, 1988).

IDEF-0 boxes are never placed randomly on a Diagram Form. Instead, they are placed according to their relative order of importance. Usually, the most dominant box is placed in the upper left-hand corner of the diagram, the least dominant box in the lower right-hand corner. The result is a staircase type of pattern. To reinforce this, an IDEF-0 analyst can number each box according to its dominance over the other boxes. IDEF-0 is a simple language to learn, because it reduces processes into sub-processes, in much the same way one thinks of tasks that have been set. Due to the easily understandable way IDEF-0 diagrams are created and interpreted it has withstood the test of time to be one of the few methods to enable development and analysis to be carried out professionally and effortlessly (National Institute of Standards and Technology, 1993; Marca, and McGowan, 1988).

4.7.2 The Contents of the IQCF

Table (4.3) shows the table of contents for the IQCF

- **IQCF/A-0:** Investigating Risks associated with the JBCC (PBA) from the contractor's perspective (Figure 4.15.) which is the top level diagram.
- **IQCF/A0:** Investigating Risks associated with the JBCC (PBA) from the contractor's perspective (Figure 4.16) which represents the three steps of the framework.
- **IQCF/A1:** Identifying risk associated with the JBCC (PBA) from the contractor's perspective (Figure 4.17) is a decomposition of box 1 in IQCF/A0.
- **IQCF/A2:** Quantifying risk associated with the JBCC (PBA) from the contractor's perspective (Figure 4.18) is a decomposition of box 2 in IQCF/A0.
- **IQCF/A3:** Classifying risk associated with the JBCC (PBA) from the contractor's perspective (Figure 4.19) is a decomposition of box 3 in IQCF/A0.

Table 4.3. Table of contents for the IQCF.

Diagram Reference		**Description**
IQCF/A-0:		Investigating Risks associated with the JBCC (PBA) the from contractor's perspective.
IQCF/A0:		Investigating Risks associated with the JBCC (PBA) the from contractor's perspective.
	IQCF/A1	Identifying risk associated with the JBCC (PBA) from the contractor's perspective.
	IQCF/A2	Quantifying risk associated with the JBCC (PBA) from the contractor's perspective.
	IQCF/A3	Classifying risk associated with the JBCC (PBA) from the contractor's perspective.

The top level diagram (IQCF/A-0) is shown in Figure 4.15. It contains a single activity "Investigating Risks Associated with the JBCC (PBA)" which transforms the input JBCC (PBA) clauses into the output Identified risk, Quantified risk and Classified risk using the questionnaire, interviews and IDEF-0 notation.

Figure 4.16. shows the three steps of the framework, identifying risk in the JBCC (PBA) from the contractors perspective as step 1, quantifying risk in the JBCC (PBA) from the contractors perspective as step 2 and classifying risk in the JBCC (PBA) from the contractors perspective as step 3.

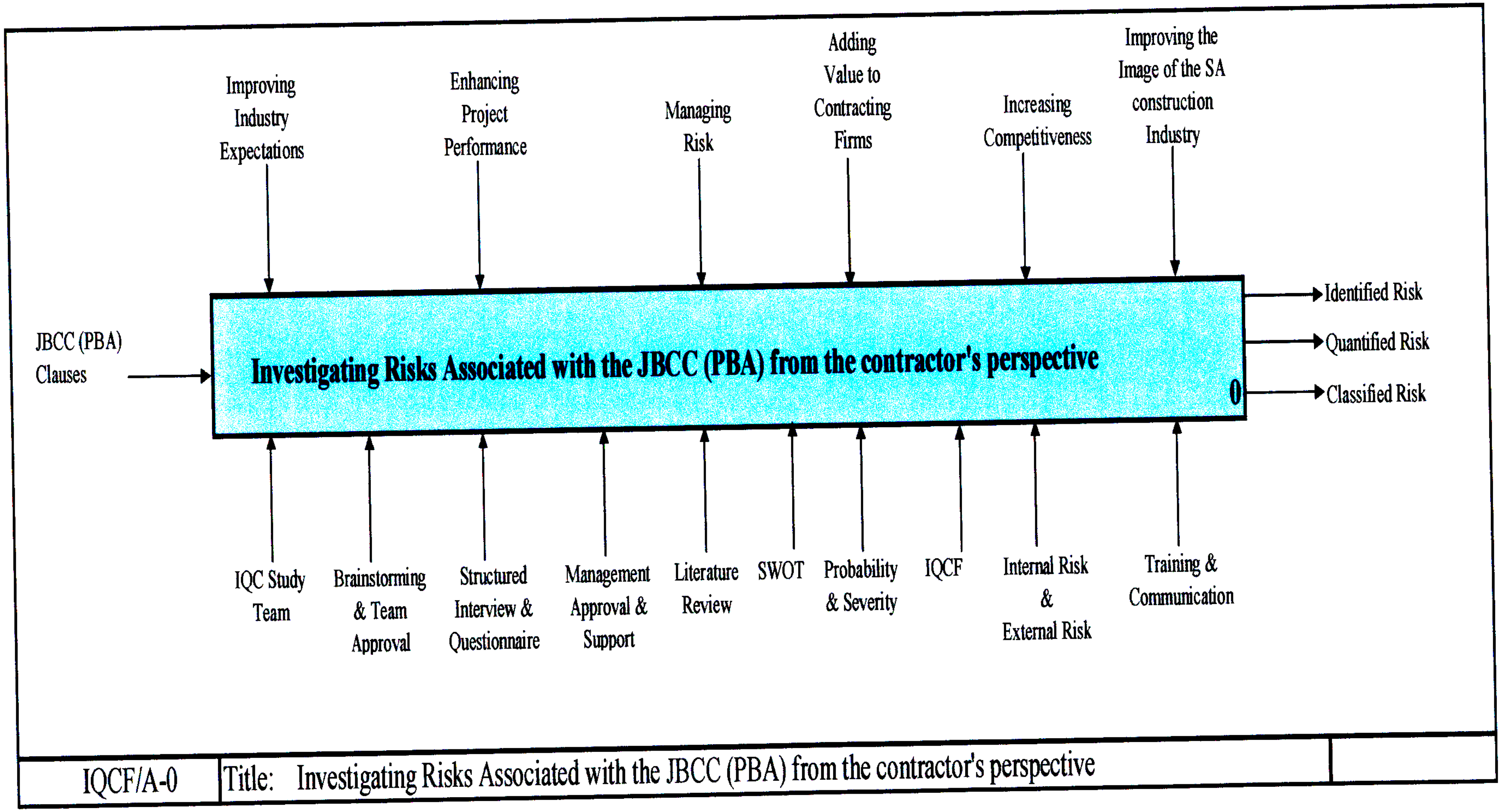


Figure 4.15. Investigating Risks Associated with the JBCC (PBA) from the contractor's perspective.

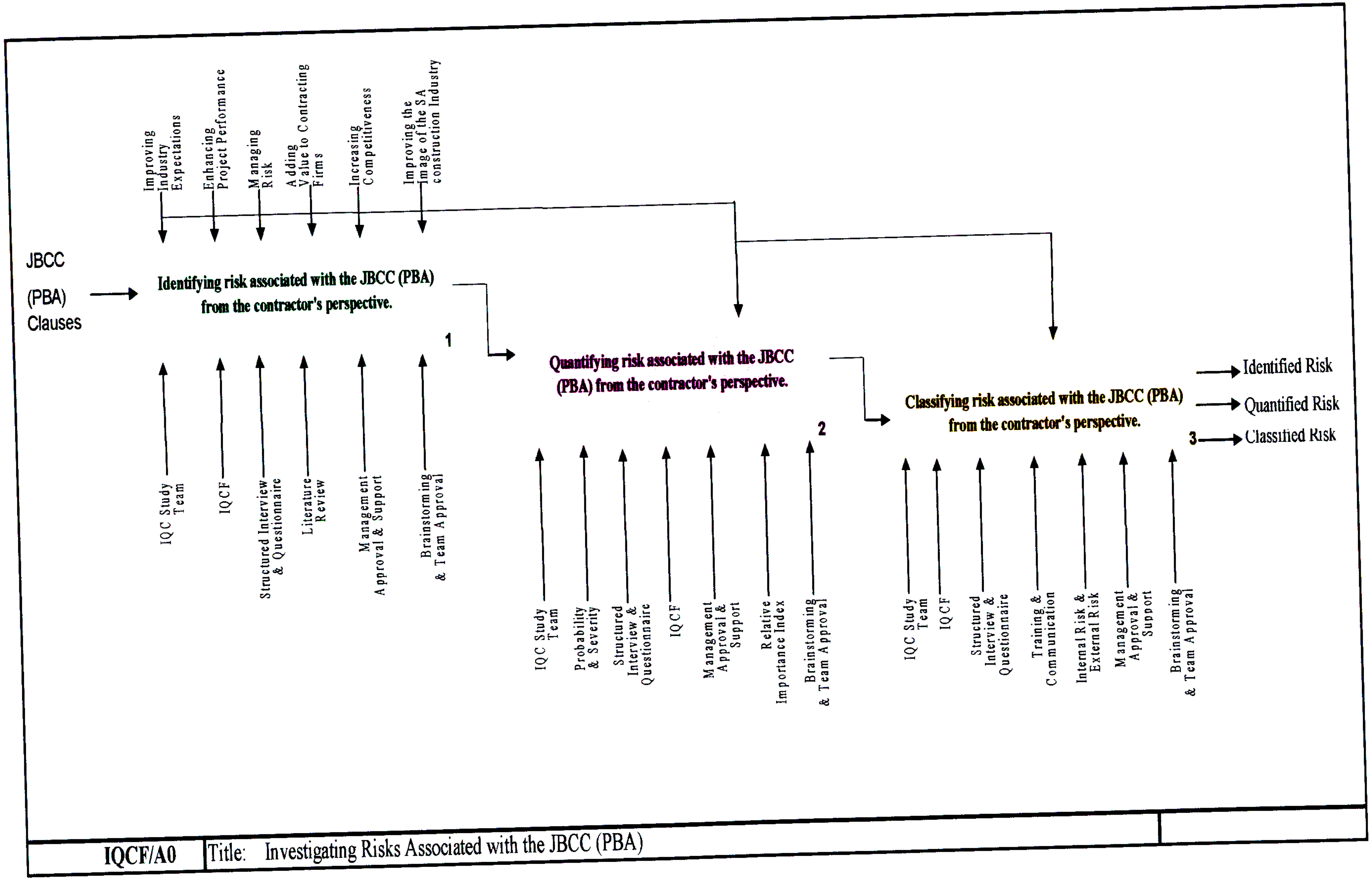


Figure 4.16. Investigating Risks Associated with the JBCC (PBA) - The Three levels of the IQCF

4.7.2.1 Identifying risk associated with the JBCC (PBA) from the contractor's perspective.

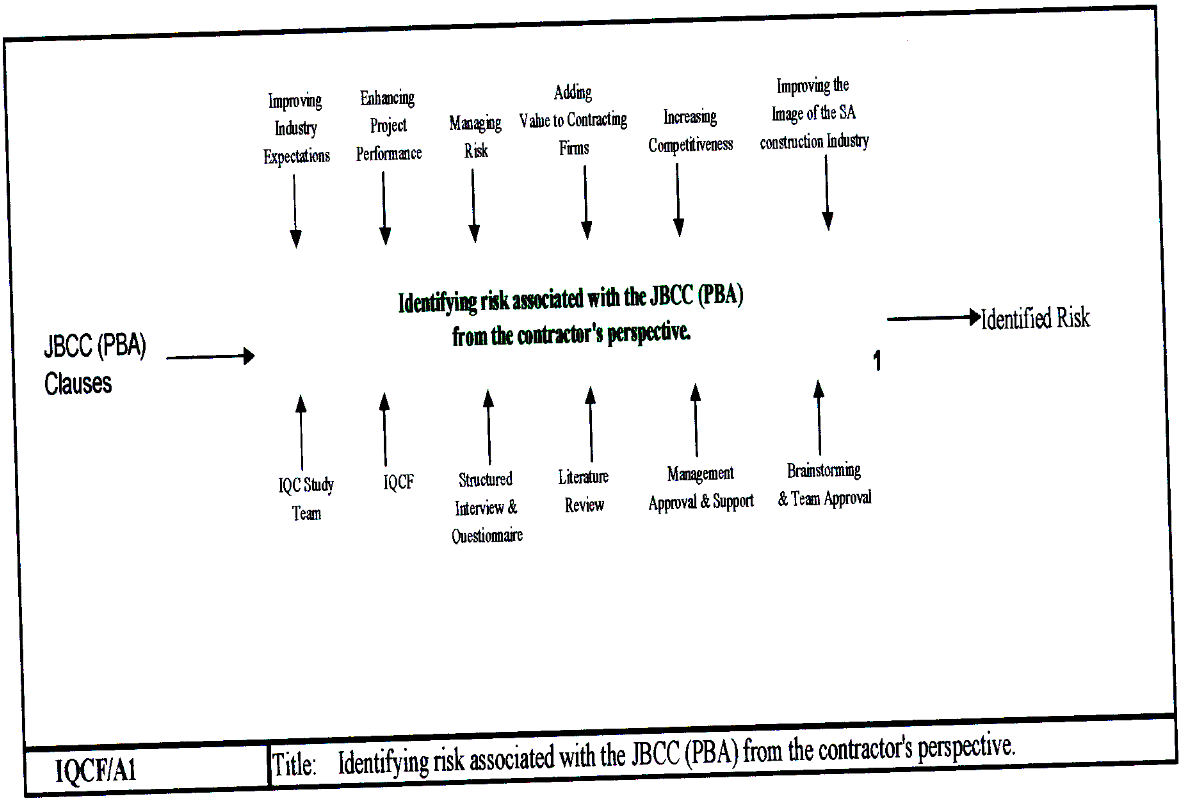


Figure 4.17. Identifying risk associated with the JBCC (PBA) from the contractor's perspective.

The 'Identifying risk associated with the JBCC (PBA) from the contractor's perspective' function (Figure 4.17.) deals with identifying risk in the JBCC (PBA). This is a decomposition of box 1 in the IQCF/A0 diagram (Figure 4.16.). The Input to this process is the JBCC (PBA) clauses. The Mechanisms used in the identification process were IQC study team, IQCF, structured interviews and questionnaires and a literature review. The study team will need to set up brainstorming sessions, times and location. Management needs to ensure that the team is well representative of its company dynamics to ensure successful outcomes in each stage. Management also needs to provide support and approval for the process. The controls were managing risk, improving industry expectations, enhancing project performance, adding value to contracting firms, increasing competitiveness and improving the image of the South African construction industry. The output of this process is the identified risks. Once the risks have been identified and the data collected, it can be analysed and the team can proceed to the next step.

4.7.2.2 Quantifying risk associated with the JBCC (PBA) from the contractor's perspective.

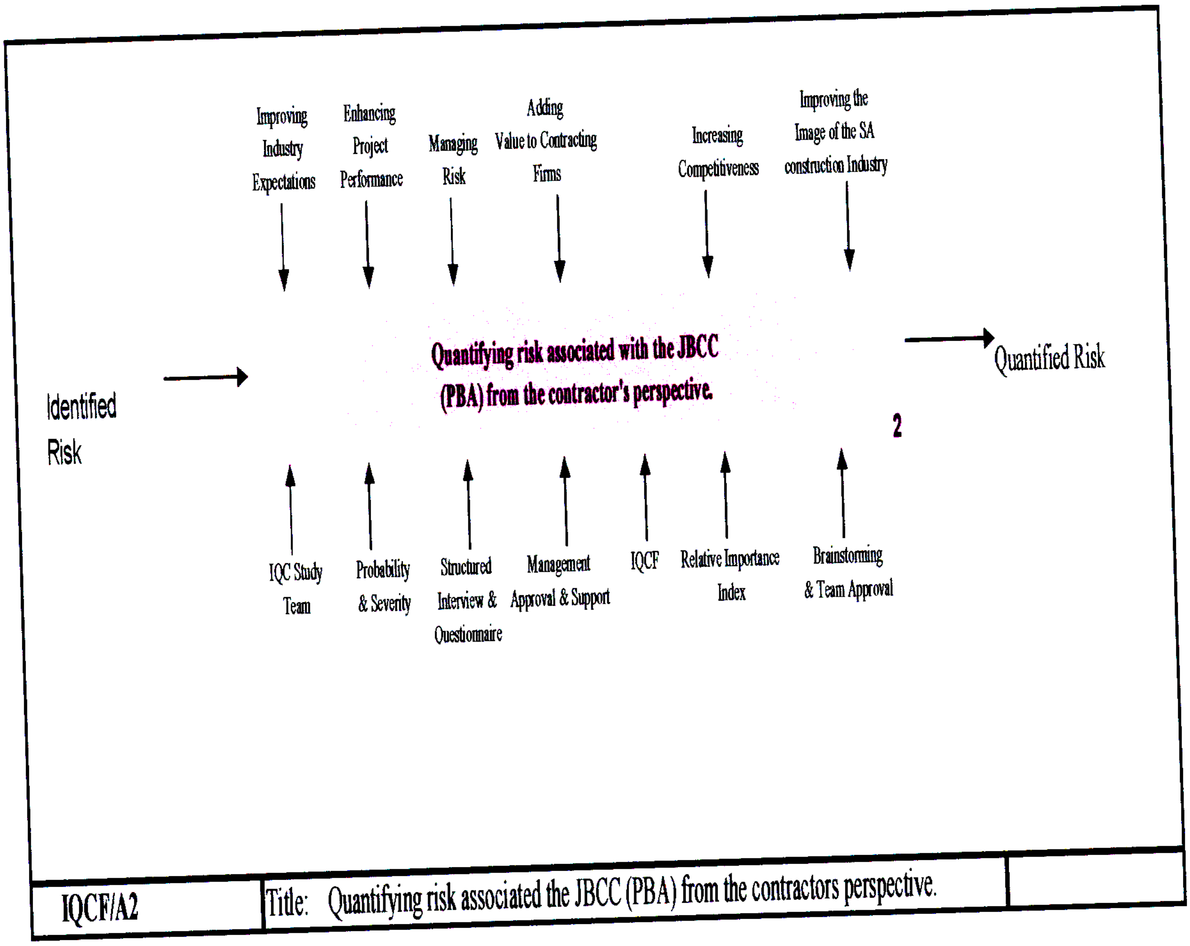


Figure 4.18. Quantifying risk associated with the JBCC (PBA) from the contractor's perspective.

The 'Quantifying risk associated with the JBCC (PBA) from the contractor's perspective' function (Figure 4.18.) is a decomposition of box 2 in the IQCF/A0 diagram (Figure 4.16). This figure deals with quantifying the risk in the JBCC (PBA) according to the contractor's perspective. The input into this activity was the output from the previous activity which is the identified risk. The mechanisms used were the IQC study team, probability and the severity of the risk occurrence (clause by clause), structured interviews and questionnaires, the Relative Importance Index, management approval and a brainstorming session. The controls were managing risk, improving industry expectations, enhancing project performance, adding value to contracting firms, increasing competitiveness and improving the image of the South African construction industry. The output of this stage is the quantified risk.

4.7.2.3 Classifying risk associated with the JBCC (PBA) from the contractor's perspective.

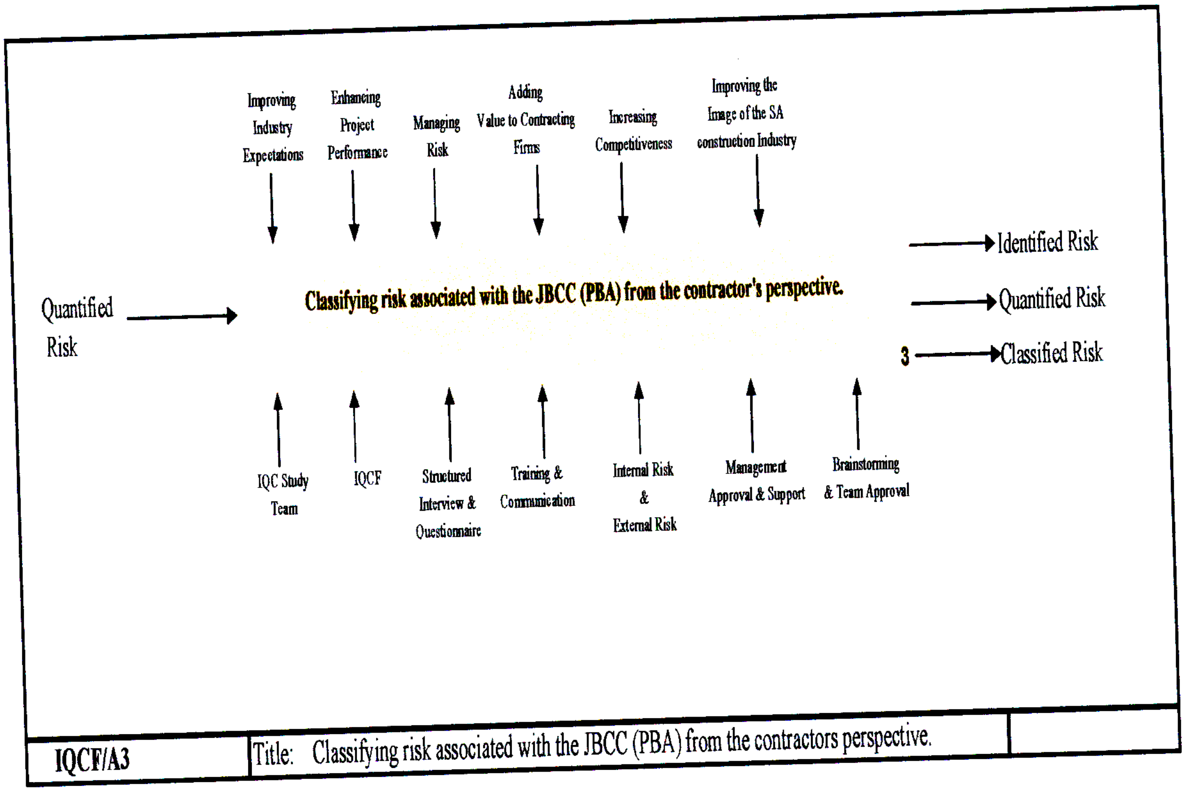


Figure 4.19. Classifying risk associated with the JBCC (PBA) from the contractor's perspective.

The 'Classifying risk in the JBCC (PBA) from the contractors perspective' function (Figure 4.19.) is a decomposition of box 3 in the IQCF/A0 diagram (Figure 4.16). The risk classification stage in Figure 4.18. deals classifying the risks in the JBCC (PBA) from the contractor's perspective. The input to this process is the identified and quantified risk from the previous stages. The mechanisms are the IQC study team, the IQCF, the structured interviews and questionnaires, internal and external risk and management approval and support. Brainstorming sessions need to be set up and the data collected and analysed. Once management approval has been obtained, the process can be communicated so that the work force can be trained. The controls were managing risk, improving industry expectations, enhancing project performance, adding value to contracting firms, increasing competitiveness and improving the image of the South African construction industry. The output of this stage is the identified, quantified and classified risk.

4.8 Evaluation of the Identification, Quantification and Classification Framework (IQCF)

The IQCF was developed and sent for evaluation by the construction contractors in the Durban area, via a questionnaire. The contractor's were asked to evaluate the framework in terms of the SWOT analysis for risk identification, the probability and severity of risk occurrence for risk quantification and in terms of internal and external risk for risk classification.

The feedback received was used to update the framework so that the latest and most useful version could be applied in the interview. Results of the evaluation are explained in chapter 5.

4.9 Application of the Identification, Quantification and Classification Framework (IQCF)

The IQCF is intended to be used by building contractors in order to identify, quantify and classify risks pertaining with the JBCC (PBA) contract, so that appropriate management strategies can be made with regards to risk management. The IQCF can be applied to any job provided that the contract been used is the JBCC (PBA). It can also be utilised to ensure all the risks in the contract have been accounted for.

In order to understand how the IQCF works and to investigate how it will be implemented, it was applied with the contractors during the interviews. Each clause was analysed in terms of the risk identification, quantification and classification criteria. Each respondent was given an opportunity to comment and the results were analysed as presented in chapter 5.

4.10 Benefits of the Identification, Quantification and Classification Framework (IQCF)

Risks are present in every aspect of business. As one of the biggest industries worldwide, the construction industry is plagued with risks. These risks could have adverse effects on the construction industry. In order to overcome these adverse effects and improve the image of the South African construction industry, the Identification, Quantification and Classification Framework (IQCF) is developed as an innovative tool to assist construction contractors better understand the risks associated with the clauses of the JBCC (PBA). It is a decision making tool designed to enable contractors to identify, quantify and classify the risks of the JBCC (PBA) clauses. The IQCF will help the contractors draw the appropriate risk management plan to mitigate the adverse effects of these risks.

Proper implementation and understanding of the IQCF will provide the following benefits:

- **Enhanced risk identification** to enable adequate risk response. The SWOT analysis covers all aspects of risk identification and therefore enables management to have more confidence in the system.
- **Appropriate risk quantification.** The risk quantification was analysed by calculating the Probability and Severity (R=P*S) of risk occurrence.
- **Proper risk classification.** Risk were classified either as internal or external risk.
- **Fewer disputes and disagreements.** Due to early risk identification, quantification and classification, contractors will be able to identify potential problems early enough to mange it, which will result in fewer disputes.
- **A better reputation for contractors**. Ultimately with few disputes and increased performance the reputation of contractors will be improved.
- It also adds in **improving the image of the South African construction industry.**
- It allows contractors to make **decisions on an informed basis.**
- Contractors are able to **develop better risk management plans.**

4.11 Limitations of the Identification, Quantification and Classification Framework (IQCF)

Due to the current boom in the South African industry, a limitation to the IQCF is the effective implementation of the framework by contractors, caused by time constraints. Lack of qualified, trained personnel could also prove a limitation. In order to properly implement the IQCF, personnel need to have adequate understand the JBCC (PBA). In order to overcome the limitations of the framework and facilitate its use, the benefits have to be clearly presented to the building contractors in order to win over their confidence and enhance the role the framework could play in managing project risks.

4.12 Conclusion

This chapter presented the identification, quantification and classification framework and its importance. The framework aims to enable contractors to identify, quantify and classify the risks associated with the Joint Building Contractors Committee Principal Building Agreement Series 2000 (JBCC PBA). By applying the IQCF, contractors will make decisions on informed bases and will be able to develop an appropriate risk management plan. In addition it will help improve the image of South African construction industry.

The conceptual description of the IQC framework was presented. The IQCF is based on three systematic steps: 1) Risk Identification, 2) Risk Classification and 3) Risk Quantification. In order to select the appropriate way to represent the framework, various modelling tools were reviewed. The IDEF-0 was adopted as the most appropriate tool. The IDEF-0 description and rationale behind its selection was illustrated. The benefits and limitations of the IDEF-0 methodology were also discussed. The IQCF was modelled and its application, benefits and limitations were discussed. The next chapter will analyse the questionnaires that were sent out and the personal structured interviews that were conducted.

CHAPTER 5

DATA ANALYSIS

CHAPTER 5

DATA ANALYSIS

5.1 Introduction

This chapter analysed the data collected from the questionnaires and the structured interviews. Answers were categorised, totals were added, and patterns were discovered so that the responses could be expressed in statistical terms. All of this was accomplished with the aid of a Microsoft Excel. Both the questionnaire and the interview are broken down into questions and each question contains 3 sections. The first part states the question, the second part explains the objective of the question and the third part analyses the response and in certain cases provides a graphical presentation of the analysis. The questions in both the questionnaire and the interviews were constructed with a great amount of care in order to aid in data collection, analysis and understanding.

5.2 Response Rate

The questionnaire was sent out to 19 construction firms, of which 9 replied, providing a response rate of 47%. According to Babbies (1992) as a rule of thumb 50% is adequate while, Mcneil and Chapman (2005); Saunders *et. al.* (2003); Gillham (2000a); Tashakkori *et al.* (1998) and Fellows and Liu (1997) state that 30-40 per cent is acceptable because of the fact that few people respond to questionnaires.

It was initially intended to interview all 9 respondents, however due to time constraints and work commitments of Commercial Managers and the unwillingness of some firms, only four interviews were conducted in the first interview which aimed to test and analyse the IQCF. A total of nine questionnaires and interviews were conducted in the second interview which aimed to test and analyse the risk source correlation matrix. The responses, comments and viewpoints of the interviewees presented an indispensable and beneficial insight to the research.

5.3 Data Analysis

Balnaves and Caputi (2001) state that numbers tell a story. The broad aim of the analysis according to Bauer and Gaskell (2000) is to look for meanings and understanding. Miles and Huberman (1994) describe data analysis as an organised assembly of information that permits conclusion drawing and action taking. According to Glesne and Peshkin (1992) matrices, graphs, flowcharts, and other sorts of visual representations assist in making meaning of data, as well as exposing the gaps or the areas where more data are needed.

Research data analysis is essentially an exercise in observing numbers and hence tends to revolve around statistics. The correct choice of analysis is important because

- Wrong analysis will inevitably lead to wrong conclusions and / or;
- Important conclusions may go undetected and / or;
- Incorrect conclusions may be drawn (Holt, 1998).

Descriptive statistics involves describing and displaying results in the form of tables and diagrams, such as bar charts and pie charts. Pie charts are easily understood by the reader and simple to construct. The whole circle represents the whole sample and it is divided according to the size of standard pie chart (White, 2002).

Both quantitative and qualitative data analysis approaches were applied to interpret the data collected from the questionnaire and the interview. Quantitative analysis was used to assess closed-ended questions using Microsoft Excel spreadsheets by utilising tables and graphs. Qualitative analysis was employed to analyse open-ended questions in order to gain an understanding from the respondents' point of view.

Quantitative analysis requires the data to be in the form of numbers. With interviews and questionnaires, for example, the raw information is mostly in the form of descriptions, or ticks in boxes. This data then needs to be transferred into numbers. This process is called coding. It is achieved by working through the interview transcripts, questionnaires, etc. and allocating each separate idea or concept identified a numerical code (White, 2002).

5.3.1 Coding

According to Saunders *et al.* (2003); Fellows and Liu (1997); Cooper and Schindler (1995) and Babbies (1992) coding represents a key step in the process of data analysis. Coding involves assigning numbers or other symbols to answers so the responses can be grouped into a limited number of classes or categories.

It has been described by Charmaz (1983 cited in Bryman and Burgess, 1994) as the process of categorising and sorting data, while 'codes' are described as serving to summarise, synthesize, and sort many observations made out of the data.

In order to enable analysis by computer and to enable data to be quickly and easily entered with minimal errors, the researcher coded the data. Closed questions were pre-coded. Each 'yes' or 'no' answer was assigned with a number ((0) for a 'no' and (1) for 'yes')

According to Kidder (1981) not all questions are so neatly and easily handled by pre-coding. The problem arises when the researcher is not able to specify all the possible responses to open-ended questions. The best way to analyse open-ended questions is to code the information in terms of ideas and themes. The purpose of coding such questions is to reduce the large number of individual responses to a few general categories of answers that can be assigned a numerical code (Naoum, 1998). In this research, the researcher recorded the verbal, responses of respondents and then post-coded the responses.

The Likert scale is used and was chosen for this research as it is simple to construct and understand and by allowing the use of latent attitudes; it produces a highly reliable scale.

5.4 Data Analysis of the Framework Evaluation - Questionnaire

The questionnaire is presented and analysed in the same format as the original questionnaire answered by the respondents. The aim of the questionnaire was to evaluate the identification, quantification and classification framework and gain the industry feedback. As described in chapter 2, risk is defined in various ways and in particular by Cloete (2001), Valsamakis, *et al.* (1999) and Doherty (1985) as the possibility of either loss or no loss or on the other hand those that offer a chance of gain or loss. Within this research the negative approach was adopted.

Question 1 - Risk Identification

Risk Identification criteria are broken into 4 categories, the risk could reduce the company's strengths, increase the company's weaknesses, and reduce its opportunities or increasing its threats. An example is provided.

Clause No	JBCC (PBA) Clause	Risk Identification Criteria			
		Reducing Strength	Increasing Weakness	Reducing Opportunities	Increasing Threats
3.0 DOCUMENTS	The employer shall provide a payment guarantee where required within 21 calendar days of acceptance of the tender	X			X
4.0 DESIGN RESPONSIBILITY	The contractor shall not be responsible for the design of the works other than the contractor's or his subcontractor's temporary works.			X	

Do you consider this as an acceptable method of identifying risks in the JBCC (PBA) contract Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 1a

Do you have any further suggestion on how this framework can be improved?

Objective:

This question was used to identify if the above format is acceptable to the contractor for identifying risks in the JBCC (PBA).

Response:

All the respondents considered the method to identify risks as acceptable with 67% rating as very good, while 33% gave it a rating of good. None of the respondents made any suggestions as to how this part of the framework could be improved.

Question 2 - Risk Quantification

In order to accurately quantify risks, it is broken down into 2 categories, the probability of the risks occurring and the severity of the risk. By multiplying the probability and severity the quantification can be obtained.

Clause No	JBCC (PBA) Clause	Risk Quantification										
		Probability (P)					Severity (S)					Result
		1	2	3	4	5	1	2	3	4	5	= (PxS)
3.0 DOCUMENTS	The employer shall provide a payment guarantee where required within 21 calendar days of acceptance of the tender			X						X		12
4.0 DESIGN RESPONSIBILITY	The contractor shall not be responsible for the design of the works other than the contractor's or his subcontractor's temporary works.				X						X	20

Do you consider this as an acceptable method of quantifying risks in the JBCC (PBA) contract Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 2a

Do you have any further suggestion on how this framework can be improved?

Objective:

This question aimed to determine if the risk quantification method utilised in the framework is acceptable to construction contractors.

Response:

The risk quantification system employed in the framework was rated as been very good by 45%, good by 44% and average by 11%. The group of the respondents that rated the quantification method as average, did not however provide suggestions on improvement.

Question 3 - Risk Classification

Risk in this framework is classified as either internal or external. Internal risks are the ones which emerge from within the contractor's organisation, where the external risks are the ones which emerge from outside the contractor's organisation.

Clause No	JBCC (PBA) Clause	Risk Classification	
		Internal risk	External risk
3.0 DOCUMENTS	The employer shall provide a payment guarantee where required within 21 calendar days of acceptance of the tender		X
4.0 DESIGN RESPONSIBILITY	The contractor shall not be responsible for the design of the works other than the contractor's or his subcontractor's temporary works.	X	

Risk in this framework is classified as either internal or external. Internal risks are the ones which emerge from within the contractor's organisation, where the external risks are the ones which emerge from outside the contractor's organisation.				
Do you consider this as an acceptable method of classifying risks in the JBCC (PBA) contract Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 3a

Do you have any further suggestion on how this framework can be improved?

Objective:
This question aimed to seek out whether the risk classification method provided was suitable.

Response:
Sixty seven percent of the respondents rated the risk classification system applied in the framework as very good while 33% rated it as good. Suggestions for further improvement were not made by any of the respondents.

Question 4

How do you rate the framework? Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 4a

Do you have any further suggestion on how this framework can be improved?

Objective:

This question was used to obtain a rating for the overall framework in order to progress further with the study, by applying it to all the clauses of the JBCC (PBA).

Response:

Fifty six percent of the respondents, considered the framework as very good while 44% rated it as good. One respondent did suggest that the framework could be elaborated on in further studies, by incorporating health and safety as well as quality aspects.

5.5 Data Analysis of the Framework Application -Structured Interview-1

The interview is presented and analysed in the same format as the original interview see Appendix (D) answered by the respondents. The aim of the interview was to apply the framework to identify, quantify and classify the risks associated with JBCC (PBA) clauses. This was done with construction companies in Durban.

Question 1

Do you identify all risks in the JBCC when tendering for projects	Yes	No

Objective:

This question was used to enquire if firms identified all risks in the JBCC when tendering for projects.

Response:

Seventy five percent of the respondents confirmed that they did indeed consider risks in the JBCC when tendering for projects (explained in question 1a), while 25 % of the respondents said that it was done but not often enough.

Question 1a and Question 1b

Question 1a

If your answer to Question 1 above is Yes, How do you account for risks when tendering for projects	
1	Planning meetings
2	Analysing the tender document
3	Looking for conditions that are onerous
4	Other, Specify

Question 1b

If your answer to question 1 above is No, please explain why		
1	Too costly	
2	Too time consuming	
3	Lack of understanding of the JBCC (PBA)	
4	Lack of qualified personnel	
5	Lack of training	
6	Other, Specify	

Objective:

Questions 1a and 1b were used to elaborate further on question 1, in order to probe whether risks were identified and how this was done.

Response:

The seventy five percent of the respondents that considered risks in the JBCC when tendering for projects stated they utilised all the methods provided for in question 1a as well as any amendments that were made to the JBCC (PBA) contract itself. They did however state that their methods were not always in-depth and due to time pressures poorly carried out. The 25% that indicated that risks were not identified often enough believed this was not done because it was too time consuming and the lack of training.

Question 2

Are you able to quantify the risks in the JBCC contract	Yes	No

Question 2a

If your answer to Question 2 above is Yes, How do you quantify the risks

Objective:

This question aims to determine if risk quantification in the JBCC contract was carried out and if so, to identify the method or technique used for that.

Response:

Risk quantification is carried out by 75% of the firms. They quantified risk by looking at the impact of the clauses on the contract, the Preliminaries and general structure, the profitability, duration, the buildability of the project and value engineering. 25% of the respondents stated that risk quantification can be done, but was not done often enough due to time constraints and lack of training.

Question 3

Are you able to classify the risks in the JBCC contract	Yes	No

Question 3a

If your answer to Question 3 above is Yes, How do you classify the risks

Objective:

This question allowed the researcher to determine if firms were able to classify risk in terms of the JBCC contract.

Response:

All of the respondents affirmed that they did indeed classify risk. 75% of the respondents utilised Excel spreadsheets to assist them in the classification of risk. A method used was signing points to each participant to see the risk carried by them. One respondent stated that proper selection of clients and agents greatly reduces the risk encountered.

Question 4

What techniques do you employ to manage risks that occur?

Objective:

This question was utilised to identify and understand the techniques employed to manage the occurrence of risks.

Response:

The techniques employed by the respondents to manage risk were listed as:

- Contingence measures
- Meetings
- Probability of occurrence
- Profile risks
- Crisis management
- Post tender - value engineering

The next section of the interview applied the framework to the JBCC contract clause by clause, under the categories of risk identification, risk quantification and risk classification. This section can be read in conjunction with Appendix (G).

Risk Identification - Criteria

Given the summarised clauses on the following pages, Select from the 4 categories presented

The respondents were asked to identify risks according to 4 categories, the risk could reduce the companies strengths, increase the companies weaknesses, reduce its opportunities or increasing its threats.

Objective:

This part of the framework was used to identify the risks in the JBCC contract according to the developed criteria.

Response:

Figure 5.1. and Table 5.1. are sorted according to the various risk identification categories and produced the following responses:

- **All the respondents stated that Clause 40 and Clause 17 fall under all the risk identification criteria.**

  Disputes are considered a risk to the contractor because:

  - Disputes can reduce a company's strength due to the fact that it can be a long drawn out process that could involve key personnel.
  - In addition it could increase the company's weakness because of the time, cost and resources involved.
  - It reduces a company's opportunities because of the bad name that the company obtains and the capital that is tied up.
  - It increases the company's threats by reducing the number of potential new jobs as clients would not want to hire a contractor that they believe will rush into a dispute.

  Contract instructions are considered a risk to the contractor because:

  - It can reduce a company's strength due to the time, cost, quality and resources that are tied up.
  - It increases the weakness by obtaining a poor reputation.

- ➢ It reduces its opportunities by making it unable to free resources for other jobs.
- ➢ It increases its threats because a poor reputation will lead to lack of new work.

- **5% of the clauses totally reduced the company's strength by 100%.**

  Clause 29 (Revision to date for practical completion) and Clause 30 (Penalty) were seen by the respondents as totally affecting a company's strength because an extension of time means that the resources (both manpower and plant) are not available for other jobs, and by paying hefty penalties that clients are now insisting on, the company can go into a negative cash flow situation.

- **5% of the clauses increased the company's weakness by 100%.**

  Clause 20 (Nominated subcontractors) and Clause 21 (Selected subcontractors) were seen by the respondents as totally increasing a company's weakness because if any subcontractor delays the completion of their job, they will definitely delay the main contractor. Even though the main contractor will get and extension of time if the nominated sub-contractor defaults, it will still mean he has to wait to complete the job, utilising resources that could have been better used elsewhere. Selected subcontractor poses an even bigger risk due to the fact that the main contractor is part of the selection process there is very little recourse available to him should the sub-contractor default.

- **2.5% of the clauses reduced the company's opportunities by 100%.**

  Clause 4 (Design Responsibility) was seen by the respondents as totally reducing a company's opportunities because contractors felt that they could have a valuable input into the design process in terms of constructability. Although the contractors liked the fact that they were not responsible for the architects/engineers design, they could have a good opportunity to improve their performance and produce a better product if their feedback is reflected in the design decision making process.

- **7.5% of the clauses increased the company's threats by 100%.**

  Clause 7 (Regulations), Clause 15 (Works execution) and Clause 31 (Interim payment) were seen by the respondents as totally increasing a company's threats. The contractor could face serious problems should the regulations and laws of the local or other authorities suddenly changed The execution and completion of work is at risk if the employer does not hand over site on time. The contractor's cash flow is at great risk when the interim payments are delayed. It can be seen from the above that these threats are external to the contractor.

- **10% of the clauses reduced the company's strength by 50% and at the same time increased its weakness by 50%.**
  - Clause 16 - Access to the works
    - The employer and his agents are to have reasonable access to site, but every time someone comes to site the construction manager or his representative has to free up time to take them on a site tour. This reduces the company's strength because the construction manager could have been busy elsewhere.
    - At the same time it increases the company's weakness because frequent delays and even injuries (should something happen to the employer and his agents) will result in delays that could cost the main contractor a lot of money.
  - Clause 18 - Setting out of the works
    - It reduces the company's strength because the contractor is ultimately liable for setting out the works, and it will cost him additional funds to correct should the works be incorrectly set out.
    - At the same time it increases the company's weakness because extra resources, material, time and money will be required for rectification that could have been utilised elsewhere.
  - Clause 33 - Recovery of expense and loss
    - It reduces the company's strength because recovery statements very rarely accompany payment certificates, and the contractor is not always aware of the amounts owed by him to the employer and owned to him from the employer. Should he owe the employer money and does not budget for it, it will reduce his strength.
    - Lack of recovery statements that show money owed to the contractor increases the company's weakness because the contractor have utilised the finances elsewhere.
  - Clause 34 - Final account and Final payment
    - It reduces the company's strength because on a lot of projects the final account and final payment takes more than the 3 months to prepare and the contractor is unable to obtain closure for the project. He will have to utilise his own cash flow and resources until final payment.

- At the same time it increases the company's weakness because the company still has to have a quantity surveyor, account on this job until it is closed and the final payment values could be used on another job.

- **12.5% of the clauses reduced the company's strength by 50% and at the same time increased its threats by 50%.**
  - Clause 10 - Works insurances
    - This clause states that the party stated in the schedule will effect the insurance, and depending on the party (if the employer takes out he insurance) it will reduce the strength and increase the threat of the company.
  - Clause 11- Liability insurances
    - It reduces the company's strength if the employer has to take out liability insurance, as the contractor may have to go through more red tape in order to make a claim.
    - At the same time it increases the company's threats because the client could impose certain restrictions on the contractor, for example, not fixing/maintenance of machinery on site, this will mean that the contractor has to remove all machinery for fixing and maintenance costing him extra capital.
  - Clause 12 - Effecting insurances
    - This clause states that the party stated in the schedule will effect and keep in force the insurance, and depending on the party (if the employer take out he insurance) it will reduce the strength and increase the threat of the company. In some cases the employer could be the better party to take out the insurance but insists that the contractor insure the works, and the contractor complies as he needs the work. This is unfair and increases the company's threats and reduces its strength.
  - Clause 22 - Direct contractors
    - It reduces the company's strength as the main contractor has not control over direct contractors.
    - At the same time increases the company's threats because direct contractors could delay and damage the works, which the main contractor has to rectify.
  - Clause 32 - Adjustment to the contract value
    - It reduces the company's strength because incorrect adjustments and pressure from the employer's agents could result in the contractor loosing money.

- ❖ At the same time increases the company's threats because the contractor cannot be sure of the cost of unforeseen events, like an increase in the price of petrol or the increase in cement prices, all of which affect how the contract value is adjusted.

- **10% of the clauses increased a company's weakness by 50% and at the same time reduced the company's opportunities by 50%.**
  - ➢ Clause 6 - Site representative
    - ❖ Poor choice and lack of experience in a site representative could increase a company's weakness because they will not be able to perform the administrative duties.
    - ❖ It reduces the company's opportunities as the client will not have faith in the contractor's ability and may therefore not provide the company with any more work.
  - ➢ Clause 23 - Domestic sub-contractors
    - ❖ The main contractor is solely reliable for the timely completion and quality of the work that is produced by the domestic sub-contractor. Should this domestic sub-contractor fail to complete the work or produce poor quality work it would increase the main contractor's weakness and reduce his opportunities for work elsewhere due to for example a poor reputation.
  - ➢ Clause 28 - Sectional completion
    - ❖ It increases the company's weakness as not all sections will have the same working conditions and the contractor might have to have special meets etc. to discuss this with the client's agents.
    - ❖ At the same time it reduces the company's opportunities because certain sections could take longer to complete and require specialised skills that the contractor could have used on another job.
  - ➢ Clause 35 - Payment to other parties
    - ❖ It increases the company's weakness as the contractor could have had a special reason for non payment and he was overruled because the client made direct payment the other party.
    - ❖ At the same time reduced the company's opportunities because the contractor is entitled to a mark-up on these payments, which he looses out on and if for example, direct payment was made to a selected subcontractor and this was recovered from the main contractor by and the selected sub-contractor absconds, the main contractor will still have to incur the cost of completing his work, thereby losing out twice.

- **5% of the clauses increased its weakness and at the same time increased the company's threats.**
  - Clause 5 - Employers agents
    - Clause 5 states that the employer is to appoint an agent, and if the agent is not concerned about the welfare of the job (e.g. placing unreasonable deadlines) this will result in a weakness and threat to the main contractor.
  - Clause 36 - Cancellation – Contractors default
    - It increases the company's weakness as the contractor could be faced with a temperamental client and due to circumstances other than his own the client cancels. For example, continuous rain or the need for special equipment could have delayed the commencement of the project and the contractor has to start within a certain time period. The client then uses this as a means to cancel.
    - At the same time it increases the company's threats because the contractor needs the capital form this job to pay off creditors and keep employees.

- **17.5% of the clauses reduced the company's opportunities by 50% and at the same time increasing the company's threats by 50%.**
  - Clause 9 - Indemnities
    - It reduces the company's opportunities when the employer fails to indemnify the contractor against an act or omission arising out of a loss or claim that was his (the employers) fault.
    - At the same time it increases the company's threats because the contractor is now exposed to more risk then he would have been had he been indemnified.
  - Clause 19 - Assignment
    - It reduces the company's opportunities when the employer cedes his rights and obligations as the contractor might not be able to secure additional work form the employer.
    - At the same time increases the company's threats because the new employer could prove to be more risky or inexperienced.
  - Clause 24 - Practical Completion, Clause 25 - Works completion, Clause 26 - Final Completion
    - With regards to clauses 24, 25 and 26, should the main contractor complete all work and remedy all defects timeously, it will increase his opportunities of getting other work with this client and will also free up key personnel for other jobs. But if the

contractor meets his deadlines and the client's agents (e.g. the principal agent takes longer than stated to issue a practical/works/final completion certificate) this will result in a threat to the company.

- Clause 37 - Cancellation by employer – loss and damage
  - It reduces the company's opportunities as the employer can cancel the agreement if the works have been destroyed for whatever reason. This means that he will have to either place employees on stand by or retrench them while waiting for a new job to start.
  - At the same time it increases the company's threats because this type of cancellation could occur at any time.
- Clause 39 - Cancellation – cessation of works
  - It reduces the company's opportunities and at the same time increases the company's threats because the contractor faces increased risk from the employer canceling.

- **12.5% of the clauses affected two and more of the identification criteria:**
  - Clause 27 - Latent Defects Liability Period
    - 25% of the respondents stated that Clause 27 reduced the company's strength because of the time, cost and manpower involved in remedying the defect. It could also potentially affect the company's reputation.
    - 50% of the respondents stated that Clause 27 increased the company's weakness because of the time; cost and manpower involved in remedying the defect could put current and future jobs at risk.
    - 25% of the respondents stated that Clause 27 reduced the company's opportunities because the commitment of time and resources to remedy the defect does not afford the company the opportunity to find other work and could give the company a bad reputation.
  - Clause 3 - Documents
    - 25% of the respondents stated that Clause 3 reduced the company's strength because for example should the company not be able to obtain a payment guarantee it reduces the company's strength to tender and construct other projects.
    - 50% of the respondents stated that Clause 3 increased the company's weakness because for example the waiver of the lien and lack of payment guarantee puts the company at a distinct disadvantage.

- 25% of the respondents stated that Clause 3 increased the company's threats because of the reliance on external parties and the waiver of the lien.
- Clause 38 - Cancellation by contractor - employer's default
  - 25% of the respondents stated that Clause 38 reduced the company's strength as cancellation of the contract means the job is over and there is no source of income.
  - 50% of the respondents stated that Clause 38 reduced the company's opportunities because the company might not be able to get other jobs as clients might be afraid to do business with them.
  - 25% of the respondents' stated that Clause 38 increased the company's threats because it could earn the company a bad reputation, and thereby reduce its work opportunities, which could result in retrenchment of employees.
- Clause 8 – Works risk
  - 25% of the respondents stated that Clause 8 reduced the company's strength because the contractor is now liable for the site and should anything happen (like theft) the company would be responsible.
  - 25% of the respondents stated that Clause 8 reduced the company's opportunities for example, on sites that are restricted in terms of space and time, would require experienced staff, and more manpower, reducing its chances of taking on other work.
  - 50% of the respondents stated that Clause 8 increased the company's threats because the contractor is now responsible and has to take extra precautions to ensure there are no mishaps or delays in construction.
- Clause 14 - Security
  - 25% of the respondents stated that Clause 14 increased the company's weakness as in some instances the guarantees provided are not returned.
  - 50% of the respondents stated that Clause 14 reduced the company's opportunities because in certain cases the guarantee was provided but the client did not provide a payment guarantee which reduces the company's opportunities.
  - 25% of the respondents stated that Clause 14 increased the company's threats because certain unscrupulous clients could claim against this.

- **7.5% of the clauses are not applicable** because they either do not contain any words or they are explanations of various aspects of the contract.

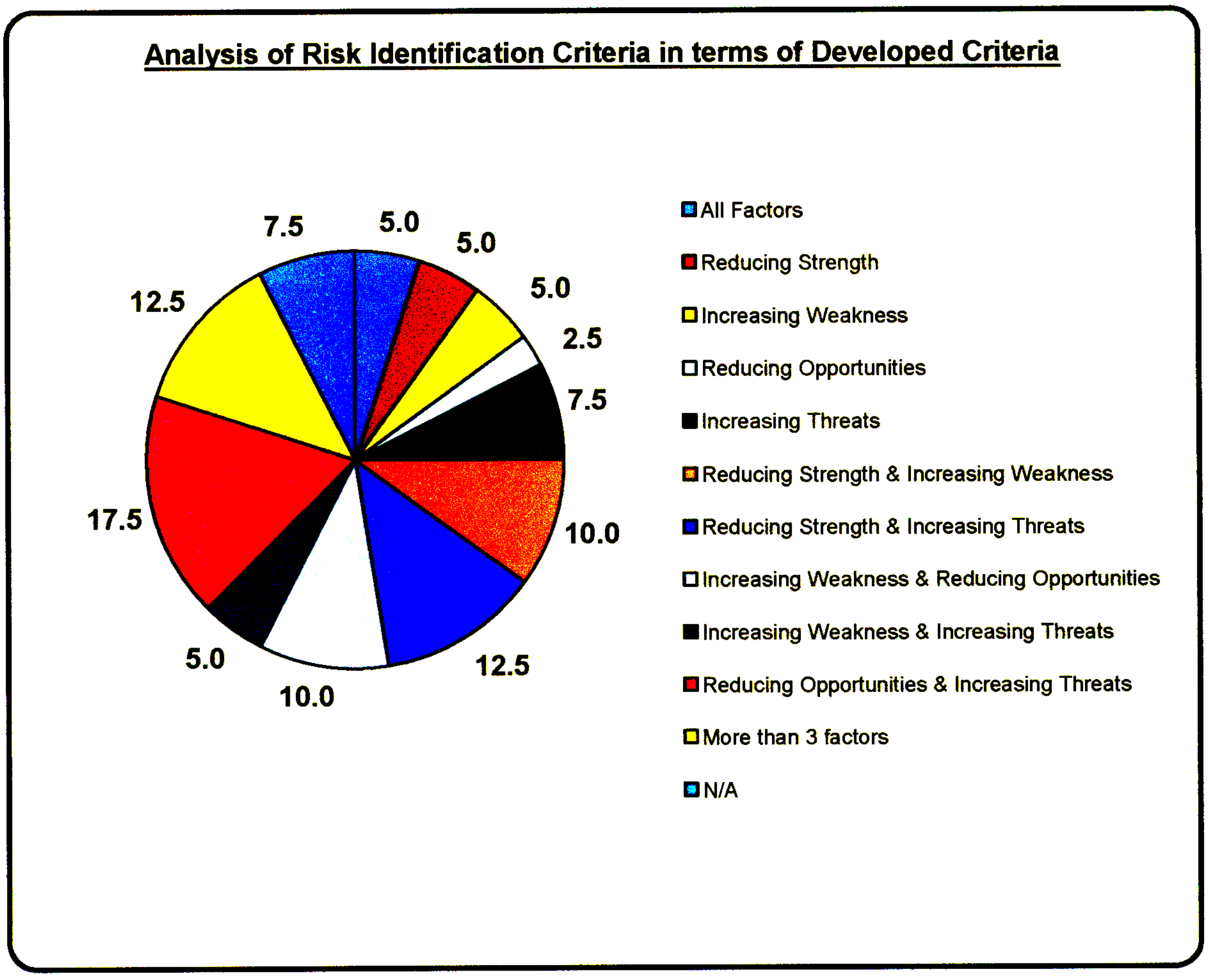


Figure 5.1. Analysis of the Risk Identification Criteria in terms of Developed Criteria

Table 5.1. Risk Identification Criteria

	CLAUSES	Risk Identification Criteria: Reducing Strength	Increasing Weakness	Reducing Opportunities	Increasing Threats
40.0	DISPUTE SETTLEMENT	100%			
17.0	CONTRACT INSTRUCTIONS	100%			
29.0	REVISION OF DATE FOR PRACTICAL COMPLETION	100%			
30.0	PENALTY	100%			
20.0	NOMINATED SUBCONTRACTORS		100%		
21.0	SELECTED SUBCONTRACTORS		100%		
4.0	DESIGN RESPONSIBILITY			100%	
7.0	REGULATIONS				100%
15.0	WORKS EXECUTION				100%
31.0	INTERIM PAYMENT				100%
16.0	ACCESS TO THE WORKS	50%	50%		
18.0	SETTING OUT OF THE WORKS	50%	50%		
33.0	RECOVERY OF EXPENSE AND LOSS	50%	50%		
34.0	FINAL ACCOUNT AND FINAL PAYMENT	50%	50%		
10.0	WORKS INSURANCES	50%			50%
11.0	LIABILITY INSURANCES	50%			50%
12.0	EFFECTING INSURANCES	50%			50%
22.0	DIRECT CONTRACTORS	50%			50%
32.0	ADJUSTMENT TO THE CONTRACT VALUE	50%			50%
6.0	SITE REPRESENTATIVE		50%	50%	
23.0	DOMESTIC SUBCONTRACTORS		50%	50%	
28.0	SECTIONAL COMPLETION		50%	50%	
35.0	PAYMENT TO OTHER PARTIES		50%	50%	
5.0	EMPLOYER'S AGENTS		50%		50%
36.0	CANCELLATION - CONTRACTOR'S DEFAULT		50%		50%
9.0	INDEMNITIES			50%	50%
19.0	ASSIGNMENT			50%	50%
24.0	PRACTICAL COMPLETION			50%	50%
25.0	WORKS COMPLETION			50%	50%
26.0	FINAL COMPLETION			50%	50%
37.0	CANCELLATION BY EMPLOYER. LOSS AND DAMAGE			50%	50%
39.0	CANCELLATION-CESSATION OF WORKS			50%	50%
27.0	LATENT DEFECTS	25%	50%	25%	
3.0	DOCUMENTS	25%	50%		25%
38.0	CANCELLATION - EMPLOYER'S DEFAULT	25%		50%	25%
8.0	WORKS RISK	25%		25%	50%
14.0	SECURITY		25%	50%	25%
1.0	DEFINITIONS	N/A			
2.0	OFFER, ACCEPTANCE AND PERFORMANCE	N/A			
13.0	NO CLAUSE	N/A			

Risk Quantification – Criteria

Select the probability and severity of the risk occurring

In order to accurately quantify risks, it is broken down into 2 categories, the probability of the risks occurring and the severity of the risk. By multiplying the probability and severity the quantification can be obtained. The maximum quantification that can be achieved is 25.

Objective:
This section of the framework was utilised to quantify risks in the JBCC (PBA) contract.

Response:
A two stage approach was utilised for quantitative data analysis in this research. The first stage involved the measure of the central tendency (mean, median and mode) of the interview responses. The measure of central tendency was used to get an overview of the typical value for each variable by calculating the mean, median and mode. The second stage involved the use of the relative importance index as all the clauses in the JBCC (PBA) do not have the same influence on the contractor.

According to Wright (1997) the central tendency informs one of where the centre of the distribution lies. The mean is the average from a set of variables. The median is the middle number from a set of variables and the mode is the most common value from a set of variable.

The three highest results are listed below; the results were obtained by multiplying the mean of the probability (P) and the mean of the severity (S).

- Clause 17 (Contract instructions) had the highest result of 20. The respondents felt that this clause had the highest probability of occurrence (with a mean of 4.5, median of 4.5 and mode of 4) and the greatest severity (with a mean of 4.5, median of 4.5 and mode of 4) once it occurs. Contract instructions affect the projects duration, cost and sometimes even quality. One respondent stated that a particular project has 897 site instructions and doubled the original contract value.

- Clause 5 (Employers agent) and clause 29 (Revision to date of practical completion) had a result of 17. The probability of occurrence for clause 5 was 4 (with a mean of 4, median of 4 and mode of 4) and a severity of 4.3 (with a mean of 4.3, median of 4 and mode of 4) once it occurs. The probability of occurrence for clause 29 was 4.3 (with a mean of 4.3, median of 4.5 and mode of 5) and a severity of 4 (with a mean of 4, median of 4 and mode of 3) once it occurs. Poor choice of agents can seriously hinder the project completion and quality, while extensions of time require resources that could be utilised elsewhere.

- Clause 25 (Works completion) had the third highest score of 15. The probability of occurrence for clause 25 was 3.5 (with a mean of 3.5, median of 3.5 and mode of 3) and a severity of 4.3 (with a mean of 4.3, median of 4.5 and mode of 5) once it occurs. The respondents felt that sometimes clients were unreasonable in terms of the site handover date and insist that damages whether caused by the contractor or not are remedied.

The remainder of the responses to this section is represented in Table 5.2. and they are rounded off to the nearest whole number. It is noteworthy to mention that the close results of the mean, median and mode shows homogeneity of the collected data.

Table 5.2. Risk Quantification Criteria

Risk Quantification		Probability (P)			Severity (S)			Result
	CLAUSES	**Mean**	**Median**	**Mode**	**Mean**	**Median**	**Mode**	**=(P*S)**
17.0	CONTRACT INSTRUCTIONS	4.5	4.5	4	4.5	4.5	4	**20**
5.0	EMPLOYER'S AGENTS	4.0	4	4	4.3	4	4	**17**
29.0	REVISION - DATE FOR PRACTICAL COMPLETION	4.3	4.5	5	4.0	4	3	**17**
25.0	WORKS COMPLETION	3.5	3.5	3	4.3	4.5	5	**15**
3.0	DOCUMENTS	3.5	3	3	4.0	4	4	**14**
27.0	LATENT DEFECTS	3.5	4	4	4.0	4	4	**14**
24.0	PRACTICAL COMPLETION	3.3	3.5	4	4.0	4	4	**13**
26.0	FINAL COMPLETION	3.3	3.5	4	3.8	4	4	**12**
30.0	PENALTY	3.3	3.5	4	3.8	4	4	**12**
14.0	SECURITY	3.3	3	2	3.3	3	2	**11**
23.0	DOMESTIC SUBCONTRACTORS	3.3	3	2	3.3	3	2	**11**
32.0	ADJUSTMENT TO THE CONTRACT VALUE	3.5	3.5	3	3.0	3	3	**11**
34.0	FINAL ACCOUNT AND FINAL PAYMENT	3.0	3.5	4	3.8	4	4	**11**
21.0	SELECTED SUBCONTRACTORS	2.8	2.5	2	3.3	3.5	4	**9**
22.0	DIRECT CONTRACTORS	3.0	2.5	2	3.0	2.5	2	**9**
40.0	DISPUTE SETTLEMENT	2.8	3	3	3.3	3	3	**9**
28.0	SECTIONAL COMPLETION	2.8	2.5	2	2.8	2.5	2	**8**
31.0	INTERIM PAYMENT	2.5	2.5	3	3.3	3	3	**8**
35.0	PAYMENT TO OTHER PARTIES	2.8	2.5	2	2.8	2.5	2	**8**
38.0	CANCELLATION - EMPLOYER'S DEFAULT	2.5	2	2	3.3	3	2	**8**
10.0	WORKS INSURANCES	2.3	2.5	3	3.3	3	3	**7**
11.0	LIABILITY INSURANCES	2.3	2.5	3	3.3	3	3	**7**
15.0	WORKS EXECUTION	2.3	2	2	3.0	3	3	**7**
37.0	CANCELLATION - LOSS AND DAMAGE	2.3	2	2	3.0	2.5	2	**7**
8.0	WORKS RISK	2.3	2.5	3	2.8	3	3	**6**
9.0	INDEMNITIES	2.0	2	2	3.0	2.5	2	**6**
12.0	EFFECTING INSURANCES	2.0	2	2	3.0	2.5	2	**6**
20.0	NOMINATED SUBCONTRACTORS	2.3	2	2	2.8	2.5	2	**6**
36.0	CANCELLATION - CONTRACTOR'S DEFAULT	2.0	2	2	2.8	2.5	3	**6**
7.0	REGULATIONS	1.8	2	2	2.8	2	2	**5**
18.0	SETTING OUT OF THE WORKS	2.3	2.5	3	2.3	2.5	3	**5**
33.0	RECOVERY OF EXPENSE AND LOSS	2.3	2.5	3	2.3	2.5	3	**5**
39.0	CANCELLATION-CESSATION OF WORKS	1.8	2	2	2.5	2	2	**4**
16.0	ACCESS TO THE WORKS	1.8	2	2	1.8	2	2	**3**
4.0	DESIGN RESPONSIBILITY	1.3	1	1	1.3	1	1	**2**
6.0	SITE REPRESENTATIVE	1.3	1	1	1.3	1	1	**2**
19.0	ASSIGNMENT	1.3	1	1	1.5	1.5	2	**2**
13.0	NO CLAUSE		N/A			N/A		**0**
1.0	DEFINITIONS		N/A			N/A		**0**
2.0	OFFER, ACCEPTANCE AND PERFORMANCE		N/A			N/A		**0**

Relative importance of the JBCC (PBA) clauses

To allow for further analysis of the data, a relative importance index (RII) was utilised to rank the clauses according to their influences.

Investigation of the results showed that the clauses could be classified into three categories as shown in Table 5.3. The first category contains clauses with a very high influence with an RII above 0.70. This includes

- Clause 17 - Contract instructions
- Clause 29 - Revision of date for practical completion
- Clause 5 - Employers agents
- Clause 27 - Latent defects
- Clause 25 - Works completion
- Clause 3 - Documents

The second category contains clauses with an average to high influence, with RII's lying between 0.45 and 0.70. This includes:

- Clause 30 - Penalty
- Clause 26 - Final completion
- Clause 24 - Practical completion
- Clause 23 - Domestic subcontractors
- Clause 14 - Security
- Clause 34 - Final account and final payment
- Clause 22 - Direct contractors
- Clause 40 - Dispute settlement
- Clause 35 - Payment to other parties
- Clause 28 - Sectional completion
- Clause 21 - Selected subcontractors
- Clause 38 - Cancellation by contractor - employer's default
- Clause 31 - Interim payment
- Clause 37 - Cancellation by employer. Loss and damage
- Clause 33 - Recovery of expense and loss

Table 5.3. Relative Importance Index of the risks associated with the JBCC (PBA) clauses

Risk Quantification				
	CLAUSES	**RII**	**Rank**	
17.0	CONTRACT INSTRUCTIONS	0.90	1	[1]
29.0	REVISION OF DATE FOR PRACTICAL COMPLETION	0.85	2	[2]
5.0	EMPLOYER'S AGENTS	0.80	3	[3]
27.0	LATENT DEFECTS	0.70	4	[4]
25.0	WORKS COMPLETION	0.70	4	[5]
3.0	DOCUMENTS	0.70	4	[6]
30.0	PENALTY	0.65	5	[7]
26.0	FINAL COMPLETION	0.65	5	[8]
24.0	PRACTICAL COMPLETION	0.65	5	[9]
23.0	DOMESTIC SUBCONTRACTORS	0.65	5	[10]
14.0	SECURITY	0.65	5	[11]
34.0	FINAL ACCOUNT AND FINAL PAYMENT	0.60	6	[12]
22.0	DIRECT CONTRACTORS	0.60	6	[13]
40.0	DISPUTE SETTLEMENT	0.55	7	[14]
35.0	PAYMENT TO OTHER PARTIES	0.55	7	[15]
28.0	SECTIONAL COMPLETION	0.55	7	[16]
21.0	SELECTED SUBCONTRACTORS	0.55	7	[17]
38.0	CANCELLATION - EMPLOYER'S DEFAULT	0.50	8	[18]
31.0	INTERIM PAYMENT	0.50	8	[19]
37.0	CANCELLATION BY EMPLOYER. LOSS AND DAMAGE	0.45	9	[20]
33.0	RECOVERY OF EXPENSE AND LOSS	0.45	9	[21]
20.0	NOMINATED SUBCONTRACTORS	0.45	9	[22]
18.0	SETTING OUT OF THE WORKS	0.45	9	[23]
15.0	WORKS EXECUTION	0.45	9	[24]
11.0	LIABILITY INSURANCES	0.45	9	[25]
10.0	WORKS INSURANCES	0.45	9	[26]
8.0	WORKS RISK	0.45	9	[27]
36.0	CANCELLATION - CONTRACTOR'S DEFAULT	0.40	10	[28]
12.0	EFFECTING INSURANCES	0.40	10	[29]
16.0	ACCESS TO THE WORKS	0.35	11	[30]
7.0	REGULATIONS	0.35	11	[31]
32.0	ADJUSTMENT TO THE CONTRACT VALUE	0.35	11	[32]
39.0	CANCELLATION-CESSATION OF WORKS	0.35	11	[33]
19.0	ASSIGNMENT	0.25	12	[34]
9.0	INDEMNITIES	0.25	12	[35]
6.0	SITE REPRESENTATIVE	0.25	12	[36]
4.0	DESIGN RESPONSIBILITY	0.25	12	[37]
1.0	DEFINITIONS	0	13	[38]
2.0	OFFER, ACCEPTANCE AND PERFORMANCE	0	13	[39]
13.0	NO CLAUSE	0	13	[40]

- Clause 20 - Nominated subcontractors
- Clause 18 - Setting out of the works
- Clause 15 - Works execution
- Clause 11 - Liability insurances
- Clause 10 - Works insurances
- Clause 8 - Works risk

The final category contains clauses with very low to low influences with RII's less than 0.45. This includes:

- Clause 36 - Cancellation - contractor's default
- Clause 12 - Effecting insurances
- Clause 16 - Access to the works
- Clause 7 - Regulations
- Clause 32 - Adjustment to the contract value
- Clause 39 - Cancellation-cessation of works
- Clause 19 - Assignment
- Clause 9 - Indemnities
- Clause 6 - Site representative
- Clause 4 - Design responsibility
- Clause 1 - Definitions
- Clause 2 - Offer, acceptance and performance
- Clause 13 - No clause

Figure 5.2. shows the relative importance index (RII) broken down into the three groups in graphical form.

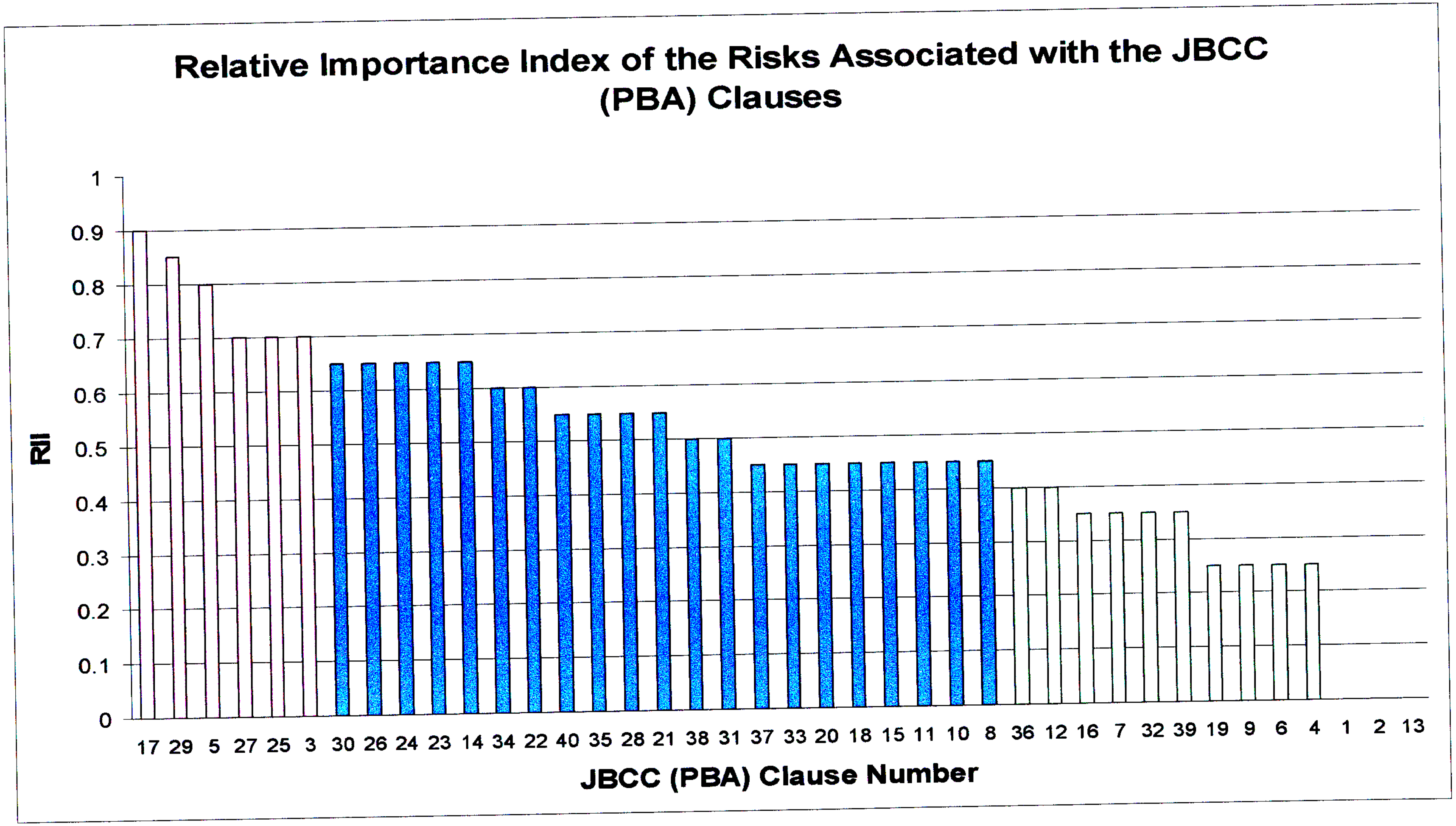


Figure 5.2. Relative Importance Index of the risks associated with the JBCC (PBA) clauses

Risk Classification - Criteria

Select the classification of the risk occurring, either internal or external

Risk in this framework is classified as either internal or external. Internal risks are the ones which emerge from within the contractor's organisation, where the external risks are the ones which emerge from outside the contractor's organisation.

Objective:

This segment was used to classifying risks in the JBCC (PBA) contract

Response:

As can be seen from the responses in Figure 5.3 and Table 5.4.

- 20% of the risks are internal, that is, they emerge from within the contractor's organisation. Internal risk clauses are:
  - Clause 6 - Site representative
  - Clause 14 - Security
  - Clause 15 - Works execution
  - Clause 18 - Setting out of the works
  - Clause 21 - Selected subcontractors
  - Clause 23 - Domestic subcontractors
  - Clause 27 - Latent defects
  - Clause 30 – Penalty

- 23% of the risks according to the respondents are external, that is, they emerge from outside the contractor's organisation. External risk clauses are:
  - Clause 5 - Employers agents
  - Clause 7 - Regulations
  - Clause 20 - Nominated subcontractors
  - Clause 22 - Direct contractors
  - Clause 29 - Revision of date for practical completion
  - Clause 35 - Payment to other parties

- Clause 36 - Cancellation - contractor's default
- Clause 37 - Cancellation by employer. Loss and damage
- Clause 38 - Cancellation by contractor - employer's default

- 49% of the risks are classified as both internal and external risks. They are:
  - Clause 3 – Documents
  - Clause 4 - Design responsibility
  - Clause 8 - Works risk
  - Clause 9 - Indemnities
  - Clause 10 - Works insurances
  - Clause 11 - Liability insurances
  - Clause 12 - Effecting insurances
  - Clause 16 - Access to the works
  - Clause 17 - Contract instructions
  - Clause 19 - Assignment
  - Clause 24 - Practical completion
  - Clause 25 - Works completion
  - Clause 26 - Final completion
  - Clause 28 - Sectional completion
  - Clause 31 - Interim payment
  - Clause 32 - Adjustment to the contract value
  - Clause 33 - Recovery of expense and loss
  - Clause 34 - Final account and final payment
  - Clause 39 - Cancellation-cessation of works
  - Clause 40 - Dispute settlement

- 8% of the risks are not applicable because they either do not contain any words or they are explanations of various aspects of the contract. They are clauses
  - Clause 1 - Definitions
  - Clause 2 - Offer, acceptance and performance
  - Clause 13 - No clause

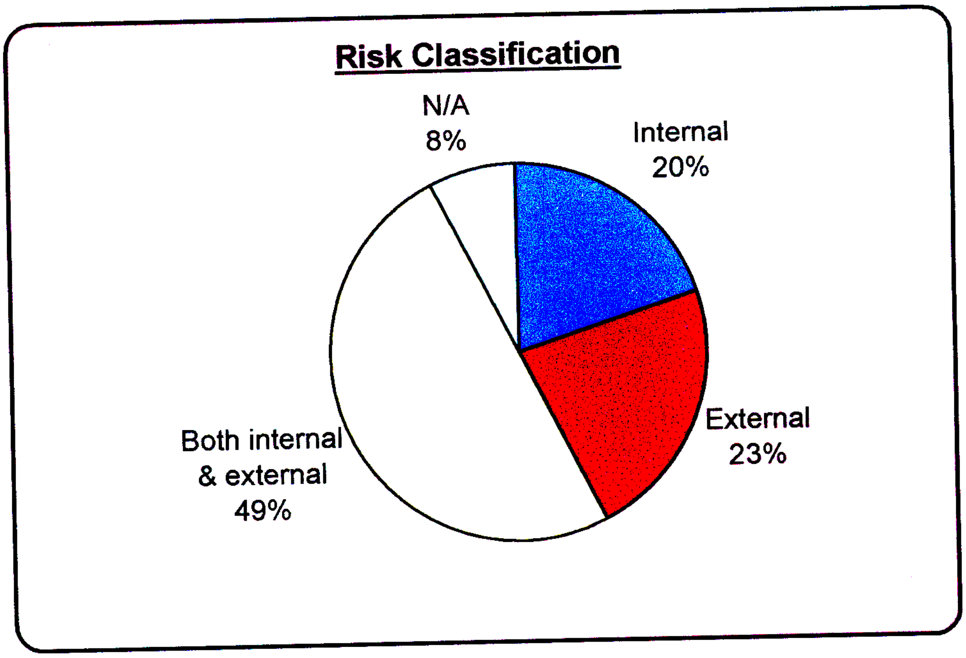


Figure 5.3. Risk Classification Analysis

Table 5.4. Risk Classification Criteria

		Risk Classification	
	CLAUSES	**Internal**	**External**
6.0	SITE REPRESENTATIVE	100%	
14.0	SECURITY	100%	
15.0	WORKS EXECUTION	100%	
18.0	SETTING OUT OF THE WORKS	100%	
21.0	SELECTED SUBCONTRACTORS	100%	
23.0	DOMESTIC SUBCONTRACTORS	100%	
27.0	LATENT DEFECTS	100%	
30.0	PENALTY	100%	
5.0	EMPLOYER'S AGENTS		100%
7.0	REGULATIONS		100%
20.0	NOMINATED SUBCONTRACTORS		100%
22.0	DIRECT CONTRACTORS		100%
29.0	REVISION OF DATE FOR PRACTICAL COMPLETION		100%
35.0	PAYMENT TO OTHER PARTIES		100%
36.0	CANCELLATION - CONTRACTOR'S DEFAULT		100%
37.0	CANCELLATION BY EMPLOYER. LOSS AND DAMAGE		100%
38.0	CANCELLATION - EMPLOYER'S DEFAULT		100%
3.0	DOCUMENTS	50%	50%
4.0	DESIGN RESPONSIBILITY	50%	50%
8.0	WORKS RISK	50%	50%
9.0	INDEMNITIES	50%	50%
10.0	WORKS INSURANCES	50%	50%
11.0	LIABILITY INSURANCES	50%	50%
12.0	EFFECTING INSURANCES	50%	50%
16.0	ACCESS TO THE WORKS	50%	50%
17.0	CONTRACT INSTRUCTIONS	50%	50%
19.0	ASSIGNMENT	50%	50%
24.0	PRACTICAL COMPLETION	50%	50%
25.0	WORKS COMPLETION	50%	50%
26.0	FINAL COMPLETION	50%	50%
28.0	SECTIONAL COMPLETION	50%	50%
31.0	INTERIM PAYMENT	50%	50%
32.0	ADJUSTMENT TO THE CONTRACT VALUE	50%	50%
33.0	RECOVERY OF EXPENSE AND LOSS	50%	50%
34.0	FINAL ACCOUNT AND FINAL PAYMENT	50%	50%
39.0	CANCELLATION-CESSATION OF WORKS	50%	50%
40.0	DISPUTE SETTLEMENT	50%	50%
1.0	DEFINITIONS	N/A	
2.0	OFFER, ACCEPTANCE AND PERFORMANCE	N/A	
13.0	NO CLAUSE	N/A	

Question 5

Do you think this framework adequately cover all areas in the different categories when applied	Yes	No

Objective:

This question was employed to identify if the framework indeed covered all areas when applied.

Response:

All of the respondents stated that the framework adequately covered all areas of risk when applied.

Question 6

How do you rate the framework? Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Objective:

A rating of the framework was obtained with this question.

Response:

Seventy five percent of the respondents rated the framework as very good, while twenty five percent rate it as good.

Question 7

In your opinion, would an Identification, Quantification and Classification framework be of benefit to your firm?	Yes	No

Objective:
This question was used to establish if the framework would be of benefit to construction firms.

Response:
All of the respondents believed that the framework could be of benefit to their firms by either assisting junior employees, as an aid in training employees to use the JBCC contract or to fill in and compliment their current systems.

Question 8

Do you have any other suggestions to make?

Objective:
Further suggestions on the framework were obtained with this question.

Response:
The following suggestions were made by the respondents:

- It needs to include a section on health and safety
- A section might be added to account for quality
- A further study could include a column for cost.

The above factors were not included in the framework as it did not fall within the scope of the study area. These factors will be suggested for future research.

5.6 Data Analysis of the Correlation Matrix of Risk Sources

The next section is based on interview-2 (refer to Appendix (F)). This interview was used to ask the interviewee to identify which project team member represents a risk source to the contractor.

In this research both questionnaires and structured interviews were utilised to identify the contractor's risk sources associated with the JBCC (PBA). Respondents of the first questionnaire and interview were engaged in answering the second questionnaire/interview. Respondents to the questionnaire and interviewees are asked to select the risk source from a list of project team members. They were (1) client, (2) principal agent, (3) architect, (4) quantity surveyor, (5) engineer, (6) supplier, (7) sub-contractor and (8) government authority.

Question 1

Given the summarised clauses in a matrix on the following pages, Please identify which party represents a source of risk to the contractor. Note: their can be more than one party for any clause.

Objective:
To identify which party represents a source of risk as per the JBCC (PBA) clause by clause.

Response:
The outcome of the questionnaire and the interview as presented in Figure 5.4. and Table 5.5. are as follows:

- The client (25%) represents the greatest risk source to the contractor in clauses 3, 9, 10, 11, 12, 19, 31, 37, 38 and 39. This verifies various literary sources that re-iterate this point. The client poses an immense risk because he decides on the project to be built, the design, the ultimate budget, commencement and completion dates and if there are to be any variations.

- Sub-contractors represent 5% of the risk source to the contractor. This is particularly in the case of Clause 21 - Selected sub-contractors and Clause 23 - Domestic sub-contractors because if any subcontractor delays the completion of their job, they will definitely delay the main contractor.

- 15% of the risks were the source of the client and either the quantity surveyor, sub-contractor or government authority.
  - Clauses 22, 27 and 20 are a source of risk from the client and sub-contractor because a delay on their side could result in increase cost and delay to the main contractor.
  - Clauses 33 and 34 are a source of risk from the client and quantity surveyor as an incorrect and late compilation of the accounts and hinder the contractors cash flow
  - Clause 7 is a source of risk from the client and government authority as new regulations or a change in existing regulations can hinder construction operations.

- 13% of the risks are the source of the client and two or three other parties.
  - Clause 32 is the source of the client together with the architect and the quantity surveyor, because it could be a change that the client requires, that the architect needs to draw and the quantity surveyor need to price, for the adjustment of the contract value.
  - Clause 15 is the source of the client, quantity surveyor and the sub-contractor,
  - Clause 35 is the source of the client together with the principal agent, quantity surveyor and sub-contractor because the client and the principal agent will decide to pay the sub-contractor directly and the quantity surveyor has to compile the payment.
  - Clause 18 is the source of the client, engineer and the government authority,
  - Clause 4 is the source of the client, principal agent, architect and engineer.

- Clauses 17, 5, 24, 25, and 26 (13% of the clauses) are sourced from the client, principal agent, architect, quantity surveyor, engineer, and sub-contractor. A default by any one for these parties could pose a serious problem to the contractor, for example, should a principal agent not sign a contract instruction, the contractor has very little chance of getting paid.

- Clauses 16, 29 and 40 (8%) are sourced from all the categories.

- 21% of the clauses are not applicable because they either do not contain any words or they are explanations of various aspects of the contract or the contractor is directly responsible (Harinarain and Othman, 2007b).

It is interesting to note that the order of the risk sources are the client in first position, the sub-contractors in second position and the third source of risk to the contractor is the quantity surveyor. This was an unusual outcome, but the respondents explained that the quantity surveyor was critical in obtaining interim payments, final accounts, assessing claims, pricing variations, etc. any of which could hinder or cancel the project.

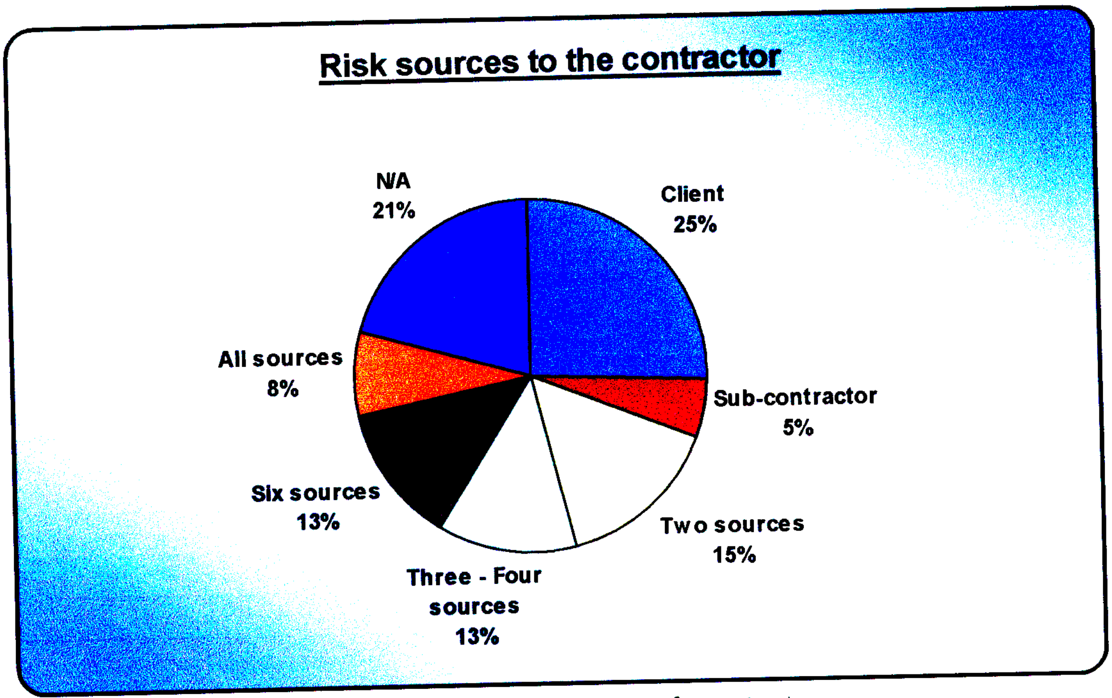


Figure 5.4. Risk sources to the contractor

Table 5.5. Correlation Matrix of Risk Sources to the contractor.

Clauses		Sources of Risk to the Contractor							
		Client	Principal Agent	Architect	Quantity Surveyor	Engineer	Supplier	Sub-contractor	Government Authority
3.0	DOCUMENTS	100%							
9.0	INDEMNITIES	100%							
10.0	WORKS INSURANCES	100%							
11.0	LIABILITY INSURANCES	100%							
12.0	EFFECTING INSURANCES	100%							
19.0	ASSIGNMENT	100%							
31.0	INTERIM PAYMENT	100%							
37.0	CANCELLATION BY EMPLOYER. LOSS AND DAMAGE	100%							
38.0	CANCELLATION BY CONTRACTOR - EMPLOYER'S DEFAULT	100%							
39.0	CANCELLATION-CESSATION OF WORKS	100%							
21.0	SELECTED SUBCONTRACTORS							100%	
23.0	DOMESTIC SUBCONTRACTORS							100%	
22.0	DIRECT CONTRACTORS	67%						33%	
27.0	LATENT DEFECTS	67%						33%	
20.0	NOMINATED SUBCONTRACTORS	50%						50%	
33.0	RECOVERY OF EXPENSE AND LOSS	50%			50%				
34.0	FINAL ACCOUNT AND FINAL PAYMENT	50%			50%				
7.0	REGULATIONS	17%							83%
32.0	ADJUSTMENT TO THE CONTRACT VALUE	44.44%		11.11%	44.44%				
15.0	WORKS EXECUTION	44.44%			44.44%			11.11%	
35.0	PAYMENT TO OTHER PARTIES	33%	17%		33%			17%	
18.0	SETTING OUT OF THE WORKS	33%				50%			17%
4.0	DESIGN RESPONSIBILITY	8%	8%	42%		42%			
17.0	CONTRACT INSTRUCTIONS	18.89%	18.89%	18.89%	18.89%	18.89%		5.56%	
5.0	EMPLOYER'S AGENTS	17.78%	17.78%	17.78%	17.78%	17.78%		11.11%	
24.0	PRACTICAL COMPLETION	17.78%	17.78%	17.78%	11.11%	17.78%		17.78%	
25.0	WORKS COMPLETION	17.78%	17.78%	17.78%	11.11%	17.78%		17.78%	
26.0	FINAL COMPLETION	17.78%	17.78%	17.78%	11.11%	17.78%		17.78%	
16.0	ACCESS TO THE WORKS	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
29.0	REVISION OF DATE FOR PRACTICAL COMPLETION	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
40.0	DISPUTE SETTLEMENT	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
1.0	DEFINITIONS	N/A							
2.0	OFFER, ACCEPTANCE AND PERFORMANCE	N/A							
6.0	SITE REPRESENTATIVE	N/A							
8.0	WORKS RISK	N/A							
13.0	NO CLAUSE	N/A							
14.0	SECURITY	N/A							
30.0	PENALTY	N/A							
36.0	CANCELLATION - CONTRACTOR'S DEFAULT	N/A							

Question 2

Do you have any other suggestions to make?

Objective:

Further suggestions on the framework were obtained with this question.

Response:

The respondents had no further suggestions to make.

5.7 Summary of Key Research Findings

The Identification, Quantification and Classification framework presented to the construction firms in the questionnaire for approval and suggestions was unanimously accepted with 75% of the respondents rating it as very good.

The evaluated IQCF was then applied to the individual clauses of the JBCC (PBA), and interviews were conducted. The findings were as follows:

1. Although the firms identify risks in the JBCC when tendering, they do not do this often enough because it was too time consuming and there is a lack of training.

2. The methods used to identify risks were planning meetings, analysing the tender documents, looking for conditions that are onerous and any amendments to the JBCC document itself. But these methods were not always in-depth and due to time pressures poorly carried out.

3. The IQCF is an innovative tool that aims to fill the gap in risk management through making risk identification, quantification and classification simple and easy understanding.

4. Most firms admitted that they quantified risk by looking at the impact of the clauses on the contract, the preliminaries and general structure, the profitability, duration, the buildability of

the project and value engineering and it is believed that the IQCF can greatly aid in improving risk quantification.

5. Majority of the respondents utilised Excel spreadsheets to assist them in the classification of risk. A method used was signing points to each participant to see the risk carried by them.

6. The techniques employed by the respondents to manage risk were contingence measures, meetings, identifying and quantifying risks, probability of occurrence, profiling risks, crisis management and post tender - value engineering. The use of the IQCF and its detailed analysis will aid and help improve current practices in place.

7. The next section of interview-1 applied the framework to the JBCC contract clause by clause, under the categories of:

   a. **Risk identification** –
      - Clause 40 and Clause 17 fall under all the risk identification criteria.
      - Clause 29 and Clause 30 reduced the company's strengths by 100%.
      - Clause 20 and Clause 21 increased the company's weaknesses by 100%.
      - Clause 4 reduced the company's opportunity by 100%.
      - Clause 7, Clause 15 and clause 31 increased the company's threats by 100%.
      - Clause 16, Clause 18, Clause 33 and Clause 34 reduced the company's strength by 50% and at the same time increased its weakness by 50%.
      - Clause 10, Clause 11, Clause 12, Clause 22 and Clause 32 reduced the company's strength by 50% and at the same time increased its threats by 50%.
      - Clause 6, Clause 23, Clause 28 and Clause 35 increased a company's weakness by 50% and at the same time reduced the company's opportunities by 50%.
      - Clause 5, Clause 36 increased the company's weakness and at the same time increased the company's threats.
      - Clause 9, Clause 19, Clause 24, Clause 25, Clause 26, Clause 37 and Clause 39 reduced the company's opportunities by 50% and at the same time increasing the company's threats by 50%.
      - Clause 27 reduced the company's strength and opportunities and increased the company's weakness
      - Clause 3 reduced the company's strength and increased the company's weakness and threats.

- Clause 8 and Clause 38 reduced the company's strength and opportunities and increased the company's threats.
- Clause 14 increased the company's weakness and threats and reduced the company's opportunities.
- The majority of the clauses, 27 in number were split between the various categories,
- Clauses 1, 2 and 13 were not applicable because they either do not contain any words or they are explanations of various aspects of the contract.

b. **Risk quantification** – clause 17; Contract instructions had the highest probability of occurrence and the greatest severity once it occurs. This was followed by clause 5 (Employers agent) and clause 29 (Revision to date of practical completion). Clause 25 (Works completion) had the third highest score.

c. **Risk classification** - 20% of the risks were classified as internal, while 23% of the risks are external. 49% of the risks are both internal and external, meaning both the contractor and the external party have control over this risk. 8% of the risks are not applicable because they either do not contain any words or they are explanations of various aspects of the contract.

8. All of the respondents stated that the framework adequately covered all areas of risk when applied.

9. 75% of the respondents rated the framework as very good, while 25% rate it as good.

10. All of the respondents believed that the framework could be of benefit to their firms by either assisting junior employees, as an aid in training employees to use the JBCC contract or to fill in and compliment their current systems.

11. It was suggested the further studies could include sections on health and safety, quality and cost, which was not included here as it did not fall within the scope of this study.

The second questionnaire and interview was used to identify **Sources of risk to the contractor.**

- 25% of the source of risk to the contractor was posed by the client in clauses 3, 9, 10, 11, 12, 19, 31, 37, 38 and 39.

- Sub-contractors pose 5% of the risk source in clauses 21 and 23.
- Clauses 22, 27 and 20 are a source of risk from the client and sub-contractor.
- Clauses 33 and 34 are a source of risk from the client and quantity surveyor.
- Clause 7 is a source of risk from the client and government authority.
- Clause 32 is the source of the client together with the architect and the quantity surveyor,
- Clause 15 is the source of the client, quantity surveyor and the sub-contractor,
- Clause 35 is the source of the client together with the principal agent, quantity surveyor and sub-contractor.
- Clause 18 is the source of the client, engineer and the government authority,
- Clause 4 is the source of the client, principal agent, architect and engineer.
- Clauses 17, 5, 24, 25, and 26 (13% of the clauses) are sourced from the client, principal agent, architect, quantity surveyor, engineer, and sub-contractor.
- Clauses 16, 29 and 40 (8%) are sourced from all the categories.
- 21% of the clauses (clauses 1, 2, 6, 8, 13, 14, 30 and 36) were not applicable because they either do not contain any words or they are explanations of various aspects of the contract or the contractor is directly responsible.
- It is interesting to note that the order of the risk sources are the client in first position, the sub-contractors in second position and the third source of risk to the contractor is the quantity surveyor. This was an unusual outcome, but the respondents explained that the quantity surveyor was critical in obtaining interim payments, final accounts, assessing claims, pricing variations, etc. any of which could hinder or cancel the project.

5.8 Conclusion

This chapter presented the analysis of the data collected from the questionnaires and the structured interviews. The analysed data provided beneficial and valuable insight to the research, which is the development of an identification, quantification and classification framework to assist contractors in managing risk associated with the JBCC (PBA) contract.

Analysis of the data collected showed typical close central values of the means, medians and modes which reflect the homogeneity of the data collected. The analysis of the sources of risk to the contractor showed that the client posed most of the risk source, followed by the sub-contractor and the quantity surveyor.

The framework presented to industry was considered to be an innovative and accepted tool that was able to fill the gap in managing project risks and compliment current practices in terms of risk identification, quantification and classification. It was seen to be of benefit to firms in assisting with training of employees and helping junior employees understand and use the JBCC (PBA).

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter outlines the conclusions and recommendations of this research. The conclusions are drawn by comparing the literature review with the findings of the survey questionnaires and interviews. It outlines the research undertaken to identify, quantify and classify risks pertaining to building contractors in the JBCC (PBA). A brief description of the research work is provided. The Identification, Quantification and Classification Framework is summarised and the research publications are presented. This chapter concludes by providing recommendations for the industry and future research.

6.2 Conclusions and Contribution to the Original Body of Knowledge

6.2.1 Definition of conclusion

According to Youngstown State University (2007) the conclusion of a research is its most important part as the conclusion is the last word on the subject; it provides the readers with a sense of completeness or finality. Holewa and Mathison (2004) state that a conclusion should stress the importance of the thesis statement, give the essay a sense of completeness, and leave a final impression on the reader. The conclusion in this research emphasizes the significant aspects of this research and provides a concise description of the study undertaken.

6.2.2 Definition of contribution

According to Merriam Webster's On-line Dictionary (2006) contribution is defined as the act of supplying (as an article) for a publication. One research paper has been published from this research and a second paper is under review.

The framework for the identification, quantification and classification of risk from the contractor's perspective has thus far received limited consideration and provides a new innovative tool for risk management. This research is original was not previously conducted. This research adds a new contribution to the original body of knowledge by providing a foundation in terms of risk and the JBCC (PBA) contract that was not researched in the past. Tangible value to the South African society is thus provided. It helps contractors manage risk and aids in improving the image of the South African construction industry.

6.3 Summary of the Research work done

Risks are present in every aspect of doing business and are a natural part of any construction project mainly because construction is a multifaceted process that has a wide variety of complex situations. It is important to understand the full potential effect of risks before entering into a contract as poor risk identification, quantification and classification could lead to increased risk exposure, a poor reputation of construction contractors and a bad image of the South African construction industry.

The construction industry is facing a more challenging environment than any time in the past. Client expectations have grown higher and clients are in need of better quality and better service. Major clients are demanding that multi-million rand projects are delivered within fixed-price budgets and tight time-scales. Eventually, all of these factors will lead to risk.

Because of the importance of improving the poor reputation and the bad image of the South African construction industry, proper risk identification, quantification and classification using the JBCC can help minimise these risks. An Identification, Quantification and Classification Framework (IQCF) can assist contractors assimilate all this information.

This research aimed to investigate the risks associated with the JBCC (PBA) from the contractor's perspective. In order to achieve this aim the following objectives had to be accomplished:

1) Establishing a clear understanding of the nature of risk and risk management in the construction industry, construction contracts (JBCC (PBA) in particular), investigate how building contractors identify, quantify and classify risks in terms of the JBCC (PBA), understanding the IDEF-0 and Plan-Do-Study-Act cycle.
2) Developing the Identification, Quantification and Classification framework.
3) Evaluating the developed framework.
4) Applying the developed framework to identify, quantify and classify the risks associated with the JBCC (PBA).
5) Developing the correlation matrix of risk sources to the contractor.

The research methodology designed to achieve the above aim and objectives adopted the Plan, Do, Study and Act (PDSA) cycle. In the **Plan Phase,** the problem statement was identified, the aim and objectives were established and the identification, quantification and classification framework was developed. In the **Do Phase** risk was identified from various literary sources and then they were compared to the JBCC contract, clause by clause. The IQCF was then compiled into a questionnaire so that feedback from the contractor's about the framework could be collected and adjusted according. The developed framework was applied using an interview process. The final process entailed developing a risk source matrix. The **Study Phase** involved the analysis of the questionnaires and interviews. In the **Act Phase** the results were reported and documented and it was also used to enrich the b body of knowledge through the compilation of two research papers. A risk source correlation matrix was developed and recommendations for the industry and further research were provided.

The data analysis stage was concerned with analysing data from the questionnaire and interview.

- Risks were identified in terms of strengths, weaknesses, opportunities and threats.
- Risks were quantified based on the probability of occurrence (P) and its severity (S), where the result is (R= P * S). The measure of Central Tendency and the Relative Importance Index were also used for quantitative analysis.
- The last step of the framework analysis was the classification of the risks identified and quantified. Classifying risks enables the contractor to consider them within a more coherent framework.
- A correlation matrix of risk sources to the contractor was also developed and analysed.

The research hypothesis was proved to be true in that an Identification, Quantification and Classification framework can assist contractors in identifying, quantifying and classifying risk in the JBCC (PBA). The conclusions drawn from this research and contribution to original knowledge are further summarised under the following headings:

6.3.1 Identification of the Risk associated in the JBCC (PBA) clauses

Since the framework adopts the contractor's perspective, the first step of risk identification was to identify all potential risks that could possibly affect the contractor. The end result of an in depth literature review resulted in identifying (136) risks. These risks were then compared with the clauses of the JBCC (PBA) in order to ensure that the most important risks were covered in the JBCC (PBA). The final step of risk identification was the establishment of the criteria that will be used to state the risks associated with JBCC (PBA) clauses. The criteria used internal risk which reduces a company's strength and increases it weakness and external risk which reduces a company's opportunities and increasing its threats. Clause 40 and Clause 17 fall under all the risk identification criteria.

6.3.2 Quantification of the Risk associated in the JBCC (PBA) clauses

The next step of the framework development was to quantify the risk associated with the JBCC (PBA) clauses from the contractor's perspective to identify the most influential ones. Risks were quantified based on the probability of occurrence (P) and its severity (S), where the result is (R= P * S). This quantification was carried out through an interview with a selected number of managers of construction companies. The Likert scale of 1 to 5 was used to quantify the probability and severity of these risks. The numerical scores from the interview provided an indication of the varying degree of influence that each risk has on the contractor. To further investigate the data, a relative importance index (RII) was used to rank the risks according to their influences. Clause 17 had the highest probability of occurrence and the greatest severity once it occurs. This was followed by clause 5 and clause 29. Clause 25 had the third highest score.

6.3.3 Classification of the Risk associated in the JBCC (PBA) clauses

The last step of the framework development is the classification of the risks identified and quantified. Classifying risks enables the contractor to consider them within a more coherent framework. It allows one to establish a common understanding of different risks, and provides an essential basis for effective knowledge transfer, within an organisation and from one project to another. Risk Classification was carried out in terms of internal risks (risks which emerge from within the contractor's organisation and falls under control of the contractor) and external risks (risks which emerge from outside the contractor's organisation). 20% of the risks were classified as internal, while 23% of the risks are external. 49% of the risks are both internal and external, meaning both the contractor and the external party have control over this risk. 8% of the risks are not applicable because they either do not contain any words or they are explanations of various aspects of the contract.

6.3.4 Developing the IQCF

IQCF is the set of functions, activities, procedures as well as the tools and techniques required to assist construction contractors better understand the risks associated with the clauses of the JBCC (PBA). The IQCF will help the contractors draw the appropriate risk management plan to mitigate the adverse effects of these risks. The conceptual description of the IQC framework was presented. The IQCF is based on three systematic steps: 1) Risk Identification, 2) Risk Classification and 3) Risk Quantification. In order to select the appropriate way to represent the framework, various modelling tools were considered, but the

IDEF-0 was adopted as the most appropriate tool. The IDEF-0 description and rationale behind its selection was illustrated. The benefits and limitations of the IDEF-0 methodology were also discussed. The IQCF was modelled and its application, benefits and limitations were discussed.

All of the respondents stated that the framework adequately covered all areas of risk when applied. The Identification, Quantification and Classification framework presented to the construction firms and it was unanimously accepted with 75% of the respondents rating it as very good. All of the respondents believed that the framework could be of benefit to their firms by either assisting junior employees, as an aid in training employees to use the JBCC contract or to fill in and compliment their current systems.

6.3.5 Risk Originators to the contractor

Respondents to the questionnaire and interviewees are asked to select the risk source from a list of project team members. They were (1) client, (2) principal agent, (3) architect, (4) quantity surveyor, (5) engineer, (6) supplier, (7) sub-contractor and (8) government authority. The order of the risk sources are the client in first position, the sub-contractors in second position and the third source of risk to the contractor is the quantity surveyor. This was an unusual outcome, but the respondents explained that the quantity surveyor was critical in obtaining interim payments, final accounts, assessing claims, pricing variations, etc. any of which could hinder or cancel the project.

6.4 Publications and Proposed Publications

Two research papers were produced from this research, one of which has been published and the other is under review..

- The published paper is entitled "A Framework for Identifying, Quantifying and Classifying Risks associated with the Principal Building Agreement in South Africa" Proceedings of the 2nd Built Environment Conference, Port Elizabeth, South Africa, 17 – 19 June 2007, pp. 138-151.
- The second paper is to be presented at the 5th CIDB Post Graduate Conference in March 2008 at the University of the Free State, is entitled "Investigating the contractor's risk Sources associated with the Principal Building Agreement in South Africa."

Both these papers present a positive contribution to construction contractors in general and in informing the academic community of the research been carried out.

6.5 Research Recommendations

As a result of the findings and conclusions of this research, the following recommendations are made:

6.5.1 Recommendations for the Industry

- The construction industry is advised to adopt the IQCF developed through this research, to assist in their risk management procedures.
- The construction industry is advised to adopt the risk source correlation matrix developed through this research, to assist in their risk management procedures.
- Escalating contractor awareness to better manage project risk.

6.5.2 Recommendations for Further Research

- Applying the developed framework to other forms of contracts in South Africa.
- Develop the framework in an electronic software or on-line format.
- Further research could be conducted by adding additional aspects such as quality, health and safety and cost to the framework.
- Further research could be conducted into incorporating all the risks identified from literary sources in Appendix (A) into the JBCC (PBA).

The research undertaken has provided knowledge and understanding to an area that has had very little coverage in the South African context. The development of an Identification, Quantification and Classification Framework (IQCF) that will assist construction contractors to identify, quantify and classify risks in the JBCC (PBA) is an area that was not previously researched. On the whole this research is innovative, unique and adds great value to the original body of knowledge by filling a gap in construction literature and covering an area that had not previously been studied.

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APPENDIX - A

IDENTIFIED RISK FROM LITERARY SOURCES

No.	Risk Cause	Literature Reference	Is this clause considered in the JBCC (PBA)	Clause No.
A	Risk considerations of contractors			
AA	**Client risks**			
1	Breach, default or abandonment of contract by client, i.e. Client cancels project	Edwards, 1995	Yes	37, 38
2	Client delays start of project	Edwards, 1995	Yes	15, 29
3	Client suspends works	Edwards, 1995	Yes	38
4	Client delays payments of certificates and claims	Edwards, 1995	Yes	3
5	Client delays taking over works	Edwards, 1995	Yes	29
6	Client Liquidity - Client insolvency leaves outstanding debts for work done	Lavender, 1996; Edwards, 1995; Athearn and Pritchett, 1984.	Yes	3, 38
7	Inadequate supply, quality, timing of information and drawings by client's designers, architects, etc.	Edwards, 1995	Yes	4, 5
8	Unexpectedly onerous requirements by client's supervisors	Edwards, 1995	Yes	5
9	Unexpected inadequacy of pre-construction site investigation data in terms of interpretation or recommendations	Edwards, 1995	Yes	7,18
10	Changes in requirements - occupancy, usage, size, scope pre- and post-contract award	Edwards, 1995	Yes	17
11	Clients are often ill equipped to deal with construction projects	Grinfeld and Simpson, 1998; Lavender, 1996	Yes	5
12	Consequence of delays in interconnecting contracts	Edwards, 1995	Yes	29
13	Inaccurate or insufficient terms of reference	Edwards, 1995	Yes	4,5
14	Changes to timescale - late decision taking, late handing over of site	Edwards, 1995	Yes	29
	Owners not providing the following items:			
15	Building site that meets local code and zoning requirements for the intended building use	Papageorge, 1988	Yes	7
16	Site survey, establishing boundary, and topographic configurations	Papageorge, 1988	Yes	18
17	Project and design budgetary funds	Papageorge, 1988	Yes	31, 32, 33, 34, 35
18	Depending on the contract between the owner and the contractor, the owner may have to provide the project insurance or require the contractor to do so	Papageorge, 1988	Yes	10, 11, 12
19	Furnish in a timely manner program information requested by the designer	Papageorge, 1988	No	
20	Timely reviews and approvals of each stage of design	Papageorge, 1988	Yes	5, 24, 25, 26
21	Timely approval of materials and building systems that owners wish to control	Papageorge, 1988	Yes	29
22	Final selection of the contractor based on the designer's recommendations	Papageorge, 1988	Yes	5
23	Within the construction process, timely payment for services rendered by the contractor and architect,	Papageorge, 1988	Yes	31, 32, 33
24	Approval or disapproval of change order work	Papageorge, 1988	Yes	17
AB	**Supplier/subcontractor risks**			
25	Subcontractor (nominated or otherwise) and or Supplier start delay	Edwards, 1995	Yes	20, 21, 22, 23
26	Supplier poor performance, quality of materials, timing, delivery of information	Edwards, 1995	Yes	20, 21, 22, 24
27	Subcontractor poor performance, quality of materials, workmanship, design, timing, delivery of information	Edwards, 1995	Yes	20, 21, 22, 25
28	Subcontractor insolvency.	Edwards, 1995	Yes	20, 21, 22, 26
29	Poor co-ordination of subcontractors	Edwards, 1995; Flanagan and Norman, 1993.	Yes	20, 21, 22, 27
30	Nominated subcontractor delaying the work,	Flanagan and Norman, 1993.	Yes	20, 21, 22, 28
AC	**Constructional plant risks**			
31	Delay in availability of constructional plant	Edwards, 1995	Yes	36
32	Poor performance/Breakdown/Damage of constructional plant	Cleland, 1998; Edwards, 1995.	No	
33	Lack of standby plant, spares	Edwards, 1995	No	
34	Fall in expected resale values	Edwards, 1995	No	
35	Fire and/or theft of material and/or equipment	Cleland, 1998; Edwards, 1995.	No	
AD	**Direct contractor risks**			
36	Shortages of experienced staff and labour	Edwards, 1995	Yes	6
37	Contractor delays start	Edwards, 1995	Yes	15, 39
38	Poor performance, inappropriate materials workmanship, design, timing	Edwards, 1995	Yes	4
39	Management inefficiency	Edwards, 1995; Flanagan and Norman, 1993.	No	
40	Poor performance by any joint venture partners	Edwards, 1995	No	
41	Liabilities for injury, damage or interference to persons or third party property on or off the site	Edwards, 1995	Yes	16
42	Long-term responsibilities for latent defects which become evident after the end of a contract	Edwards, 1995; Flanagan and Norman, 1993.	Yes	8
43	Strikes, labour disputes, strikes, sabotage, terrorism	Cloete, 2001; Cleland, 1998; Edwards, 1995; Flanagan and Norman, 1993.	Yes	8
44	Consequential losses, e.g. loss of profits arising from incidents	Edwards, 1995	No	
45	Accident to key operatives, management staff	Edwards, 1995	No	
46	Frustration of contract due to some fortuitous intervening event altering the nature of the contract to the extent that it can no longer be undertaken as intended	Edwards, 1995	Yes	31-39
47	Significant or temporary and permanent works failures during the construction due to design, materials or workmanship.	Edwards, 1995	Yes	4, 8
48	Unforeseen events and delays not allowed for in tender.	Edwards, 1995	Yes	8
49	Malicious damage, terrorism, war, civil commotion	Edwards, 1995	Yes	8

No.	Risk Cause	Literature Reference	Is this clause considered in the JBCC (PBA)	Clause No.
50	Low construction productivity	Cleland, 1998; Flanagan and Norman, 1993.	No	
51	Construction-related - different site conditions	Cleland, 1998; Flanagan and Norman, 1993.	No	
52	Construction-related - defective work	Cleland, 1998; Flanagan and Norman, 1993.	Yes	17
53	Construction-related - equipment failures	Cleland, 1998; Flanagan and Norman, 1993.	No	
	Typical risks on a construction project include:			
54	Failure to meet programme due to inadequate resources, estimates of duration of activities, shortage of material, lack of skills	Carter *et al.* , 1997; Edwards, 1995	No	
55	Failure to obtain the expected outline planning, detailed planning or building code/regulation approvals within the time allowed in the design programme	Lavender, 1996; Flanagan and Norman, 1993.	No	
56	Unforeseen adverse ground conditions delaying the project;	Edwards, 1995; Flanagan and Norman, 1993.	Yes	29
57	Unforeseen services, obstructions, contamination, water inflows, etc.	Edwards, 1995	Yes	29
58	Archaeological finds	Edwards, 1995	No	
59	Exceptionally inclement weather delaying the project;	Cleland, 1998; Flanagan and Norman, 1993.	Yes	29
60	Natural disasters (earthquakes, floods, lightning) force majeure (flood, earthquake etc.)	Cloete, 2001; Edwards, 1995; Flanagan and Norman, 1993.	Yes	17, 29
61	Unexpected price rises for labour and materials;	Flanagan and Norman, 1993.	No	
62	Failure to complete the project within the client's budget allowance.	Flanagan and Norman, 1993.	No	
63	Loss due to fire, corrosion, explosion, structural defect, war.	Cloete, 2001; Edwards, 1995; Athearn and Pritchett, 1984	Yes	17, 29
64	Failures in buildings (structural/ components/ services) through design errors, poor maintenance or wear and tear	Cloete, 2001; Edwards, 1995	Yes	4
65	Environmental risks	Cloete, 2001; Edwards, 1995	No	
66	Loss of profits following theft	Edwards, 1995; Athearn and Pritchett, 1984	No	
67	Changes in public opinion, expectations of work force, greater awareness of moral issues (e.g. environment)	Edwards, 1995	No	
68	Tortious liabilities, statutory liabilities, contractual liabilities	Edwards, 1995	No	
69	Governmental intervention, sanctions, acts of foreign governments, inflationary/deflationary policies, export/import restrictions, trading alliances, changes in legislation	Cleland, 1998; Edwards, 1995	Yes	7
70	Inadequate inflation forecasts, incorrect marketing decisions, credit policies.	Cleland, 1998; Edwards, 1995	Yes	31
71	Increased technology in manufacture, communications, data handling, interdependency of manufacturers, , methods of storage, stock control and distribution.	Cleland, 1998; Edwards, 1995	No	
72	Vague specially written conditions of contract or changed conditions in standard forms of contract which leads to poor interpretation	Edwards, 1995; Flanagan and Norman, 1993; Papageorge, 1988	Yes	17
73	Interface and co-ordination problems where more than two parties are involved, for example on a project with a suspended ceiling. The general contractor, the suspended ceiling specialist contractor, the air conditioning specialist and the electrical, specialist	Flanagan and Norman, 1993.	No	
74	Ambiguous specification clauses with decisions left at the discretion of either party;	Flanagan and Norman, 1993.	No	
75	Deficient drawings or design with discrepancies between the architectural, structural and engineering services drawings.	Cleland, 1998; Lavender, 1996; Flanagan and Norman, 1993.	No	
76	Safety and indemnification for all accidents	Flanagan and Norman, 1993.	Yes	9, 16
77	Lack of quality of workmanship and materials - responsibility for fitness for purpose and for ensuring the quality is acceptable	Carter *et al*., 1997; Flanagan and Norman, 1993.	No	
78	Late delivery of crucial materials, for instance after a fire at a suppliers' works	Flanagan and Norman, 1993.	No	
	Inherent site-specific risks			
79	Access restrictions or limitations	Edwards, 1995	Yes	16
80	Existing occupiers/users alternative provisions (e.g. accommodation, parking), working hour restrictions, maintenance of access (road-footpaths)	Edwards, 1995	Yes	17
81	Effect of existing buildings - need for protection and/or demolition	Edwards, 1995	Yes	17, 10
82	Existing site boundaries, need to protect and keep in good condition, need for temporary enhancement to suit works	Edwards, 1995	Yes	18
83	Security - protection of works in hand, including temporary works, particularly if several contractors on the same site, security provisions including staffing	Edwards, 1995	Yes	8
84	Additional land requirements for permanent works, for temporary works or for access	Edwards, 1995	No	
85	Requirements for new services from statutory undertakings of these will include water, sewage, electricity, telephone	Edwards, 1995	No	
86	Use of existing services - their availability to suit site requirements, capacity, conditions need to determine location, effect of disruption, need for relocation around site	Edwards, 1995	Yes	8
87	The company risk - Any company operates within a market. The company will have a number of current projects at anyone time, each project generally being a profit centre. Project risk and company risk are intrinsically linked. If a contractor has a major project which is losing money, it will have an effect upon the company's financial performance.	Flanagan and Norman, 1993.	No	
88	Liquidation/insolvency of contractor.	Edwards, 1995	No	

No.	Risk Cause	Literature Reference	Is this clause considered in the JBCC (PBA)	Clause No.
89	Moral Hazard - Dis-honesty or lack of integrity in an individual can increase the chance of loss to 100 percent.	Athearn and Pritchett, 1984	No	
90	Poor housekeeping (for example, allowing trash to accumulate)	Athearn and Pritchett, 1984	No	
91	Attitudes to risk - The main 'developers' are property companies, financial institutions, public sector agencies and occupiers. Some of these developers are more inclined than others to accept uncertainty, or 'take a risk', some are risk loving, risk averse, risk neutral.	Bryne, 1996; Flanagan and Norman, 1993.	No	
92	Changing method of production - may involve changes to quantity and quality of resources. Examples include using more and bigger plant, using faster production techniques	Lavender, 1996	No	
93	Whilst size is an important consideration, factors such as location, complexity, buildability, and type of building can all contribute to the risk.	Flanagan and Norman, 1993.	No	
94	It is rare for two construction projects to be exactly alike. By their nature they are different, which means every project has to be considered afresh..	Flanagan and Norman, 1993.	Yes	17
95	Employing additional resources - a quantitative increase in resources. It may sometimes be possible to accelerate the programme sufficiently by employing additional resources, but at other times this may not be practicable, for example: the location of the site may not be easily accessible, the nature of the problem activities may make it physically impossible to deploy additional resources.	Lavender, 1996	No	
AE	**Financial risks**			
96	Fixed-price budgets	Carter *et al.,* 1997	Yes	14
97	Inadequate tender pricing	Edwards, 1995; Flanagan and Norman, 1993.	No	
98	Unexpected price escalations not covered by contract	Edwards, 1995	Yes	17, 31, 32
99	Statutory pay increases, tax increases, etc.	Edwards, 1995	Yes	31, 32
100	Contract price fluctuations.	Edwards, 1995	Yes	31, 32
101	Financial loss – due to Increased material costs, expensive labour cost, expensive material, re-work, change orders, delays, poor planning	Edwards, 1995	Yes	17, 32
102	Government legislation	Edwards, 1995	Yes	7
103	Inability of those providing indemnities to meet their financial obligations.	Edwards, 1995	Yes	9
104	Inadequacy of client protection	Edwards, 1995	Yes	10, 11, 12
105	Inadequate insurance cover.	Edwards, 1995	Yes	10, 11, 12
106	Unavailability of funds from client, financial default of subcontractor, non-convertibility	Cleland, 1998; Flanagan and Norman, 1993.	Yes	38
107	Financial constraints on ability to meet payments to others .	Edwards, 1995	Yes	35, 36
108	The financial consequences of increased gas prices can be reduced by the design of a more efficient plant. Indeed one could entirely 'design out' the risk by opting for an alternative fuel source.	Flanagan and Norman, 1993.	No	
109	The net income from the building may decline because of poor management.	Cloete, 2001	No	
AF	**Third party risks**			
	Third-party-controlled risks			
110	Unexpected difficulties as a result of interface with third party utilities and others	Edwards, 1995	Yes	7
111	Delays in approvals by engineer, client, local authorities	Edwards, 1995	Yes	17, 29
112	Local environmental pressure groups	Edwards, 1995	No	
113	Damage to works by third parties.	Edwards, 1995	Yes	29
	Design Team Risks			
114	Errors and omissions in design, contract documents, drawings	Cleland, 1998; Edwards, 1995	Yes	4
115	Experience of team	Edwards, 1995	No	
116	Failure to meet required timescale for co-ordination of subconsultants, for producing various phases of duties as requited by client	Edwards, 1995	No	
117	Estimating inadequacies	Edwards, 1995	No	
118	Failure to obtain planning consents, easements, etc. in time allowed	Cleland, 1998; Edwards, 1995	Yes	7, 36
119	Different site conditions - poor design	Cleland, 1998	Yes	4
120	Type of design - established design methods or prototype leading edge	Edwards, 1995	No	
121	Lack of professional indemnity insurance, collateral warranties	Edwards, 1995	Yes	9, 10, 11,12
122	Liquidation/insolvency of members of design team.	Edwards, 1995	No	
123	Approvals for planning, use of hazardous substances on site consents, tree preservation orders, conservation consents	Edwards, 1995	Yes	7
124	Environmental Impact Assessments	Edwards, 1995	No	
125	Public inquiries	Edwards, 1995	No	
126	Legal agreements for rights of way and/or noise control requirements	Edwards, 1995	Yes	7
127	Pressure groups, local protests, industrial action	Edwards, 1995	No	
128	Terrorism in some locations, particularly overseas.	Edwards, 1995	Yes	8
AH	**Litigation/arbitration risks**			
129	Delay in resolving litigation/arbitration disputes	Edwards, 1995	Yes	40
130	Uncertainty of result of disputes	Edwards, 1995	Yes	40
131	Unfavourable decisions	Edwards, 1995	Yes	40
132	Costs of legal processes.	Edwards, 1995	Yes	40
AG	**Other risks**			
133	Remoteness of site access and/or facilities and/or communications	Edwards, 1995	No	
134	Changes in conditions affecting viability of completed project	Edwards, 1995	No	
135	Political change, i.e. those leading to changes of project scope or cancellations, sanctions and embargoes, tighter exchange controls, repatriation of funds	Edwards, 1995	No	
136	Pollution	Cleland, 1998	No	

APPENDIX – B

PAPER – 1

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A Framework for Identifying, Quantifying and Classifying Risks Associated with the Principal Building Agreement in South Africa

Nishani Harinarain and Ayman A. E. Othman
School of Civil Engineering, Surveying & Construction, Faculty of Engineering, University of KwaZulu-Natal, Durban, South Africa.

ABSTRACT

Purpose
This paper aims to develop a framework to enable contractors to identify, quantify and classify the risks associated with the Joint Building Contractors Committee Principal Building Agreement Series 2000 (JBCC PBA).

Design
To achieve this aim a research methodology consisted of literature review, questionnaires and interviews. Literature review was used for reviewing risk management, construction contracts, contractors' risks and risk classification. Survey questionnaires will be used to confirm the identified risks and add new ones that are not covered in literature review and that are reflected in the South African context. Interviews will be used to acquire the industry's feedback to improve the developed framework. To ensure its reliability and validity, a brainstorming session will be held to test and apply the developed framework.

Findings
Because of the uncertainty of the future, most business decisions are based on expectations and forecasts. Inevitably, making decisions on these bases involves risks. If not managed, these risks will affect the project success and lead to disputes and adversarial relationships. Therefore, contractors have to be aware of their obligations and the risks associated with their contracts. For years, the South African construction industry had

a poor reputation in coping with adverse effects of changes due to lack of practicing risk management.

Research Implications
The research work presented in this paper is an ongoing research being carried out at the School of Civil Engineering, Surveying and Construction, University of KwaZulu-Natal, South Africa. This promising research developed an innovative framework to enable South African contractors to identify, quantify and classify the risks associated with the Joint Building Contractors Committee Principal Building Agreement Series 2000 (JBCC PBA). Other issues highlighted by the research such as the Risk source to the contractor and results of the application of the framework will be presented in subsequent papers.

Practical Implications
Applying the framework developed by the authors will enable contractors to identify, quantify and classify the risks associated with the Joint Building Contractors Committee Principal Building Agreement Series 2000 (JBCC PBA). This will help contractors develop the appropriate risk management plan and improve the image of South African construction industry.

Originality
In depth literature review showed that the research work presented in this paper and the framework developed is original and were not done before in the South African Context.

KEYWORDS: Business decisions, Identifying Risks, Quantifying Risks, Classification Risks, Principal Building Agreement.

1. INTRODUCTION AND RESEARCH METHODOLOGY

Risks are present in every aspect of business. As one of the biggest industries worldwide, the construction industry is plagued with risks. Being such a large industry, there are hundreds of contracts signed every day. These contracts range from new construction, refurbishment to maintenance. Some projects are simple and worth few thousands of dollars where others are complex and may cost hundreds of millions. Some projects may involve just two organisations, where others may involve hundreds of suppliers, sub-contractors and consultants. Irrespective of how simple or complex the project is, all projects have something in common: they are exposed to risk and can go wrong (Edwards and Bowen, 2005).

Construction is governed by complicated contracts and involving a complex relationships in several tiers (Abdou, 1996). According to

Sawczuk (1996), as soon as the employer and the contractor have signed a contract they have taken on board risks. Their awareness of the risk and the steps to be taken to manage their share of the risk, will determine the likelihood of problems occurring. Construction projects have an abundance of risk, contractors cope with it and owners pay for it. The construction industry is subject to more risk than any other industries. Taking a project from initial investment appraisal to completion and into use is a complex and time-consuming design and construction process. It requires a multitude of people with different skills and a great deal of effort to co-ordinate a wide ranges of disparate, yet interrelated, activities. Inevitably, this complex process is compounded by many unexpected events that may cause loss to the client and other involved parties (Shen, 199; Flanagan and Norman, 1993). According to Carter *et al.* (1997) the construction industry is facing a more challenging environment than any time in the past.

Client expectations have grown higher and they call for better quality and service. Major clients are demanding that multi-million projects are delivered within fixed-price budgets and tight time-scales. Eventually, all of these factors will lead to risk. Smith (1998) highlighted that for years the South African building industry had a very poor reputation in managing construction risks. These risks could be prevented or reduced if management takes actions at early stages of the project life cycle. In order to overcome these limitations and improve the image of the South African construction industry, this paper aims to develop a framework to enable construction contractors identify, quantify and classify the risk associated with the JBCC PBA. This will help making decisions on informed bases. In addition, it will enable contractors develop particular course of actions to mitigate the effects of these risks. The research methodology designed to achieve this aim consisted of literature review, questionnaire and interview.

Firstly, literature review is used to review risk management in construction, construction contracts, contractors' potential risks and different classification of risks in construction. Secondly, survey questionnaire will be used to confirm the risks identified and add more risks that may not covered in literature review and belong to the South African context. Thirdly, interview is used to assess the developed framework and gain the industry feedback to improve the developed framework. Finally, a brainstorming session will be used to apply the framework on the different clauses of the JBCC PBA.

2. RISK MANAGEMENT IN CONSTRUCTION

The construction industry is a risky business. It is highly unlikely that a complex construction project will be planned and executed without some though of risk. Risk can't be ignored, it can only be managed, minimised, shared, transferred or accepted (Edwards and Bowen, 2005; Flanagan and Norman, 1993). Risk management is defined as the process concerned with identifying, analysing and responding to project risk. It includes maximising the results of positive events and minimising the consequences of adverse events (PMI, 2000). According to Flanagan and Norman (1993) once a risk is identified it became a management problem and the aim of risk management is to ensure that the project objectives are achieved. Edwards (1995) takes risk management to be the identification, measurement and control at the most economic cost of the hazards which can threaten life, property and the assets and earnings of an organisation.

Edwards and Bowen (2005) stated that for most project stakeholders, risk is important as it affects their business and success. Hence, risk can't be disregarded or dealt with haphazardly. Modern society's expectations of corporate behaviour and public accountability demand that organisations consider the risks which they face or which they create for others.

2.1 The Risk Management Process

The risk management process can be broken down into three components: risk identification, risk analysis, and risk responses.

2.1.1 Risk Identification

It is a diagnostic process in which all the potential risks that could affect a construction project are identified and investigated, thus enabling the involved parties understand the potential risk sources at an early stage. Such understanding at the project proposal stage will help the involved parties concentrate on strategies for the control and allocation of risk (Shen, 1999). Different methods are used in risk identification. They are brainstorming, historical data, checklist, tree diagram, and influence diagrams (Hamilton, 1997; Shen, 1999; Smith, 1999).

2.1.2 Risk Analysis

Risk analysis is used to evaluate risks and ascertain the importance of each risk to the project, based on an assessment of the probability of occurrence (Likelihood) and the possible consequence of its occurrence (Severity). Risk = Likelihood X Severity (Raftery, 1994). Risk analysis assesses both the effects of individual risks, and the combined consequences of all risks on the project objectives. The major purpose of risk analysis is to provide a project risk profile that could be used to look ahead to possible future events and see the probability of those events occurring. This enables the client decide whether or not to invest in the project, or adopt specific strategies for dealing with these risks. There are two techniques used in the risk analysis. Firstly, quantitative risk analysis which requires numerical data input and carrying out of some calculations. It provides some numerical results, which will allow the project team makes informed decisions. Secondly, qualitative risk analysis which involves subjective assessment based on experiences and intuition of the project team, which may be used to determine risk impacts. Lack of information and lack of demand for more detailed approach, and absence of numerical data related to risk identification are the main reasons that compel risk analysts to use the qualitative technique. This does not mean that the quantitative risk techniques are not used. Both techniques are used according to the importance of the project and the availability of information. There are many techniques used for risk analysis. They are: sensitivity analysis, probability analysis, simulation techniques, risk premium, expected monetary value (EMV), expected net present value (ENPV), EMV using a Delphi peer group, risk-adjusted discount rate (RADR), detailed analysis and simulation, and stochastic dominance (Raftery, 1994; Shen, 1999; Smith, 1999).

2.1.3 Risk Responses

Since all projects are unique and risks are dynamic throughout the life of the project, it is necessary to formulate the action that is required to reduce, eradicate or avoid the potential impact of risks on a project. The main aim is to initiate and implement appropriate action to prevent risks from occurring or, at minimum, limit the potential damage they may cause. Risks need to be allocated to those parties best placed to influence both the likelihood of the risk occurring and its potential impact should it occur (Laxtons, 1996; Flanagan and Norman, 1993). Typical risk responses are:

- **Risk avoidance:** means taking another course of action, so that risk cannot arise in the new circumstances for that project.
- **Risk transfer**: comprises the passing of risks to those better placed or more capable to maintain control or influence the outcome of the risk.
- **Risk reduction and residual retention:** the stakeholder is deliberately attempting to minimise risk in some way.
- **Risk retention:** retaining risks without mitigating them presumes that the decision is an informed one and based upon analysis which indicates that any reduction treatment has a negative cost/benefit ratio (Valsamakis *et al.*, 1999).

3. CONTRACTS IN CONSTRUCTION

Generally, a contract is defined as an agreement between two or more persons which gives rise to personal rights and corresponding obligations.

In other words it is an agreement which is legally binding on the parties. A building contract is an agreement between two parties, the contractor who agrees to erect a building and the employer who agrees to pay for it. This agreement creates personal rights and obligations, and the right of one party is the obligation of the other. The contractor has the obligation to erect the building and the right to be paid for it, while on the other hand the employer has the right to have the building erected and the obligation to pay for it. A contract comes into existence on the acceptance of an offer. If either party defaults on his obligation, the other party may invoke the assistance of the law to enforce his right (Finsen, 1991). The usual mode of accomplishing construction work is where the owner and contractor, as separate parties, enter into a contract with one another. The contract describes in detail the configuration of the project and how the work is to be carried out. The owner is required to pay the contractor in accordance with the provisions of the contract. In return, the contractor is obligated to construct the project in full accordance with the contract documents (Clough, 1975).

3.1 The Contract Documents

The complex nature of construction dictates a form of contract that is relatively lengthy, sacrificing brevity in order to describe precisely the legal, financial, and technical provisions. Construction contracts are substantially different from the usual commercial variety. The commodity concerned is not a standard one but a structure that is unique in its nature and whose realisation involves considerable time, cost, and hazard. The usual construction contract consists of a number of different documents such as general conditions, supplementary conditions, drawings, bills of quantities, addendums, etc. Collectively all the foregoing documents constitute the construction contract. The time for a careful reading of all contract articles is before rather than after the contract is signed. After execution of the contract, the contractor is bound by all its provisions, whether he has read them or not. During the bidding period, the contractor must evaluate each clause with regard to its possible or probable contribution to the cost of construction. On becoming the successful bidder, he must again examine the contract, but with a different purpose in mind. Many provisions require specific actions on the part of the contractor during the life of the contract (Finsen, 1991; Clough, 1975).

3.2 The JBCC Building Agreements

The Joint Building Contracts Committee (JBCC) representing the construction industry in South Africa was established in 1984. It was assigned the task of drafting a new contract agreement. The contract was complete in 1991 and committee had published the JBCC Principal Building Agreement and associated documents. The latest edition is the JBCC Series 2000 which is a suite of documents that amongst others comprises of the Principal Building Agreement (PBA), the Nominated/Selected Subcontract Agreement and the Preliminaries, which together constitute the terms and conditions of the agreement between the parties. In addition there are sundry ancillary documents that do not add to the rights and obligations of the parties but merely facilitate the administration of the contract such as the Contract Price Adjustment Provisions, the Construction Guarantee, etc. The (JBCC PBA) document records the terms of the agreement between the employer and the contractor, in which the employer is represented by a principal agent, on whom nearly all of the employer's rights and obligations devolve. The document commences with a comprehensive list of definitions and concludes with a schedule of variables, containing information specific to a particular contract (Finsen, 1999).

3.3 Risk And The (Jbcc Pba) Contract

Construction professionals need to know how to balance the contingencies of risk with their specific contractual, financial, operational and organisational requirements. In order to achieve this balance, proper risk identification and risk management is required which entails identifying construction risks and exposures to mitigate the potential for loss. Contracts are often delayed and cost more than the tender price and fail to perform to clients' expectations. The conventional approach is to recognise that many contracts will deviate from their tender price by 5% either way by the time the final account is reached, and to make allowances in the form of contingency sums and the padding of programmes to allow for slippages, with possible compromises in quality (Grinfeld and Simpson, 1998). Flanagan and Norman (1993) stated that the building sectors in a number of countries are undergoing many changes. Various building sector stakeholders are facing new construction methods, procedures, new materials and new types of buildings. As a result of these changes, project stakeholders are facing high risks towards attaining high standards of efficiency. It is therefore important to plan and make the right decisions, which will reduce risk on quality, time and cost of the building projects. Proper risk identification using the JBCC can help minimise these risks. Today, a contractor is often given a mass of information and data at the time of bidding, which may or may not be well coordinated and organised. The contractor is expected to assimilate all information in a relatively short period of time and provide the client with an intelligent and profitable bid. Risk is a concept that has always caused uncertainty and project failure to occur. The problem lies in the fact that there are a lot of risks affecting the construction industry and that even when using the (JBCC PBA) contract. It is not clear whether contractors are able to identify, understand and manage the risks that may occur. For this reason, there is a need to develop a framework to identify, quantify and classify risks in the (JBCC PBA) clauses.

4. THE IDENTIFICATION, QUANTIFICATION AND CLASSIFICATION FRAMEWORK

Framework is defined as the basic and logical structure for classifying and organising complex information (FEAF, 1999). It is a system of rules, ideas or principles that is used to plan and make a decision (Alberta Government, 2006). The Identification, Quantification and Classification Framework (IQCF) (hereinafter referred as "the framework" or the IQCF is the set of functions, activities, procedures as well as the tools and techniques required to assist construction contractors better understand the risks associated with the clauses of the (JBCC PBA). It is a decision making tool designed to enable contractors identify, quantify and classify the risks of the (JBCC PBA) clauses. The IQCF will help the contractors draw the appropriate risk management plan to mitigate the adverse effects of these risks.

4.1 The Development Of The IQCF

The IQCF was developed in a systematic process consisting of three steps: identification, quantification and classification of the risks associated with (JBCC PBA).

4.1.1 Identification of the (JBCC PBA) Risks

Since the framework adopts the contractor's perspective, the first step of risk identification was to identify all potential risks that could possibly affect the contractor. This entailed carrying out in depth literature review based on textbooks, academic journals, professional magazines, conference proceedings, seminars, dissertations and theses, organisation and government publications as well as Internet and related web sites. In addition, survey questionnaire was carried out with contractors to confirm the identified risks and add new ones that may not covered in literature review and may reflect the South African construction Industry context. Triangulation or in other words using more than one source of evidence (literature review and survey questionnaire) helped improve the validity of the collected risks that may affect the contractor through verifying findings of one source with other sources as well as helped increase background knowledge. Literature review and survey questionnaire resulted in identifying (270) risks. The second step of risk identification was the revision and refinement of risks identified. The work was reviewed and refined on a regular basis in order to omit repeated risks and merge similar ones. The end result was (184) risks. The final step of risk identification was the establishment of the criteria that will be used to state the risks associated with (JBCC PBA) clauses. In order to establish these criteria, it is essential to initiate a link between the identified risks and the factors that lead to organisation success or failure. Corporate analysis shows that every organisation has internal and external environments. Each one of them has its effect on the success or failure of the organisation. Internal environment consists of Strength factors and Weakness factors, where external environment consists of Opportunities factors and Threat factors. An event could be considered risky if it reduces the organisation's strengths and opportunities and increases the organisation's weaknesses and threats, see figure 1.1. The SWOT (Strengths, Weaknesses, Opportunities and Threats) Analysis is a systematic way used for corporate analysis. It is a means of combining the organisation to its working environment. SWOT is the first stage of planning and focusing on key issues. Contractors who regularly run a SWOT analysis of their companies ensure that they stay on track to succeed. Businesses of all sizes and types run SWOT analyses, which examine the internal working environment of a company and the external market in which that company operates.

- **The organisation's strengths**
  The strengths of an organisation could be management, marketing, finance, production or research & development which are performed well. Successful organisations pursue strategies that capitalise on internal strength.
- **The organisation's weaknesses**
  These areas such as the above which limit or inhibit a company's overall success. An organisation should pursue strategies which will effectively improve upon such internal weak areas.
- **The organisation's Opportunities**
  These are factors which could significantly benefit an organisation in the future. In addition, to environment trends, there are one-off events such as a new legislation, a new product decision, new technology. The firm should formulate strategies to take advantage of these factors.
- **The organisation's threats**
  These are the factors that are potentially harmful to an organisation present and future position, such as rising interest rate. It requires a systematic approach in identifying and evaluating environmental threats and devising strategies to avoid their impacts (Shutt, 2007).

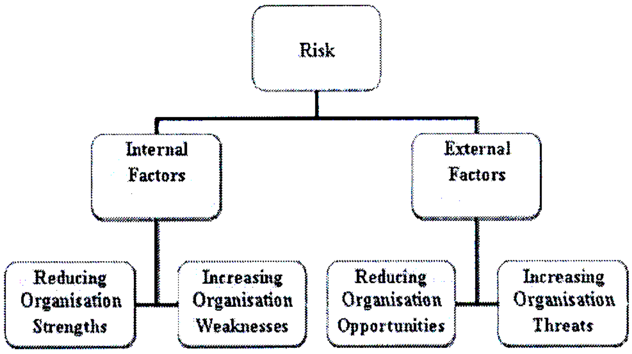

Figure 1.1 The criteria for identifying the risks associated with (JBCC PBA)

4.1.2 Quantification of the (JBCC PBA) Risks

After the identification criteria are established, the next step of the framework development is to quantify the risk associated with the JBCC PBA clauses from the contractor's perspective to identify the most influential ones. Risks will be quantified based on the probability of occurrence (P) and its severity(S), where (R= P * S). This quantification will be carried out through a brainstorming session with a selected number of managers of construction companies. The Likert scale between 1 to 5 will be used to quantify the probability and severity of these risks. The numerical scores from the brainstorming session will provide an indication of the varying degree of influence that each risk has on the contractor. To further investigate the data, a relative importance index (RII) will be used to rank the risks according to their influences (Olomolaiye et. al 1987).

4.1.3 Classification of the (JBCC PBA) Risks

The last step of the framework development is the classification of the risks identified and quantified. Classifying risks enables the contractor to consider them within a more coherent framework. It provides the construction professionals generally and the contractor in particular with a more uniform risk language, specifically in fields where risk needs to be communicated to a wide variety of project stakeholders. It allows one to establish a common understanding of different risks, and provides an essential basis for effective knowledge transfer, within an organisation and from one project to another (Edwards and Bowen, 2005). Risks in construction projects could be classified under many categories.

(1) According to the events outcome risk: upside risk and downside risk.
(2) According to the possibility of occurrence: pure risk and speculative.
(3) According to the possibility of reduction: diversifiable risk and non diversifiable risk (Williams *et al.,* 1995).
(4) Flanagan and Norman (1993) classified construction risks to political, economic, technical, external relations, management, design, environmental, legal and operational risk.
(5) Perry and Hayes (1985 cited Shen, 1999) classified risks in construction projects as: physical, construction, design, political, financial, legal-contractual and environmental risk.
(6) Santoso *et al.* (2003) classified risk as: physical, personal, technical, safety-accident, construction design causes, political and regulation, financial, contractual and environmental regulations cause risk.

In order to be in line with the internal and external perspective adopted in developing the criteria for risk identification, this research classifies risks that affect the contractor to: internal risks and external risks. Internal risks are the ones which emerge from within the contractor's organisation, where the external risks are the ones which emerge from outside the contractor's organisation. IQCF Matrix will be then developed to host all the information gleaned in the previous steps, see table 1.1. It worth to mention that during the framework development, contactors feedback was sought to improve the framework and ensure its compatibility with the industry requirements.

Table 1.1 the risk identification, quantification and classification matrix.

JBCC (PBA) Clause	Risk Identification Criteria				Risk Quantification			Risk Classification	
	Reducing Strength	Increasing Weakness	Reducing Opportunities	Increasing Threats	Probability (P)	Severity (S)	Result = (P*S)	Internal Risk	External risk

5. RELIABILITY AND VALIDITY OF THE IQCF

Reliability is defined as the extent to which a test would give consistent results if applied by a different researcher more than once to the same people under standard conditions (hall and hall, 1996). This could be transformed into the question: if someone else did the research would he or she has got the same results and arrived at the same conclusion? Hammersley (1992) defined validity as another word for truth. It refers to the correctness or credibility of a description, conclusion, explanation, interpretation or other sort of account. Hall and hall (1996) mentioned that validity means the extent to which a test, questionnaire or other method is really measuring what it is intended to measure. Because of their importance, the reliability and validity of the framework will be escalated through (1) increasing the reliability and validity of the methods used for developing the IQCF and (2) escalating the reliability and validity of the findings of the IQCF.

6. CONCLUSIONS

Construction is a risky process governed by complicated contracts and involving complex relationships. This called for contractors to understand their obligations and risks associated with their contracts. The South African construction industry had a poor reputation in coping with adverse effects of changes because of its lack of practicing risk management. As an approach to overcome these limitations and enhance the image of the construction industry in South Africa this paper presented the IQCF as a decision making tool to enable contractors identify, quantify and classify the risks associated with (JBCC PBA) clauses. The framework was developed in a systematic way. Consulting with contractors during the development of the framework and seeking their feedback helped improve the framework to meet the industry requirements. In order to ensure its reliability and validity as a decision making tool, a brainstorming session will be held with a selected number of construction managers to test and apply the framework to the different clauses of the (JBCC PBA).

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APPENDIX - C

PAPER – 2

Harinarain, N., and Othman, A.A.E. (2007b). ***Investigating the contractor's risk Sources associated with the Principal Building Agreement in South Africa.*** **5th CIDB Post Graduate Conference, South Africa, 2008.**

INVESTIGATING THE CONTRACTOR'S RISK SOURCES ASSOCIATED WITH THE PRINCIPAL BUILDING AGREEMENT IN SOUTH AFRICA

Harinarain N [1], Othman AAE[2]

School of Civil Engineering, Surveying & Construction, Faculty of Engineering, University of KwaZulu-Natal, Durban, South Africa.

[1] Harinarain@ukzn.ac.za, Tel. No. +27 31 2601206   [2] Othman@ukzn.ac.za, Tel. No. +27 31 2602821

ABSTRACT

Purpose of this paper - This paper aims to identify and quantify the risk sources to the contractor when using the Joint Building Contract Committee Principal Building Agreement Series 2000 JBCC (PBA).

Methodology/Scope - In order to achieve the above aim, a research methodology is designed to accomplish two objectives. Firstly, literature review is used to investigate the Joint Building Contracts Committee, fundamental concepts of contracts, parties of a building contact, obligations of the employer and the contractor and fundamentals of risk in construction projects. Secondly, survey questionnaire and interviews were used to identify the contractors risk sources associated with the Principal Building Agreement. Quantitative and qualitative approaches were adopted to analyse the collected data.

Findings - Establishing a correlation matrix between the project team members and the different clauses of the JBCC (PBA) to identify the sources of risk that confront the contractor when using the JBCC (PBA). Quantify the contractor's risk sources in order to enable construction companies' pay more attention when dealing with these project team members.

Practical implications - The identification and quantification of risk sources associated with the clauses of the JBCC (PBA) will enable the contractor to consider their role in the project when developing the risk management plan.

Value - In depth literature review showed that the research work presented in this paper and the developed correlation matrix is original and was not done before in the South African Context.

Keywords: Identifying and Quantifying Risk Sources, Project team members, Correlation matrix, Relative Importance Indicator, Principal Building Agreement.

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School of Civil Engineering, Surveying & Construction, Faculty of Engineering, University of KwaZulu-Natal, Durban, South Africa.

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1 RESEARCH BACKGROUND AND METHODOLOGY

Construction is a process governed by complicated contracts and involving complex relationships in several tiers, and there are many risks involved in construction projects (Abdou, 1996). These risks could be attributed to a number of reasons. Amongst them the nature of the construction process, the complexity and time-consuming design of construction activities, the involvement of a multitude of people, from different organisations, with different skills and interests, and a great deal of effort is required to co-ordinate the wide range of activities that are undertaken (Chapman, 1995; Shen, 1999).

A contract is an agreement between two parties, one of whom, the building contractor, agrees to erect a building, and the other, the employer, agrees to pay for it. Personal rights and obligations are created by the agreement, and the right of one party is the obligation of the other. A contract comes into existence on the acceptance of an offer. There is a meeting of minds, a consensus that is an essential element of a contract (Finsen, 1999).

Contractual documents are tools for managing risks (Uff, 1981). Flanagan and Norman (1993) state that the purpose of the contract is to establish the rights, duties, obligations, and responsibilities of the various contracting parties in order to allocate risk. A building contract is a trade off between the contractor's price for undertaking the work and his willingness to accept both controllable and uncontrollable risks. Controllable risks reflect, for example, variations in human performance, such as management and operative performance. Uncontrollable risks include such factors as inclement weather, the effects of inflation or ground conditions on a particular site.

Although the two parties of the contract are: the client and the contractor, other project team members are involved in the construction process (i.e. architect, quantity surveyor and supplier). Because of the different culture, interest and organisational structure of each of them, some parties represent a risk source to other parties. This paper aims to identify and quantify the contractor's risk sources associated with the Principal Building Agreement in South Africa. In order to achieve this aim the research methodology consisted of a literature review, survey questionnaire and interviews that were used to achieve two objectives. Firstly, literature review is used to investigate the Joint Building Contracts Committee, fundamental concepts of contracts, parties of a building contact, obligations of the employer and the contractor and fundamentals of risk in construction projects. Survey questionnaire and interviews were used to identify the contractors risk sources associated with the principal Building Agreement. Quantitative and qualitative approaches were adopted to analyse the collected data.

2 AN OVERVIEW OF THE JBCC BUILDING AGREEMENTS

In 1984 the Joint Building Contracts Committee (JBCC) was established, to draft an agreement for the construction industry. In 1991 the committee published the JBCC Principal Building Agreement and associated documents. In 1998 the contract was re-examined and re-drafted and a new set of documents, designated JBCC Series 2000, were published (Finsen, 1999). The JBCC is a committee which represents the variety of interests in the construction industry. It has six constituent member organisations which are: the Association of South African Quantity Surveyors; the Institute of South African Architects; the South African Association of Consulting Engineers; the South African Property Owners' Association; the Specialist Engineering Contractors Committee, and the Building Industries Federation of South Africa (BIFSA) (Van Deventer, 1993). The JBCC Series 2000 is a suite of documents that comprises the Principal Building Agreement, the Nominated/Selected Subcontract Agreement and the Preliminaries, which together constitute the terms and conditions of the agreement between the parties. In addition there are sundry ancillary documents that do not add to the rights and obligations of the parties but merely facilitate the administration of the contract. These include the Contract Price Adjustment Provisions, the Construction Guarantee, the Payment Guarantee, the Payment Certificate, the Completion Certificate, etc. These documents are intended to be used in conjunction with each other (Finsen, 1999).

2.1 The Principal Building Agreement

This document records the terms of the agreement between the employer and the contractor, in which the employer is represented by a principal agent, on whom nearly all of the employer's rights and obligations devolve. Other agents may be appointed to whom some of the principal agent's duties may be delegated. The document commences with a comprehensive list of definitions. The document concludes with a schedule of variables containing information specific to a particular contract.

3 FUNDAMENTAL CONCEPTS OF CONTRACTS:

The contract is an agreement by which the employer and the contractor agree about what should be done, how and when it should be done, and what should happen if it is not done. Agreement is the basis of the contract and absence of agreement on any fundamental aspect would be fatal to the contract and would render performance and enforcement impossible (Finsen, 1999).

Murdoch (1996), Flanagan, Norman (1993) and Uff (1981) highlighted the following fundamentals of contracts:

3.1 Contractual capacity

Anyone who has reached the age of 21 has contractual capacity, and therefore has the capacity to enter into a valid contract. Excluded are persons of unsound mind, women who are married in community of property and un-rehabilitated insolvents. A juristic person, such as a company or close corporation can enter into a contract but the act is performed by a natural person duly authorised acting on its behalf

3.2 Variation of the terms of the contract

Just as a contract comes about by the consent of the parties, so by consent they can bring it to an end, or vary any aspect of the agreement.

3.3 The lawful termination of contracts

The contract can be brought to an end by mutual agreement. The most natural way in which a contract may come to an end is by the performance by each party of all his obligations under the contract. When each party still has obligations to discharge, a contract will terminate when the parties mutually agree to bring it to an end. A contract may also come to an end when one of the parties, who no longer wishes to perform his obligations and enjoy his benefits under the contract, finds someone else to step into his shoes who will take over both his rights and obligations. Where this happens, the original contract terminates and a new contract arises, but all the original terms persist unless otherwise decided by the parties.

3.4 Breach of contract

Contracts impose various obligations on the parties. If one of the parties does not carry out any particular obligation, he or she is said to be in breach of contract. The remedies available to the innocent party prejudiced by such breach may be cancellation of the contract and a claim for damages, or he or she may elect to uphold the contract and claim specific performance together with damages.

3.5 Penalties and damages

Time is frequently stated in the tender documents as being the essence of the contract. If the building is completed later than the contracted completion date, the employer will have lost the use of it for a while. An employer who suffers financial loss as a consequence of late completion of the works is entitled to the usual contractual remedy of damages.

3.6 Extensions of time

Most building contracts contain express provisions under which the period allowed for the contractor to undertake and complete the works can be extended. The importance of losing the fixed date is that a contractor who has caused part of the delay is still liable to pay general damages for delay.

3.7 Dispute-resolution

All parties to a building contract will start off with the best intentions to get the work both completed satisfactorily in the agreed time and at the least expense to the owner. Somewhere between the beginning and the end, disagreements, disputes, disruption and delays arise which can destroy the best of intentions. The reasons for disputes are the fact that the scale of building projects has increased enormously in recent years, and their design and construction has grown in complexity. Such projects require an ever-increasing number of specialist subcontractors. The pressure has been on the construction industry to build more and more in less and less time.

4 PARTIES OF A BUILDING CONTRACT

The parties to a building contract are, on the one hand, the person who wishes to have a building built for himself, who is generally referred to in building contracts as the employer, and, on the other hand, the builder who carries out the work, generally referred to as the contractor. Architects, quantity surveyors, engineering consultants, etc. are not parties to a contract in that they do not acquire legal rights or obligations, but they are nevertheless charged with many duties as agents of the employer (Finsen, 1999). Agency is a broad term describing the relationship between two parties whereby one, the agent, acts on behalf of the other, the principal. An agency may arise under a contract, whereby the agent is appointed by his principal to carry out certain duties (Uff, 1981).

Finsen (1999), Murdoch (1996) and Van Deventer (1993) identified the parties to a contract as:

4.1 The employer

Employers may be divided into two categories: those who erect buildings for their own ownership and use, whether they intend to inhabit and use the buildings themselves or let them to others, and those whose intention is to sell the buildings as soon as they can, possibly even during the construction phase, so that they can recoup their capital, with a profit, and embark on further building projects. This latter type of employer is generally referred to as a property developer. Most of the major employers with large ongoing building programmes are members of the South African Property Owners' Association (SAPOA) which was formed to co-ordinate their views and to provide a representative body for negotiating with other representative bodies in the building industry.

4.2 The building contractor

A building contractor usually undertakes to build the entire project, moving onto a vacant site at the inception of the contract and at its completion, delivering a building that is complete in all respects and ready for occupation and use by the employer. Many building contractors are members of their local Master Builders Association, but membership of such associations is no guarantee of competence or integrity. Contractors are co-ordinated by the Building Industries Federation South Africa (BIFSA) which is a representative body that negotiates strongly on behalf of its constituent members. At one time building contractors employed most, if not all, of the tradesmen that might be required for any particular project. With the growing complexity of building techniques and installations, however, there has been very rapid growth of the subcontracting industry and there are now numerous subcontractors specialising in various aspects of building construction and installations.

4.3 Subcontracting

Essentially the typical standard form subcontract is designed to achieve a mirror image of the main contractual provisions. The reason for this is that the contractor and the employer want the subcontractor to execute work of the same quantity, quality and value as the work under the in contract. As the trend towards subcontracting developed, employers saw the opportunity of getting the best of both worlds, and the nominated subcontract was introduced which enabled the employer to have the benefit of a principal contractor to control the entire building operation while yet being able themselves to choose specific subcontractors to undertake specific work.

4.4 The architect

An architect is a person who designs buildings and superintends their erection. He is both advisor to, and agent of his client. Only persons registered as an architect in terms of the Architects' Act 1970 may hold himself out as an architect. An architect is required to be familiar with all the statutory or other legal requirements or limitations on the design of his client's building and to ensure that his design complies with them.

4.5 The quantity surveyor

The quantity surveyor is a person who calculates the quantity of labour and materials that are required to erect the building and compiles this information in a document known as a bill of quantities, which is used by tenderers as a basis for estimating the cost of the project and formulating their tenders. As an agent of the client, the quantity surveyor prepares preliminary estimates of cost, advises on the value of interim payment certificates, evaluates claims for extras and determines the proper value of the final account. In recent years the quantity surveyor's have been able to advise a client on a project's future running and maintenance costs and the income it may be expected to generate by way of rentals. During the course of the contract, he can predict the employer's cash flow in respect of monthly payments to the contractor and keep the employer continual informed on variations to the contract price caused either by cost fluctuations or changes to the design or specification. The profession of quantity surveying is governed by the South African Council for Quantity Surveyors, a statutory body established in terms of the Quantity Surveyors' Act 1970, which supervises the education of quantity surveyors, administers their registration and deals with infringements of the rules of professional conduct.

4.6 Engineering consultants

The structural design of contemporary buildings, and the design of their mechanical and electrical installations, has become so sophisticated and complex that it is beyond the technical knowledge and experience of architects, and is therefore undertaken by engineers trained and experienced in this type of work. Like the other members of the professional team, the engineer is normally engaged by the employer of the building and is liable to his client for any negligence in the execution of his professional duties.

4.7 The project manager

A project manager is involved in a number of highly specialised professional disciplines and activities in complex projects where there is a need for someone to co-ordinate these disciplines in order to ensure the timeous and harmonious completion of the project. The prime responsibility of project managers is to see that neither the programme nor the budget is exceeded. In so doing the project manager often becomes the principal agent in the building contract, with the responsibility for the contract administration duties that would otherwise devolve upon the architect.

4.8 The principal agent

In the JBCC Series 2000 edition no mention is made either of the architect or of the quantity surveyor or any of the engineers. Instead there is a principal agent who assumes all these roles. He may be an architect or anyone else, even a project manager. He is not expected to fulfill all of these roles as provision is made for the employer to appoint other agents who will continue to play their traditional roles. However, it is only the principal agent who can issue instructions, receive notices on behalf of the employer and bind the employer, although he can delegate certain of his authority to the other agents. The principal agent is not a party to the contract and does not acquire any contractual rights and obligations. He acts on behalf of the employer in respect of a great number of his obligations which, for lack of training and expertise, the employer cannot perform himself. The duties of the principal agent and the other agents to the employer under a construction contract are, first, to carry out their duties with reasonable skill and care, independently exercising reasonable professional judgment, and, secondly, to protect the employer's interests.

5 Obligations of the employer and contractor

5.1 Obligations of the employer under the Principal Agreement

The prime obligations of the employer under the contract according to Finsen (1999), Edwards (1995) and Van Deventer (1993) are:

(1) Appoint agents
The employer surrenders many of his contractual rights to his principal agent: inter alia, the right to approve work, to order additional work, to determine the value of variations, to extend the construction, and to determine the amounts of payments to be made under an interim or final payment certificate.

(2) Hand over the site to the contractor
At the commencement of the construction period, the site is required to be 'handed over' to the contractor to enable him to carry out the contract. The contractor is put in possession of the site, but ownership of the site remains with the employer.

(3) Make payments in accordance with the agreement.

(4) Provide a payment guarantee if required.

(5) Provide drawings and instructions
The contractor has undertaken to carry out the work in accordance with the drawings and instructions issued from time to time by the principal agent.

(6) Interim payments
No contractor has the financial resources to finance the construction of a project from start to finish, and it has become the invariable custom that the contractor is paid at regular intervals, usually monthly, an amount which represents the value of work done since the previous payment.

(7) Final account and final payment
The final account, which represents the contract value at the time that the contractor has finally discharged his contractual obligations, is required to be prepared by the principal agent and submitted to the contractor within 90 working days from the date of practical completion. The contractor is required to co-operate and assist in the preparation of the final account by providing all necessary documents and information that may be requested.

5.2 Obligations of the contractor under the Principal Building Agreement

The obligations of the contractor under the Principal Building Agreement are:

(1) **Submission of priced bills of quantities or lump-sum document**
The bills of quantities will be used primarily for valuing variations, but also for valuing work in progress for interim payment certificates.

(2) Furnishing of security
Clause 14.0 provides for three alternative forms of security for the due performance of the contract to be furnished by the contractor, and the choice rests with the contractor, who is required to indicate his choice in his tender. In the event that the contractor fails to provide a security, the employer may either accept the default form of security provided or cancel the agreement.

(3) Furnishing waiver of lien. Where the contractor is required to waive his lien, he shall do so, using the JBCC Waiver of Contractor's Lien form, within seven calendar days of receiving a payment guarantee from the employer.

(4) Appoint a site representative
Clause 6.0 requires the contractor to have on site at all times a competent representative to administer and control the works.

(5) Prepare a construction programme
The common-law position is that the contractor, having contracted to carry out certain work within an agreed time, is free to carry it out in whatever manner he wishes.

(6) Carry out and complete the work by the agreed date
The contractor's first and most obvious obligation is to carry out the agreed work, and to do so by the agreed date. Failure to complete the works by the agreed date renders him liable to penalties for non-completion

(7) Materials and workmanship to be satisfactory
The contractor is deemed to be an expert in building, and is expected to ensure that the materials that he acquires for the works are not defective.

(8) Contractor's obligations to subcontractors
The contractor stands in the same relationship to a subcontractor under a Subcontract Agreement as the employer does to him under the Principal Agreement, to give the subcontractor access to the portion of works necessary for the execution of the subcontract, to make payments, to furnish a payment guarantee, and to provide drawings and instructions.

(9) Limitation to liability for latent defects
The contractor's obligation is to complete the works free of patent defects. Latent defects may become apparent some time after final completion, and if they were due to some breach of the contract, the contractor would be liable for their rectification. In the JBCC Agreements, as a matter of policy, the contractor's liability for latent defects is contractually limited to five years.

(10) Liability for design
Where the design is prepared by an architect or engineer, the contractor's contractual obligation is to build in strict accordance with that design, and any deviation from it would amount to breach of contract.

(11) Suspension of the works
The contractor is not entitled to suspend the works for any reason whatsoever.

(12) Contract instructions
The employer, has the unilateral right to vary the extent and nature of the performance to be rendered by the other party. The other party, the contractor, cannot refuse to carry out the varied obligation, and his only remedies are an adjustment of the price he is entitled to be paid for the performance, and, in appropriate circumstances, an extension of the time in which to make such performance.

6 THE FUNDAMENTALS OF RISK IN CONSTRUCTION PROJECTS

Construction projects can best be understood in the context of the whole industry. Technological complexity ranges from the familiar, well-known materials and trades through to highly complex facilities involving multiple interacting sub-systems. Regardless of its technological complexity, any reasonably sized project involves a high level of organisational complexity. This arises because there are many specialised skills and professions with a useful contribution to the process (Murdoch, 1996). The fundamental risks inherent in any construction project are apportioned between the client, the design team, the general contractor, the specialist contractors, and the material and component suppliers within the various contractual relationships (Flanagan and Norman, 1993). The construction industry is fundamentally a people industry where the project is designed by people, built by people and in the majority of cases built to accommodate people (Sawczuk, 1996). Some of the biggest risks taken by contractors are at tender stage when they commit to a price and programme. Many companies now consider risk management to be an essential part of the tendering process (Finsen, 1999).

Risk management is concerned with identifying the salient risks, assessing their likelihood and deciding how best to manage the project efficiently in the light of this information. In entering into a contract, parties face a choice about how to deal with the risks inherent in the venture. The emphasis should be on the process of identifying the nature of the particular risks for a construction project and deciding where these risks should lie within the project team. Different types of building contract will allocate risks in different quarters. In allocating a risk, we are concerned with the eventual payment and responsibility for the cost of the event, should it eventuate. The main point about contractual risks is that the contract apportions these between the parties. Even if the contract is silent on a particular risk, that risk will still lie with one party or the other. The contract may seek to transfer a risk by making one party financially liable should the eventuality take place. In this way, risks are translated into financial equivalents so that they may be transferred or otherwise dealt with (Murdoch, 1996).

7 CONTRACTOR'S RISK SOURCE ASSOCIATED WITH THE PRINCIPAL BUILDING AGREEMENT

Risk is defined as any unexpected events that may occur during the process of building procurement, and can cause losses to the client or other interested parties (Shen, 1999). Based on the above definition and the criteria of identifying risks associated with the JBCC PBA, developed by (Harinarain and Othman, 2007) risk sources to the contractor could be defined as the person, authority or event that either reduce the strength of the company, increase its weakness, reduce its opportunities and increase its threats, which eventually affects the achievement of the project objectives and client satisfaction. In this research both questionnaires and structured interviews were utilized to identify the contractor's risk sources associated with the JBCC (PBA). Respondents to the questionnaire and interviewees are asked to select the risk source from a list of project team members. They were (1) client, (2) principal agent, (3) architect, (4) quantity surveyor, (5) engineer, (6) supplier, (7) sub-contractor and (8) government authority. Nine construction companies were selected from the Master Builders Association website. They were all contacted telephonically contacted to enquire if they utilise the JBCC (PBA) so that the questionnaire could be sent to them. The authors chose to telephonically contact the contractors as the details of the appropriate person in each company could be obtained to help ensure an increase in the number of respondents. The person identified was then contacted by telephone and the study was briefly explained. The respondents were advised of the confidentiality both during the telephonic conversation and in writing in the formal letter attached to the questionnaire. All of the questionnaire respondents were then interviewed to gain in depth insight and feedback.

The outcome of the questionnaire and the interview as presented in figure (1) are as follows:
External risks where broken down further into sources of risk to the contractor as can be seen in figure 6.9 and table 6.5. This section was sent to all nine respondents so that a wider sample could be obtained. Figure 6.9 and table 6.5 shows the following:

- The client (25%) poses the greatest risk source to the contractor. This verifies various literary sources that re-iterate this point. The client poses an immense risk because he decides on the project to be built, the design, the ultimate budget, commencement and completion dates and if there are to be any variations.
- Sub-contractors pose 5% of the risk source to the contractor.
- 15% of the risks were the source of the client and either the quantity surveyor, sub-contractor or government authority.
- 13% of the risks are the source of the client and two or three other parties. For example clause 32 is the source of the client together with the architect and the quantity surveyor, while clause 35 is the source of the client together with the principal agent, quantity surveyor and sub-contractor.
- Clauses 5, 17, 24, 25, and 26 (13% of the clauses) are sourced from the client, principal agent, architect, quantity surveyor, engineer, and sub-contractor.
- Clauses 16, 29 and 40 (8%) are sourced from all the categories.
- 21% of the clauses are not applicable because they either do not contain any words or they are explanations of various aspects of the contract or the contractor is directly responsible.
- The third source of risk to the contractor is the quantity surveyor. This was an usually outcome, but the respondents explained that the quantity surveyor was critical in obtaining interim payments, final accounts, assessing claims, pricing variations, etc. any of which could hinder or cancel the project.

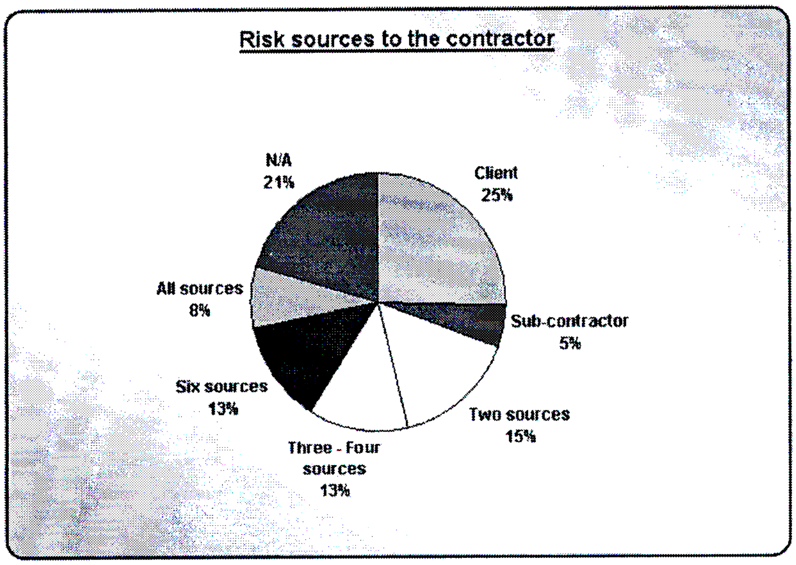

Figure (1) Risk sources to the contractor

8 Conclusions and Recommendations

Construction is high-risk venture. Each project is unique and has its own specific design to be constructed on a particular site within a special time frame with special materials, equipment and labour. Successful construction requires flawless functioning of the project team comprising the client, the design team, the construction team, and various trades, manufacturers, suppliers in a professional and timely manner. In spite of the client and the contractor as the contract parties, other project players are involved in the construction process. Due to the different culture, interest and organisational structure of each of them, some parties represent a risk source to other parties. This paper identified the contractor's risk sources associated with the Principal Building Agreement in

South Africa. Analysis of data collected from survey questionnaire and interview showed that the client poses the most among of risk to the contractor.

Table (1) Correlation Matrix of Risk Sources to the contractor

		Sources of Risk to the Contractor							
	Clauses	Client	Principal Agent	Architect	Quantity Surveyor	Engineer	Supplier	Sub-contractor	Government Authority
3.0	DOCUMENTS	100%							
9.0	INDEMNITIES	100%							
10.0	WORKS INSURANCES	100%							
11.0	LIABILITY INSURANCES	100%							
12.0	EFFECTING INSURANCES	100%							
19.0	ASSIGNMENT	100%							
31.0	INTERIM PAYMENT	100%							
37.0	CANCELLATION BY EMPLOYER. LOSS AND DAMAGE	100%							
38.0	CANCELLATION BY CONTRACTOR - EMPLOYER'S DEFAULT	100%							
39.0	CANCELLATION-CESSATION OF WORKS	100%							
21.0	SELECTED SUBCONTRACTORS							100%	
23.0	DOMESTIC SUBCONTRACTORS							100%	
22.0	DIRECT CONTRACTORS	67%						33%	
27.0	LATENT DEFECTS	67%						33%	
20.0	NOMINATED SUBCONTRACTORS	50%						50%	
33.0	RECOVERY OF EXPENSE AND LOSS	50%			50%				
34.0	FINAL ACCOUNT AND FINAL PAYMENT	50%			50%				
7.0	REGULATIONS	17%							83%
32.0	ADJUSTMENT TO THE CONTRACT VALUE	44.44%		11.11%	44.44%				
15.0	WORKS EXECUTION	44.44%			44.44%			11.11%	
35.0	PAYMENT TO OTHER PARTIES	33%	17%		33%			17%	
18.0	SETTING OUT OF THE WORKS	33%				50%			17%
4.0	DESIGN RESPONSIBILITY	8%	8%	42%		42%			
17.0	CONTRACT INSTRUCTIONS	18.89%	18.89%	18.89%	18.89%	18.89%		5.56%	
5.0	EMPLOYER'S AGENTS	17.78%	17.78%	17.78%	17.78%	17.78%		11.11%	
24.0	PRACTICAL COMPLETION	17.78%	17.78%	17.78%	11.11%	17.78%		17.78%	
25.0	WORKS COMPLETION	17.78%	17.78%	17.78%	11.11%	17.78%		17.78%	
26.0	FINAL COMPLETION	17.78%	17.78%	17.78%	11.11%	17.78%		17.78%	
16.0	ACCESS TO THE WORKS	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
29.0	REVISION OF DATE FOR PRACTICAL COMPLETION	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
40.0	DISPUTE SETTLEMENT	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%
1.0	DEFINITIONS	N/A							
2.0	OFFER, ACCEPTANCE AND PERFORMANCE	N/A							
6.0	SITE REPRESENTATIVE	N/A							
8.0	WORKS RISK	N/A							
13.0	NO CLAUSE	N/A							
14.0	SECURITY	N/A							
30.0	PENALTY	N/A							
36.0	CANCELLATION - CONTRACTOR'S DEFAULT	N/A							

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APPENDIX - D

FRAMEWORK EVALUATION - QUESTIONNAIRE

UNIVERSITY OF
KWAZULU-NATAL

September 2007

Dear Sir/Madam

I am currently conducting an academic research as a partial fulfillment for the requirement for a Masters Degree in Construction Project Management at the School of Civil Engineering, Surveying and Construction, at the University of KwaZulu-Natal, Howard College Campus, Durban.

The aim of this research is to develop a unique, innovative framework to identify, quantify and classify risks in the Joint Building Contracts Committee (JBCC), Principal Building Agreement (PBA) that affect contractors.

Questionnaires constitute an important part of academic research. Attached is a questionnaire on the Identification, Quantification and Classification Framework (IQCF). In order to appropriately utilise this framework, I require your input. The aim of this questionnaire is to obtain your comments and or suggestions on the IQCF and apply this framework to all the clauses in the JBCC (PBA) contract to analyse all the risks contained therein. This questionnaire is directed to a selected number of building contractors, of which you have been selected. I would appreciate it if you could answer the questionnaire to the best of your ability as your response will aid in the successful completion of my research.

I would like to assure you that your response will be strictly confidential and not used for any other purpose besides the academic research.

I understand the constraints of time on your busy schedule, and have endeavored to make this questionnaire as simple as possible. Should you have any queries, please do not hesitate to contact me on the details provided below.

Thank you,

Yours truly,

Nishani Harinarain
Masters Student
Tel: 031-260 2687

Dr. Ayman Othman
Research Supervisor

Please return all completed questionnaires to:
Ms. Nishani Harinarain
Fax: 031-2601411

Faculty of Engineering
School of Civil Engineering, Surveying & Construction
Property Development Programme

Postal Address: King George V Avenue, Durban 4041, South Africa

Telephone: +27 (0)31 260 2687 **Facsimile:** +27 (0)31 260 1411 **Email:** pdce@ukzn.ac.za **Website:** www.ukzn.ac.za

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

SECTION A - GENERAL INFORMATION

Name:	**Company Name:**
Company Address:	
Your Designation	
Phone No:	**Fax No:**
Email:	

SECTION B - A framework for Identifying, Quantifying and Classifying Risks in the JBCC (PBA)

Please find attached the layout of a framework that was developed in order to Identify, Quantify and Classify risks in the JBCC (PBA)

Question 1 - **Risk Identification**

Risk Identification criteria is broken into 4 categories, the risk could reduce the companies strengths, increase the companies weaknesses, reduce its opportunities or increasing its threats. An example is provided overleaf

Do you consider this as an acceptable method of identifying risks in the JBCC (PBA) contract				
Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 1a

Do you have any further suggestion on how this framework can be improved.

Question 2 - **Risk Quantification**

In order to accurately quantify risks, it is broken up into 2 categories, the probability of the risks occurring and the severity of the risk. By multiplying the probability and severity the quantification can be obtained.

Do you consider this as an acceptable method of quantifying risks in the JBCC (PBA) contract				
Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 2a

Do you have any further suggestion on how this framework can be improved.

Question 3 - **Risk Classification**

Risk in this framework is classified as either internal or external. Internal risks are the ones which emerge from within the contractor's organisation, where the external risks are the ones which emerge from outside the contractor's organisation.

Do you consider this as an acceptable method of classifying risks in the JBCC (PBA) contract				
Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 3a

Do you have any further suggestion on how this framework can be improved.

Question 4

How do you rate the framework. Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 4a

Do you have any further suggestion on how this framework can be improved.

The Identification, Quantification and Classification Framework with 2 examples.

Clause No	JBCC (PBA) Clause	Risk Identification Criteria: Reducing Strength	Risk Identification Criteria: Increasing Weakness	Risk Identification Criteria: Reducing Opportunities	Risk Identification Criteria: Increasing Threats	Risk Quantification: Probability (P) 1	P 2	P 3	P 4	P 5	Severity (S) 1	S 2	S 3	S 4	S 5	Result = (PxS)	Risk Classification: Internal risk	Risk Classification: External risk
.0 DOCUMENTS	The employer shall provide a payment guarantee where required within 21 calendar days of acceptance of the tender	X			X			X						X		12		X
4.0 DESIGN RESPONSIBILITY	The contractor shall not be responsible for the design of the works other than the contractor's or his subcontractor's temporary works.			X					X						X	20	X	

APPENDIX - E

FRAMEWORK APPLICATION - INTERVIEW

UNIVERSITY OF
KWAZULU-NATAL

September 2007

Dear Sir/Madam

I am currently conducting an academic research as a partial fulfillment for the requirement for a Masters Degree in Construction Project Management at the School of Civil Engineering, Surveying and Construction, at the University of KwaZulu-Natal, Howard College Campus, Durban.

The aim of this research is to develop a unique, innovative framework to identify, quantify and classify risks in the Joint Building Contracts Committee (JBCC), Principal Building Agreement (PBA) that affect contractors.

Interviews constitute an important part of academic research. I will be conducting this interview on the Identification, Quantification and Classification Framework (IQCF). In order to appropriately utilise this framework, I require your input. The aim of this interview is to apply this framework to all the clauses in the JBCC (PBA) contract to analyse all the risks contained therein. This interview is directed at a selected number of building contractors, of which you have been selected. I would appreciate it if you could answer the questions to the best of your ability as your response will aid in the successful completion of my research.

I would like to assure you that your response will be strictly confidential and not used for any other purpose besides the academic research.

I understand the constraints of time on your busy schedule, and have endeavored to make the questions as simple as possible.

Thank you,

Yours truly,

Nishani Harinarain
Masters Student

Dr. Ayman Othman
Research Supervisor

Faculty of Engineering
School of Civil Engineering, Surveying & Construction
Property Development Programme

Postal Address: King George V Avenue, Durban 4041, South Africa

Telephone: +27 (0)31 260 2687 **Facsimile:** +27 (0)31 260 1411 **Email:** pdce@ukzn.ac.za **Website:** www.ukzn.ac.za

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

SECTION A - GENERAL INFORMATION

Name:	
Company Name:	
Company Address:	
Your Designation	
Phone No:	**Fax No:**
Email:	

SECTION B - RISK

Question 1

	Yes	No
Do you identify all risks in the JBCC when tendering for projects	0	1

Question 1a

If your answer to Question 1 above is Yes, How do you account for risks when tendering for projects

1	Planning meetings	
2	Analysing the tender document	
3	Looking for conditions that are onerous	
4	Other, Specify	

Question 1b

If your answer to question 1 above is No, please explain why

1	Too costly	
2	Too time consuming	
3	Lack of understanding of the JBCC (PBA)	
4	Lack of qualified personnel	
5	Lack of training	
6	Other, Specify	

Question 2

Are you able to quantify the risks in the JBCC contract	Yes	No
	0	1

Question 2a

If your answer to Question 2 above is Yes, How do you quantify the risks

Question 3

Are you able to classify the risks in the JBCC contract	Yes	No
	0	1

Question 3a

If your answer to Question 3 above is Yes, How do you classify the risks

Question 4

What techniques do you employ to manage risks that occur?

SECTION C - IQC FRAMEWORK

On Page 4 - is the IQC framework that was developed in order to Identify, Quantify and Classify risks

Risk Identification - Criteria

Given the summarised clauses on the following pages, Select from the 4 categories presented

Risk Quantification - Criteria

Select the probability and severity of the risk occurring

Risk Classification - Criteria

Select the classification of the risk occurring, either internal or external

Question 5

Do you think this framework adequately cover all areas in the different categories when applied	Yes	No
	0	1

Question 6

How do you rate the framework Please select the appropriate box, where 1=Poor and 5 =Excellent				
1	2	3	4	5

Question 7

In your opinion, would an Identification, Quantification and Classification framework be of benefit to your firm?	Yes	No
	0	1

Question 8

Do you have any other suggestions to make?

APPENDIX - F

CORRELATION MATRIX OF RISK SOURCES - QUESTIONNAIRE AND INTERVIEW

UNIVERSITY OF
KWAZULU-NATAL

October 2007

Dear Sir/Madam

I am currently conducting an academic research as a partial fulfillment for the requirement for a Masters Degree in Construction Project Management at the School of Civil Engineering, Surveying and Construction, at the University of KwaZulu-Natal, Howard College Campus, Durban.

The aim of this research is to develop a unique, innovative framework to identify, quantify and classify risks in the Joint Building Contracts Committee (JBCC), Principal Building Agreement (PBA) that affect contractors.

Questionnaires and Interviews constitute an important part of academic research. I will be conducting this questionnaire and interview on the risk sources associated with the JBCC (PBA) clauses. In order to appropriately apply this, I require your input. This interview is directed at a selected number of building contractors, of which you have been selected. I would appreciate it if you could answer the questions to the best of your ability as your response will aid in the successful completion of my research.

I would like to assure you that your response will be strictly confidential and not used for any other purpose besides the academic research.

I understand the constraints of time on your busy schedule, and have endeavored to make the questions as simple as possible.

Thank you,

Yours truly,

Nishani Harinarain
Masters Student

Dr. Ayman Othman
Research Supervisor

Faculty of Engineering
School of Civil Engineering, Surveying & Construction
Property Development Programme

Postal Address: King George V Avenue, Durban 4041, South Africa

Telephone: +27 (0)31 260 2687 **Facsimile:** +27 (0)31 260 1411 **Email:** pdce@ukzn.ac.za **Website:** www.ukzn.ac.za

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

SECTION A - GENERAL INFORMATION

Name:
Company Name:
Company Address:
Your Designation
Phone No: **Fax No:**
Email:

SECTION B - RISK SOURCES IN THE JBCC (PBA)

Question 1

Given the summarised clauses in a matrix on the following pages, Please identify which party poses a source of risk to the contractor. Note: their can be more than one party for any clause.

Question 2

Do you have any other suggestions to make?

PA=Principal Agent

Clause No.	JBCC (PBA) CLAUSES (Note: The clause descriptions have been edited due to space constraints)	Sources of Risk to the Contractor: Client	Principal Agent	Architect	Quantity Surveyor	Engineer	Supplier	Sub-contractor	Government Authority
1.0 DEFINITIONS	N/A	N/A							
2.0 OFFER, ACCEPTANCE AND PERFORMANCE	N/A	N/A							
3.0 DOCUMENTS	The employer shall provide a payment guarantee where required within 21 calendar days of acceptance								
4.0 DESIGN RESPONSIBILITY	The contractor shall not be responsible for the design of the works other than his or his subcontractor's temporary works.								
5.0 EMPLOYER'S AGENTS	The PA shall be the only person who shall have the authority to bind the employer.								
6.0 SITE REPRESENTATIVE	The contractor shall keep a representative competent to administer and control the works continuously on the site .	N/A							
7.0 REGULATIONS	The parties shall comply with all laws and regulations of local or other authorities having jurisdiction of the works.								
8.0 WORKS RISK	The contractor shall take responsibility for the works from the date of site possession to practical completion.	N/A							
9.0 INDEMNITIES	The contractor indemnifies and holds the employer harmless against any loss in respect of expenses arising from: Claims, etc								
10.0 WORKS INSURANCES	The party responsible in terms of the schedule shall effect contract works insurance								
11.0 LIABILITY INSURANCES	The party responsible shall effect public liability insurance. The contractor shall effect workmen's compensation								
12.0 EFFECTING INSURANCES	The party responsible shall effect and keep in force: Contract works insurance, Public liability and Support insurance								
13.0	No Clause	N/A							
14.0 SECURITY	The contractor shall have the right to select the security to be provided as stated in the schedule.	N/A							
15.0 WORKS EXECUTION	The contractor shall submit on acceptance of the tender : The priced BOQ, Security and waiver of lien								
16.0 ACCESS TO THE WORKS	The employer and agents shall have reasonable access to the works, workshops and other places where work in terms of this agreement is being prepared, executed or stored								
17.0 CONTRACT INSTRUCTIONS	The PA may issue contract instructions provided that such contract instructions shall not substantially change the scope of the works.								
18.0 SETTING OUT OF THE WORKS	The employer shall appoint an agent to establish the boundary pegs or beacons. The contractor shall not be liable for incorrect setting out if he received incorrect information.								
19.0 ASSIGNMENT	Neither the employer nor contractor shall assign or cede his rights or obligations without the written consent								
20.0 NOMINATED SUBCONTRACTORS	The PA shall Prepare tender documents in conformity with the JBCC Nominated / Selected Subcontract Agreement and this agreement and thereafter call for tenders								
21.0 SELECTED SUBCONTRACTORS	The PA shall Prepare tender documents in conformity with the JBCC Nominated / Selected Subcontract Agreement and this agreement. Such preparation to be carried out with the approval of the contractor								
22.0 DIRECT CONTRACTORS	A direct contractor executing such work shall be subject to reasonable controls as required by the contractor								
23.0 DOMESTIC SUBCONTRACTORS	The contractor shall appoint all his domestic subcontractors and the associated risks shall be the direct responsibility of the contractor								

JBCC - Principal Building Agreement - Series 2000

PA=Principal Agent

Clause No.	JBCC (PBA) CLAUSES (Note: The clause descriptions have been edited due to space constraints)	Sources of Risk to the Contractor: Client	Principal Agent	Architect	Quantity Surveyor	Engineer	Supplier	Sub-contractor	Government Authority
24.0 PRACTICAL COMPLETION	Where the works: Has reached practical completion, the PA shall issue a certificate of practical completion, Has not reached practical completion, the PA shall issue a list of defects to be rectified								
25.0 WORKS COMPLETION	Within 7 calendar days of practical completion the PA shall issue to the contractor a list defining the outstanding work and defects at the date of practical completion to be completed for works completion.								
26.0 FINAL COMPLETION	The defects liability period commences on the date of works completion and end at midnight 90 calendar days later								
27.0 LATENT DEFECTS	The latent defects liability period shall end five (5) years from the date of achievement a final completion								
28.0 SECTIONAL COMPLETION	Where sections are required to be completed, terms and conditions shall apply mutatis mutandis to each section.								
29.0 REVISION OF DATE FOR PRACTICAL COMPLETION	There are certain cases where the contract value can be adjusted e.g. Failure to give possession of the site to the contractor, and others where the value cannot be adjusted, e.g. The inability to obtain materials and goods								
30.0 PENALTY	Where the contractor fails to bring the works to practical completion, he is liable for the penalty for noncompletion .	N/A							
31.0 INTERIM PAYMENT	The PA shall issue an interim payment certificate every month until the issue of the final payment certificate.								
32.0 ADJUSTMENT TO THE CONTRACT VALUE	The PA shall determine the value of adjustments to the contract value according to the BOQ. Items of additional work required by PA, the contractor may agree on the adjustment before the commencement of work								
33.0 RECOVERY OF EXPENSE AND LOSS	The PA shall issue a recovery statement monthly to the employer and contractor simultaneously with the payment certificate.								
34.0 FINAL ACCOUNT AND FINAL PAYMENT	The contractor shall assist the PA in the preparation of the final account. The PA shall submit the final account within 90 working days of the date of practical completion								
35.0 PAYMENT TO OTHER PARTIES	The PA shall issue special payment certification to other parties with copies to the contractor where the employer Engages other parties to execute work, Elects to pay a nominated/ selected subcontractor direct.								
36.0 CANCELLATION - CONTRACTOR'S DEFAULT	The employer may cancel this agreement where the contractor Fails to comply in accepting the tender or commencing work or Refuses to comply with a contract instruction	N/A							
37.0 CANCELLATION BY EMPLOYER. LOSS AND DAMAGE	The employer may cancel this agreement where The completed portion of the works constructed has been substantially destroyed, or the works is for alterations and/or additions to an existing building which has been substantially destroyed howsoever caused								
38.0 CANCELLATION BY CONTRACTOR - EMPLOYER'S DEFAULT	The contractor may cancel this agreement where The employer fails to appoint agents, fails to give possession of the site, fails to provide a payment guarantee, fails to issue or pay any payment certificate, The employer prevents the PA from exercising hi								
39.0 CANCELLATION-CESSATION OF WORKS	Either party may cancel this agreement on the cessation of the works for a continuous period of 90 calendar days, or intermittent period totaling 120 calendar days, due to circumstances beyond the control of either party.								
40.0 DISPUTE SETTLEMENT	Should any disagreement arise between the employer or his agents and the contractor as to any matter arising out of or concerning this agreement either party may give notice to the other to resolve such disagreement, via mediation, adjudication, arbitrati								

APPENDIX - G

ANALYSIS OF THE JBCC (PBA) CLAUSES

JBCC - Principal Building Agreement - Series 2000

PA=Principal Agent

Clause No	JBCC (PBA) CLAUSES (Note: The clause descriptions have been edited due to space constraints)	Risk Identification Criteria				Risk Quantification: Probability (P) - Mean					Severity (S)					Result	Risk Classification	
		Reducing Strength	Increasing Weakness	Reducing Opportunities	Increasing Threats	1	2	3	4	5	1	2	3	4	5	=(P*S)	Internal	External
1.0 DEFINITIONS	N/A	N/A				N/A											N/A	
2.0 OFFER, ACCEPTANCE AND PERFORMANCE	N/A	N/A				N/A											N/A	
3.0 DOCUMENTS	The employer shall provide a payment guarantee where required within 21 calendar days of acceptance	25%	50%		25%			3.5						4.0		14	50%	50%
4.0 DESIGN RESPONSIBILITY	The contractor shall not be responsible for the design of the works other than his or his subcontractor's temporary works.			100%		1.3					1.3					2	50%	50%
5.0 EMPLOYER'S AGENTS	The PA shall be the only person who shall have the authority to bind the employer.		50%		50%				4.0					4.3		17		100%
6.0 SITE REPRESENTATIVE	The contractor shall keep a representative competent to administer and control the works continuously on the site .		50%	50%		1.3					1.3					2	100%	
7.0 REGULATIONS	The parties shall comply with all laws and regulations of local or other authorities having jurisdiction of the works.				100%	1.8						2.8				5		100%
8.0 WORKS RISK	The contractor shall take responsibility for the works from the date of site possession to practical completion.	25%		25%	50%		2.3					2.8				6	50%	50%
9.0 INDEMNITIES	The contractor indemnifies and holds the employer harmless against any loss in respect of expenses arising from: Claims, etc			50%	50%		2.0						3.0			6	50%	50%
10.0 WORKS INSURANCES	The party responsible in terms of the schedule shall effect contract works insurance	50%			50%		2.3						3.3			7	50%	50%
11.0 LIABILITY INSURANCES	The party responsible shall effect public liability insurance. The contractor shall effect workmen's compensation	50%			50%		2.3						3.3			7	50%	50%
12.0 EFFECTING INSURANCES	The party responsible shall effect and keep in force: Contract works insurance, Public liability and Support insurance	50%			50%		2.0						3.0			6	50%	50%
13.0	No Clause	N/A				N/A											N/A	
14.0 SECURITY	The contractor shall have the right to select the security to be provided as stated in the schedule.		25%	50%	25%			3.3					3.3			11	100%	
15.0 WORKS EXECUTION	The contractor shall submit on acceptance of the tender : The priced BOQ, Security and waiver of lien				100%		2.3						3.0			7	100%	
16.0 ACCESS TO THE WORKS	The employer and agents shall have reasonable access to the works, workshops and other places where work in terms of this agreement is being prepared, executed or stored	50%	50%			1.8					1.8					3	50%	50%
17.0 CONTRACT INSTRUCTIONS	The PA may issue contract instructions provided that such contract instructions shall not substantially change the scope of the works.		100%						4.5					4.5		20	50%	50%
18.0 SETTING OUT OF THE WORKS	The employer shall appoint an agent to establish the boundary pegs or beacons. The contractor shall not be liable for incorrect setting out if he received incorrect information.	50%	50%				2.3					2.3				5	100%	
19.0 ASSIGNMENT	Neither the employer nor contractor shall assign or cede his rights or obligations without the written consent			50%	50%	1.3					1.5					2	50%	50%
20.0 NOMINATED SUBCONTRACTORS	The PA shall Prepare tender documents in conformity with the JBCC Nominated / Selected Subcontract Agreement and this agreement and thereafter call for tenders		100%				2.3					2.8				6		100%
21.0 SELECTED SUBCONTRACTORS	The PA shall Prepare tender documents in conformity with the JBCC Nominated / Selected Subcontract Agreement and this agreement. Such preparation to be carried out with the approval of the contractor		100%				2.8						3.3			9	100%	
22.0 DIRECT CONTRACTORS	A direct contractor executing such work shall be subject to reasonable controls as required by the contractor	50%			50%			3.0					3.0			9		100%
23.0 DOMESTIC SUBCONTRACTORS	The contractor shall appoint all his domestic subcontractors and the associated risks shall be the direct responsibility of the contractor		50%	50%				3.3					3.3			11	100%	
24.0 PRACTICAL COMPLETION	Where the works: Has reached practical completion, the PA shall issue a certificate of practical completion, Has not reached practical completion, the PA shall issue a list of defects to be rectified			50%	50%			3.3						4.0		13	50%	50%
25.0 WORKS COMPLETION	Within 7 calendar days of practical completion the PA shall issue to the contractor a list defining the outstanding work and defects at the date of practical completion to be completed for works completion.			50%	50%			3.5						4.3		15	50%	50%
26.0 FINAL COMPLETION	The defects liability period commences on the date of works completion and end at midnight 90 calendar days later			50%	50%			3.3					3.8			12	50%	50%
27.0 LATENT DEFECTS	The latent defects liability period shall end five (5) years from the date of achievement a final completion	25%	50%	25%				3.5				4.0				14	100%	
28.0 SECTIONAL COMPLETION	Where sections are required to be completed, terms and conditions shall apply mutatis mutandis to each section.		50%	50%			2.8					2.8				8	50%	50%

JBCC - Principal Building Agreement - Series 2000

PA=Principal Agent

Clause No	JBCC (PBA) CLAUSES (Note: The clause descriptions have been edited due to space constraints)	Risk Identification Criteria: Reducing Strength	Increasing Weakness	Reducing Opportunities	Increasing Threats	Risk Quantification: Probability (P) - Mean: 1	2	3	4	5	Severity (S): 1	2	3	4	5	Result =(P*S)	Risk Classification: Internal	External
29.0 REVISION OF DATE FOR PRACTICAL COMPLETION	There are certain cases where the contract value can be adjusted e.g. Failure to give possession of the site to the contractor, and others where the value cannot be adjusted, e.g. The inability to obtain materials and goods	100%							4.3					4.0		17		100%
30.0 PENALTY	Where the contractor fails to bring the works to practical completion, he is liable for the penalty for non-completion .	100%						3.3					3.8			12	100%	
31.0 INTERIM PAYMENT	The PA shall issue an interim payment certificate every month until the issue of the final payment certificate.				100%		2.5						3.3			8	50%	50%
32.0 ADJUSTMENT TO THE CONTRACT VALUE	The PA shall determine the value of adjustments to the contract value according to the BOQ. Items of additional work required by PA, the contractor may agree on the adjustment before the commencement of work	50%			50%			3.5					3.0			11	50%	50%
33.0 RECOVERY OF EXPENSE AND LOSS	The PA shall issue a recovery statement monthly to the employer and contractor simultaneously with the payment certificate.	50%	50%				2.3					2.3				5	50%	50%
34.0 FINAL ACCOUNT AND FINAL PAYMENT	The contractor shall assist the PA in the preparation of the final account. The PA shall submit the final account within 90 working days of the date of practical completion	50%	50%					3.0					3.8			11	50%	50%
35.0 PAYMENT TO OTHER PARTIES	The PA shall issue special payment certification to other parties with copies to the contractor where the employer Engages other parties to execute work, Elects to pay a nominated/ selected subcontractor direct.		50%	50%			2.8					2.8				8		100%
36.0 CANCELLATION - CONTRACTOR'S DEFAULT	The employer may cancel this agreement where the contractor Fails to comply in accepting the tender or commencing work or Refuses to comply with a contract instruction		50%		50%		2.0					2.8				6		100%
37.0 CANCELLATION BY EMPLOYER. LOSS AND DAMAGE	The employer may cancel this agreement where The completed portion of the works constructed has been substantially destroyed, or the works is for alterations and/or additions to an existing building which has been substantially destroyed howsoever caused			50%	50%		2.3						3.0			7		100%
38.0 CANCELLATION BY CONTRACTOR - EMPLOYER'S DEFAULT	The contractor may cancel this agreement where The employer fails to appoint agents, fails to give possession of the site, fails to provide a payment guarantee, fails to issue or pay any payment certificate, The employer prevents the PA from exercising his independent judgement	25%		50%	25%		2.5						3.3			8		100%
39.0 CANCELLATION-CESSATION OF WORKS	Either party may cancel this agreement on the cessation of the works for a continuous period of 90 calendar days, or intermittent period totaling 120 calendar days, due to circumstances beyond the control of either party.			50%	50%	1.8						2.5				4	50%	50%
40.0 DISPUTE SETTLEMENT	Should any disagreement arise between the employer or his agents and the contractor as to any matter arising out of or concerning this agreement either party may give notice to the other to resolve such disagreement, via mediation, adjudication, arbitration.		100%				2.8						3.3			9	50%	50%

NGODWANA TOTAL MILL BALANCE: ECF BLEACHING MEMBRANE TREATMENT PROCESS