RISK MANAGEMENT IN THE BUILDING INDUSTRY IN KENYA:

An Analysis of Time and Cost Risks

Hezekiah Gichunge

B.A. (Bldg. Econ) Hons, Nairobi; Msc (Const. Mangt.), Reading (U.K); MAAK (Q.S)

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Dept. of Building Economics and Management
UNIVERSITY OF NAIROBI.

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DECLARATION

I, Hezekiah Gichunge, hereby declare that this thesis is my original work and has not been presented for a degree in any other University.

Signed: ....

DECLARATION BY SUPERVISORS

This thesis has been submitted for examination with my approval as the University supervisor.

1. Prof. P. M. Syagga, PhD

Signed: ....

2. Prof. I. Mbeche, PhD

Signed: ....

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I wish to dedicate this work, first and foremost, to the Almighty God, through Jesus Christ, for He gave me good health and the ability to do the work;

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- Samuel Muthomi
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ABSTRACT

Three major risks are involved in a building project during the construction period: the likelihood of cost overrun, likelihood of time overrun and the likelihood of poor quality workmanship. Formal and empirical risk management techniques have been used at least during the last decade, to identify, measure and respond to risks (Flanagan & Norman 1993).

However, the methodology of risk management in building projects in Kenya is still rather informal and intuitive in nature. It is normally based on the skill and past experience of the 'risk manager'. This approach to risk management is unlikely to give adequate identification and measurement of risks and response to them. Consequently, cost and time overruns have been observed to be the norm rather than the exception in the Kenyan building industry (Mbatha 1986, Talukhaba 1989).

This study aims at investigating time and cost risks in building projects in Kenya. It examines the factors that expose building projects to the risks of cost overruns, time overruns and poor quality workmanship, and assesses the adequacy of the risk management criteria used in the country's building industry. In addition, the study also develops a mathematical model for predicting the expected cost and time overruns in proposed building projects.

The target population in the study comprises all the professionally designed and managed building projects executed in Nairobi between 1990 and 1999. A sample of 37 projects has been studied. The data was collected from the architects, quantity surveyors and contractors involved in the projects, using questionnaires and has been analysed using frequencies, descriptive statistics (mean, mode, median etc), correlation and regression analyses.

The study observes that the Conditions of Contract used in the mainstream building industry are a major risk factor in the building project. This factor occurs as early as the inception stage of the project and influences all the other stages.

The most serious source of cost and time risks in building projects during the construction period is 'extra work' (technically termed as variations), which normally occurs in 73.50% of the building projects in the population from which the data was obtained. 'Defective materials' is the major cause of poor quality workmanship and occurs in 38.20% of the projects. The more frequent a risk factor is the greater is its severity (seriuosness of adverse impact) on the project cost, time or quality. Severity has been measured on a 5-point horizontal numeric scale, with 1 representing *not severe at all* and 5 representing *extremely severe*.

The standard of risk identification, measurement and response in the Kenyan building industry has been observed to be relatively low. The levels of adequacy of risk identification, measurement and response are 68.1%, 27.6% and 63.5% respectively. The levels of adequacy have been measured by investigating the amount of information available to the project team and the specific precautions taken by the team to identify, measure and respond to the risks during the inception, design and construction stages of the project. The method of measuring the magnitude of risks is the most inarticulate aspect of the risk management approach in Kenya. Using this risk management approach, the mean probability of a cost overrun or a time overrun in a proposed building project is quite high.

Multiple regression analysis produced four mathematical models for predicting: -

- Cost risk – the likelihood of a cost overrun occurring in a proposed project;
- Time risk - the likelihood of a time overrun occurring in a proposed project;
- Cost overrun - the magnitude of the expected cost overrun (millions of Kshs);
- Time overrun - the magnitude of the expected time overrun (weeks).

The models are formulated as follows: -

(i) Cost Risk (CR)

$$\mathbf{CR = e^{\eta} / (1 + e^{\eta})}$$

$$\eta = 6.485 + 0.015CE - 10.092I + 1.285TP1 - 1.111CL - 1.020\,TD1$$

($R^2 = 0.7544$)

(ii) Time Risk (TR)

$$TR = e^{\lambda} / (1 + e^{\lambda})$$

$$\lambda = 7.120 + 0.017CE - 9.958\,I + 1.372\,TP1 + 3.093\,T4 - 1.643\,CL - 1.377\,TD1$$

($R^2 = 0.6198$)

(iii) Cost Overrun (CO)

$$CO = 10.946\,CR + 0.166\,CE \qquad (R^2 = 0.7544)$$

(iv) Time Overrun (TO)

$$TO = 5.2176 + 45.3838TR \qquad (R^2 = 0.6052)$$

Where: CR – probability that cost overrun will occur

TR – probability that time overrun will occur

CE – contact sum in millions of Kshs

I – adequacy of risk identification [(measured as a proportion, in the interval (0 1)]

TP1 – type of building (residential =1, other =0)

TP4 – type of building (industrial=1, other =0)

CL – type of client (private = 1, public =0)

TD1 – method of tendering (selective = 1, other = 0)

e = 2.7183

CO – cost overrun in millions of Kshs

TO – time overrun in weeks

R^2 - Square of the Multiple correlation coefficient.

In the models, the independent variables explain 75.44%, 61.98%, 75.44% and 60.52% of the variability in cost risks, time risks, cost overruns and time overruns respectively.

The study recommends that the Conditions of Contract be revised. It also recommends that the prediction models developed in the study be *refined* (by incorporating more independent variables and applying better scales of measuring the variables in order to increase the R^2 values), *tested* and then *used* in the Kenyan building industry - together with the other formal risk management techniques existing in the risk management theory- to manage the risks that occur in building projects during the construction period.

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Chapter I

INTRODUCTION

1.1 Background of the Problem

The building industry like any other industry experiences incidences of the management of risks. Several scholars have offered different definitions to "risk". Green (1968) defines risk as the uncertainty that exists as to the occurrence of some event which causes economic loss or value. Levey and Sanart (1986) have on the other hand defined risk or uncertainty as describing an option whose profit is not known in advance with absolute certainty but for which an array of alternative outcomes and probabilities are known. They argue that risk depends on chance.

There are several parties that take part in the construction of a new building project. The client or the promoter of a project may contact an architect or any other professional in the construction industry. Such a party endeavours to render advice to the client as to how he should go about initiating his project.

The client should narrate to the architect or give in writing what he or she requires in the form of space and specification denoting the quality and standard of construction to be expected in the proposed building. This narrative is referred to as the client's brief. A client who may not understand the operations and complexities of the building industry would be unable to produce a workable brief.

Such a client would need enormous assistance from those with expertise on how the building industry functions.

The client's brief should contain what the client intends to build and this information should be as clear as possible. The person taking the brief, who in this case is normally the architect, should clarify pertinent issues if he has to design a project that fulfils the client's dreams. The following areas should be stated clearly: the purpose of the project, the capacity for which the same is designed, the availability of land and financial resources both in the short and long term. These details would enable the designer to decide on the standard and quality that have to be catered for in the design.

The architect has, however, to contact other members of the design team, namely: engineers and quantity surveyors. Structural engineers provide information on structural stability whereas the quantity surveyor provides estimates and information on the cost effectiveness of various aspects of the project. The details and information produced by the above parties would depend on the design stage of the project. The quantity surveyor prepares a preliminary estimate based on a rate per square metre at the sketch design stage, whereas approximate quantities are used to arrive at an estimate at the detail design.

The quantity surveyor should work closely with engineers in order to arrive at a meaningful estimate (Ferry, 1977). The architect should brief the client on the progress made at all the stages. He should also ensure that drawings are approved by the client to avoid waste of time and resources.

The Architects and Quantity Surveyor Act, Cap 525 delves into great detail on the practice of the practitioners concerned including business ethics. The Act also outlines the duties of architects and quantity surveyors from inception up to the completion of the project. Resolution of disputes between the parties and the client is also covered particularly on the interpretation of the Act. The Act stipulates that the parties should note that the decision of the board on the disputes in question shall be final. The Act does not, however, handle the issue of apportionment of risks between the parties and the client on factors such as quality, time and costs. It would have been expedient for the Act to given direct on who bears the risks in regard to the risk factors referred to above.

The Government of Kenya's conditions of appointment (1974) recognize Architects and Quantity Surveyors Act. They state that architects and quantity surveyors shall be governed by the Act. The conditions, however, refer to architects and quantity surveyors including engineers appointed to undertake a project as consultants. In the responsibilities section; there is one outstanding clause which states that the first and primary duty of the consultant is to safeguard the interests of the client. He should also ensure that the latter receives the best possible advice, followed by the execution of the project on the basis of sound construction practice at a minimum cost. This clause serves as a protection to the client and does not examine the management of risks. Both the Act and the conditions of appointment/engagement do not address the issue of risk management adequately.

According to Cap. 525 of the Laws of Kenya and the Ministry of Public Works Conditions of Engagement, tenders are invited after production of working drawings. Tender documents comprise of drawings, bills of quantities and conditions of tender. Bills may however, be substituted by specification depending on the nature and type of the project. Prospective contractors are selected through competitive, selective or negotiated type of tendering. In competitive tendering all tenderers are invited to submit their bids within a given period of time. Such invitations are called open and may be placed on the dailies. This system of tendering is expensive and time consuming because of the big numbers of applicants.

Selective tendering involves some conditions such as technical and financial ability of the tenderer, which have to be fulfilled before being allowed to tender. Unlike open tendering system, this system is cheaper in terms of time and cost. Negotiated tendering is usually used where the project is of a peculiar nature requiring specialised skills in the construction of a project such as armoury or where it may be considered economical to hire the same contractor who is already on site to complete subsequent phases of a similar nature. There is an advantage of saving on preliminaries, mobilisation costs, time and improved quality due to acquired experience from the learning curve phenomenon.

The three methods are employed as a means of identifying a contractor who would translate the client's dreams as shown on the drawings to a building. The Quantity Surveyor provides tender analysis and makes recommendations, which enable the employer to make a decision on the award of the tender.

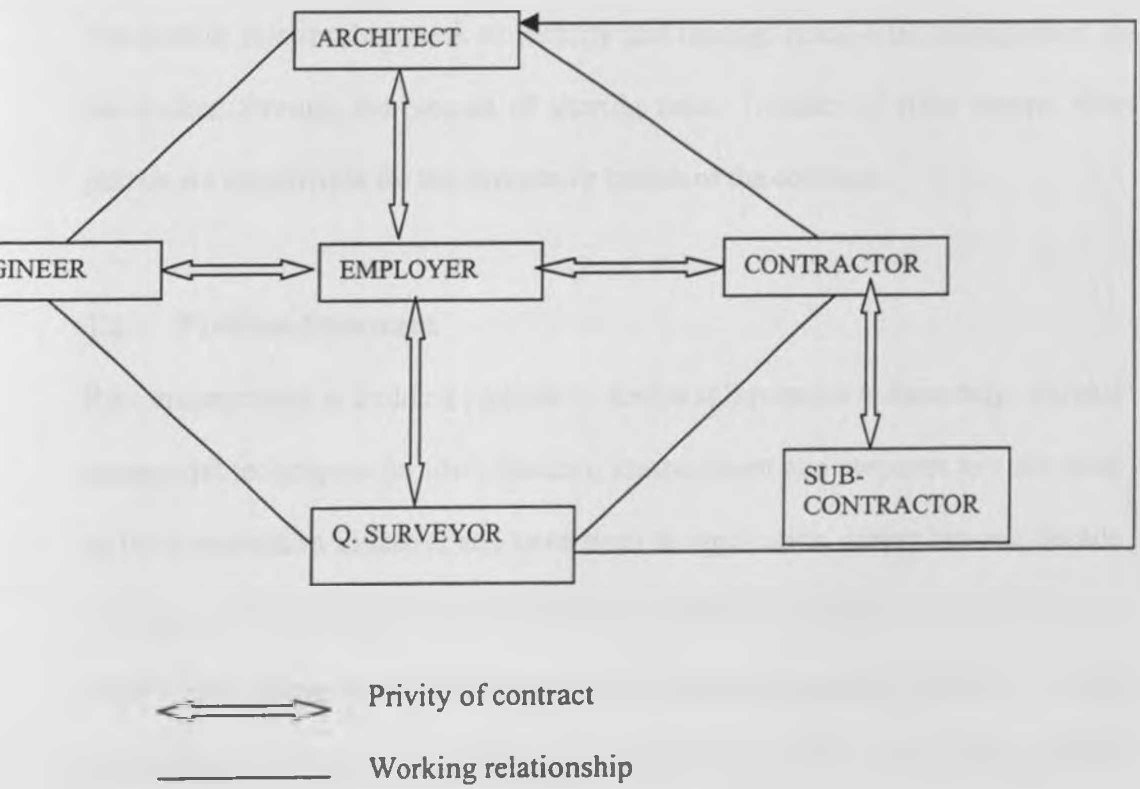
Two separate contracts exist in a building project. Members of the design team enter into a contract of engagement with the client. The contractor and the client also enter into a contract after the award of the tender. The parties to a contract have to be informed clearly about their responsibilities and obligations to each other. The letter of appointment indicates under what conditions they are engaged. Private clients appoint consultants under Chapter 525, Architects and Quantity Surveyors Act under the Laws of Kenya whereas the government uses Ministry of Public Works Conditions of Engagement.

The contract of engagement stipulates the responsibilities of the consultants in rendering their services including the client's obligations. Consultants should render their services in a professional manner to a standard expected under common law i.e. that of a reasonable professional person.

The successful tenderer is also required to enter into a contract with the client after the award has been made. Under private projects, the contractor and the client enter into contract as stipulated in the Schedule of Agreement and Conditions of Contract sanctioned by the Architectural Association of Kenya. Figure 1.1 shows the contractual relationship between the various parties to the contract. Privity of contract shows which parties have a legal right to sue the other in a court of law. The contracts entered into are those of a professional service.

The contractor, because of his role in the construction of the project, is seen as the centre of action. The contractor, however, does not have a contractual relationship with the members of the design team.

Figure 1.1 Contractual Relationships



Source: Own Concept, 1999

The design serve as the client's agents and therefore the contractor should sue the client where a breach of contract has purportedly occurred. The client can.

however, sue any of the members of the design team. The contractor and the sub-contractor can sue each other if there is a breach of contract between the two parties.

The contractor has to work with members of the design team very closely in order to produce a finished product which satisfies the client's requirements. Therefore, there is a working relationship among the members of the design team as well as with the contractor and his sub-contractors.

Contractual relationships seek to identify and manage risks. Risk management is undertaken through the process of sharing risks. Transfer of risks ensures that parties are responsible for the defaults or breach of the contract.

1.2 Problem Statement

Risk management in building projects in Kenya still remains rudimentary. Formal managerial techniques for identification, measurement and response to risks exist in the construction industry, and have been in application during the last decade (Flanagan & Norman 1993). However, the Kenyan building industry is yet to apply these management techniques in any meaningful manner, leading to poor performance of projects - in terms of the targeted cost, time and quality - in the industry.

A study done in Kenya for public building projects established that out of one hundred (100) of the projects, seventy three (73) experienced time overruns compared to thirty eight (38) out of one hundred (100), which suffered cost overruns (Mbatha 1986). Another study undertaken for both public and private building projects came up with a similar conclusion (Talukhaba 1989). The overall implication is that national resources are significantly wasted. The observations also imply that project risks may not have been adequately examined before the award of the contracts studied. Happold (1984) has affirmed the fact that projects are rarely completed on time as initially planned. He says "..... I put the fact that the industry has at least recognised that through the complex networks of relationships that are wrapped around us or we wrap around ourselves lying out there, somewhere, is a customer. A customer who has always been entitled to, but rarely, a good building on time".

The opinion expressed by Happold (1984) is of cardinal importance since it expresses the client's predicament that in spite of engaging consultants and employing a contractor to construct the building, the latter is rarely delivered to him on time. Delay in completing building projects on time would make the client suffer by creating uncertainty and also adversely affecting his investment plans. Delays usually affect the performance of a building project negatively through increased costs resulting from price escalations on materials, labour and construction finance costs. Consequently, the client would lose anticipated income to concurrent cost, which may result from ad hock arrangements for alternative accommodation.

The problems of time and cost overruns in the building industry are also found in other parts of the world. A third of all the construction projects in the United States of America finish late (CII, 1990). This results from poor planning, lack of experience in similar projects, owner's change of mind, unforeseen circumstances or indecisiveness, which can tarnish the image of the consulting and contracting firms. This may happen even when the firms are not responsible, hence impacting negatively on their future chances of repeat orders from potential owners and also tying up resources in the current project.

Generally speaking, the construction industry has a bad reputation in respect of planned costs and construction time overruns (Thomson & Perry, 1992). The World Bank data for the 1974-1988 period showed that planned cost and construction time were exceeded by 40% and 70%, respectively. In Great Britain, construction time for public sector projects is exceeded by more than 40% in every sixth project. For a larger number of projects, it is exceeded by over 80% (Thomson & Perry 1992). Planned construction time and cost were exceeded in Croatia with the construction time and costs exceeding the planned values by 100% and 50%, respectively. The reasons given for this state were transition and deficiency of capital (Radujkovic, 1993).

It is a general observation that the phenomenon of cost and time overruns is a big problem in the Kenyan building industry. Time and cost overruns are therefore big risks in the building industry not only in Kenya but also worldwide.

The construction industry is subject to higher risk and uncertainty than any other industry (Flanagan & Norman, 1993). The process from inception through the initial investment appraisal, up to completion is complex in nature. Complexity is linked to size, cost, time and intricacy of construction which are interrelated. Gidado (1996) defines complexity as the measurement of the difficulty of implementing the planned production work flow in relation to a number of quantifiable managerial objectives. Sidwell (1990) describes it as the diversification and complexity of the operating environment, which of course is influenced by size, cost and intricacy.

The processes involved in the production of buildings in the construction industry are also complex. Design and production processes are time consuming and they require skilled man- power. A multitude of people with different skills is required to realise the client's objectives. Co-ordination of a wide range of activities requires the skill of a project manager. Complexity of this nature is compounded by many uncontrollable factors such as weather and government intervention among others.

The conditions of contract including those of engagement do not adequately address the issue of the management of risks in building projects. There have been very few court cases as illustrated in law reports in Kenya where clients have sued consultants for negligence in the execution of building projects.

Clients are apparently not well appraised on their contractual rights. In other countries such as the United Kingdom (U.K), clients for building projects have formed their own federations. As a result, they are in a stronger position to seek legal advice. They also cause the production of conditions of contract which cater for their own interests. Organisations such as the Federation of Kenyan Employers (F.K.E) have not hitherto been able to address adequately the subject of risk management in building projects in Kenya.

Besides time and cost overruns, the level of quality achieved is another indicator of risk during the construction of a building project. When the quality of a building project has been affected negatively, it increases both time and cost of the same above the stipulated figures. Correction of defective work will take time and effectively will increase the cost.

Architects and other members of the design team are readily available to give explanations as to why there have been time and cost overruns. Such explanations may fall under the following categories:

(i) Inclement weather

(ii) Delayed site instructions

(iii) Delayed payments to contractor

(iv) Fluctuations in prices of materials and emoluments to labour

(v) Uncertainties not foreseeable at the inception of the project.

If there are convincing reasons, the contractor claims for extension of time and/or loss of income in accordance with the conditions of contract. The client may not be conversant with the responsibility and liability of the parties as stipulated in the conditions of contract or engagement. He may, therefore, be content with the explanation he receives regarding time and cost due to his lack of knowledge in such matters. The client may therefore not be in a position to contest the claims submitted to him.

The standard Conditions of Contract used in building contracts and sanctioned by the Architectural Association of Kenya (AAK) have not undergone significant changes although Conditions of Contract used in the United Kingdom have undergone numerous changes in order to cater for changing environments and also seek to allow for a better system of risk management. The AAK conditions of contract do not adequately address themselves to the management of risks. They are not specific as to who caused the risk but stipulate on how the aggrieved party should be compensated. The members of the design team and contractors are left to make decisions on risk management without actively involving the client. It is naturally expected that they may shy off from making the decision especially if the blame is attributed to them. The conditions of engagement e.g. Cap. 525 likewise lack the precision they deserve in regard to management of risks. Such agreements do not usually contain a wide scope which would embrace the management of risks for the parties to the agreements.

The current Conditions of Contract used in Kenya are of the same version which were used in Britain in 1963. The amendments which have been instituted since then by the stakeholders in the Kenyan industry are cosmetic. The scenario in the industry does not support the idea that the building industry is dynamic. The Kenyan conditions of contract are therefore not dynamic in either amendments or production of new conditions to reflect the nature of a building industry. However, the British industry has had several conditions since 1963 such as JCT80, JCT81 etc. to address the dynamism of the building industry.

The 1963 JCT form had major defects and was condemned by judicial and extra-judicial opinion. No architect is therefore justified in using it when there is in existence, and agreed by whole industry, the JCT 80 form which corrects at least ten of the major defects in the old forms (Paris 1989).

The 1963 JCT had given the architect enormous authority to vary the contract at the expense of the employer. The JCT 80 comprises of two fashions; one for local authorities with or without quantities and the other for private sector with or without quantities.

The architect is not a party to the JCT 80 contract. He has no contractual obligation to do all the things stated in the contract. It, therefore follows that the architect cannot be enjoined as a party to any arbitration arising out of JCT 80 without his consent. The duties laid on an architect under JCT 80 serve two purposes: they delimit the architect's authority in relation to the contractor, and they also delimit the area in which the architect is acting as the authorized agent of the employer.

The architect has no implied authority to vary the contracted work. The architect should not make any material alterations without the knowledge and authority of the employer. The contractor does not have to be concerned as to whether the employer has given authority for variations to the work. The employer shall still be held liable for any variations to the contract. Failure to carry out what the contract requires of an architect may serve as evidence of negligence in an action by the contractor in tort against the architect.

Clause 4.3.1. of JCT 80 requires that all instructions issued by the architect shall be in writing. It then goes on to give elaborate provisions to cover the situation where the architect gives only oral instructions.

The contractor is conferred the power by clause 4.1.1. to object to variations ordered by the architect. He, however, has to give a reasonable notice of objection in writing failure to which the matter may be referred to arbitration. Clause 25 requires the architect to deal with the extension of time not later than 12 weeks from the receipt of the notice from the contractor. Other variant clauses between the JCT 1963 and JCT 80 shall not be examined herein. JCT 80 contract seeks to reduce the contractual authority of the architect. The employer is made more aware of his legal and contractual rights. This contract handles the issue of allocation of risks more satisfactorily than JCT 1963.

Dynamism refers to change in the building industry. In the sixties, Kenya was under the rulership of the colonial masters. The latter were principally concerned with building constructions which were necessary to achieve their objectives. Construction activities were therefore minimal.

Since independence and particularly in the nineties the construction industry has revolutionized with many multi-storey buildings constructed in Nairobi and in a smaller scale in other major towns. New technology has been put into place including employing costly cranes to enhance efficiency in the construction of multi-storey buildings. Investment of high capital outlay has also contributed to dynamism with regard to activities in the production work and involvement of human resources. This, therefore, requires that the AAK conditions of contract should be modified to reflect this dynamism to include method statement, works programme and constructibility among others.

1.3 Objectives

The objectives of this study are: -

1. To examine the nature of risks in building projects.
2. To examine the adequacy of management of risks – risk identification, measurement and response.
3. To propose predictive models for risk management in the building industry.
4. To propose response measures for risk management.

1.4 Hypothesis

The hypothesis of this study is that *the magnitude of loss in a building project is directly related to the adequacy of the risk management for the project.* The sub-hypotheses of the study are as follows: -

1. The risk involved in a building project decreases as the adequacy of the identification of the risk factors increases. This adequacy may be indicated by the amount of information available for planning and design at the pre-contract period. The more the information 'generated' (and communicated to the relevant parties in the project team) the more adequate is the risk identification exercise likely to be. A most adequate risk identification exercise would determine the sources of risks (risk factors), their relative frequencies and their severity (likely adverse effect) on the project. If the risk factors are poorly identified then the project cost and time are exposed to risks of overruns. This also poses risks to the quality of the workmanship in the project.

2. The risk involved in a building project decreases as the adequacy of measurement of the risks anticipated increases. The measurement involves combining the frequency of occurrence of the risk factors identified and the severity of their impact on project time, cost and quality. If the risks associated with the risk factors identified are not computed with sufficient accuracy, the magnitude of the risks is likely to be underestimated. This fails to give the right warning

signals to the project team early enough for them to take an appropriate response to the risk. The way in which the information availed by the identification exercise is treated (in order to evaluate the risks) indicates the adequacy of the risk measurement technique.

3. The risk involved in a building project decreases as the efficiency of the response to the risk increases. Normally each member of the project team takes certain measures to prevent the occurrences of any anticipated risk factors or minimise their impact on the project cost, time and quality if the occurrence of the factors is inevitable. If the measures taken are very efficient the impact (time overruns, cost overruns or incidence of poor quality) of the occurrence of the factors is likely to be minimal.

4. The magnitude of loss (cost overrun, time overrun or poor quality workmanship) in a building project is determined by the magnitude of risk thereof (i.e. probability that the loss will occur).

1.5 Scope of the Study

Originally, it was planned that the research would cover the big towns in the country namely Mombasa, Nairobi, Nakuru, Eldoret and Kisumu. A pilot study undertaken by the author as a precursor to the full study revealed that most of the towns had very few projects of the nature required in the study. The fact that the projects were very few made the study thereof rather unjustifiable.

According to the Central Bureau of Statistics, Nairobi city has had the biggest share of big building projects, amounting to over 70% of the national total output over the last ten (10) years. Most of the consultants and clients who undertake building projects in the big towns have their offices in Nairobi. The consultants travel to the other towns to give their professional services. The same situation also applies to main contractors and sub-contractors who are contracted to execute construction in the said towns. The construction features and the standard of workmanship do not differ greatly in executing building projects, which are similar in different towns. For instance solid standard doors or concrete mix 1:2:4 would remain the same in spite of the type of building and its location. The researcher, therefore, decided to concentrate his research in Nairobi in view of the factors stated above.

The study covers only the losses and risk factors that occur in building projects during the construction stage of the project development. The variables considered in the study have been identified from the AAK conditions of contract and also from the literature review. The minimum cost value of the projects was set at Kshs 10 million. It was considered that the adverse impact on society, of occurrence of risk factors, is likely to be relatively insignificant in smaller building projects, although the accumulation of many small projects would have a significant effect.

Lastly, only buildings started and completed in the last ten years (1990 to 1999) were included in the sample. This period was considered long yet recent enough for generalisations to be made to the majority of building projects in Kenya.

1.6 Significance of the study

Although risks have always occurred in the Kenyan building industry, no study has been undertaken to examine the management of the risks in the industry. The results of this study can assist the stakeholders in the building industry to improve the management of risks by using the methods suggested in the study.

The mathematical models developed can be used by the consultants and the contractors to predict the risks and the losses expected in every building project with sufficient accuracy and objectivity. This would assist them in structuring effective methods of responding to the risks, thereby minimizing the actual losses experienced. This would result in saving the limited resources in the building industry, hence resulting to availability of more resources for further development in the industry.

The Kenyan building industry has not developed any system or a methodology for reasonable management of risks between the parties to a contract. In spite of the fact that little research has been done on time and cost overruns, these risks have continued to persist in the building industry. Some projects have experienced very large 'losses' arising from their risks.

For example, some parastatal projects such as the Post Office Headquarters in Nairobi was planned for a construction period of 104 weeks at a contract sum of KShs. 800,000,000/-. The project has taken over eight (8) years and it is not yet complete and it is projected that it will cost approximately KShs. 3 billion.

(Source: Information from the industry consultants of the project). There are several other projects which have continued to suffer such excessive time and cost overruns. This state of affairs causes a great deal of concern to the stakeholders in the Building Industry. Scarce resources which are available are used inefficiently hence compounding the problem of lack of financial resources to the industry. If the findings and the recommendations of this study were applied in the mainstream building industry, cost or time overruns of such magnitude would not occur in the industry.

1.7 Definition of Terms

The meaning of the following terms used herein is as stated below:-

Contractor:	A person or a firm that has been awarded a contract after the completion of a successful tendering process.
Client:	Employer or the promoter of a building project. He is the employer of the contractor and the members of the design team.
Design Team:	Shall denote the architect, engineer and the quantity surveyor.
Project Team:	Design team, Client and Contractor(s)
Building Project:	The project which offers accommodation in the form of office, commercial industry or residential space.
Project Manager:	A professional who is trained in planning, organising, directing, controlling financial management and marketing. Such a person possesses skills which enable him to run a project efficiently and hence minimise risks.

Risk:	Likelihood or probability of cost overrun, time overrun or poor quality workmanship.
Speculative risk:	The possibility of gain or the chance of loss. The study will concentrate on this type of risk in particular on the loss side.
Pure Risk	There is a possibility of a loss or no loss at all.
Loss:	Cost overrun, time overrun or poor quality workmanship.
Risk factor:	Factor whose occurrence is likely to cause loss.

1.8 Outline of the Study

Chapter I covers the problem statement in terms of poor risk management in building projects, the objectives of the study, hypothesis, scope, significance and the outline of the study. Chapter II covers the concept of risk and its application in building projects while Chapter III discusses management of risks in building projects.

Chapter IV discusses the research methodology in detail. The study population is defined and sampling, data collection and data analysis procedures as used in the study are described. The variables in the study and their measurement criteria are also discussed.

Chapter V presents the analysis of the data and Chapter VI covers conclusions and recommendations based on the study findings, and areas for further research.

Chapter II

CONCEPTS OF RISK MANAGEMENT

2.1 The Concept of Uncertainty and Risk

The Collin's Dictionary defines risk as a possibility of incurring misfortune or loss or other event on which a claim may be made. The idea muted by this definition is that when one undertakes an enterprise, there is a probability of suffering loss. The latter may, however, be difficult to determine at the inception of any undertaking. In spite of this fact, the promoter of a project should be in a position to estimate the magnitude of a loss that is likely to occur.

The same dictionary has defined uncertainty as the state of being uncertain i.e. changeable or unreliable. Uncertainty may also be defined as a situation in which there is no historic data or previous history relating to a situation being considered by the decision-maker. In other words, it is one of its kind. Uher (1990) stated that uncertainty exists where there is an absence of information about future events, conditions and values. Uncertainty can arise due to ignorance of the identity of variables or factors that explicitly define a system or randomness, or lack of knowledge of values of the variables which describe a system (Toakley, 1989).

Risk and uncertainty are found in all aspects of construction work, irrespective of the size, complexity, location, resources or speed of the construction of the project. The magnitude would, however, vary. Perry and Hayes (1984) argue that writers have attempted to distinguish between risk and uncertainty and also between pure and speculative risks. In the practice of construction risk management such distinctions are usually unnecessary and may not even be helpful. It is, however, important to recognize that uncertainties are a precursor to risks.

Skitmore *et al* (1989) state that the influence of uncertainty in the construction industry, and of the risks generated by such uncertainty, has been of increasing concern over the last two decades since the report of the Tavistock Institute (1966). There is awareness that uncertainty does in deed lie at the heart of many of the industry's organisational problems. Research in this direction is, therefore, a priority, and that any knowledge that may help decision-makers in the construction industry to recognise and minimise uncertainty and risk is likely to be of some potential value.

Risk stems from uncertainty which in turn is caused by lack of information (Flanagan and Norman, 1993). This scenario is shown below: -

No Information → Uncertainty → Risk

Certainty exists only when one can specify exactly what will happen during the period of time covered by the decision. This does not, of course, happen very often in the construction industry.

A company has to operate in an environment where there are many uncertainties. There is, therefore, the need to identify, analyse, evaluate and operate on risks hence converting uncertainty to risk. The following basic concepts describe uncertainties and risks (Perry & Hayes, 1984).

a) Uncertainties and risks are associated with specific events or activities which can individually be identified.

b) A risky event implies that there is a range of outcomes of an event and any outcome has a probability of occurrence.

c) Some risks offer only the prospect of an adverse consequence (loss) e.g. structural collapse, bankruptcy, war, sea or flood damage. These may be of low or high probability of occurrence but their impact is high.

d) Risks and their effects should be considered at all key decision points throughout the project and by all parties involved in the decision-making process.

Newton (1992) states that there is some disagreement in the literature regarding distinction between uncertainty and risk. Uncertainty is associated with the bits we cannot measure objectively whereas risk is used to refer to measurable quantities. Flanagan (1990) has argued that risk is a measurable uncertainty while uncertainty is an immeasurable risk. It is apparent that the two terms are very closely related.

Rosenbloom (1972) has stated that risk is a major aspect of our environment. He has emphasized the fact that we are surrounded by innumerable risks from birth to death and that risk is as pervasive as the air we breathe. If one has to survive in an unpredictable environment, then knowledge of risk and how to handle it is mandatory.

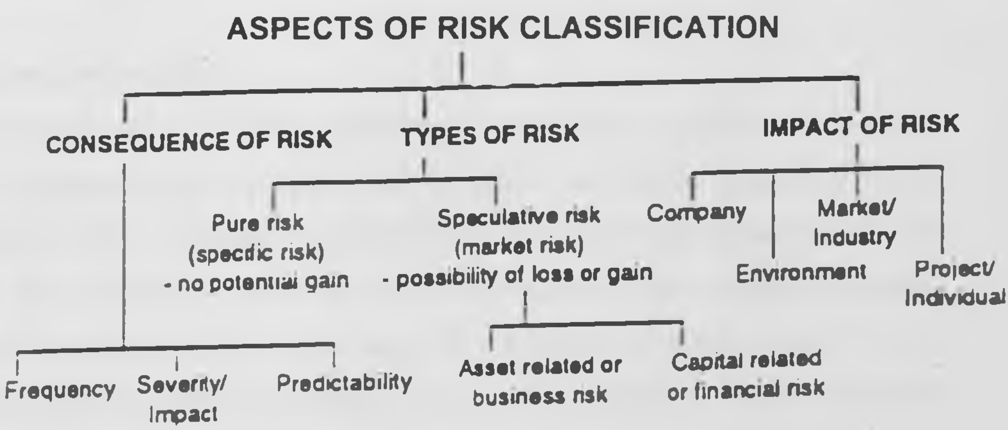
Levey and Sarnat (1986) have defined risk to be equivalent to uncertainty and that it describes an option whose profit is not known in advance with absolute certainty but for which an array of alternative outcomes and probabilities are known. The thrust of their argument is that risk depends on chance. This thought line may not hold water always since the Bible says that what one sows, so he reaps (Galatians 6: 7). The effort that one puts at the inception of a project would have a strong bearing on the results.

Risk permeates almost every facet of business life. To be in a position to counteract the negative forces of risk, a businessman should be knowledgeable on the subject of risk. Griffiths (1981) has, however, stated that one may not have perfect knowledge of the nature of risk. In spite of this fact the businessman is better placed when in possession of the knowledge of risk he has to undertake. Crockford (1986) underlines the importance of knowledge on risk when he states that awareness of the potential risk is a major step towards meeting it. Awareness of the risk prepares the risk taker so that he makes provision in order to minimise the impact of risk. Green (1978) emphasizes this concept by saying that being aware of the risk one may consciously make adjustments in his operations which would help to alleviate the impact of risk.

2.2 Classification of Risks

Researchers and practitioners in the field of risk management have used various aspects in classifying risks. Flanagan and Norman (1993) examine the subject of risk in three aspects: consequence of risk, types of risk and impact of risk. Consequence of risk includes frequency, severity / impact and predictability of a risk. Types of risk is the classification of risks and categerises the risks into two, namely: *pure* - or specific risk, which does not have potential gain- and *speculative* risk - which denotes market risk. This risk has a possibility of loss or gain. This risk covers thc areas of asset related (or business risk) and capital related (or financial risk). Impact of risk has the bearing on company, environment, market/industry and project or an individual. Figure 2.1 shows the three aspects of the subject of risk.

Figure 2.1 Aspects of Risk



Source: Flanagan & Norman (1993).

Cooper and Chapman (1987) classify risks into two major categories: Primary and Secondary risks. This classification is done according to their nature and magnitude. The former class focuses on risks that directly affect the project whereas the latter focuses on risks that result from factors that are extraneous to the project.

Risks are also classified on the basis of their type. Rosenbloom and Crockford (1987), and Flanagan & Norman (1993) have classified risks in two groups: Speculative and Pure Risks. Tah and Carr (1998) have grouped project risks in terms of their source into two classes namely: internal and external risks. The difference between the two types of classifications is not major but the second one focuses more on detail.

Internal risks may be local or global and they affect a particular project. Their control is usually made through the project e.g. human or technical resources including work packages relevant to sections of the project. Global risks affect the whole project. External risks are external to the project and indeed an organisation. They affect more than one project and they are uncontrollable. They also affect the project as a whole.

2.2.1 Speculative Risks

Speculative risks have the notion that there is a possibility of gain or the chance of a loss. Speculative risks recognise the fact that there is the possibility of an advantage and that all risks are not threats and therefore they do not have to be avoided. This notion serves as a catalyst to developers and gives them the impetus to invest. Positivity in this regard may be regarded as the nerve centre of an intending investor. Speculative risks may arise from three types of situations namely Management, Politics and Innovation.

2.2.1.1 Management Risks

Management risks arise due to the fact that business decisions are made by mortal beings who are fallible. Education and training in the relevant field play an important role in decision making. A manager who receives relevant education and training in his area of specialisation acquires necessary skills which enable him to make viable business decisions. Availability of information also plays an important role in decision making. Inaccurate decisions are unpopular with business enterprises since they may result to a loss. A manager should therefore be prudent to evaluate consequences of his/her decisions to guarantee the welfare of the promoter.

Management risks may be sub-divided into three categories: market, financial and production.

➢ ***Market Risks***

Some factors create uncertainty as to whether the final product can be sold at an economic price in order to produce an acceptable return on investment. The intervening period between the production stage and eventual sale is a major component of market risks. Factors which determine market risks are changes in general price level, taste, market potentiality and new technology. Lapse in time would have a great bearing in the magnitude of changes resulting from such factors. If the time span is long i.e. in a period of one year, all the above factors in the market may change drastically. In markets where sensitivity of the product is high, it may be recommended that data be collected and analysed on monthly or quarterly basis.

A general price level of a market may change once in a year hence affecting the price increase for most commodities. Inflation may be used to explain such a phenomenon although it may not be an easy task to predict future inflationary treads in any given market.

Taste is another factor which can also change in the twinkling of an eye due to change in choice and preference. This may call for very frequent checks on the market otherwise one may be priced out of the market sector. Detailed market research is mandatory in order to establish market potentiality. It is unprofessional for one to dream of a great venture and then the following day indulge in the market without the necessary information concerning competitors, their weaknesses and strong areas including the market niche and share of the business. A potential investor should have sufficient market information in order to make a viable decision on the role he/she should play in the market.

A promoter of a business enterprise should also keep abreast with new technologies in the market. Such knowledge would contribute greatly to the businessman's innovation in his/her market sector. Innovation involves taking risks in terms of business adventure and investment, which may result in good return and better productivity.

➢ ***Financial Risks***

Decisions made on financial policy may give rise to financial risks. Such decisions involve short term or long term funding and amount of profits to be retained for the growth of the business. It is exceedingly difficult to predict with confidence the financial position of an investment since the value of money erodes with passage of time. This phenomenon is envisaged in discounting rates which are much lower for long periods.

Retention of profits also plays an important role in the financial policy of a firm. Retained profits serve as a financial resource and it's funding system which is more preferable than the external one. A good balance should, however, be maintained between retained profits and declared dividends. Companies with low rates of declared dividends may be regarded poor economic performers. This would create negative feelings to would be future investors in such companies. Future being uncertain, one should seek to make accurate decisions in order to minimise financial risks. If such risks are not taken care of they may result to bankruptcy which is undesirable.

➢ ***Production Risks***

For any commercial production to be realised, factors such as land, materials, labour and technology have to be provided failure to which production risks may be created. Land is the craddle on which other factors have to be supported in order for them to be productive. No production would take place without availability of the above factors each of which plays its own role. Inadequacy in supply of each of the factors affects the production mix hence resulting to lower production. Such production if it does not yield marginal profits would create production risks which may consequently make the business enterprise to close down.

2.2.1.2 Political Risks

Government as the custodian of every state plays a very key role in regulating the economy. This is done through fiscal policies hence bringing a direct bearing on taxes, tariffs and import restrictions. Government intervention may create markets which are monopolistic in nature hence influencing the price market directly. The Government policy on protection for goods and services may produce monopolies. The protectionist nature produced by monopolies increases costs. Monopolies hinder competition and this may result to unfair distribution of resources.

Governments' political philosophy will affect incentives and remuneration for the labour force. Capitalistic systems produce competition and hence create incentives and good remuneration for labour. Socialistic systems produce results which are not conducive to favourable business climate. Increase of taxes and tariffs make both local and imported goods and materials more expensive.

Political instability is another factor which seriously affects production. People who feel insecure and therefore in a state of fear are not in a position to be productive. This state of affairs has been illustrated by low production of agricultural produce from those areas affected by "political clashes" in Kenya. Due to low productivity, the economic laws of supply and demand come in motion setting prices to sky rocket (Hardwick, 1982). Impacts of such phenomena affect the whole country. Government intervention cannot easily be predicted hence creating a difficult situation in handling political risks.

2.2.1.3 Innovation Risks

Every industry requires innovation if it has to grow. Innovation would also enable an industry to survive in a competitive market. The introduction of a new product should be examined critically. Comprehensive investigations have to be carried out in order to establish whether such a product exists and also whether competition is existent in the market. There are questions which should be answered, viz:

- What improvement would be required on the intended new product which would make it more superior to the one produced by the opponent?
- What market share would the new product take?
- What resources would be required for the production of the product.

Uncertainties exist when considering innovation. Technology involved in the production of a particular good is dynamic. Research on current technologies and future projections should be undertaken in order to realise good results from innovation. The promoter should, however, provide both human and financial resources for the execution of research.

2.2.2 Pure Risks

Pure risks are based on the notion that there would be loss or no loss at all. The underlying principle is that this depends purely on chance. Brealy and Myers (1985) have categorized pure risks in two broad classes i.e. unique and market risks. Unique risks stem from the fact that many of the perils that surround an individual company are peculiar to that company and perhaps its immediate competitor. The nature of products plays an important role in the success of the company. Unique risks may be eliminated by diversification. Market risks stem from the fact that there are other economy-wide perils, which threaten business. Government intervention could create economic perils. Government policy on taxes, protection etc., would affect business at macro-level. The impact of a government policy could be so great that diversification would not eliminate market risks. The characteristics of unique and market risks under speculative risks are similar to those of pure risks.

The following are the sources of pure risks:

- *Physical Damage to Assets.*

  Assets may be damaged by fire or acts of God such as earthquakes. Physical damage would make a company to wind up.

- *Indirect or Consequential Losses.*

  These losses may result from transaction indulgement. Transaction costs may be so great that business may ground to a halt. Economic recession may contribute to transaction costs.

- *Loss Through Fraud or Criminal Acts*

  A company may experience losses through fraud by staff or outsiders. Huge sums of money may be withdrawn fraudulently without being duly authorised. Such withdrawals would greatly affect cash flow of companies.

- *Loss of Assets due to Responsibilities to Others.*

  Business transactions are undertaken with other parties. The latter may in the process cause loss of assets belonging to the promoter.

- *Loss of Business Resulting from an Employee's Death or Disability.*

  Death or disability of an employee who has professional skills or whose trade is not easy to replace would adversely affect the operations of a company in the short run hence resulting to pure risk. The impact of pure risks could be disastrous and eventually result to closing down the operations of a firm.

2.3 Risk as a Concept in Insurance

Risks are a focal point in insurance. The latter examines the magnitude of risk involved in an enterprise and such information is used to fix the premium to be charged in order to cover the risk. Insurance apparently, however, looks at risks from the point of view of pure risks which result to physical loss of property. The higher the risk, the more the premium to be paid by the insured.

Insurance depends very much on probability that loss may or may not occur. Where the probability is high, then insurance companies charge higher premiums. Statistics on incidence of claims plays an important part to this effect. The more the claims, the higher the premiums to be charged on a new cover.

Abrahamson (1984) states that in most works, the unexpected happens. The preparedness for such eventualities in order to be able to forestall their effects is the test of good construction practice. Abrahamson strongly supports the concept that risks are unexpected and that business men have to plan in order to manage risks effectively. Strategic planners should forecast on the future taking into account all uncertainties and hence allow for risks in the plan. Strategic planning, therefore, becomes the bedrock on which the future of companies rests. Insurance companies take strategic planning seriously and using past records, they are able to make future projections.

Houtte (1988) says that risks constitute damages which are not caused by negligence. This may not, however, apply to all cases because damage caused by fire may result from negligence. She states that the common meaning of risk is the combined effect of the probability of occurrence of an undesirable event and the magnitude of event mathematically expressed as:

$$Risk = Hazard \times Probability\ of\ Occurrence$$

Insurance companies apply this principle when computing premiums which are a reflection of the magnitude of the risk involved. If hazard and probability are high, the premium is increased proportionately. Statistical data on the occurrence of past hazards is useful if the above model has to be operational. Gordon and Dickson (1984) argue that risk is universally accepted as the uncertainty of loss. Such a concept, however, excludes situations where no likelihood of loss exists and those situations which would definitely take place.

Insurance generally views risk as unpredictability, the tendency that actual results may differ from predicted results. This incidence lays emphasis on the importance of risk. Insurance, however uses historical data to predict outcomes. The data should be relevant to the area of study if it has to serve any useful purpose.

However, insurance does not address itself to speculative risks which occur in building projects since the major focus is on physical damage to the projects. Risks such as time and cost overruns as well as quality are not covered in insurance policies.

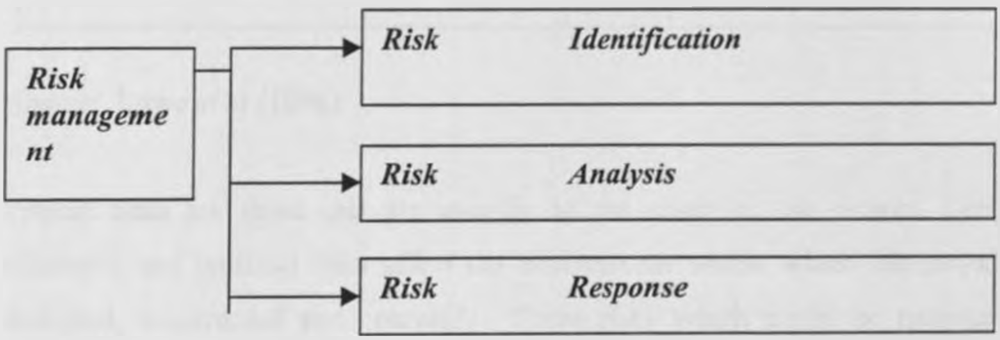
2.4 Risk Management

Risk management covers both uncertainty and risk (Lowe and Witwort , 1996). It is defined as the management of pure or non-speculative risks to which assets, personnel and income of a business are exposed (Betts and Mc George, 1989).

Risk management involves identification of the significant risks which may impair performance of a specific project (Lewis and Carter, 1992). It requires the assessment of the effect of these risks on the project and the establishment of policies for dealing with them. These policies may involve transferring, retaining or allocating risks to the various parties, determination of appropriate time, cost and quality allowances for risks. Steps are also set to reduce the likelihood, magnitude and impact of risks. Risk management theory in essence offers direction on how risk can be identified, quantified and minimised.

Gordon and Dickson (1984) have defined risk management as the identification, evaluation and economic control of the risks which threaten the assets or earning capabilities of an organisation. Risk management is viewed as a synthesis of three distinct stages: identification, analysis and response (Raftery, 1994).

Figure 2.2 Risk Management



Source: Raftery (1994).

For a risk management system to be successful, the three stages have to apply. Lewis and Carter (1992), Flanagan and Norman (1993), Isaac (1995), Lowe and Witwort (1996) confirm the above three stages of risk management.

2.4.1 Risk Identification

The first stage in risk management is the identification of potential risks and the determination of what could go wrong. This stage has received little attention until recently (Raftery, 1994). Risk identification is an important and difficult task (Toakley, 1991). It must be undertaken before any process of risk management can be implemented.

Risk identification involves physical inspection, examination and organisational charts, flow charts and check lists. These are the tools which would identify risks. In identifying risks, three categories are considered; those specific to the project, general economic and political risks as shown Table 2.1:

Table 2.1 Types of Risks Encountered in Projects

Project Risks	General Economic Risks	Political Risks
Cost and time overruns Client's special risks Project specific risks Design risks Construction Risks	Demand fluctuations Competition Currency fluctuations Inflation Rates Interest rates	Government instability Internal unrest or conflicts Regional Political factors Corruption.

Source: Lowe *et el* (1996).

Project risks are those that are specific to the client or the project. General economic and political risks affect the environment within which the project is designed, constructed and operated. These risks which could be national or international are closely related. The process of identifying risks involves standard check lists, brain-storming sessions, review meetings with key staff and risk audit interviews. This system of risk identification process has been advocated by Central Unit on Procurement Guidance Note No. 41 (C.U.P. 1993) after extensive research in the United Kingdom (UK). This system has not been used in the Kenyan building industry although in the UK it has been used in this decade.

Risk identification provides and establishes projects' constraints and useful data to assist the choice between different projects. Later in the project, risk identification provides a basis from which the appropriate organisational structure, tendering procedure, type of contract and risk allocation through contract documents can be formulated. The building contractor should identify risks allocated to him in the contract and those inherent in the nature of the work in order to prepare a balanced tender. The ultimate burden of responsibility for the identification of risks and the subsequent treatment rests with the client through his legal agents.

2.4.2 Risk Analysis

The risks identified should be assessed and analysed. This involves understanding or quantification of the effects of potential risks. This may be quantitative or qualitative. Quantitative approaches to risk analyses are more formal and clearly depend on existence of data to enable probabilities and consequences to be quantified. A qualitative approach involves the identification of a hierarchy of risks, their scope and potential dependencies (CUP, 1993). The hierarchy is based on the probability of the impact on the project.

Key elements required in a quantitative analysis include an estimate of the likely risks, the characteristics of important risks including variability and the maximum likely risk estimate. A sensitivity analysis is useful in this respect. This will identify the impact on the project out-turn of a change in the assumptions underlying a key element of a risk. A good example of a sensitivity analysis is to examine the impact on the viability change in interest rates or currency exchange rates.

The probabilistic approach involves computing the expected impact of events identified by multiplying their effect and the probability of their occurrence. The expected impact of all possible outcomes stemming from an individual option is aggregated so as to make a decision between alternative options.

Flanagan *et al* (1997) has considered risk management in the context of life cycle costing concentrating on the analysis phase of risk management. The materials and construction technology used at the initial stage of the production process have a great bearing on the incidence of risks both during the construction stage and in future.

Risk analysis has rarely been extensively used in the Kenyan building industry. In order for risk analysis to be applied, risk variables need to be logically and systematically arranged to form an analysis model. The development of a model is based on the type of the problem and the number or variables involved.

Thompson & Perry (1992) argue that successful risk management requires qualitative risk analysis. This analysis identifies sources of risk and provides an initial evaluation of their influence on the project's goals. The analysis requires from the analyst a lot of time, discipline, experience and creativity. Risk evaluation may be taken qualitatively or quantitatively. Severity and frequency of risks are taken into consideration. When values obtained are high in regard to some activities as compared with others, then the former are taken to be high risk variables.

The manager has to use all information available to make the best decisions on how to minimise risks. Figure 2.3 illustrates the processes involved in Risk Management. The management can best be done through collating relevant information, making the right decisions and hence reducing the incidence of risk.

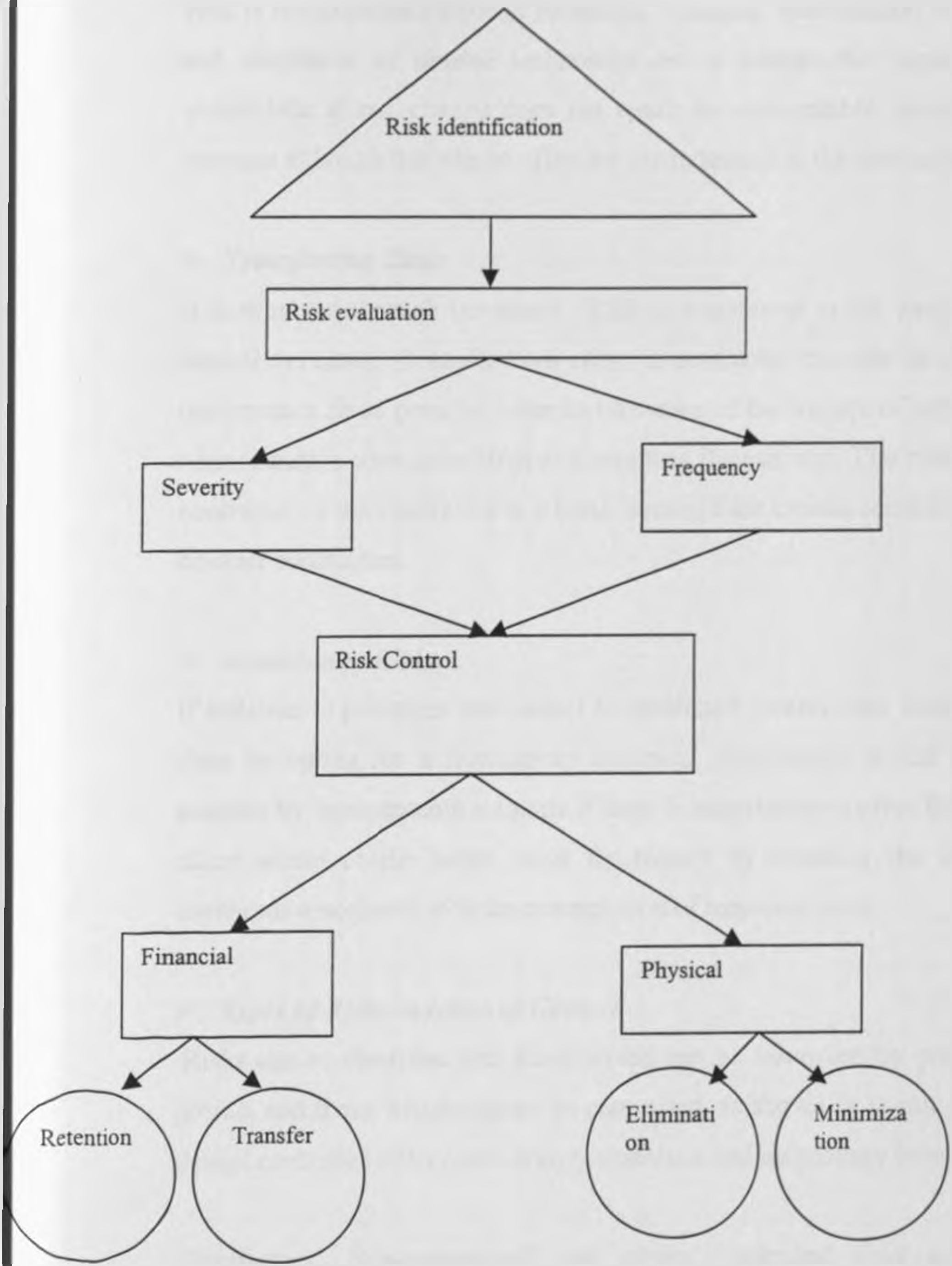
2.4.3 Risk Response

The completion of the risk analysis stage calls for an appropriate action to address the particular risk. The following are the responses to risk:

- Reduce the risk
- Insure against the risk
- Transfer all or part of the risk to another party.
- Retain all or part of the risk.

The above types of risk responses are examined below in regard to the building industry: -

Figure 2.3 The Risk Management Process



Source: Gordon & Dickson (1984; 6/1)

- ***Reduction of Risks***

This is accomplished through re-design, changing specification of materials used and avoidance of untried technology or to change the project plan. It is worthwhile if any change does not result to unacceptable increase in the base estimate although this can be offset by the reduction in the contingency.

- ***Transferring Risks***

It is achieved through insurance. Risk is transferred to the party best placed to control the same. Transfer from client to contractor can also be done by making the contract fixed price in order to take care of the impact of inflation. It avoids administrative costs associated in computing fluctuations. The transfer of risk by a contractor or sub-contractor to a bond-issuing bank creates confidence in the client or other contractors.

- ***Retention of Risks***

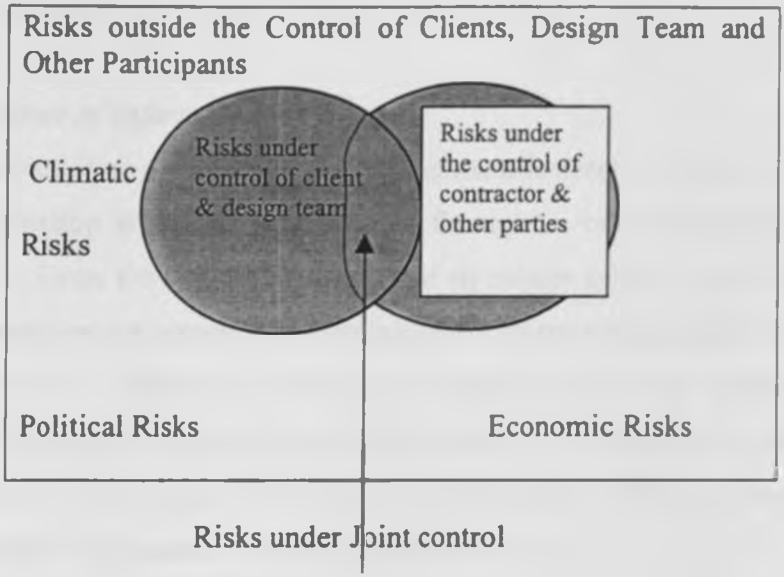
If inflation is prevalent and cannot be predicted, clients may decide to retain the risks by opting for a fluctuations contract. Contractors would increase tender margins by unacceptable amounts if there is uncertainty in price fluctuations. The client would obtain better value for money by retaining the risk in spite of overheads associated with the computation of increased costs.

- ***Types of Risks in terms of Control***

Risks can be classified into those which can be controlled by participants in the project and those which cannot be controlled, as shown in Figure 2.4. Client and design controlled risks cover design, materials and technology involved.

Contractors', Sub-contractors' and others' controlled risks encompass risks associated with the construction of the project. The intersection area comprises of risks which arise due to contractual relationships among the project participants.

Figure 2.4 Total Project Risks



Source: CUP (1993)

2.5 The Role of Information in Risk Management

2.5.1 Definition of Information

Information is a collection of processed data which are used for decision making by organisations. Barton (1985) has stated that information represents data or knowledge evaluated for specific use. Facts or data are processed in order to provide meaningful information.

The concept of information is therefore related to facts, data and knowledge. A fact is something that has happened in the real world and that can be verified. Data is facts obtained through empirical research or observation. Knowledge represents facts or data gathered in any way and stored for future use. Knowledge may therefore be thought of as a body of well confirmed, law-like generalisations which relate data to their environment. Information is not useful unless it is communicated to relevant parties who need to make application of the same. Communication, therefore, plays an important role in the transmission of information. Information is of no use if it is not communicated after which action is supposed to be taken. Information is, therefore, the life line of every organization.

2.5.2 Importance of Information.

Information is vital if an organisation has to function effectively. Harrison (1987) says that information is the life blood which flows into, out of and within an organisation. It forms the basis of decisions and stimulates action. Success of an enterprise depends on the accuracy and timing of the information supplied and the effective use of it. Information which is supplied and stored without its application would serve no useful purpose. Developments in computer technology have aided firms in the storage and analysis of information. This is welcome in view of the massive information that is available currently.

Information may be needed in an enterprise for the following reasons:-

- To provide up-to-date records on assets and liabilities in order to ascertain the financial position at any time. This information is vital in order to determine the business standing of the firm. Financial management ratios for example on profit and dividend, gearing etc., could serve as a pointer on the healthy position of the firm.
- To co-ordinate activities within and between departments to meet the objective of the organisation. Departments are production units which have to be integrated in the vision in order to achieve the set goals.
- To analyse trends so that appropriate action can be taken. Economic cycles should be considered if firms have to prepare for recession times and hence to survive adverse consequences.
- To comply with legislation for example Companies Act, Health and Safety Acts, Employment Act among others. Failure to comply with statutory legislation may lead to prosecution which may not augur well for the firm's public image.

- To keep abreast with political trends and government's intervention in business practices. These trends are so important that they affect the future of the firm. Management has therefore to study such trends seriously.

Most of the information required in the day to day running of a business is available within the organisation itself. External source of information is, however, necessary if the firm has to withstand competition.

2.5.3 Sources of Information in the Building Industry

Information in the building industry is poorly collated. There is no centre where information is centrally available. The building industry is a complex one where several parties are involved in the delivery process of creating a product in the name of a building to the satisfaction of a client. The parties involved in the delivery process are the client, the members of the design team namely the Architect, Engineers and the Quantity Surveyor, the Main Contractor and his Sub-Contractors. Each of these parties serves as a source of information.

➢ ***Client***

The client is the prime mover. He originates the idea from his mental conception of a building. He, therefore, comes up with a brief which looks at space requirements and the standard of quality envisaged. The client also provides financial information through carrying out investigation on sources of finance. The information provided by the client obligates all the other parties to meet the former's needs.

The client's information, therefore, should be well thought of in view of the important role it plays in guiding the other parties.

➢ ***Design Team***

The Design team is highly skilled due to their educational and professional training which is geared towards visualisation of the client's proposed building.

Their background in training contributes as a source of information. Architects and Engineers produce drawings and specifications which form basic information in the production process.

Quantity Surveyors translate the client's brief, the drawings and specification into a document called Bills of Quantities. The Standard Method of Measurement has very rich information which is used fully to the benefit of the building industry.

- ***The Main Contractor***

The Main Contractor is a specialist in construction technology. His training and experience in the building process are a great source of information. He has wide knowledge in the management of sub-contractors and procurement of building materials. His information, however, is not documented as in the case of the Design Team. His skill is reflected in the pricing of the tenders and the quality of construction work..

- ***Schedule of Agreement and Conditions of Contract.***

This document is central in the regulation of terms of the contract between the Main Contractor and the Employer. The conditions are the tools of implementation which state duties and obligations of the parties concerned. The information contained in the conditions is wide in scope and if well understood could be very useful to the building industry. The Conditions of Contract have useful information for the management of the project including contractual obligations between the relevant parties.

- ***Joint Building Council***

This is a body which comprises of contractors and members of the Design Team drawn from the Architectural Association of Kenya. Contractors are elected by their constituent association called Kenya Association of Building and Civil Engineering Contractors (KABCEC). JBC regulates prices of materials in accordance with the Fluctuations Clause 32 of the Schedule of Agreement and

Conditions of Contract sanctioned by the Architectural Association of Kenya (A.A.K). The JBC price list is used as a tool to settle claims on price fluctuations for materials and labour during the construction period. In the past, the list was limited to a few items but the list has of late been extended to include many items. This is loosing the purpose since computations are taking much time and therefore the revision of the list is mandatory. Information in the Kenyan building industry is disintegrated which has been caused by the competitive nature of parties involved and also the notion that the information should be treated as "bona fide".

2.5.4 Information and Minimisation of Risk

Carnal (1988) states that entrepreneurs take risks, handle uncertainties, make initial decisions over objectives, the firm's directions and innovation. In order to achieve this, entrepreneurs should have knowledge which is taken to be power and emanates from information. Sufficient and relevant information is, therefore, necessary if effective decisions have to be made.

Entrepreneurs have to decide on what type of information they require otherwise not every information would be useful. They should, therefore, set objectives of what they want to achieve and then look for information which would enable them to achieve such an end. Entrepreneurs have to use resources available to them in the process of managing their enterprises. Human, capital and financial resources play a key role in entrepreneurship. Managers and operatives, land and equipment, capital inputs and finances which serve as mobilizers are all necessary resources for the enterprise. The manager, however, acts as a catalyst as well as a co-ordinator in the process of production. The manager has to employ available information in decision making so as to obtain optimum results.

Kogan (1977) has said that decision-makers in top management are faced with two kinds of situations. The first is that the executive does not have enough information on which to base his decision and the second is that he has too much information. In both cases, intuition and judgement are essential in order to manage. There are no substitutes for experience and training when going through the decision making process.

Every management decision involves a series of steps:

- Identify the alternative course of action that might be taken, and considering all possible consequences of that action.
- Gather relevant information that would help to determine the consequences of a particular action.
- Make a preliminary diagnosis.
- Evaluate the desirability of likely consequences.
- Make the decision to take a particular action.

In undertaking all the above steps, one is making a decision and hence a judgement. The latter is a choice between alternatives. Most books for example, tell readers that decision making involves first the finding of facts. Managers who make effective decisions start with opinions instead of facts. The understanding that underlies the right decision grows out of the clash and conflict of divergent opinions and out of serious considerations of competing alternatives. Opinions are untested hypotheses and as such worthless unless tested against reality. It is worthy to note that testing an opinion against reality is based on the notion that opinions come first.

In analysing divergent opinions, dissent is bound to arise in decision making. The occurrence is, however, desirable since it guards the decision-maker from being a prisoner of the organisation or its operatives. The way to get free from pleadings and pre-conceived notions is to make use of the argued, documented and well thought disagreements. Disagreements are necessary in order to stimulate imagination which is a pertinent ingredient in the finding of the right solution to a problem.

Decision-making is not mechanical in nature but requires critical thinking and application of relevant information in regard to a particular problem. Rosemary (1979) has endorsed the fact that in some instances, decisions have to be made with utmost speed. Under these circumstances all the information required may not be available but duty still calls that a decision must be made. Managers have to examine the consequences of making the said decisions in the light of risks involved and expected benefits. The major role of a manager is to make a decision in spite of the quantum of the information available. Decision-making is indeed risk taking. The more relevant information available in decision making the less the risk. The manager's insight and judgement play a key role in the minimisation of the risk. Good judgements may not be expected when information is scanty.

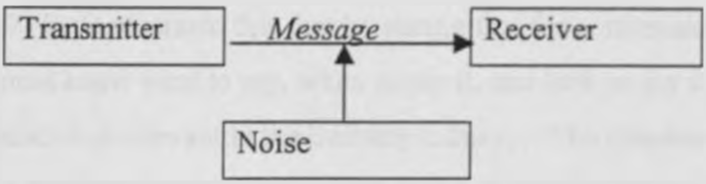
Decisions are not made for the past but for future operations which are prone to uncertainties or risks. The past could, however, be very useful as a basis for future projections. Koontz (1988) has reiterated the fact that insufficient information limits a manager's ability to make good decisions. Inadequate information, time and risk limit rationality in spite of thc fact that a manager may endeavour to be rational. A manager should, therefore, be trained in order to minimise risk through evaluating and applying relevant information in conjunction with well co-ordinated staff in his department in order to achieve a set goal.

2.5.5 Risks Reduction in Communication of Information

Information is transmitted by the process of communication which involves the interchange of thoughts or opinions by words, letters or similar means (Barton 1985). Generally there is an information source which provides the raw materials for a message which is to be transmitted to a destination.

A communication model would conceptually include a transmitter and a receiver. The concept of a noise is also included which interferes with information flow between the transmitter and the receiver (see Figure 2.5).

Figure 2.5 General Model of the Communication Process



Source: Barton (1985; 1)

Communication is the transfer of information to the receiver with the information being understood by the receiver (Koontz *et al*, 1984; 525) or the exchange of information and the transmission of meaning (Katz and Khan 1978; 48).

Information has been defined as a formulated object (endowed with identifiable forms) artificially created by the human being to represent a type of event which he can perceive and identify in the real world" (Hartubise, 1984; 23).

Communication plays a pivotal role in the management of any organisation. Information which is essential to the running of any undertaking has to be generated and then passed to decision-makers. Decisions are then taken and the same transmitted to implementers for action. An organisation may be said to be non-functional if the communication process is non-existent

2.5.6 The Role of Communication in the Building Industry.

The building industry comprises of various parties who are involved in the production process of a building project. The client, design team, contractors, sub-contractors, suppliers and statutory undertakers are the parties that play an active role in the delivery process of a building. Loosemore (1995) argues that communication influences the occurrence of client risks. The client is the risk taker on all construction projects.

Effective communication between the parties is vital if a client has to receive a building which satisfies his brief. The members of the design team have therefore to be clear on the information that they have to communicate. Stallworthy and Khabanda (1983; 97) have reiterated this fact by stating that for communication to be successful, we must know what to say, when to say it; and how to say it." This format of communication is relevant in the building industry. The members of the design team have to understand the client's brief which in turn they translate into drawings and bills of quantities. These media of communication usually referred to as channels of communication enable the contractor to understand the client's brief which he affirms by a quotation. The latter is a response as to how much price he is willing to pay in terms of quantity and quality of the work as envisaged in the client's brief.

Conditions to tenderers state that if information or quantities given to the tenderer is unclear, they should clarify the same with the Quantity Surveyor. This serves as a feedback which is necessary for effective communication. It affirms whether or not the Receiver has understood the information being transmitted to him.

It is usually recommended in the practice of implementation that information should be in writing in order to reduce the chances of making errors. The human mind is bound to forget or misunderstand the information or instructions so given verbally because of the quantum of information that it is loaded with at any particular time. The Architectural Association of Kenya (A.A.K) Agreement and Schedule of Conditions of Contract (Clause 2) emphasises the fact that Architect's instructions must be in writing. All verbal instructions should be confirmed in writing before the settlement of the Final Account.

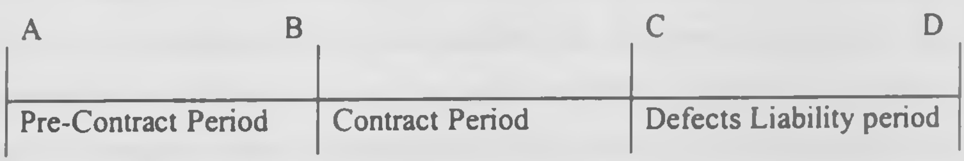
Communication in the building industry reduces risk in the following ways:-

- Effective communication enables all the parties in building contracts to spend time economically. Transaction costs are lowered hence reducing the risk of excessive costs.

- Communication creates efficiency in the implementation of the project. Detailed drawings and accurate bills of quantities are produced hence contributing to viable tenders. This state of certainty effectively lowers the magnitude of risk.
- Effective communication creates a good working relationship between all the relevant parties. Consequently, there is cohesiveness which enables a smooth delivery process where a client receives his "dream" building. Due to the minimization of the adversarial relationship, there is a resultant reduction in risk.

The issue of when to communicate is important since failure to communicate when required could have serious consequences. It has been said that justice delayed is justice denied and this saying is relevant to the execution of building contracts. Communication should therefore be undertaken at the various stages of construction. There are several stages of communication in any building project as illustrated in Figure 2.6.

Figure 2.6 Stages of Construction



Source: A.A.K. (1977)

The pre-contract period may be referred to as a time when the employer gives his brief to the design team for action. The brief is supposed to communicate explicitly what his requirements are. Failure to communicate effectively during this time may lead to numerous variations or changes in the contract which render contract administration difficult.

Contract period stage is the time when the actual construction takes place after the award of contract. It is therefore advisable that prompt action is taken in order to avoid delay. Memory is also fresh during this period, therefore, it is easier to settle disputes other than later. The building contract A.A.K. (1977) recommends that oral instructions should be formalised in writing within seven (7) days. This shows that action should be taken with expediency, particularly during the contract period.

The defects liability period is the time when defects are supposed to be made good. Defects such as cracks and leakages are common during this period.

Instructions in regard to additional work are required to be given fourteen (14) days after the expiry of defects liability period. If instructions are given outside this time scale, they are of no practical consequences in regard to the contractor's performance. Communication should, therefore, be done at the right time in order for it to serve the intended purpose.

Information and it's communication play a very important role in the three stages of risk management; identification, analysis and response. Information particularly on cost management is not collated and therefore this hampers risk management in the building industry. Tah and Carr (1998) confirm this fact when they say that communication of construction project risks is poor, incomplete and inconsistent throughout the construction supply chain. Risk management tends to be conducted in an ad hoc basis and is dependent on the experience and risk orientation of the particular player. Because of the individual nature of construction projects, there is usually insufficient objective data to calculate the probability of occurrence of specific outcomes of risky events, some degree of subjectivity in judgement is usually employed (Perry and Hayes, 1984).

2.5.7 The Practice of Risk Management.

Risk management is not extensively used in the building industry. Isaac (1995) carried out risk management for British Telecommunications Company. The purpose was to study the requirement for risk assessment and risk control as a consequence of the implementation of a standard project management methodology. The project team was called to a workshop with the aim of introducing a new information and control system. The feedback indicated that whilst the project team could see more benefits from carrying out risk assessment and risk control, these benefits were outweighed by the inability to prioritise risks which led to a large amount of time spent on paper work. After lengthy discussions and questions, it was agreed that writing a purpose statement would resolve ambiguity. This resulted in a purpose statement that contained the following components:-

- ***Objective***: Why is the analysis being done? What is needed? For example, what decision is required? By when?
- ***Project***: This is the project being analysed
- ***Scope:*** The scope is defined by boundaries or limits of analysis, for instance: one work package.

The group came up with a model for risk management, as shown on Figure 2.7.

Any risk that referred to time, cost and performance was potentially a statement of impact because those were the measures used for assessing impact. The possibility that a project may be delayed by two weeks is both a risk and an impact of any number of other risks (Isaac 1995). The project team came up with the following conclusions:

- The impact is often unaffected by a response that reduces the likelihood of occurrence.
- When a response totally avoids a risk, it is necessary to assess the secondary risks associated with that response to enable a comparison to be made.

Figure 2.7 A Model for Risk Management

1. Risk Assessment

Write purpose statement
Divide project
Identify Risks
Assess likelihood and Impact

2. Risk Control

Generate responses
Identify links
Select responses
Create a risk management strategy

- Often, a single response will be implemented for a number of risks, the benefits of which may not be apparent when evaluating the risks individually.

- If the worst case impact is the only one considered, then the pessimist will not be able to differentiate between the potential responses. Using the best, most likely and worst case impacts can demonstrate the effectiveness of a response.

Isaac (1995) came up with recommendations for creating a risk management strategy as follows: -

People interested in risk management should consider:

- The method is not as important as the goal of risk management;
- Agree on the purpose of risk analysis;
- Try to use a cause effect diagram to identify risks;
- Use a carefully chosen phrase to describe each risk;
- Agree on the ratings to be used for likelihood and impact;
- Assess the impacts for the whole project and avoid the inclusion of assumed responses in the assessment;

- Clearly identify triggers for contingency responses.

Jean (1995) undertook risk management in Canada and made the following general recommendations:

- *When Technical Risk is High*
  - i) Emphasise team support
  - ii) Increase project manager's authority
  - iii) Improve problem handling and communication
  - iv) Avoid stand-alone project structure
  - v) Increase the frequency of project monitoring
  - vi) Use PERT / CPM techniques.

- *When Cost Risk is High*
  - i) Increase the frequency of project monitoring
  - ii) Use PERT / CPM techniques.
  - iii) Improve communication and project goals, understanding and team support.
  - iv) Increase project manager's authority.

- *When Schedule / Time Risk is High*
  - i) Increase frequency of project monitoring
  - ii) Select the most experienced manager
  - iii) Project success is influenced significantly by the selected management approach.

The above recommendations would be applicable to building projects with modifications. The approach also should include the various stages of the building process in the construction.

In general, risk management concepts are applicable to building projects. It is worthwhile to note that the practice of risk management in building projects is not adequately done and documented in the building industry.

2.6 Information Technology and Risk Management

Information technology (IT) is defined as computer based information systems which include electronic communication such as document transfer and computer aided design (CAD) techniques (Baxendale 1999).

The construction industry has always been bedeviled with great difficulties in sharing information (McCaffer, 1974). Improving the existing communication capacity was a major consideration of the British Property Federation (1983) in the development of a new system for building design and construction. The situation in the United States is hardly better regarding the communication problem. A report of the Business Roundtable (1982) contained the following conclusions:

- There is little sharing of actual reliable cost data within the construction industry.
- Most published cost data are viewed as lacking credibility in the real world.
- Even within companies, feedback of actual costs is not consistently used to review and adjust the basis for estimating.

An international group of outstanding construction experts from both industry and academic establishments held a conference on future computer applications in construction engineering and management in the University of Illinois, Urbana - Champagne on 19 - 21st May 1985. Their overwhelming consensus was that the underlying issues of information flow processes in construction are not properly understood and therefore need urgent research (Ibbs, 1985).

The situation in the Kenyan Building Industry is even worse than that of America. In the 1990, very few architectural and quantity surveying firms started appreciating the application of computing knowledge in the industry. Programmes such as Archicard and expert systems have been rampantly used.

Document management is a powerful approach for communicating and controlling product development Amani and Beghini (June, 2000). From this perspective, documents are transmission channels throughout which most processes in organizations and project management are managed. To control product development (e.g. time, cost and quality) document management premises productivity and performance improvement. In order to provide the project manager with a powerful tool allowing control of product development through communication, a software programme called DOMAIN has been developed. Project managers can use DOMAIN to plan documents, control baselines and procedures and assign rules. The use of DOMAIN improves communication among people and groups.

Documents can be electronically captured, organized, stored, retrieved, transmitted and displayed, and control and communication be enormously improved. Electronic Document Management (EDM) has the following benefits:

- Improved communication EDM expands the scope of information management from data records and databases to concepts and ideas that are captured, stored and communicated.
- Re-engineering product development processes. Real benefits of EDM can be obtained not only from automating product development processes, but also from the re-designing or re-engineering processes.
- Leveraging organizational memory. One of the major components of organizational memory is data stored in documents.

The use of a document management approach reduces the level of ambiguity and equivocality in a dynamic environment and rapid management turn over.

The use of EDM in the building industry would create efficiency and hence minimise time and cost overruns. This would particularly enhance communication between the site office and consultants' and contractors' offices.

Consultants and contractors would love to share electronic data. But the construction's culture of distrust rather than technical difficulties comes between them.

2.6.1 Application of IT at Construction Site

A study undertaken in the United Kingdom established that the implementation of advanced IT is very fragmented even within large projects (Baxendale, 1999). Some leading projects demonstrated exceptional use of IT for integration of the communication system and increasing drawing transfer speed. The smaller sites did show some signs of IT usage with the projects. Project managers were aware of the developments taking place but were prevented from using new technologies due to budget restrictions. There was the will at site level to adopt innovations but it might not happen until strategic decisions are made that show a perceived benefit from an increase in expenditure.

The same scenario applies to the Kenyan building industry where IT is hardly used at construction sites. CAD is also scantily used in the building industry.

2.7 Summary

This chapter has examined concepts of risk in general terms. The difference between risk and uncertainity has been explained. Risks have been classified into broad categories: speculative and pure risks. The latter have been further sub-divided into management, market financial, production, political and innovative risks.

The concept of risk in insurance has also been discussed. This concept basically falls under pure risks. Risk management embraces both uncertainity and risk, the latter resulting from inadequate information. The components of risk management namely: identification, analysis and response are described. For any risk management to be effective and successful, the three components/stages have to be applied in the building process. The role of cost information in risk management has also been examined with the chapter ending with the practice of risk management. Risk management methodologies/strategies in UK and Canada have also been described.

Information technology plays an important role in minimizing risks although the former is scantily applied in the Kenya Building Industry.

The following chapter seeks to address risk management in building projects in the light of several procurement systems. The components of risk management namely risk identification, analysis and response will be discussed in reference to the said procurement systems.

Chapter III

RISK MANAGEMENT IN BUILDING PROJECTS

3.1 Procurement Management

Clients of the construction industry rely extensively upon the advice given in respect of the most suitable method of procuring their project from inception through to completion.

The advice given should therefore be both relevant and reliable based upon the appropriate levels of skills and expertise which are available. Procurement procedures are dynamic. They will continue to evolve to meet the changing and challenging needs of society and the circumstances under which the industry will find itself working. A procurement system should incorporate the following Ashworth, 1994): -

- Client's requirements and objectives.
- Assessment of the viability of the project and advice on funding, taxation and residuals.
- Advice on organizational structure for the project as a whole.
- Recommendation on consultants and contractors.
- Management and co-ordination of the process from inception to completion.

3.1.1 Procurement Strategy

The selection of appropriate contractual arrangements for any type of project is difficult owing to the diverse range of options and professional advice available. The proliferation of differing procurement arrangements have also resulted in an increasing demand for systematic methods of selecting the most appropriate arrangements for a particular project.

A particular project with defined objectives will result in the selection of appropriate procurement options. The following are factors which should be considered when choosing the procurement path (Ashworth, Ibid.)

- Size - Small projects are not suited to complex arrangements.
- Design - Aesthetics, function, maintenance, buidability contractor integration.
- Cost - Price competition/negotiation, fixed price arrangements, price certainty, price forecasting, contract sum, bulk-purchase arrangements, life cycle costs, penalties for default, variations and final cost.
- Time - Inception to handover, start and completion dates, early start on site, contract period, optimum time, phased completion, fast track, delays and extension of time.
- Quality - Quality control, defined standards, independent inspection, design and detailing, single and multiple contractors, contractor reputation, long term reliability and maintenance.
- Accountability - Contractor selection, adhoc arrangements, contractual procedures, auditing, simplicity, value for money.

- Organization - Complexity of arrangements, standard procedures, responsibility, sub-contracting and lines of management.
- Risk - Evaluation, sharing, transfer and control
- Market - Work loads, effects of procurement advice
- Finance - Collateral, payment systems remedies for default and funding charges.

Consideration of the above factors would lead the project manager to make a choice of an appropriate procurement system for a particular project.

3.2 Management of Risks

The process of risk management, namely: identification, measurement/analysis and response referred to in the previous chapter can be universally applied. The same process of risk management is, therefore, applicable in the building industry. The principal purpose of building contract agreements is to apportion risks between employers and contractors (Jaafari, 1996). This is achieved by deciding during the pre-contract period on the tendering method and the type of contract to be used in the execution of the work. The process involved herein is known as procurement system which is a prerequisite before the complete delivery of the building.

Cox and Townsend (1998) have argued that risk management can aid procurement. Risk management may be used to establish project priorities, the roles of the various parties in the process and the number/type of work packages to achieve these aims. Cox and Townsend (1998) have underlined key issues concerning contract strategy, addresed as follows: -

1. Division of responsibility among the client, the design team and the contractor;
2. Terms of payment to the parties concerned;
3. Basis of contractor selection;
4. Degree of client control/involvement in the project;
5. The most appropriate allocation of risks.

The design team has to advise the employer accordingly in regard to the system which is appropriate for the particular project. In order to advise properly, three major factors have to be considered. In the light of those factors, the most appropriate procurement system should be adopted (Bennett 1985). The factors are: -

- Type of development
- Conditions of engagement
- Procurement systems

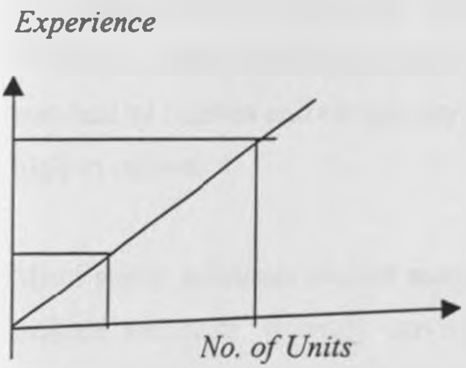
3.2.1 Type of Development

There are various types of developments which take place in the building industry, namely: residential, industrial, office/commercial as discussed below:-

> ***Residential Housing***

This may comprise one unit or several of them in an estate. If the same type of construction is applicable and in similar units, then the construction period may be shorter due to skills and experience gained as a result of improvement on the learning curve as shown in Figure 3.1.

Figure 3.1 The Learning Curve



Source: Bennett (1985)

The figure shows that the more the units constructed the more experience is gained and hence the improvement in performance. The latter units of construction would be better and would be finished faster. They would also be better in quality because of the improvement on errors made earlier.

There are no outstanding special features in this type of construction and therefore a contract which apportions risks to the parties in the contract would be acceptable. Selective tendering method may augur well for a construction scheme of this nature except that if time is of essence, then negotiation may be recommended.

➢ ***Industrial Buildings.***

These are buildings used to provide a space for the production of goods or for use as stores. The quality of finishes may not be very high although storey heights may be approximately six (6) metres. Buildings such as nuclear plants or military ware-houses are a big security concern to the state. It is therefore not advisable to engage general contractors. Design and build or what is usually referred to as turnkey contracts are usually recommended for such projects which are realised through negotiation.

➢ ***Office Blocks/Commercial Buildings.***

Buildings under this category may be in single storey or in multi-stories. The standard of finishes and complexity of construction vary from being simple to very high in calibre.

Multi-storey buildings require many experts in their construction. These experts include architects, quantity surveyors and structural engineers. In the west, management contracting has been applied in the execution of such projects. This procurement system involves a management contractor who is taken as a member of the design team and manages many specialist-contractors on the construction site.

In selecting the type of procurement to use, the design team is in effect considering the extent of risks involved. Hughes (1985) states that conditions of contract allocate risks likely to be met in the course of work to one party or the other. Parties may, however, not be aware of their responsibilities and obligations when they execute contract documents.

3.2.2 Conditions of Engagement and Allocation of Risks

Conditions of engagement stipulate the terms and obligations between the employer and the design team. In the private sector, Architects and Quantity Surveyors are appointed in accordance with Chapter 525, Architects and Quantity

Surveyors Act, of the Laws of Kenya (Republic of Kenya, 1974). The Act sets out the duties of the Architect as that of advising his clients, studying their needs, preparing, directing and co-ordinating design and supervising works executed under a building contract. The Architect has received education which equips him with relevant skills. The latter enable him to understand the scope of work in regard to understanding the client's needs and design perspective. The architect prepares his design with focus on the client's needs which he endeavours to meet in the design. The Quantity Surveyor being a consultant on building costs is also engaged to give advice on this specialist area.

The client, on the other hand, is usually not trained to understand the complexities of the building industry. He has therefore to buy the skills of experts in the industry. He serves the role of an entrepreneur.

The Act does not, however, address itself fully to the issue of liability in spite of the fact that there is reference to arbitration in incidences where disputes arise. The client would however be given redress in courts of law where sufficient proof of negligence has been given in regard to the consultant's dispensation of his duties.

The Ministry of works conditions of Engagement recognise the fact that Architects and Quantity Surveyors are governed by the Architects' and Quantity Surveyors' Act (Cap. 525) (Republic of Kenya, 1974). The professional appointed is referred to as a consultant.

Clause 201 - 11 stipulates that the consultant shall exercise all reasonable skill, care and diligence in the discharge of the duties agreed to be performed by him. The consultant has to work in close consultation with the client before making any substantial changes.

The documents in regard to engagement are however not detailed and they are not explicit in regard to the allocation of risks. This leaves ambiguity which could be exploited by either party. It is therefore, imperative they should be revised to address the issue of apportionment of risks to the relevant parties.

Members of the design team are aware of the fact that risks may result which may ground their practices. These risks may arise from negligence while undertaking their professional duties. Practicing professionals in the building industry take insurance cover on professional indemnity. Such covers may, however, be insufficient since the professionals take them on their own volition. The umbrella professional bodies such as the Architectural Association of Kenya (A.A.K.) should encourage their members to take comprehensive covers which are commensurate with the size of practice. Conditions of engagement could also elaborate more on the issue of allocation of risks and may-be make it mandatory that the consultant takes insurance cover on professional indemnity.

Consultants in the building industry should be more aware of the fact that any advice they give due to their professional inclination would create risks for them. Crockford (1986) reinforces this fact by stating that a person who gives advice is responsible for what happens if his advice is taken; particularly if one has greater knowledge than the layman, one must accept responsibility if following that advice proves to have unfortunate consequences. The bearing of risk is aggravated if the person giving advice is a professional with a contractual relationship with the recipient who has a right of action against him. Caution, therefore, is called upon all professionals in the building industry to have restraint when executing their duties in the industry more so when dealing with the client.

3.2.3 Procurement Systems and Allocation of Risks in the Building Industry

Turner (1988), has suggested that the following criteria be used in giving the client the most appropriate procurement system:-

- ***Speed***

The speed at which the building is required to be provided is important. If the building has to be delivered within a very short time, then cost is not critical. The client may, therefore, be prepared to part with huge amounts of money in order to get the building on time. Negotiated contracts as stated earlier may be considered to be appropriate. The client would be in a position to bear more risks than the contractor.

- ***Complexity***

Complexity plays a key role in the choice of a procurement system. A complex construction project cannot be undertaken by a general contractor. Technology may have been introduced in the design which would require the services of a specialised contractor. This may, therefore, call for a negotiated contract. Alternatively, shortlisting of contractors may be undertaken on a selective basis, basing the same on past experience.

Complexity is linked to size, cost, time and intricacy of construction, and the diverse number of the professionals required to handle the said complexity, with all the interrelationships which go with it. Gidado (1996) defines complexity as the measure of the difficulty of implementing the planned production work flow in relation to a number of quantifiable managerial objectives. Sidwell (1990) describes complexity as the diversification and complexity of the operating environment, which of course is influenced by size, cost and intricacy. The level of technology required to undertake the construction also contributes to complexity.

- ***Quality Level***

Some buildings such as executive residential housing or office blocks may call for very high quality finishes. Selection of contractors could, therefore, be considered as that of complexity as stated above.

➢ ***Competition***

A Client may consider speed to be unimportant and also funds may be a limitation. He would therefore choose a competitive procurement system which would be open to many tenderers. The cost of administering this system may, however, be very expensive due to documentation. Producing documents for over 100 contractors would costs colossal sums of money in photocopying and binding.

➢ ***Risk Certainty***

The conception of the magnitude of risk to be borne becomes good basis on which a decision has to be made on contractual commitment. In the past, cases have arisen where contractors have declined to participate in a tendering system where they envisage that the incidence of risk is very high. Cases of this nature have occurred in big construction projects with a value of over Kshs.100 million, where the price fluctuations clause is not operational.

The factors described in sections 3.2.1 to 3.2.3 above are some of the factors which would be used to determine the selection of a procurement system. The factors contain some element of risk.

Most clients would take keen interest to understand the impact that each of the factors would have on the project. Allocation of risks varies with the type of contract to be used. Morris (1989) supports this view by stating that the criteria applied in the selection of the particular type of contract should be considered before tendering. Benefits accruing from open, selective and negotiated tendering methods should be considered before calling for bids. Open and selective tendering methods are time consuming but may eventually be cheaper. It may, however, be difficult to guarantee quality. Negotiated tendering requires a shorter time, guarantees quality but it may end up being more expensive. The reason for this is that in negotiation, the contractor is in a position to pass more of the risks to the client.

These methods of tendering are used in traditional contracts. An example of the traditional contracts is the Agreement and Schedule of Conditions of Contract sanctioned by the Architectural Association of Kenya, which is currently used in the Kenyan building industry (A.A.K, 1977).

3.3 Risk Allocation in the A.A.K. Conditions of Contract

Risks are allocated to the parties in contract. Privity of contract requires that it is only parties to a contract that can benefit from risks resulting from a contract. Major (1979) reiterates this fact by reference to the court case: Tweddle V. Atkinson (1861) that foreigners to a contract have no right to claim and that a person who is not a party to a contract cannot have obligations imposed on him by the contract even if he knows of its terms. The case of Mc-Gruther V. Pitcher (1904) illustrates that a person who is not a party to a contract can not have obligations imposed on him by the contract, even if he knows of its terms.

The parties to the building contract are the Employer and the Contractor. These two parties have the legal right to sue each other in accordance with the terms of contract. Architect and other members of the design team are by extension agents of the employer and they could contribute greatly to the risks to be borne by either the contractor or the employer.

The terms of contract allocate risks between the employer and the contractor. The parties should seek to understand terms very clearly before entering into contract. It may be very difficult to change the terms of contract after execution. Risks may arise during the construction period and any endeavour to redistribute them would be resisted by the other party.

The Federation of Insurance Institute (FII, 1986) has underscored the fact that risk management has created a situation where risks are transferred to the other party.

The building contract supports this fact since it allows for the transfer of risks by the employer to contractor and vice-versa depending on the circumstances.

Green (1978) states that ignorance of risk can result in unpleasant surprises when the loss occurs which would have far more negative impact on operations. The parties to the contract should be aware of the risks that they are taking in the building contract. Wilkie (1987) has stated that contractual liabilities derive from the terms of an agreement between the plaintiff and the defendant and is limited by those parties. The AAK conditions of contract examine the whole process of construction taking into account the risks involved and allocating them to the party concerned. The employer's major concern is that the project under construction is undertaken in the prescribed manner in terms of quantity, quality and time. Failure to complete on time would mean more expenses. The Design team has therefore to employ all their resources in providing information to the contractor and supervising the works in order to satisfy the employer's criteria in terms of reference.

The contractor, on the other hand, takes into account the magnitude of the work involved and provides resources for the construction of the same. His main concern is that he is paid amounts of monies owed to him when they fall due. In applying for payments he considers site instructions and variation to the contract which have cost effect. Clauses 2 and 11 give authority that any extra costs which may arise from instructions and variations should be allowed for in interim valuations. The flow of funds to the contractor from the employer during interim valuations enables the contractor to maintain a good cash flow and hence to execute the work with expediency. If this lifeline or the money chord is severed, then the contractor has no option but to determine his own employment in accordance with clause 26 1 (a). The employer should endeavour to avoid this situation arising since it affects his reputation negatively. He should therefore set aside sufficient funds for the construction.

The contractor is exposed to risks of different nature, as stated below, while executing the works: -

- ***Lack of Information.***

  In order to undertake the works as per the schedule, the contractor requires the project specification e.g. type of paint or colour scheme, and drawings. This information may not be available on time hence affecting the planning schedule and the deploying of the labour force. Consequently, a delay in the execution of the work. He should therefore apply for extension of time as provided for in clause 23. He may, however, claim for loss and expenses which may be suffered (Clause 24) but it is very unlikely that he would be compensated fully.

- ***Volatile Economic Situation.***

  The contractor has to purchase materials and goods to enable him to undertake the works. Prices of such materials and goods are not constant during the period when works are executed. If the contract sum is fixed, then the contractor may suffer a serious financial loss since he cannot be reimbursed. For large contracts i.e. contracts exceeding Kshs. 2 million in accordance, with the Ministry of Works regulations, the Fluctuations Clause (Clause 32) of the A.A.K. conditions of contract would be operational. The contractor would be reimbursed for additional costs incurred in fluctuations in prices of materials and changes on duties.

- ***Externalities.***

  Incidences like acts of God, i.e. floods, fires etc., and strikes by the workers would greatly affect the performance of the contractor in undertaking the construction of the project.

The above are only few occurrences where the contractor faces risks. It is apparent that most of the risks are transferred to the employer because the contract allocates them that way. The employer needs more consideration in regard to the allocation of risks. It may, of course, be argued that some of the risks consequently spring from the members of the design team. The employer may take redress from either litigation or arbitration. The processes involved in redressing are tedious and expensive.

Eaglestone (1979) has stated that the employer requires cover against the risk of failure by the contractor to complete the contract in accordance with its terms. Time overruns are a problem in most projects in Kenya (Talukhaba, 1989). It is very rare for a contractor to complete the project without invoking Clause 26 of the contract. There are also cases of non- completion of building projects.

Clause 22 provides for damages for non-completion of the project as scheduled. The employer is compensated in this manner. The magnitude of damages would depend on the type of a project i.e. housing, industrial or office or commercial. The income to be foregone is the key in the establishment of damages.

A bond in accordance with clause 31 is provided at 10% of the contract period and it is discharged at practical completion. The bond is provided by a surety that would be held liable to the employer in case there is non-performance in the execution of the project. Cases have arisen where the surety relies squarely on the advice from the contractor particularly in regard to determination by the employer and the surety has declined to honour his contractual commitment. Such cases tend to result in the long processes of legal litigation. There should be a provision in the contract that, if the contractor does not perform, the surety automatically forfeits the bond. The percentage provided (10%) is usually not sufficient to cater for the risks to be borne by the employer.

The contract, however, provides a safety valve for the parties to the contract. The clauses (25 and 26) on determination, extension of time (23), loss of expense (24), fluctuation (32) and arbitration (36) bring into play to some degree the principle of equity where the aggrieved party can seek redress. The contractor is in the business of constructing and making a profit without which he cannot continue in business. The employer being a promoter is also in the same category. Arrow (1970) states that profits are the reward of the risk taking in a sense that profit is a necessary inducement for risk bearing.

3.4 Risk Management in Building Contracts

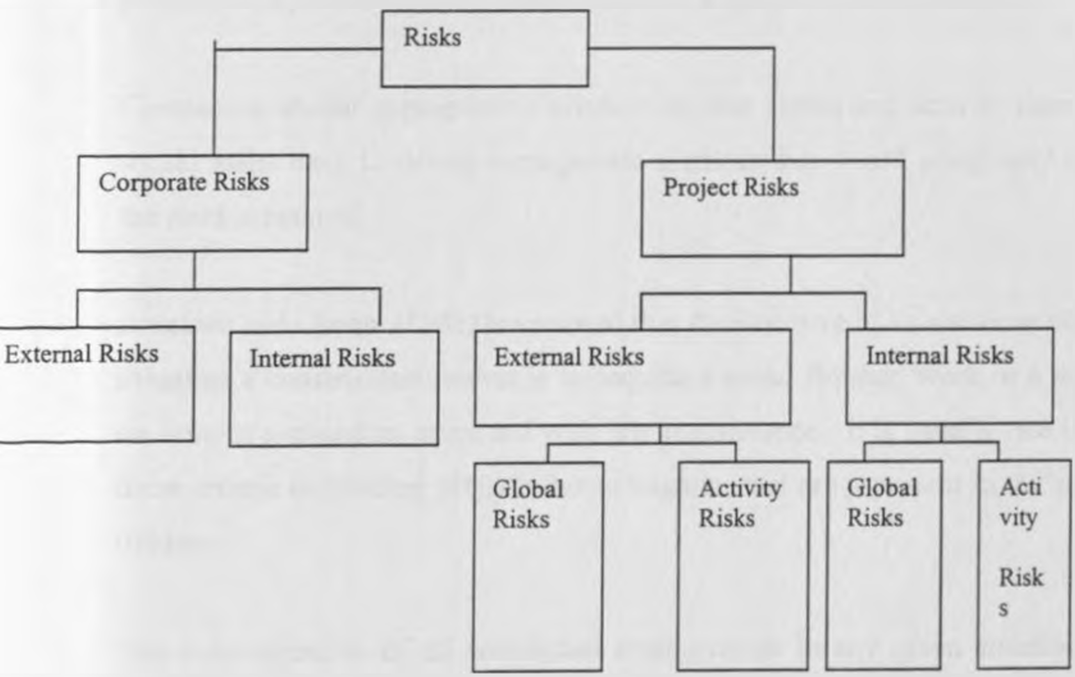
Risks in the construction process may be classified as either contractual or constructional (Uher, 1990). Contractual risks arise primarily from interaction among different parties in the construction process and are introduced through lack of contract clarity, absence of "perfect" communication between the parties involved, and problems in contract administration. Contractual risks cannot be reduced by transferring them to another party in the contract. Constructional risks arise from factors such as weather, differing site conditions, acts of God, resource availability or any other risk inherent in the work itself.

Porter (1981) said that every business enterprise experiences business (speculative and pure (insurance) risks. Speculative risks have chances of making a profit or a loss whereas pure risks have only a chance for loss and no chance for making a profit. The three parties to a contract - the client, the design team and the contractor - can use the model of the general classification of risks. The model is shown on Figure 3.2.

3.4.1 Corporate Risks

External risks mainly comprise of economic risks such as interest rates, inflation, market conditions including level of capital investment, investment opportunities, government legislation, changes in tax and the labour market. Internal risks include staff, liquidity risk, financial risk and operating leverage. The latter should indicate mark-ups and the rates of profitability to be allowed by an enterprise.

Figure 3.2 General Classification of Risks



Porter's (1981) model

3.4.2 Project Risks

External risks comprise of building regulations, level of competition, project type and size, location, pressure groups and external economics e.g. inflation, interest rates, the present and future demand of the facility. Availability and suitability of land are also important.

Internal risks arise from management structure, completeness of design brief, accuracy of documents, contract selection, contract administration, tender process (number of bidders, tender period, completeness of documents), competence of design consultants, contractor, sub-contractors and other parties in the project, weather, safety, and industrial issues, accuracy of feasibility studies and cost estimates; industrial relations, availability of resources; quality of work; maintaining budget (time and cost) and technology applied in the execution of the project. The pre-cursor of all these risks would be time and cost overruns.

Contractors should appropriately divide risks into global and activity risks. This would assist them to devise management methods that would adequately address the risks concerned.

Aniekwu and Okpala (1988) have stated that the objective of an owner or client on initiating a construction project is to acquire a sound finished work or a building on time, at a minimum price and with low maintenance. It is usually rare to meet these criteria in building projects due to vagaries that are prevalent in the building industry.

The main objective of all contractual arrangements in any given situation is to optimise the client's requirements in quality, time and price. This requires a contract agreement that serves as a vehicle that effectively manages contractual risks.

The Architectural Association of Kenya (AAK), Agreement and Schedule of Conditions of Contract is predominantly used by the private sector in Kenya. This contract proposes ways and means of managing both speculative and pure risks although the former takes the majority.

Pure risks are covered under clauses 18, 19 and 20. These address the issue of losses which may be suffered due to damage caused by fire or negligence of the contractor including other vagaries such as acts of God, inclement weather among others. These pure risks are insurable under workman's compensation policy and all contractor's risks policy. It is, however, doubtful whether insurance companies take precaution to ensure that contractors maintain sufficient cover for such risks.

Speculative risks as earlier stated are predominant in A.A.K. Conditions of Contract. Crockford (1986) states that success in business is seen as very much a matter of managing speculative risks. The latter is seen as a possibility of a gain or a loss. The contract generally provides for omissions or additions in the contract. The former may be a loss to the contractor in terms of profit not earned whereas the same may be a gain to the client financially. It should be noted that the omission should not affect the quality of work and functionality of the building. Additions on the other hand may be financially beneficial to the contractor.

3.4.3 Speculative Risks in the A.A.K. Conditions of Contract

There are clauses in the contract that are the source of speculative risks. These clauses are examined below: -

❖ Clause 2 - The Architect is authorised to issue instructions. He is expressly empowered by this Clause to issue instructions in regard to any matter. The assumption here is that the instruction shall be for the good of the project and hence the express authority. The instruction to be issued herein could have the effect of either omission or addition to the contract. The process of formalising the instruction in writing gives it the authenticity and the binding effect of the responsibility on the part of the Architect.

- Clause 4 - The Contractor shall comply with all statutory obligations, notices and payment of fees and charges to that effect. Costs related to this requirement are supposed to be added to the contract sum if the same had not been part of the contract sum.

The issue of provisional sum covered under sub-clause 4(2) (b) is important. A contingency sum usually included in the bills of quantities under the section of Provisional Sums is worked out by quantity surveyors to cover any eventualities which may arise during the period of contract administration. There is no established methodology currently into play in working out the contingency sum. The latter should vary depending on the type of the project, size and construction details available at the tender stage. The magnitude of the figure should be an indication of the speculative risk expected during the execution of the project.

A common practice in the building industry is to assess a single value estimate of risk using a contingency (Newton, 1992, Uher, 1996). The contingency approach does not adequately measure risk. This fact is exhibited by the numerous cost overruns in the industry. Cox and Townsend (1998) state that there is a history of frequent and excessive cost overruns due to poor contingency management. They argue that a less subjective approach to contingency allocation be employed rather than the provision of meaningless global percentage of values which are mainly based on an estimator's perceptions of project risks. A database would provide a knowledge-based system, to capture knowledge, experience and judgement of an expert practitioner.

- Clause 6 - Materials, goods and workmanship should conform to the specification on the drawings or included in the contract bills. Late arrival of materials and goods produced locally or imported would have a negative effect on the contract period. The contractor should therefore act expeditiously in order to avoid delays in procurement of materials and goods.

- Clause 11 - Variations in the contract works have a very important bearing in speculative risks. This clause outlines the methodology involved in arriving at rates where variations have occurred. Numerous variations would be an indication that the brief had not been fully addressed during the pre-contract stage. It is advisable that clients take this briefing stage seriously in order to minimise speculative risks.

  Variations would seriously affect time and cost overruns hence endangering the success of the construction project. Bromilow (1970) and Levido *et al* (1980) examined causes of delays of head contract, identified variations as being the most significant factor causing delays in the completion of construction projects.

  Bromilow (1970) found out that both the value and number of variations occurring in a contract were a function of size. The occurrence of variations is a reflection of incompetence in design, lack of application of constructability and poor planning and control. Hampton (1994) attributed this phenomenon to the procurement process that does not allow suitable criteria, giving rise to the appointment of a design team not best qualified to provide the services. Variations may also be an indication that the client's brief was inadequate at the inception stage of the building project. Variations are generally a very important factor in the execution of building projects. The building industry should, therefore, give serious consideration to the issue of variations.

Fist (1982) states that contractor's participation in value engineering by providing a statement of the construction method given at the inception stage of the project could minimize risks. The traditional building contract does not allow for the statement of construction method, which creates risks in the selection of the contractor.

- Clause 12 - The contract bills play a key role in describing the quality and quantity of work included in the contract sum. The clause states that any error in description or in quantity or omission of items from the contract bills shall not vitiate the contract but shall be corrected and deemed to be a variation required by the Architect. This clause apparently justifies speculative risks. It also protects contract bills so that they are not discounted by the parties to the contract in case the said bills are found wanting.

- Clause 21 - The completion period is usually given under this clause. The design team gives the contract period in consultation with the client. They also may allow tenderers to bid for completion period as a competitive factor. This, however, has not resolved the problem of time overruns.

The building industry does not have a methodology for fixing completion period. It is generally based on experience which may be considered to be subjective.

Harrison (1981) argues that the forecast of project completion date is a highly emotive factor that often causes problems and misunderstandings. It is not possible at the start of the project to accurately forecast actual completion date since there is not enough information available and that time is not a constant.

Time is a variable depending on many factors and also on decisions taken in the past, the present and the future. The actual completion date can only be forecast with a degree of reliability only after considerable work has been carried out on a project. Harrison (1981) recommends that in planning a target date a contingency of 10-20% should be allowed on time just as a contingency sum is allowed on the budget. The building industry faces a challenge to look for a methodology of setting completion time which is objective. Nkado (1992) argues that the building industry should create a data bank to provide a construction time information system.

- Clause 22 - Damages for non-completion serve as a safety valve in case the contractor defaults. The figure included in the bills should not be punitive but it should seek to compensate the client for non-completion. There is no acceptable formula/methodology in the industry, which would be applicable when computing damages. Loss of revenue for non-completion would, however, be used as valid evidence in case the matter ended in courts of law.

- Clause 23 - Causes of time overruns are covered under this clause. It covers areas in both speculative and pure risks which would cause delay and hence result to extension of time. Extension of time would have negative effect in the completion of the project.

- Clause 24 - Delays occasioned under Clause 23 disturb the regular progress of work resulting to the Contractor suffering loss and expense. The effect in this phenomenon is that speculative risks have arisen in the contract. It is important to note that all delays are not necessarily compensated under loss and expense. This clause, however, addresses itself fully to the effects of time overrun which may end up in cost overruns particularly if the contingency sum has been exhausted.

- Clause 30(3), (4)(b) - Retention Fund. The retention fund under this clause is usually 10% although this depends on the monetary value of the project. The bigger the project, the lower the retention fund since this is a reflection of the amount retained. A big project may result to a big sum of money belonging to the Contractor being retained by the Employer. The retention fund is like an insurance sum which would cater for non-completion risks in case the contractor defaulted. This risk decreases drastically at practical completion and hence the release of the fifty (50) percent of retention.

  The retention fund serves as a catalyst in that it makes the contractor to be prudent in managing risks in order to ensure that the project is completed as per the conditions of contract.

- Clause 31 - Bond. This clause serves the same purpose as that stated under Clause 30(3), (4)(b) above. The only major difference is that the cover is provided by third party and that the Employer is also required to provide cover for the second moiety of retention. Employers find it difficult to provide this cover although this should be adhered to since contractors may end up not receiving final payments.

- Clause 32 - Fluctuations. This clause deals with fluctuations on all government taxes and changes in exchange rates. Fluctuations in prices of materials and goods including labour costs are also covered. This clause is important since some contractors may decline to undertake building contracts which do not allow for the operation of this Clause.

It is not clear what size of projects should be covered under this clause. Ministry of Works (M.O.W.) used to have all projects whose value was in excess of Kshs. 2 Million covered by the fluctuations clause. The private sector did not have any criterion. It may be advisable to find out the views of the private sector on this matter.

The Clauses covered in this section were a source of the variables used in this study. There are other clauses which deal with risk management but they have not been discussed herein. The reason for this being that their effect may be minimal or that they mostly point to pure risk management which is not the thrust of this study.

Aniekwu and Okpala (1988) studied and ranked variables involved in risk management of contract services in Nigeria and the following were the results:

Variable		*Rank*
a)	Shortage of materials	1
b)	Financing and payment for completed works (causing delays and cost overruns)	2
c)	Variations (cost overruns)	3
d)	Non-adherence to conditions of contract	5
e)	Changes in design	6
f)	Approval of test samples of materials	7
g)	Sub-Contractors and nominated suppliers	9
h)	Errors during construction	10.

This study analyses projects in Kenya, their type and size to arrive at a ranking which could be used in future to foretell what is expected during the execution of a project.

3.5 Risk Allocation in Other Procurement Systems in the Building Industry

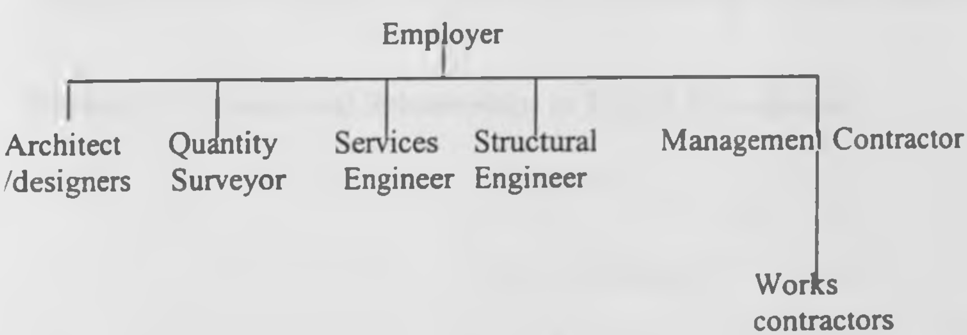
There are other forms of procurement systems which are employed in the Kenyan building industry although their scope may be very small. The contracts are:

Management Contracting, Project Management and Design and Build usually referred to as turn key. These types of contracts are new phenomena in Kenya except Design and Build where the Japanese have been involved in funding these projects and constructing the same. Much time will not be used to delve very much on this issue except that these types of contract will be examined briefly below:

3.5.1 Management Contracting

This is a contractual arrangement where the contractor is taken as a member of the design team. The management contractor is experienced in construction and his skills are employed at the inception of the project. The principles of buildability where design and practicability in the construction are brought together into play. The management contractor is required to give input on scheduling, budgeting and meeting target in the construction. The contractor should, therefore, understand what is involved in the design in order to establish durations required per stage. The contractor is remunerated for his services at a fee of 2%.

Fig. 3.3 Contractual Relationships in management contracting



Source: Murdoch and Hughes, 1997, Pg.64

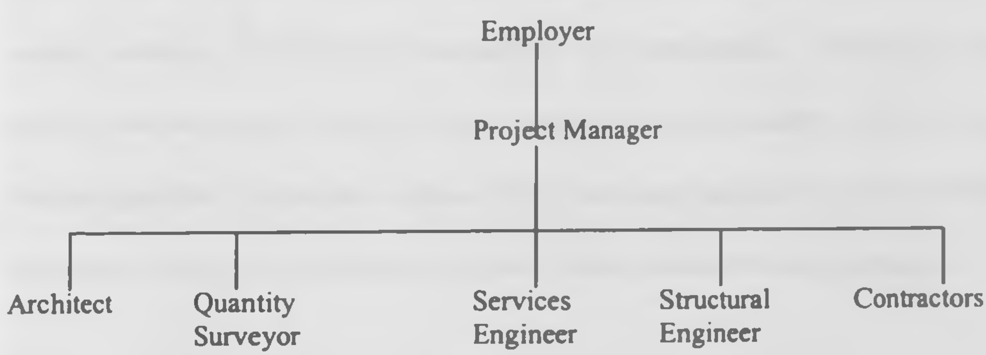
This contract arrangement has been criticized as being contributory to burdening the employer in terms of extra fees. The management contractor has also been criticised as not being well trained professionally and, therefore, he should not be regarded as one of the design team.

Regarding risk, the Management contractor has been taken as risk free. He has, however, to co-ordinate all the works-contractors work on site in order to meet set targets set for the performance of the project. Many works-contractors are appointed after the award of the contract, through tendering on the work-packages and they participate in the construction process. If the Management contractor undertakes his duties well, then there is minimisation of risks due to time saved in construction. Quality of work being undertaken by specialists in their own disciplines guarantees good standard of workmanship. Members of the design team devote more time to design and production of information in lieu of spending much time in administrative duties on site, hence reducing incidences of delay. The employer may, however, seek for redress in court from the Management contractor if targets are not met.

3.5.2 Project Management.

Burstein and Stasiowski (1984) have defined project management as planning, organising, directing, controlling, financial management and marketing. For one to qualify in this discipline, he should have broad training in all these disciplines.

Figure 3.4: Contractual Relationships in Project Management



Source: Franco 1990, pg. 21

Bennett (1985) has differentiated project management in the building industry by referring to the discipline as construction project management. Projects in the building industry as earlier stated are complex due to their nature and the calibre of skilled human resources.

The employer appoints a project manager who recommends the other consultants and the contractor for appointment. All the above parties have a contractual relationship with the employer.

Locker and Gordon (1996) have defined a project as a unique process consisting of a set of co-ordinated and controlled activities with start and finish dates. A project is undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources. Building projects are capital projects which are carried out within normal organizational structures which may extend over a number of accounting periods. Building projects employ enormous capital outlay.

Locker and Gordon (1996) have stated that any project has four distinct phases namely concept, development, realisation and termination. Building projects under these stages are broadly divided into two phases namely pre- and post-contract periods. Locker and Gordon (1996) have emphasized the use of networks in project planning in structuring analysis which enables the design team to concentrate on risks associated with particular activities and on the interfaces between functions, suppliers and external factors which may have a high level of risks.

There are few practices of construction project management in Kenya. The firms in business may not have qualified people who have been trained in the discipline of project management as related to building construction. The staff may have received training in other areas of project management which they improvise to suite the building industry.

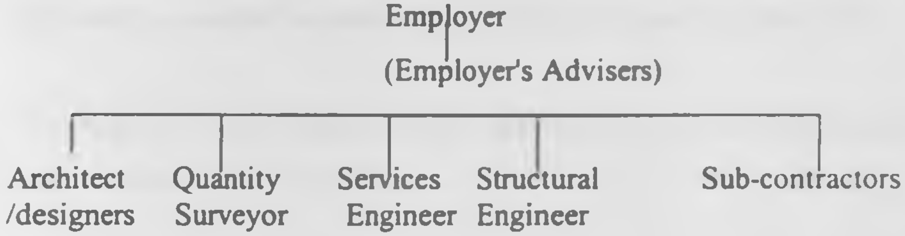
Project management may be practiced under a Department in employer's organisation. This Department would play a co-ordination role between the design team, the contractor and the client. Scheduling of activities would form a key part in the execution of the project manager's duties. His good performance would reduce risks which fall on the employer.

The project manager who serves in an independent organisation would undertake duties as those of a Management contractor except that his degree of performance would be lower in regard to buildability. Mbatha (1993) has reiterated the fact that there is potential for project management in Kenya and that all efforts should be made to promote it.

3.5.3 Design and Build.

This is a procurement system where all the stages of the design process are undertaken under one roof. The contractor undertakes the responsibility for the design and the construction of the project. Risk management is feasible here because all the required expertise is centralized. The client is dealing with a central point of responsibility, hence enhancing efficiency.

Fig. 3.5 Contractual Relationships in Design and Build



Source: Murdoch and Hughes (1997; 50).

This contract system is used where building projects are very complex and the coordination role is very demanding.

This contract works well where the client's brief is complete. The contractor designs and builds according to the brief. Variations during construction become expensive to the client. The contractor bears most of the risks because he undertakes the responsibilities for designing and building the project including assuring the client that the work will be completed on cost and time.

The major purpose for design and build contracts is that high management skills are employed in the execution of the work creating a co-ordinated environment where speed, quality and cost can be assured to some degree hence minimising risks.

This procurement system manages risks well due to the single point responsibility. The contractor is responsible for both design and construction and therefore he is in a better position to manage risks. He, however, bears most of the risks in terms of time and cost. The issue of quality control may be at stake because of the fact that design, construction and quality control are under the same roof.

The employer would create risks for the project in terms of time and cost risks if there are variations to the works.

Measurement of risk is complex in nature. It is not possible when examining a particular project to state that the employer and the contractor would bear a certain percentage of risks. The whole concept of risk allocation may therefore be better understood by having an examination of the area of risk management. Dale and Chris (1987) have underscored this fact by stating that it is at the level of project management that insight plays the critical aspect which leads to better decision making and better risk management. It has been stressed herein before that risk cannot be eliminated but it can only be minimized.

3.6 New Trends in Global Risk Management Systems

Procurement systems and contracts have endeavored to allocate risks to the relevant parties. In spite of this scenario, risks have not been minimized. It is in view of this fact that developed countries such as the United States of America, United Kingdom and Japan have sought alternative ways of allocating risks in building projects as described hereunder. The building industry has to learn from the successes of manufacturing and service industry in order to integrate its fragmented production processes.

3.6.1 Partnering

Partnering has been defined as a change in business behaviour and not a technical change to a contract (Gransberg *et al* 1998). Partnering involves two or more organizations working together to improve performance through agreeing on mutual objectives, devising a way for resolving any disputes and committing themselves to continuos improvement, measuring progress and sharing its gains (Egan *et al*, 1998). Partnering has also been defined as a cooperative approach to project management that is intended to reduce cost and conflict (Ceran, 1995). Partnering attempts to ensure that the client and all contractors develop a win-win relationship that discourages gain by one party at the expense of the other.

The partnering approach relies on the fact that the best conflict resolution strategy is the one that prevents conflicts from occurring (Abudayyeh, 1994). The main objective of partnering is to encourage all parties of a contract to change their relationship from adversarial to co-operative by building a friendly environment with all parties acting as members of one team. This change in relationships requires changes in attitude to achieve mutual trust, respect and open communication among all the parties involved. Partnering is accomplished in an organize sequence of steps, starting at the beginning of the project, before the problems come up. These steps include: -

- Making initial contacts to establish relationships
- Developing a mission statement
- Designing a project-specific partnering process

The parties to partnering should come together through the initiative of the client.

For partnering to have a positive influence, the parties in both sides of the construction contract must be willing to accept a higher level of trust than that which has been traditionally found in contractual relationships. Partnering is a means to control the two performance indicators namely cost and time overruns.

Concepts of Partnering

- *Tendering:* There is a reduced requirement for tendering. This may go against the public sector which takes tendering as a way of explicating transparency and accountability. Partnering envisages rigorous measurement of performance and hence ensures the client value for money.
- *Communication:* In privately financed projects, partnering is a strategic relationship that is developed for relatively long periods for multiple projects particularly housing. One of the main advantages of partnering is a thorough understanding of the partners' motivations, trustworthiness and means of communication.

- Growth of partnering is directly related to increase in claims and litigation regarding construction contracts throughout the United States of America (Kugal, 1994). The use of partnering means avoiding disputes and ultimately reduces the cost of delivering facilities.

- Partnering is most valuable on projects with tight schedules where such issues as escalation and open communication tend to enhance the efficiency of critical decision making.

- Selection of partners is not necessarily about the lowest but ultimately about overall value for money. Partnering implies selection on the basis of attitude to teamworking, ability to innovate and to offer efficient solutions. It offers a much more satisfying role for most people engaged in construction.

- All the players in the team share in success in line with the value that they add to the client. Clients should not value all the benefits. Partnering ensures proper incentive arrangement which enables cost savings to be shared and all member of the team making fair and reasonable returns.

- Partnering ends reliance on contracts. Effective partnering does not rest on contracts. Contracts can add significantly to the cost of a project and often add no value for the client. If the relationships between the contractor and the employer is soundly based and the parties recognize their mutual interdependence, the formal contract documents should gradually become obsolete. The building industry may find this revolutionary. It should, however, borrow from the motor industry where Nissan in U.K. and its 130 principal suppliers have non contractual relationships.

Concepts of partnering have also been explained as follows: Unlike either arbitration or mediations, partnering is an undertaking by all parties to avoid disputes by anticipating problems that cause disputes and by having in place structured approach to recognize the possibility or probability of a dispute before it arises. Partnering represents a philosophy of dispute avoidance and equitable risk allocation rather than a legalistic and confrontational approach. (Bilmon, 1994).

There are benefits which accrue to both the client and the contractor from partnering (Abbudayyeh, 1994): -

(a) Benefits to client:

- Potential claims reduction due to open communication.
- Reduced cost overruns and delays due to improved cost and schedule control.
- Improved conflict resolution strategies due to open communications and unfiltered information.
- Lower administration costs due to the elimination of the effort required in defensive case-building.
- Increased opportunity for innovation through open communication that encourages proposals for new construction methods and for constructability improvements.

(b) Benefits to contractor

The following is the list of potential benefits to contractors:

- Reduced costs related to potential claims and litigation.
- Improved productivity due to focus on the project rather than on case-building.
- Improved cost and schedule control.
- Low risk of cost overruns and delays.
- Increased opportunity for financial success through innovative construction methods.

The above potential benefits accrue to the two parties due to lack of adversarial relationship which are prevalent in other procurement paths.

Application of Partnering

The partnering approach may succeed best for the procurement of high value/high risk construction requirements and where the account may be considered attractive to the contractor. (Cox and Townsed, 1998). Partnering can, however, occur irrespective of the type of supply relationship experienced. Partnering represents a desirable spirit of co-operative teamworking as a procedure for making relationships work better.

Partnering can be used as a collaborative approach where there is a relationship based on regular spending and where there is a coincidence of interest between buyers and suppliers. Clients and practitioners partnering should be pursuing more collaborative and less adversarial approaches in their projects.

3.6.2 Lean Thinking

This is a procurement system that us used in the United States of America. The U.K. construction industry has put up a strong case that this system should be tried in Britain (Egan, 1998).

Lean production is the generic version of the Toyota Production System recognized as the most efficient production system in the world. Leading accompanies which are implementing the principles have achieved dramatic success.

Principles of Lean Thinking

- It is an emerging business philosophy.
- Lean thinking describes the core principles underlying the system, which can apply to every other business activity.
- The starting point is to recognize that only a small fraction of the total time and effort in any organization actually adds value for the end customer.
- By clearly defining value for a specific product or service from the end customer's perspective, all non value activities, often as much as 95% of the total, can be targeted for removal step by step.
- Few products or services are provided by one organization alone, so that waste removal has to be pursued throughout the whole value system- the entire set of activities across all firms involved in jointly delivering the product or service.

New relationships are required to eliminate inter-firm waste and to manage the value system as a whole.

- Instead of managing the work load through successive departments, processes are recognized so that the product or design flows through all the value adding steps without interruption, using the tool box of lean techniques to successively remove the obstacle top flow.
- Activities across each firm are synchronized by pulling the product or design from upstream steps just when required in time to meet the demand from the end customers.
- Removing wasted time and effort represents the biggest opportunity for performance improvement. Creating flow and pull starts with radically reorganizing individual process steps, but the gains become significant as all steps link together.
- More and more layers of waste become visible and the process continues towards the theoretical end point of perfection, where every asset and action add value for the end customer.
- Lean thinking represents a path of sustained performance improvement and not a one-off programme.

Application of Lean Thinking in Construction

Pacific contracting of San Francisco, a specialist cladding and roof contractors, have used the principles of lean thinking to increase their annual turnover by 20%. The key to this success was improvement of the design and procurement processes in order to facilitate construction on site by investing in the front end of projects to reduce costs and construction times.

They identified two major problems to achieve flow in the whole construction process - inefficient supply of materials which prevented site operations from flowing smoothly and poor design information from the prime contractor which frequently resulted in large amount of re-design work.

To tackle these problems, they used computerized 30-design system to provide a better, faster method of redesign which leads to better construction information or details. They also used a process planning tool known as Last Planner, developed by Glen Ballard of the Lean Construction Institute, to improve the flow of work on site through reducing constraints such as lack of materials or labour.

The Neenan Company, a design and build firm, is one of the most successful and fastest growing construction companies in Colorado. The firm uses lean thinking principles in their business by applying Study Action Teams, of employees to rethink the way they work. Neenan Company has reduced project times and costs by upto 30%. They use the following tools: -

- Visual control of processes
- Using dedicated teams working exhaustively on one design from the beginning to the end developing a tool known as "Schematic Design in a Day" to dramatically speed up design process.

- Innovating in design and assembly e.g. use of pre-fabricated bricks infill panels manufactured offsite and pre-assembled atrium roofs lifted into place.
- Supporting sub-contractors in developing tools for improving processes.

3.7 Risk Management and Court Cases.

Courts have been used in the process of managing risks. A plaintiff, resorts to litigation when in his opinion he has been allocated more risks than he should bear. Courts, therefore, have to decide on who should bear what risk. Court decisions contribute to management of risks since such decisions are used as precedents which would serve as a guide in future litigations. Parties to a contract could then utilize such information to allocate risks between themselves and in the process minimise or manage risks. These risks shoud, however, be based on the conditions of contract which the courts would use as the basis for their decisions.

In Kenya, there have been very few court cases in regard to management of risks. The cases so far heard have delved very much on determination of contractor's employment and the rights and obligations of parties thereafter (Parris, 1989). The following cases deal with claims related to unlawful termination of contract: -

- Nairobi City Commission V. Sanitary Equipments and Builders Ltd (1988). The case refers to wrongful determination of a contract by the client who was the Nairobi City Commission. The contractor was Sanitary Equipments and Builders Ltd. The project involved the carrying out of extensions to 12 No. primary schools in the city of Nairobi. The court heard that the city commission wrongfully terminated the contract after the works in question had been completed or substantially performed. The court found the client at fault and awarded the plaintiff Kshs. 3 million for the unlawful termination of their employment.

- E.A. Power & Lighting Co. Ltd. V. Kilimanjaro Construction Ltd (1983). Kilimanjaro Construction Ltd entered into a contract with the client to carry out the work of transmission lines on five (5) named sub-stations situated in different parts of Kenya. The contract sum was Kshs 9 million plus the price of any extra work, which might be occasioned thereby in the project. The client unlawfully and without any notice terminated the contract and ordered the contractor to stop all work on the project with immediate effect. The contractor should have been given 30 days' notice to take away his materials and equipment. This did not happen. The court decided that the case be referred to the arbitrator, Acres International Ltd, for hearing and decision as per the agreement. It is however, unfortunate that awards made through arbitrations are treated as confidential in Kenya and therefore not publishable. This has greatly hampered knowledge development in the field of arbitration. The practice in the United Kingdom is different since all awards are published and hence accessible to the public. The Institute of Arbitrators of Kenya needs to address this issue as a matter of urgency.

The following are possible reasons why very few cases have taken place in Kenya:

- Contractors are not fully aware of their contractual rights and hence are not claim conscious. They also would not want to jeorpadize their chances for repeat orders from consultants.
- Some cases are resolved through arbitration. Arbitration awards are not made public and this is detrimental to the resolution of disputes.

Court cases involve long process in litigation and making decisions. They are also expensive. This discourages the injured parties from taking legal action.

3.8 Summary

This chapter has examined risk management in building projects. Various types of building projects: residential, industrial and office/commercial have been described. Risk allocation in the light of Architects and Quantity surveyors, Act Chapter 525 has been examined.

The allocation of risk in the Architectural Association of Kenya (AAK) conditions of contract has been looked at in detail. Reference has been made to the relevant clauses which deal with risk management. The issues of variations- clause 11, construction period- clause 21 and extension to time- clause 23 have a strong bearing in risk management. It has, however, been observed that these conditions of contract should be revised to reflect contemporary issues of constructibility etc. in the building industry.

Other procurement systems such as management contracting, project management and design & build have been discussed. These systems are called fast track since they consider time to be very important. If projects are completed on time, it means savings in the building cost. Fast track procurement systems are populous in the Western and Japanese construction industries although they are rarely used in Kenya. Some of these systems should, however be marketed aggressively in the Kenyan building industry.

Partnering and lean thinking are new concepts which have evolved from developed construction industries. They address risk management in a better way than the existing traditional and fast track of procurement path. They reduce the risks of cost and time due to the reduced adversarial relationships and the collaborative working relationships. Building industries have developed new procurement systems such as partnering and lean thinking to improve productivity /performance. This has resulted in reducing risks drastically. It may be prudent for construction industries to consider the new procurement systems. Time has now come for developing construction industries to consider these new concepts of procurement.

The following chapter examines the research methodology used in the field work.

Chapter IV

RESEARCH METHODOLOGY

4.1 The Research Design

This study is a survey A survey investigates what is actually happening in the field of interest without introducing *treatments or controls* over any of the interacting variables. Results of a random sample are generalized to the target population. The survey research design is better than the *case study*[†] *or experimental* designs in research studies where no treatment or control is introduced on the study units, and where random sampling of the study units is necessary.

The outputs of the study are as follows: -

- A descriptive exposition of the nature of the nature of risks (frequency of occurrence and severity of the risk factors) and the adequacy of the risk management method in the Kenyan building industry;
- Statistical relationships between:-
  - Risks (*probabilities of* cost/time overruns) and the adequacy of the risk management methods;
  - Losses (cost/time overruns) and the risks in a building project.

[†] The design is a survey as opposed to *case study* or *experimental* designs. A case study is the simplest among designs that show effects of some causal variables. In this design, the case and/or the elements of the study (those units which are exposed to the causal variable) are not selected randomly but are selected on other basis such as self selection dictated by convenience or based on expert opinion (Luck & Rubin 1987; 59). Experimental design is one in which the cause and effect relationships are studied by introducing some *control over* some of the variables in the study.

❖ Proposal for improving the current methodology of risk management in the building industry in Kenya.

The study objectives and the nature of the input data have dictated the analysis procedure to be employed. Quantitative as well as qualitative data are used in the study. The descriptive exposition has been done using frequency tables and simple descriptive statistics such as the mean, median and mode. The relationships have been established using multiple regression analysis.

The proposal for the way forward in improving the existing risk management methods is based on: -

- the deductions made from the descriptive characteristics of the variables in the study and the relationships among them;
- the opinion of consultants and contractors engaged in the building industry.

Clients were not interviewed in this study because in the pilot survey, none of the clients expressed interest to participate in the research. However, the exclusion of the client is not expected to introduce any bias in the study findings because the observations and opinions of the professionals concerning risks in the building industry are unlikely to differ significantly from those of the client since the client engages them as his agents in a project.

Engineers were also not interviewed in the study because in the pilot survey, only one engineer expressed interest to participate in the research. The exclusion of the engineer is unlikely to introduce bias in the study findings. The architect is more often than not, the lead consultant (and specifically the leader of the design team) in a building project. The Conditions of Contract give him the power to give variation orders, which may have implications of extra time and cost. Any engineering design issues likely to pose time or cost risks in the building projects are normally communicated to the project architect. The architect has also to sanction the instruction to this effect. Therefore, the architect's views on time and cost risks are likely to give a sufficient coverage of the views of the engineer.

4.2 Population, Sample and Sampling Technique

The target population was defined as follows:

- all the professionally designed and managed building projects executed in Nairobi, Mombasa, Nakuru, Eldoret or Kisumu between 1990 and 1999.
- the cost value of each of the projects studied was at least Kshs10 million
- both private and public projects were studied.

The researcher conducted a pilot study prior to the full study, which showed that Nairobi would be a sufficient representative of the other four towns. The observations made in the pilot study are described in section 1.5.

A two-stage cluster sample of 120 projects was targeted. Building projects handled by Nairobi-based architectural firms were considered to be clusters of the cases to be studied. The sample was limited to this size by budget constraints. The amount of money to be spent on data collection increased drastically with increase in the sample size and therefore 120 cases was the maximum size affordable. "Ordinarily, a sample size of less than about 30 cases provides too little certainty to be practical" (Alreck and Settle 1985) and therefore a target of 120 cases was considered to be sufficient since it was way above the practical minimum.

A list of 133 Nairobi-based architectural firms practising in Kenya was obtained from the Architectural Association of Kenya. The list consisted of all the firms that were members of the Association as at March 30, 1999. Forty clusters (architectural firms) were selected randomly from the 133 in the first stage of the sampling process. In the second stage, each of the selected firms was requested to provide information on the largest three completed building projects the firm had handled between 1990 and 1999 (inclusive).

4.3 Data Collection

The data was collected from the architects, quantity surveyors and contractors involved in the projects using questionnaires. There was a different questionnaire for each of the three parties. This helped to collect the information on a particular project from the three parties.

The questions covered the incidence/sources of risks and their management from inception up to practical completion and final account stages of the projects. The information required was obtained from contract documents, site minutes and the expert experience of the respondents. Some of the respondents gave their documents for the researcher to extract the information and complete the questionnaires, while others completed the questionnaires themselves. Control questions were asked to tally and collate the information collected from the architect, quantity surveyor and contractor. Information from two projects was rejected because the information from the three sources did not tally.

Six research assistants were engaged to collect the data, between April 12,1999 and May 31, 1999. The research assistants had a background of the building industry and were also trained on how to administer the questionnaires. Appendix B (1-3) shows the questionnaires.

A letter of introduction was given to the research assistants, as shown in Appendix A (1& 2). The researcher telephoned the respondents to introduce to them the research study and the research assistants, collected and edited the questionnaires immediately after they were brought in by the assistants, and met the assistants on weekly basis to review progress and to lay strategies for the following week.

4.4 Variables in the study

4.4.1 Losses

In this study, loss is defined as the deviation of the performance of a project from the planned target. The goal of the parties in a building project is to obtain a built facility within the specified budget, time and specification.

The loss caused by occurrence of risk factors in a building project was measured by: cost overrun, time overrun and the level of quality in the project. The loss in cost was indicated by the cost overrun (in millions of Kshs) and loss in time indicated by the time overrun (in weeks).

The loss caused by poor quality workmanship was indicated by the rating of the occurrence of 6 major defects in the project. The contractors were asked to indicate how often each of the defects had occurred in the project during the construction and the defects liability period. The frequency of occurrence was measured on a 5–point scale, where 1 represented 'never occurred' and 5 represented 'always occurred'. On this scale, the sum of the measures of the frequencies of occurrence of the six defects would have a minimum of 6 and a maximum of 30 units. The defects rating in a project was therefore obtained by summing up the measures of the defects observed in the project and dividing the sum by 30.

4.4.2 Adequacy of Risk Identification

The adequacy of the risk identification exercise at the project planning and design stages is indicated by the percentage (proportion) of information available at the pre-contract period. A risk identification exercise should reveal information concerning factors in a project (e.g. underground water, changes in design, shortages of materials etc.) that are likely to pose risks to the project time, cost and quality.

The information that *a most adequate identification of risks could ever reveal* was split into 7 groups of factors, as shown on Table 4.1. The number of individual factors in each group determines the weight of the group in contributing to the amount of information necessary. *Information considered during design*, for example, is given a weight of 12 because there are twelve key items that need to be considered during design. The way in which these items were grouped and conceptualized is shown in the Architect's Questionnaire (AQ) – question 4 (see Appendix B1). Table 4.1 shows the relevant questions architects, quantity surveyors and contractors were asked in order to obtain information about each of the seven items.

Table 4.1. Factors indicating adequacy of information

	Groups of Factors	Weight
1.	Stages of involvement of architect, quantity Surveyor and contractor AQ3(A), QSQ3(A), CQ3(A)	5
2.	Information given by the feasibility study QSQ4(A)	8
3.	Information considered during design AQ4(A&B)	12
4.	Information available for preparing the Bills of Quantities QSQ4(C)	6
5.	Information used in computing the contingency sum QSQ4(E)	5
6.	Tender documents used AQ8(A), QSQ8(A), CQ4(A)	3
7.	Factors considered in awarding the tender AQ6, QSQ6	6
	TOTAL WEIGHT	45

Source: Own construction 1999

AQ – Architect's Questionnaire

QSQ – Quantity Surveyor's Questionnaire

CQ – Contractor's Questionnaire

The items are various aspects of each group that would facilitate a comprehensive risk identification exercise, and are shown in the questionnaires in Appendices B1 to B3. The respondents were asked to indicate the information they considered available and adequate in each group of factors, especially during the pre-contract period.

The amount of information available was then used as the scale for measuring the adequacy of risk identification. On this scale, the adequacy of risk identification in a project would score a maximum total of 45 units for all the seven groups of factors in a project. The rating of the adequacy of risk identification in a project is therefore obtained by dividing the total score observed in the project by 45.

4.4.3 Adequacy of Risk Measurement

The adequacy of a risk measurement technique refers to the accuracy and comprehensiveness of the method used in evaluating risks. It could be indicated by the method or procedure used to estimate the risk (likelihood of loss) using the information provided by the risk identification exercise. The magnitude of risk indicates the exposure of the project to the adverse impact of occurrence of the risk factor(s) identified.

Risk measurement techniques in the building industry range from simple judgement to complicated mathematical computations. The most advantageous method of measuring risks is probability analysis (Newton 1992, Yeo 1990). Therefore, any method that did not involve use of probability analysis or Monte

Carlo simulation was considered to be rather inadequate. The respondents were asked to describe how the risks had been accounted for in the project. Providing an adequate contingency sum in a contract is normally done to cater for the cost risk. Quantity surveyors were asked to describe how they had considered the factors they had used in computing the contingency sum. The methods of accounting for the contingency sum were weighted as shown on Table 4.2.

The weight accorded to each of the techniques is based on the *number of individual steps (in other words, the amount of input data and the formulae)* ideally followed in computing the expected building cost or construction period. For example, the *mathematical/probabilistic analysis* method has the highest weight because it normally involves sophisticated formulae and more of input data than the other two techniques.

Table 4.2 Techniques of risk measurement

Technique	Weight
1. Simple judgement (intuition) QSQ4(E&F)	1
2. Application of a percentage on cost estimate based on the office tradition/practice QSQ4(E&F)	2
3. Mathematical/probabilistic analysis QSQ4(E&F)	7
TOTAL WEIGHT	10

Source: Own Construction 1999

QSQ – Quantity Surveyor's Questionnaire

If a time/cost estimator has used mathematical analysis in a project, this implies that he also had the data that could have been used in the *Simple judgement* or *Application of percentage* methods. Mathematical analysis involves techniques such as sensitivity analysis, probability analysis, Monte Carlo simulation and/or fuzzy set algebra.

The relevant question quantity surveyors were asked in order to find out the technique they had used in measuring risk (i.e. computing the contingency sum) is shown in the Quantity Surveyor's Questionnaire (QSQ) – question 4 (see Appendix B2). The technique used was rated on the scale above and the rate thereof used as the measure of the adequacy of the risk measurement.

On this scale the minimum score would be 1 and the maximum 10. The rating of the adequacy of the risk measurement technique used in a project was therefore obtained by dividing the score by 10.

4.4.4 Adequacy of Response to Risks

Adequacy of risk response refers to the effectiveness of the actions taken to mitigate the adverse effects of the risk factors. The precautionary steps that had been taken in a project to prevent (or minimise) possible loss associated with occurrence of the actual/anticipated risk factors, were used in order to measure this variable.

The set of actions required to prevent (or minimise) possible loss associated with occurrence of the actual/anticipated risk factors was conceptualized in terms of six major items, as shown on Table 4.3. Items 1 – 5 on the Table, are given in form of questions and are given a weight of 1 each because the answer to each one of them is either *a yes or a no.*

Table 4.3 Elements of risk response

	Element of response	Weight
1.	Was the contingency sum adequate? QSQ4(G), QSQ21(A)	1
2.	Were the anticipated risks fully communicated to the parties in the project team? AQ12(A), QSQ21(A), CQ3(A)	1
3.	Were the preliminaries and preambles adequate? AQ12(A), QSQ21(A), CQ13(A)	1
4.	Were any financial appraisals done during the contract period? AQ12(A), QSQ21(A), CQ13(A)	1
5.	Did the contractor take any specific measures to avert the impact of the risk factors? CQ5(B), CQ 6(D), CQ 7(C), CQ 8(B)	1
6	Strictness of the project team in minimising time & cost overruns (NB: Strictness scores 5 if the overruns were minimal 1 if the overruns were very heavy – see Table 4.4)	5
	TOTAL WEIGHT	10

Source: Own Construction 1999

AQ – Architect's Questionnaire

QSQ – Quantity Surveyor's Questionnaire

CQ – Contractor's Questionnaire

However, item 6 (*Strictness of the project team in minimising time & cost overruns*) is more complicated and has a weight of 5. Ideally, this strictness starts with setting realistic targets. The strictness was rated on the basis of percentage time and cost overruns observed at the end of the project.

Table 4.4 Strictness in Minimizing Overruns

Average of percentage cost overrun plus time overrun	Score given to the Strictness – Aspect No.5 of risk response (see Table 4.3)
$X \leq 10$	5
$10 < X \leq 20$	4
$20 < X \leq 30$	3
$30 < X \leq 40$	2
$40 < X \leq 50$ and above	1

Source: Own Construction 1999

The higher the overrun the lower the strictness, as shown on Table 4.4. This factor therefore indicates the project teams accuracy of targeting and the commitment of the project team to meeting the project targets of time and cost.

The relevant questions architects, quantity surveyors and contractors were asked in order to find out the precautionary actions taken to mitigate the risks identified in a project are indicated on Table 4.3 and are fully shown in the Questionnaires (see Appendices B1 to B2). The precautionery action was rated and its rating used as the measure of the adequacy of the risk response.

On this scale the minimum score would be 1 and the maximum 10. The rating of the adequacy of the risk response action in a project was therefore obtained by dividing the score by 10.

The three scales described for measuring the adequacy of *risk identification*, *risk measurement* and *risk response* (Tables 4.1 to 4.4) were hypothetically developed by the researcher on the basis of his past experience in the building industry. In absence of any other reference that could have been done as a measure of these variables, the scales were the best in the circumstances. However, the scales need to be tested and developed further with input of the stakeholders – clients, consultants and contractors in the building industry.

4.4.5 Frequency of Risk Factors

Using Aniekwu and Okpala's (1988) grouping of risk factors and the clauses in the AAK Conditions of Contract, which address various speculative risks (see section 3.6), risk factors that normally cause delays and cost overruns in the building industry were grouped into 12 categories: -

1. Underground conditions - unexpected subsoil conditions, such as water, rock etc.
2. Inclement weather - especially rainfall
3. Late site instructions- architects instructions, work and material approvals by architect and engineers etc.
4. Extra work - additional work in the contract.
5. Changes in design - changes in the architectural and engineering design that could be termed as variations in the contract.
6. Delays in the settlement of payments - delayed payments to contractors and sub- contractors
7. Nominated sub-contractors - Specialist sub-contractors' material shortages or

slowness in executing their part of the works.

8. Nominated suppliers - slow progress or extra costs caused by nominated suppliers (shortage of materials/components the suppliers were to provide, fluctuations in the prices of the materials/components etc.)
9. Shortage of materials - material shortages for the main contractors' works e.g. shortage of cement, sand, timber etc., which are normally supplied by the main contractor.
10. Delays in construction drawings - delays associated with preparation of detailed/shop drawings by designers/contractors.
11. Damages caused by fire, earthquake etc.
12. Others e.g. industrial disputes, unavailability of plant, accidents on site, absence of power, contractual claims etc.

The importance of each factor (in causing delay or cost overrun) was rated on a 5-point scale. The respondents (contractors) were asked whether a certain risk factor had occurred in the project or not and how important the respondents considered the factor to have been in causing cost overruns, time overruns or poor workmanship. The factors were then grouped into two: factors given an importance value of 1or 2 were grouped as *unimportant* while factors given a value of 3, 4 or 5 were grouped as *important*.

The frequency of a factor refers to the number of projects in which the factor occurred and caused an important impact. The relative frequency of the risk factor is the frequency divided by the total number of projects studied, and indicates the probability that the factor would actually occur and cause impact in a proposed future project.

4.4.6 Severity of Risks

Severity refers to the seriousness of the impact (of the risk factors, when they occurred) on time, cost and quality. Occurrence of a risk factor is likely to have some adverse impact on (i.e. cause loss in) the project. The severity of each of the 12 factors was measured on a 5-point scale as described in section 4.4.5 before.

The mean severity of each of the 12 factors was used to rank the factors in a decreasing order of their impact on project time and cost. The ranking is meant to show the factors whose occurrence is most detrimental to a building project in Kenya.

4.4.7 Risks

This is the likelihood or probability of loss occurring due to occurrence of risk factors. Probability is a proportion/ratio and is therefore unitless. In this study, the magnitude of risk has been estimated by considering each unit of the 5-point scale (used in rating the importance of the risk factors – see section 4.4.5) to be a binary response unit.

For example, take one factor of risk e.g. changes in design, and assume its importance in causing delays/cost overruns is rated at 3.00. The meaning of the rate can simply be interpreted by assuming the respondent (or the lead consultant in the project) has 5 variation orders (or extensions of time) to account for. The rate (3.00) means that if the respondent were to be asked whether changes in design accounted for any of the 5 variation orders, the respondent would give a 'yes' in 3 out of the 5 answers.

Each unit of the 5-point scale can therefore be viewed as a binary response unit (i.e. with only two alternatives – yes or no) variable and the basic principles of generating and analyzing binary data then applied in the study of risks. For this reason, each of the 12 factors was considered to be a batch of 5 binary responses and produced grouped binary data (Collett, 1991; 1).

The rating of a risk factor indicates the proportion of all the reasons given for extra cost or time, that could be attributed to the factor. It represents the probability that the factor is a cause of time or cost overrun. To get the *average probability* that all the 12 factors together would cause time or cost overruns, the mean of ratings for all the factors was computed. The overall mean rate was then divided by 5 to give the overall probability of time or cost overrun.

In the light of the foregoing discussion of the variables in this study, cost and time risks in a building project (explained in section 4.4.7) can be expressed in terms of the adequacy of risk identification, the adequacy of risk measurement and the adequacy of risk response (explained in sections 4.4.2 to 4.4.4) in the following mathematical model: -

$$R = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$$

Where:

R is the Cost (or time) risk (probability)

β_0, β_1, β_2 and β_3 are parameters; $\beta_j \neq 0$

X_1, X_2 and X_3 are the measures of the adequacy of risk identification, the adequacy of risk measurement and the adequacy of risk response.

$\in$ is the random error term, whose characteristics are described in Section 4.5.

A similar functional relationship between overruns (in cost or time) and risks can be formulated as follows: -

$$O = \beta_0 + \beta_1 R + \in$$

Where:

O is the Cost (or time) overrun (cost overrun - in millions of Kshs; time overrun in weeks)

β_0, β_1 are parameters; $\beta_j \neq 0$

R is the measure of risk (time or cost risk - probability).

$\in$ is the random error term, whose characteristics are described in Section 4.5.

The two mathematical functions above represent the conceptual framework applied in this study.

4.5 Data Analysis

The data was analysed using the Statistical Package for Social Sciences - SPSS for windows version 6.1. Frequency tables are used in sections 5.1, 5.2 and 5.4 to describe the type of data collected, the methods of risk management used in Kenya today and the frequency of occurrence of risk factors in the building industry.

Descriptive statistics (mean, median, mode, minimum, maximum, standard deviation, kurtosis and skewness) of losses and risks have been computed and used in sections 5.3, 5.5 and 5.6 to show the most typical observation, the amount of deviation from the observation and the form of the distribution of the variable. Histograms were also drawn to show the shapes of the distributions diagrammatically. Multiple regression analysis has been employed in sections 5.7 and 5.8 to establish statistical models for predicting risks and losses in the building industry.

The mean, median and mode are the statistics used to show the most typical observation. In a distribution, the most appropriate of the three statistics depends on the shape of the distribution. While the mean is the most commonly used average, it is rather inappropriate in distributions which are very 'asymmetrical' or where there are a few outliers on the far extreme. The shape of a distribution is indicated by the skewness and the kurtosis of the distribution. The skewness and the kurtosis of the 'bell-shaped' normal distribution are both equal to zero. The greater the amount of skewness the lower is the appropriateness of the mean as a measure of the most typical case. The mode is the best indicator of the most typical case when the distribution is skewed and has a high peak, indicated by a positive kurtosis. This is because a large portion of the cases is very close to the mode in such a distribution. When the distribution is slightly skewed and relatively flat so that the kurtosis is negative, or when it is near normal with only a few extreme values far to one side, the median is the most appropriate average to indicate the most typical case (Alreck and Settle 1985).

The minimum, maximum and standard deviation are the statistics used to indicate the spread of the data around the 'most typical' observation. The minimum value indicates how far the spread extends towards the lower direction while the maximum value shows the extent of the spread towards the upper direction from the average. The maximum and minimum values are very important in regression models. They define the range of the values of an independent variable within which the use of a regression model (developed using the data) is most valid and reliable. The standard deviation measures the spread of the data away from the mean (Alreck and Settle 1985).

The significance of the occurrence of each of the risk factors is examined by a one tail *test of hypothesis about one proportion.* This test employs the normal distribution and the z- value to be used in determining whether the relative frequency was statistically significant or not is given by: -

$Z = (p - P)/ [p(1 - p)/n]^{1/2}$ (Dowdy 1991)

Where: p is the observed relative frequency

P is the test value and is zero in this study because the alternative hypothesis is: $p > 0$.

n is the sample size.

At 95% confidence level, the value of Z above which the null hypothesis ($p = 0$) is rejected is 1.645 and is normally exceeded when the value p (observed proportion –relative frequency) is about 0.09 (9%). Therefore, a proportion that is about 9% and above can be considered statistically significant at 95% confidence level.

The relationships between dependent variable (risk or loss) and the independent variables (adequacy of risk identification, adequacy of risk measurement, adequacy of response etc) have been modeled as linear functions. Multiple regression analysis has been used to model the relationships between the variables. In this procedure, the relationship between the dependent variable (y) and the independent variables (x's) is formulated as follows: -

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots + \beta_n x_n + \epsilon$$

where, α and β are the regression coefficients

ϵ is the error factor.

X's - adequacy of risk identification, adequacy of risk measurement, adequacy of risk response, contract sum (in millions of Kshs), type of building, type of client, method of tendering etc.

In this study, the independent variables have been entered into the regression model using the backward elimination method of multiple regression analysis in the SPSS program. This method works from *the whole to the part*. It starts with all the variables in the regression model, and automatically eliminates the least significant independent variables, one after the other, until it leaves only the significant variables in the final step of the regression process. The elimination of a variable is based on its contribution to the *magnitude of the mean square error* (MSE) of the regression estimate. MSE is the estimate of the variance (σ^2) of the error term ($\in$) in the regression model. The smaller the MSE the more precise is the regression equation. If the presence of a variable in the equation increases the MSE, the variable is removed from the equation. This process continues until the minimum possible MSE is obtained.

The strength of the relationship between the Y and the X's is normally determined using the square of the Multiple correlation co-efficient (R^2). The possible values of R^2 range from 1 to 0. At one extreme, $R^2 = 1$ in which case all the independent variables included in the model are deemed to completely account for the variation in the dependent variable. At the other extreme, when $R^2 = 0$, the independent variables account for no variation in the dependent variable. Generally, the closer R^2 is to 1.00 or say 0.90, the more complete the variation in the dependent variable under study would be explained by the independent variables together. Ferry and Brandon (1991; 267) recommend that the value of R^2 should be at least 0.90 for a prediction model to be most reliable.

Some of the independent variables in the study e.g. type of building and type of client, are *categorical* (measured in terms of groups - on a nominal scale). In order to include a grouped variable in a regression model, dummy variables should be created out of the grouped variable. A grouped variable with c groups is normally represented by c-1 dummy (binary) variables each taking values 0 and 1 (Neter *et al* 1996; 456). A dummy variable is an artificial dichotomous (binary) variable i.e. a variable which takes only two alternative values in measurement. The variable takes two values 1 or 0 to indicate either of the two alternatives it can attain in observations. It is artificial because it is created from a grouped variable, in order to facilitate inclusion of the grouped variable in a linear regression equation. A dichotomous variable, whether it is natural or artificial behaves like a continuous numerical variable in statistical analysis. The value 1 or 0 assigned to either of the alternatives of a dummy variable does not have any "quantitative" connotation; it is simply an assignment of a group value label.

In this study, the buildings were grouped into 5 types, clients into 2 types and methods of tendering into 3 types. Therefore the number of dummy variables for type of building, type of client and method of tendering are 4, 1 and 2 respectively. The dummy variables are as follows: -

❖ TYPE1	1	if residential building
	0	otherwise
❖ TYPE2	1	if commercial building
	0	otherwise
❖ TYPE3	1	if institutional building

	0	otherwise
❖ TYPE4	1	if industrial building
	0	otherwise
❖ CLIENT	1	if private client
	0	if public client
❖ TENDER1	1	if selective tendering
	0	otherwise
❖ TENDER2	1	if open tendering
	0	otherwise

According to Carrol (1988), Dowdy (1991) and Neter *et al* (1996) the linear regression procedure has six *basic assumptions*, namely: -

- that y is approximately a linear function of the x's and that $\in$ measures the discrepancy in this relationship;
- that the $\in$'s are normally distributed with a mean of zero and a variance of σ^2;
- that the $\in$'s are independent of the x's and independent of each other;
- that the x's are not very strongly related to each other;
- that there are no outlier observations in the data.

For a regression equation to be valid and reliable, it *should not violate* these assumptions (conditions).

In this study, violations of the basic assumptions of regression were tested by examining plots of the standardized residuals of the regression against the independent variable. Where the violations were evident, the data was transformed as appropriate; where the violation of any of the assumptions was evident in order to ensure that the relationship was formulated as precisely as possible (Chatterjee 1977).

The range of the standardized regression residuals (Z residuals) is used to test whether the data has any outliers or not. If the Z residuals range between –2 and +2 (approximately), this indicates that none of the observations in the data can be considered to be an outlier (Chatterjee 1977, Neter *et al* 1996).

The assumption that *the independent variables are not very strongly related to each other* in a multiple regression model is tested by examining the behaviour of the regression coefficients and the their standard errors. The significance of the regression coefficients was tested at 95% confidence level. If the independent variables are strongly related, this condition is referred to as *multicollinearity*. It distorts the regression coefficients (estimates of β's) making them ambiguous.

The presence of multicollinearity in data is indicated by the instability of the regression coefficients. The coefficients exhibit large changes when a variable is added or deleted or when a data point is altered or dropped. Once residual plots indicate that the regression model has been satisfactorily specified, multicollinearity may be present if: -

- the algebraic signs of the regression coefficients do not conform to prior expectation;
- coefficients of the variables that are expected to be important have large standard errors (Chatterjee 1977).

Multicollinearity was, therefore, detected by examining the regression coefficients and the correlations of the independent variables in the multiple regression equation. There are several methods of solving the multicollinearity problem. The simplest of the methods is to *delete* one of the variables exhibiting multicollinearity from the regression model (Chatterjee 1977).

In this study, if two independent variables were found to be so strongly related that the regression coefficients were distorted as explained above, this problem was solved by removing one of the two variables from the equation and doing the regression exercise again without the variable. In such circumstances, the independent variable removed from the equation is the one which is *harder and lees convenient* to measure.

The dependent variables in this study are risks (*probability* of loss - time/cost overrun) and losses (actual time/cost overruns in weeks/Kshs). The risks are binary response variables because their concern is whether or not cost or time overruns would occur under certain circumstances. Their measures are probabilities (proportions) which must lie in the interval (1,0). An ordinary linear regression of risk on the independent variables can not produce a reliable equation for predicting risk. The regression coefficients are totally unconstrained, and can take any value, positive or negative, large or small, so that any linear combination of them can in principle lie anywhere in the range ($-\infty$, $+\infty$). Since the predicted probabilities are obtained from the linear regression equation ($p = a + b_1x_1 + b_2x_2 + b_3x_3$), there can be no guarantee that the predicted values will not lie outside the range (0,1) (Collet 1991; 52).

Therefore, a logistic regression model was adopted in this study. A logistic regression model is normally employed to explore the relationship between a binary response variable and one or more explanatory variables. In this model, the binary response data (probability of occurrence) is transformed in order to shift the probability scale from the range (0,1) to ($-\infty$, $+\infty$). A linear model is then adopted for the transformed data, a procedure that ensures that the predicted probabilities will lie between zero and one. The logistic transformation is the one most suited for this purpose (Collet, 1991; 55).

The logistic transformation of a probability p is the $\log_e$ (p/1-p) which is written as logit p. The relationship between p and logit p is linear between p = 0.20 and 0.80, but outside this range it becomes markedly non-linear. A logistic transformation was therefore applied on the cost and time risks. The transformed risks were then regressed on the independent variables.

Chapter V

ANALYSIS OF DATA AND RESULTS

5.1 Characteristics of the Projects Investigated

The projects studied had different basic characteristics such as functional use, size, and type of client. Out of the 120 projects initially targeted for this study, only 37 projects were obtained. This represents a response rate of 30.83 %. Table 5.1 shows the numbers of various types of building projects studied. The respondents interviewed were 28 architects, 24 quantity surveyors and 31 contractors, who were involved in the execution of the 37 projects.

Table 5.1 Types of Building Projects Studied

Project type	Numbers	Percentage
1. Residential (bungalows, maissonetes & flats)	13	35.10
2. Commercial (shops, offices & warehouses)	12	32.40
3. Institutional (schools, colleges & hostels)	9	24.30
4. Industrial (factories)	1	2.70
5. Others – hotel & hospital	2	5.40
TOTAL	37	100.00

Residential buildings were observed to be the most common project type followed by commercial buildings, accounting for 35.10% and 32.40% respectively. Industrial buildings were the least common project type observed. These observations imply that residential and commercial buildings were the most common developments in Kenya between 1990 and 1999, while industrial building development was negligible. The observations also imply that development of residential, commercial and institutional buildings accounts for about 90% of the building projects in Kenya.

About 76% of all the projects studied had been commissioned by private clients and 24% by public clients. This implies that there had been more building development activity in the private sector than in the public sector in Kenya between 1990 and 1999.

Contract sums of the projects were adjusted to the 1999 overall construction cost index and were given in millions of Kenya Shillings. The indices were obtained from the Central Bureau of Statistics. Appendix C shows the cost indices used for each year,. The cost index applicable in adjusting the contract sum was taken to be the index at the date of tender opening.

The total cost value (at 1999 overall construction cost index) of the 37 projects is about Kshs 2.28 billion, in terms of the contract sums estimated at the start of the project (see Table 5.2). The value in terms of the Final Account sums is about Kshs 2.80 billion.

The smallest size (Final Account sum) of the contracts observed was Kshs 9.45 million while the largest one was Kshs 436.11 million. The construction periods thereof ranged between 20 and 300 weeks as shown on Table 5.3.

Table 5.2 Contract Sums

Variable	Mean	Std Dev	Minimum	Maximum	Sum
CE	61.71	74.97	9.06	367.32	2283.45
FA	75.63	91.21	9.45	436.11	2798.39

Labels
CE – Estimated Contract Sum in Millions of Kshs, adjusted to 1999 cost index
FA – Final Account Sum in Millions of Kshs, adjusted to 1999 cost index

The observations made in this study, as described in sections 5.2 to 5.9 can therefore be generalized to apply to every building project whose size lies within these ranges.

Table 5.3 Contract Periods

Variable	Mean	Std Dev	Minimum	Maximum
ESTTIME	44.95	23.67	14.00	150.00
ACTTIME	69.85	48.43	20.00	300.00

Labels
ESTTIME – Estimated Contract Period (Weeks)
ACTTIME – Actual Contract Period (Weeks)

A larger sample could not be obtained from the cluster of the 40 architectural firms selected. Although the firms were requested to provide information on *three completed projects*, most of the firms provided information on only one project. A large number of them would not provide any information on the projects that they had handled. The reason given by the respondents was that the projects they had handled between 1990 and 1999 fell outside the definition of the population in the study (see section 4.1). The projects were smaller in scope than that specified specified in the population definition. Others would not give the information because the jobs they had been involved in had started but were not yet complete (reached Final Account stage).

All the variables were measured as explained in section 4.3 and their observations are shown in Appendix D2.

5.2 The Nature of Risk Management in Kenya Today

- The risks encountered in building projects in Kenya fall into two main categories: risks in the contracts between the client and his consultants
- risks in the contracts between the client and the contractor(s)

In the first category, the risk is mainly the likelihood of the client failing to pay for the professional services rendered or considerably delaying the payment for the services. Consultants may also fail to perform their duties in accordance with the client's objectives. In the second category, the main risks are likelihood of cost overrun, time overrun and poor quality workmanship. Consultants also play an important role in this category of risks.

The techniques used for risk identification, measurement and response in the country are less formal than the techniques applied in the risk management theory. The nature of risk management in Kenya mainly relies heavily on rules of thumb and experience based knowledge. The identification of the risk factors, measurement of the risks, and response to the risks starts from the inception of the project to its completion.

5.2.1 Inception Stage

Once the client conceives a project in his mind, he engages consultants (architects, quantity surveyors etc.) to assist him in the planning and design of the project. The consultants get appointment letters from the client confirming their engagement in the project and specifying their terms of reference. A contract is entered into between the client and the consultant(s). Out of the 52 consultants (28 architects & 24 quantity surveyors) interviewed 76.60% had been given appointment letters by the clients, when they got engaged in the project. However, a majority of the letters had not sufficiently specified the terms of reference. The respondents gave the following as the major issues that a comprehensive and clear letter of appointment to consultants in almost every building project should include: -

- type of services to be rendered
- type of project
- type of conditions of engagement.
- the consultants obligations

- the clients obligations
- redress in case of failure to fulfill the obligations
- type of redress required.

Only 40.40% of the consultants had had their appointment letters specifying more than half of the seven major issues. On average, only three (the first three, in most cases) issues were specified in the appointment letters.

This implies that the consultants' terms of reference were rather vague to start with posing the risk of:-

- the consultants not being well motivated to complete planning/design work in time.
- the client failing to honour his obligation to pay in time for the services rendered.

This observation was further confirmed by the consultants opinion on the conditions of their engagement in the project. 71.20% of the consultants had been engaged under the AAK - Cap 525 conditions as shown on Table 5.4. The 'others' consists of seven 'negotiated' terms (not based on any standard conditions), one RIBA conditions engagement and one German conditions of engagement.

Table 5.4 Conditions of Engagement

Condition	Frequency	Percentage
AAK - cap 525	37	71.20
MOW conditions	5	9.60
Others	9	17.60
No response	1	1.90
Total	52	100.00

46.2% of the consultants felt that the conditions of engagement they had adopted did not sufficiently address the issue of the liability between the parties to the contract; 63.50% of the respondents recommended that the conditions be revised in areas such as those respecifying the liability between the parties, revising the professional fees, incorporating advance payment and provision of bond by client and including payment of interest on delayed payments for professional services.

The conditions of engagement used in Kenya currently expose the parties (especially the consultants) to a lot of risk. They are likely to be a major cause of the risk in the contract between the client and the contractor. Though consultants identify this risk in their engagement, they have not adopted any formal techniques of estimating the magnitude of the risk. Also, they seem not to have instituted utmost efficient measure to provide for the undesirable consequences of the risk.

The respondents gave the following as some of the undesirable consequences of the risk:-

- many clients fail to pay consultancy fees, especially when they fail to secure development funds.
- some clients fail to recognize the copyrights/ patent rights of the consultants - e.g. some clients use the project drawings.
- fees for arbortive, additional and special works which normally arise after the initial appointment are not adequately paid for, they are not covered in the conditions.
- interest is not charged on fees outstanding beyond the due date.

Risk identification and evaluation at the feasibility study stage is rather unpopular and inadequate. Only 25% of the consultants interviewed had carried risk identification and evaluation in the building project. The identification exercise during the pre-contract period would reveal factors that were likely to occur in the project to disturb the regular progress of the works and increase costs and is rated to be 67.10% adequate (on average). However, the risk measurement exercise was poorly done; it was mainly intuitive in nature and is rated to be 27.60% adequate.

Adequate communication of the risks to the members of the project team is poorly done in the industry generally. Only 44.23% of the consultants had considered sufficient communication of the risks to all members of their project team to have been done to facilitate an efficient response to the risks.

5.2.2 Design Stage

A major risk at this stage is the likelihood that the detailed design (at the pre-tender stage) is changed significantly by the time the construction work is completed. In 58.80% of the projects, changes in design occurred, and were considered to be a very important cause of time and cost overruns. Change in design scored an average severity measure of 3.318 (out of 5). Therefore the risk of change in design is very high during construction of building projects in Kenya.

This implies that the information used in the scheme and detailed designs (which are used in preparing the cost estimates and bills of quantities) is generally insufficient. It suggests that either the client's brief (statement of his requirements) is usually unclear or the design work is not sufficiently completed at this stage. The risk of design change makes the cost estimate (contract sum) and project period estimate (contract period) more probabilistic than deterministic because it increases the uncertainty inherent in the estimate. A contingency sum is usually allowed for in the cost estimate in order to bear the risk of cost overrun in the project.

The contingency sum was considered to have been inadequate in a majority of the projects, perhaps because the method of estimating the contingency sum was rather imperfect. In all the projects, the contingency was estimated using the estimation intuition based on experience. The contingency had been estimated at 10% of the builder's work, in most of the projects. This technique of estimating the contingency sum is inaccurate because the mean cost overrun (16.7%) for all the projects is statistically significant. The technique does not adequately consider the cost risk factors inherent in a particular project setting.

The method of fixing the contract period was also observed to be largely intuitive. In 75.68% of the projects the period was tendered for competitively and in 10.81% it was fixed by the architect, as shown Table 5.5

Table 5.5 Fixing the Contract Period

	Who fixed?	Frequency	Percentage
1.	Architect	4	10.81
2.	Quantity surveyor	2	5.41
3.	Contractor	28	75.68
4.	Other e.g. negotiated with client etc.	3	8.10
	TOTAL	37	100.00

A majority of the consultants stated that there was no standard method used in the industry, in fixing the construction period. But a number of them indicated that the estimate of the contract period was based on the client's cash flow capability. The cost estimate is simply divided by the expenditure the client can commit per week, in order to get the number of weeks required. This method is inefficient and hence becomes a source of risk.

The large amount of time overruns in the building projects (55% on average) implies that the technique of fixing the contract period in Kenya is unrealistic. The following are possible reasons why the use of pure intuition or the client's cash flow capability is unrealistic:-

- The methods fail to consider other factors such as the efficiency of the contract procurement system, complexity of the building, interactions of the teams in the project etc., which influence the construction period.
- The cash flow capability method takes the clients expenditure to be approximately equal for every month week of the construction period. However, the principle of the S-curve applied in cash-flow budgeting shows that this is not the case. This error may lead to the clients failure to honour payments in time, especially during the second third of the construction period, when about 50% of the expenditure is normally incurred, according to the s-curve (Brandon & Ferry 1991; 47).
- Contractors may not be very keen in giving a realistic estimate because the details of the data they use in estimating the period is not a requirement in the current contract. There is no comprehensive method of evaluating the practicability of the construction period quoted by the contractor. Such a method would sufficiently consider the project size, complexity and environment (including likely variations) and factor-in their influence into the period estimate.
- A contingency figure is not allowed for in the construction period.

Only one of the 37 projects did not have a time overrun. In 91.89% of the projects, the time overrun was statistically significant. This means that the overrun was statistically significant. The risk of having a wrong pre-contract estimate of the construction period was very high. This causes difficulties in estimating time-related factors of production such as cost of finance, insurance, water, electricity, telephone etc. It also makes the management of the estimated contract period (to ensure that the project is completed on time) impracticable.

Allowing adequate preliminaries and preambles in the bill of quantities was stated to be the most commonly used method of response to risks in cost, time and quality. It was applied in about 85% of the projects. However, it seems that the content of the preliminaries and preambles does not adequately communicate the risks to the members of the project team. In 55.80% of the projects, the communication of the risks was not sufficiently done.

5.2.3. Tendering Stage

Selective tendering is the most commonly used method of choosing the main contractor because it is considered by consultants to be the most efficient in avoiding (or minimising) delays, cost overruns and poor quality workmanship. It was used in 75.7% of the projects, as shown on Table 5.6 and in 16.2% of the projects, negotiated tendering was used.

Table 5.6 Tendering Methods

	Method	Frequency	Percentage
1.	Open	3	8.10
2.	Selective	28	75.70
3.	Negotiated	6	16.20
	TOTAL	37	100.00

Table 5.7. Probability of Cost & Time Overruns & Poor Quality Workmanship

Tendering Method	Mean Probability of Loss
Cost Overrun	
1. Selective	0.3060
2. Open	0.4778
3. Negotiated	0.3528
Time Overrun	
1. Selective	0.3927
2. Open	0.5722
3. Negotiated	0.5139
Poor Quality Workmanship	
1. Selective	0.3120
2. Open	0.3556
3. Negotiated	0.3111

The opinion that selective tendering was the most efficient in reducing cost risks is fully supported by the frequency and severity of the factors that actually occurred in the project. The mean likelihood of cost overrun, time overrun and poor quality workmanship were observed to be lower for projects that had used selective tendering as shown on Table 5.7. In spite of this, the mean likelihoods of overruns and poor quality associated with the selective tendering are statistically significant. Also, a high frequency of projects experiencing cost and time overruns persists. These observations imply that selective tendering is not a very effective method of minimising the overruns and poor quality.

About 30% of the contractors interviewed said they considered the site investigation report to identify risk factors likely to occur when they are tendering for a project. 30% of them said they mainly used their past experience in handling risk factors and also considered the nature of the client and consultants involved in the project.

Variations in the works were observed to be the most frequent risk factor followed by delays in the issue of detailed drawings. Delays in settlement of payments to the contractor were also observed to be a significant risk factor, as described in section 5.4.1. These observations suggest that contractors intuitively estimate the likelihood of occurrence of factors such as settlement of payments by the client. They, perhaps, base their estimate on the reputation of the client and the consultants, and the physical and socio-economic characteristics of the site location.

In awarding a contract to a tenderer, six major factors are usually considered, the most important being the contractor's report of past performance, as shown on Table 5.8.

Table 5.8. Factors Considered by Consultants in Awarding a Contract

	Characteristic of tenderer	Mean importance
1.	Report of past performance	4.363
2.	Technical ability	4.333
3.	Financial ability	4.255
4.	Size(cost value) of previous projects done	3.863
5.	Clients recommendation	2.327
6.	Others e.g. current work load, claim consciousness & construction time offered	0.549
	Overall mean	3.282

NB: The importance was measured on a 5-point scale where 1 represented most unimportant and 5 represented most important.

It is encouraging that most of the six factors are considered to be important and are used in evaluating, albeit intuitively, the suitability of a tenderer.

However, the fact that the construction time offered is one of the 'others' which are considered to be of least importance indicates that the issue of the contract period is not usually given a very serious thought from the very onset of the project. This implies that most consultants assume that the contract period is realistic if the tender sum (and pricing for individual items) and the other five factors are acceptable. This assumption is unrealistic because some factors have a significantly greater impact on the construction period than on the construction cost. For example the severity of delays in the issue of detailed drawings on time was observed to be very high (mean = 2.65 out of 5) while the severity of the same factor on cost was observed to be negligible. This suggests that the estimate of the construction period should be given more attention than it normally receives in practice.

The AAK conditions of contract were the ones most commonly used in the projects. About 80% of the contractors prefer the AAK conditions to the MOW conditions. The contractors consider the AAK conditions to be more modern, detailed, clearer and fairer to the contractor and the client. They considered the AAK conditions to be more efficient than the MOW conditions in minimising delays, cost overruns and poor quality workmanship. It follows that the AAK conditions are considered to be more suitable in the management of time, cost and quality risks in building projects.

The consultants were asked to rate (on a 5-point scale) the efficiency of both conditions in minimising the three risks. The overall efficiency of each of the conditions was then computed by adding the efficiencies in minimising cost, time and quality. The AAK conditions were observed to have an overall average efficiency of 71.30% while MOW conditions have 44.83%.

About 70% of the contractors responded that they had worked under atleast one of the following non-traditional conditions of contract:-

- Project management

- Management contracting
- Design and Building
- Turn key

While 41.90% of the contractors recommended a change in the industry in order to use the design and build contract, 38.50% of the consultants recommended a change to the project management contract. These changes were proposed as means of minimising delays, cost overruns and poor quality workmanship. The fact that they were given by a good percentage of the respondents indicates, *interalia*, that the conditions of contract traditionally used for risk management in building projects in Kenya are inefficient and need either to be revised or abandoned.

Taking an insurance cover is a most common method of response to risks in building projects. It was applied in almost all the projects examined. This measure is however, taken as a precaution against possible injury to workers or visitors on site and damage to property. It does not serve the purpose of minimising delays, cost overruns or poor quality overruns.

5.2.4. Construction Period

The consultants and contractors interviewed gave various measures they normally take to minimise cost overruns, delays and poor quality workmanship during the construction period. The following are the measures which architects normally take:-

- requiring preparation and strict adherence to an effective progress schedule, by contractor.
- Issuing working drawings on time.
- Approving materials before being used in the works.
- Ordering repeat works or opening covered works where the quality is questionable.
- Instituting penalties e.g. Liquidated and ascertained damages as per the contract.
- Maintaining good public relations in the project team.
- Frequent site meetings and inspections.
- Minimizing variations.
- Requiring financial appraisals.

The quantity surveyors answered that they prepared appraisals and valuations for payments on time: The contractors responded that they ensured that the required materials were delivered on site in time, employed competent personnel on site and maintained a close supervision of the works.

The above risk management procedures employed during the construction period are good in principle but are inefficient in the current practice in spite of their application, the risks have persisted in the construction industry.

About 53% of the respondents (consultants & contractors) agreed that the current methods used in risk identification were poor, and suggested that better risk identification criteria as a solution to the problems of persistent delays, cost overruns and poor quality workmanship are required in building projects in Kenya.

It can, therefore, be deduced that the causes of the occurrence of risk factors in building projects arise from all the stages (inception, design, tendering & construction phases) of the project. An affective approach in those early stages could ensure adequate risk identification and measurement and create an enabling environment in which a most efficient response to the risk can be instituted in all the stages of the project.

Fast track methods of procurement e.g. project management, design & build and management contracting have been found to be relatively more effective in this field because they are supported by a significant percentage of the key players in the building industry (see Section 5.2.3). They bring in the contractor to a project at the inception stage of the project. This allows the project to benefit from the contractor's expertise in planning and buildability.

5.3 Adequacy of the Risk Management Method

5.3.1 Introduction

This section presents the main characteristics of the variables: adequacy of identification, adequacy of measurement and adequacy of response. It shows the most typical value, the amount of deviation from it and the form of the distribution. The most typical value is indicated by the mean, mode or median depending on the form of the distribution as explained in section 4.4. The amount of deviation from the most typical value is indicated by the standard deviation while the form (shape) of the distribution is indicated by the kurtosis and skewness of the variable. The minimum and maximum values are also given to show the spread in the data. Histograms (with the normal curve imposed on them) are also presented to show the distributions diagrammatically. The descriptives of the severity of risk factors, risks and losses are shown in sections 5.4, 5.5 and 5.6, respectively.

5.3.2 Adequacy of Risk Identification

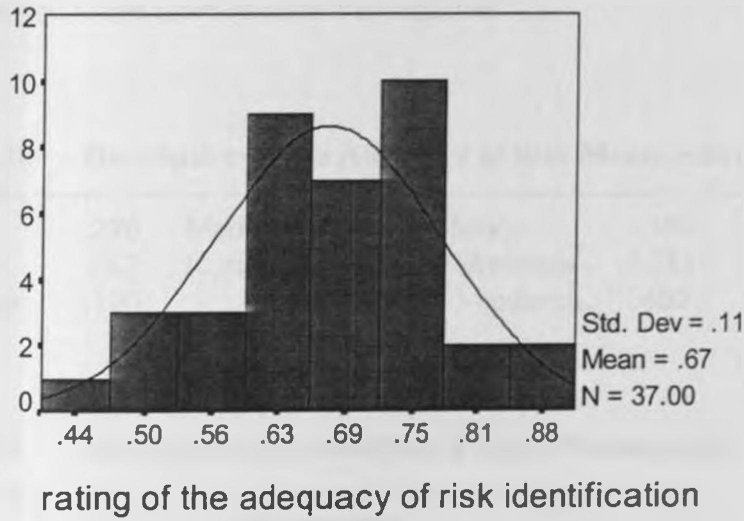
The mean rating of the adequacy of risk identification in the 37 projects studied was observed to be 0.671 as shown on Table 5.9. It implies that the amount of information available in the projects at the pre-contract period was 67.10% of the amount considered necessary to facilitate a most efficient management of risks in building projects.

Table 5.9 Descriptives of the Adequacy of Risk Identification

Mean	.671	Median	.689	Mode	.689
Std dev	.107	Kurtosis	-.674	Skewness	-.126
Minimum	.467			Maximum	.889

The rating of the risk identification exercise in most of the projects was slightly higher than the mean, as shown by the skewness. The distribution of the variable closely approaches the normal distribution as shown in Figure 5.1.

Figure 5.1 Histogram of the Adequacy of Risk Identification



An average of 32.90% of the amount of information considered necessary (in an ideal situation) for most efficient management of project risks (during the construction period) was lacking in the projects studied. The risk identification exercise can, therefore, be considered to have been only slightly above average *but not most adequate.*

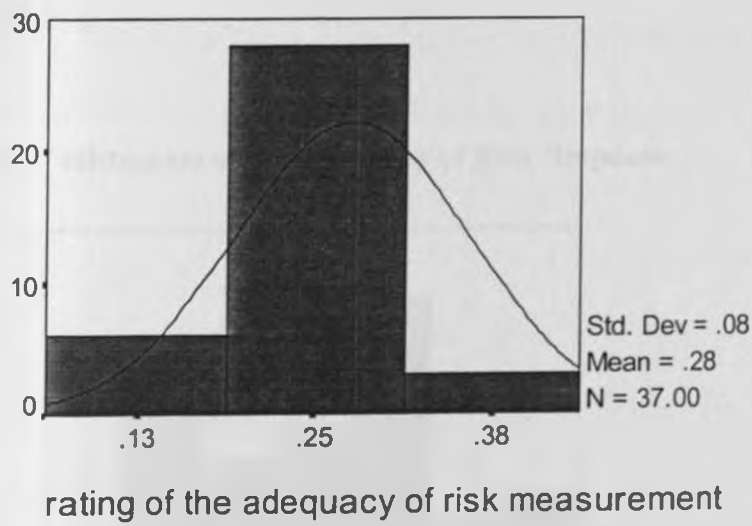
5.3.3 Adequacy of Risk Measurement

The mean rating of the adequacy of risk measurement was observed to be 0.276 as shown on Table 5.10. This value is very low; it is less than half the mean of the rating of the risk identification and risk response (see Table 5.11). It implies that the techniques used in the measurement of risk were not sufficiently elaborate in the population from which this data was obtained. The risk measurement process was based more on intuition than on mathematical/probabilistic analysis. None of the projects had adopted probabilistic techniques such as sensitivity analysis, Monte Carlo Simulation or fuzzy set algebra, which have been tested in other countries and found more reliable than intuition.

Table 5.10 Descriptives of the Adequacy of Risk Measurement

Mean	.276	Median	.300	Mode	.300
Std dev	.083	Kurtosis	1.183	Skewness	-1.353
Minimum	.100			Maximum	.400

Figure 5.2 Histogram of the Adequacy of Risk Measurement



These observations show that risk measurement is the weakest area in the process of risk management in the population from which this data was obtained.

5.3.4 Adequacy of Response to Risks

The mean rating of the adequacy of the project team's response to the risk factors that occurred in the projects studied is 0.635 as shown on Table 5.11. The mean is only sligtly lower than the one of the rating of the adequacy of risk identification.

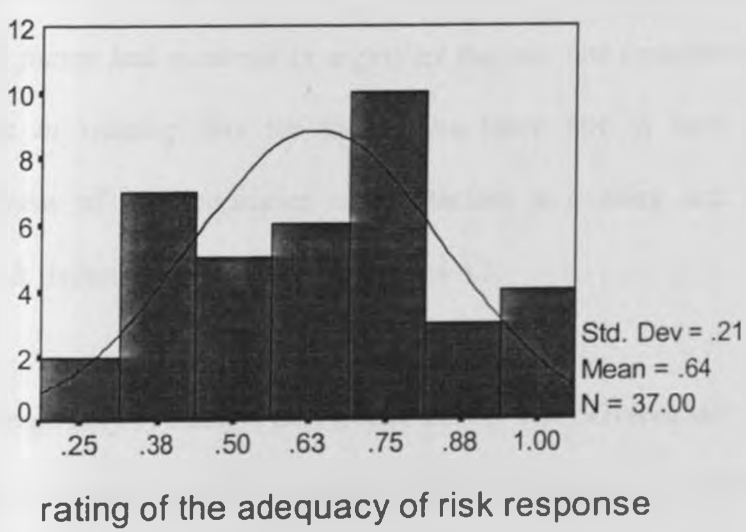
Table 5.11 Descriptives of the Adequacy of Risk Response

Mean	.635	Median	.600	Mode	.400
Std dev	.208	Kurtosis	-.898	Skewness	.280
Minimum	.300			Maximum	1.000

- Multiple modes exist. The smallest value is shown.

The distribution of the variable also closely approaches the normal distribution (see Figure 5.3).

Figure 5.3 Histogram of the Adequacy of Risk Response



These observations suggest that the project teams were very vigilant in responding to all the risks identified because the rating of the identification is almost equal to the rating of the response. The fact that the risks had been poorly measured seems not to have influenced the response. However, the risk response exercise can not be considered to have been very adequate because it falls short of the ideal (shown by the measurement criteria in section 4.4.4) by a whole 36.50%, which is a statistically significant margin.

5.4 Frequency and Severity of the Risk Factors

The relative frequency of occurrence of a risk factor is a measure of the probability that the factor occurs in a future/proposed building project. Twelve different factors whose occurrence led to delays or cost overruns were considered. Six factors whose occurrence caused poor quality were considered and were slightly different from the 12 factors causing delay/cost overruns. A factor was taken to have occurred if: *it had occurred and had been considered important in causing loss*. If *a factor had occurred in a project but was not considered to have been important in causing loss* the factor was taken not to have occurred. The measurement of the importance of the factors in causing loss – delays, cost overruns & defects- is explained in section 4.4.5.

5.4.1. Frequency of Factors that Cause Cost & Time Overruns

'Extra work' was observed to have the highest frequency of occurrence (73.50%) followed by 'changes in design' (58.80%), both of which are technically termed as *variations* in the building contract. The frequency of each of the 12 factors considered is shown on Table 5.12. Ten of the factors had a statistically significant relative frequency (i.e. relative frequency > 10% - see section 4.5).

Table 5.12. Relative Frequency of Factors that Cause Time & Cost Overruns

	Risk Factor	*Relative Frequency*
1.	Extra work	73.50%
2.	Changes in design	58.80%
3.	Delays in the preparation of detailed drawings	55.90%
4.	Late instructions	52.90%
5.	Nominated Subcontractors	47.10%
6.	Nominated Suppliers	47.10%
7.	Unexpected Underground conditions	44.10%
8.	Delays in settlement of contractor's payments	38.20%
9.	Inclement weather	23.50%
10.	Shortage of main contractor's materials	17.60%
11.	Perils – fire, earthquakes etc	5.90%
13.	Other factors – Contractual claims, industrial disputes etc	0 %

3.3.2. Frequency of Factors that Cause Poor Quality

'Defective materials' were observed to have the highest frequency of occurrence (38.20%) followed by the 'Condemnation of some works (35.20%). However, the relative frequencies of the factors were generally lower than the relative frequencies of the factors that cause time/cost overruns. Table 5.13 shows the relative frequencies of the factors.

Table 5.13 Relative Frequencies of the factors that Cause Poor Quality Workmanship

Risk Factor		*Relative Frequency*
1.	Defective materials	38.20%
2	Some works condemned	35.20%
3.	Cracks in wall, floor etc	23.50%
4.	Defective design	23.50%
5.	Leaks in roof, walls etc	14.70%
6.	Other defects	0%

5.4.3 Severity of the Impact of Risk Factors on Cost

The severity of the impact of the occurrence of the risk factors was measured on a 5-point scale as explained in section 4.4.6.

Extra work had the highest mean (3.38 out of 5.00) severity on the project costs followed by Changes in design (3.18). Table 5.14 shows the severity of the factors on the project cost. The arrangement of the factors in a decreasing order of their mean severity on cost is similar to their arrangement in terms of their relative frequency of occurrence, as shown in section 5.4.2 before. This implies that the more frequent a factor is, the greater the impact it has on project cost.

Table 5.14 Severity of Impact on Cost

Risk Factor		Mean Severity on Cost
1.	Extra work	3.38
2.	Changes in design	3.18
3.	Late instructions	3.03
4.	Nominated Subcontractors	2.06
5.	Unexpected Underground conditions	1.85
6.	Nominated Suppliers	1.74
7.	Delays in settlement of payments	1.65
8.	Shortage of main contractor's materials	1.56
9.	Other factors – Contractual claims, industrial disputes etc	1.29
10.	Perils – fire, earthquakes etc	0.03
11.	Inclement weather	0
12.	Delays in the preparation of detailed drawings	0

5.4.4. Severity of Impact of Risk Factors on Time

For each of the 12 factors, the mean severity of impact on project time is slightly higher than the mean severity on cost as shown on Table 5.15. Although the respondents did not consider 'Delays in the preparation of detailed drawings' to have had any impact on the project cost, they considered them to have had a significant impact (2.65) on the project time.

Table 5.15 also shows that the factors that had a strong impact on the project cost also had a strong impact on the time. These observations imply that the occurrence of risk factors has a greater impact on the building project time than on the project cost.

Table 5.15 Severity of Impact on Time

Risk Factor		*Mean Severity on Time*
1.	Extra work	3.59
2.	Changes in design	3.26
3.	Delays in the preparation of detailed drawings	2.65
4.	Unexpected Underground conditions	2.62
5.	Late instructions	2.62
6.	Nominated Subcontractors	2.38
7.	Delays in settlement of payments	2.18
8.	Nominated Suppliers	2.15
9.	Shortage of main contractor's materials	1.82
10.	Inclement weather	1.68
11.	Perils – fire, earthquakes etc	0.79
12.	Other factors – Contractual claims, industrial disputes etc	0.06

The observations suggest that the severity of the factors on time or cost is highly dependent on the frequency of occurrence of the factors.

5.4.5 Severity of Impact of Risk Factors on Quality

The mean severities of impact of the factors that were considered to cause or indicate poor quality are generally lower than the severities of impacts of risk factors than on project cost and time. Defective materials were observed to have the highest severity as shown on Table 5.16. The order of the factors graded in terms of their severities is also similar to their order in terms of their frequencies. This implies that the impact of a factor on quality depends on its relative frequency of occurrence in the population from which these data was obtained. The same observation was also made in the case of risk factors that impact on project time and cost.

Table 5.16 Severity of Impact on Quality

Risk Factor		*Mean Severity on Quality*
1.	Defective materials	2.06
2	Cracks in wall, floor etc	2.03
3.	Some works condemned	1.97
4.	Defective design	1.76
5.	Leaks in roof, walls etc	1.62
6.	Other defects	0.03

5.5 Risks of Loss

This is the probability (likelihood) of occurrence of loss- cost overruns, time overruns or poor quality workmanship. Twelve factors were considered in measuring the likelihood of loss in cost and time, while six factors were used in measuring the likelihood of loss in quality. Each factor was rated on a 5-point scale as explained in section 4.4.7, giving the maximum possible sum of rankings as 60 (for time and cost risks) and 30 (for quality risk). The probability that loss would occur was obtained by summing up the rankings in importance of various factors in causing the loss, and dividing the sum by the maximum possible sum of the rankings of all the factors.

5.5.1 Risk of Cost Overrun

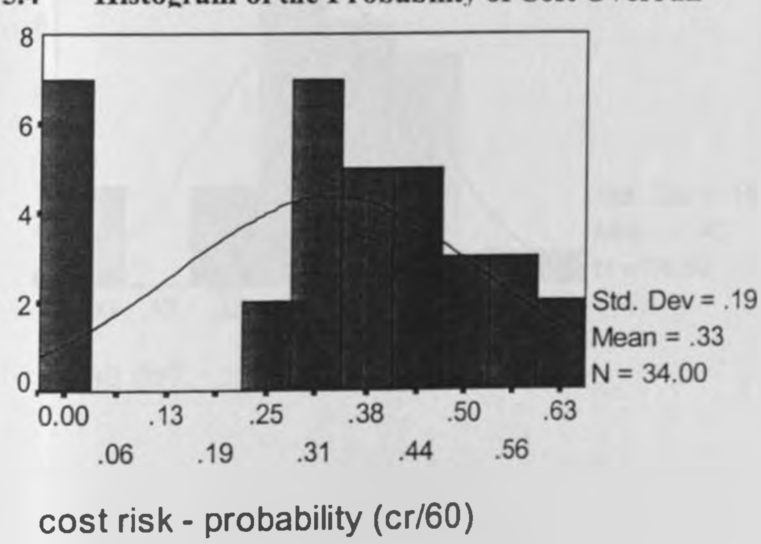
Cost risk is the probability that the occurrence of the 12 factors described in section 5.4.1 would cause a cost overrun. The mean probability of cost overrun was observed to be 0.329 as shown on Table 5.17.

Table 5.17 Descriptives of the Probability of Cost Overrun

Mean	.329	Median	.375	Mode	.000
Std Dev	.194	Kurtosis	-.645	Skewness	-.603
Minimum	.00	Maximum	.62		

Its distribution is platikurtic (less peaked than the normal bell-shaped distribution) and negatively skewed as shown on Figure 5.4.

Figure 5.4 Histogram of the Probability of Cost Overrun



The median is therefore the best indicator of the most typical observation in this variable, as explained in section 4.5.

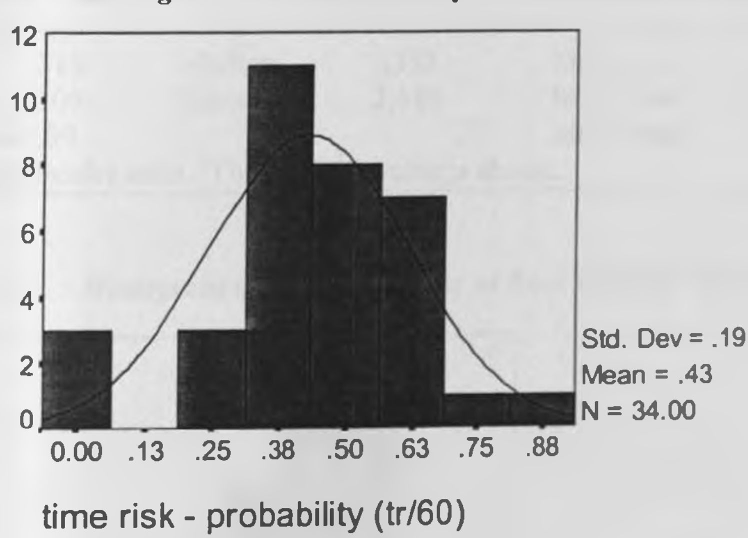
5.5.2 Risk of Time Overrun

Time risk is the probability that the occurrence of the 12 factors described in section 5.4.1 would cause a time overrun. The mean probability of time overrun is 0.430 and is greater than the mean probability of cost overrun, as shown on Table 5.18.

Table 5.18 Descriptives of the Probability of Time Overrun

Mean	.430	Median	.442	Mode	.317
Std Dev	.190	Kurtosis	.619	Skewness	-.508
Minimum	.00	Maximum	.85		

Figure 5.5 Histogram of the Probability of Time Overrun



Its distribution is leptokurtic (more peaked than the normal distribution) and negatively skewed as shown on Figure 5.5. The mode is therefore the best measure of the most typical observation in the variable.

5.5.3. Risks of Poor Quality Workmanship

Quality risk is the probability that the occurrence of the 6 factors described in section 5.4.2 would cause poor quality workmanship. The mean probability of poor quality workmanship is 0.316 and is almost equal to the mean probability of cost overrun. Table 5.19 shows the descriptive ststistics of the variable.

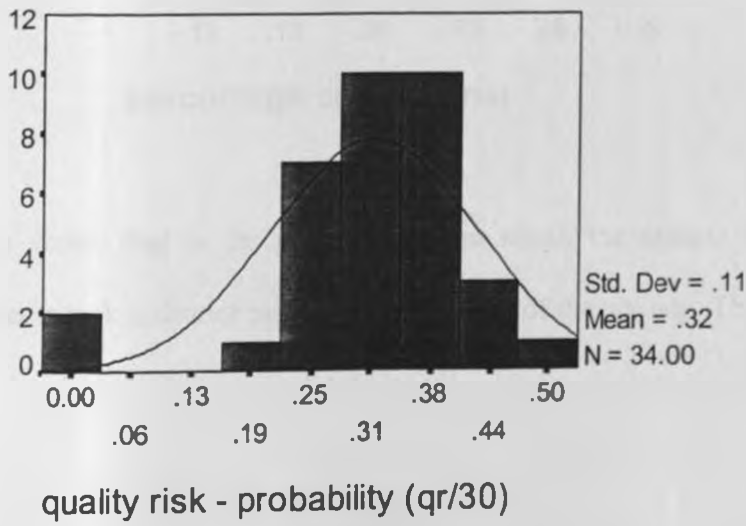
Its distribution is more highly peaked than the distribution of cost and time risks, as shown on Figure 5.6. Also, it is more negatively skewed than the other two distributions.

Table 5.19 Descriptives of the Probability of Poor Quality Workmanship

Mean	.316	Median	.333	Mode	.300
Std Dev	.109	Kurtosis	2.618	Skewness	-1.300
Minimum	.00			Maximum	.50

* Multiple modes exist. The smallest value is shown.

Figure 5.6 Histogram of the Probability of Poor Quality Workmanship



5.6. Losses

5.6.1. Cost Overruns

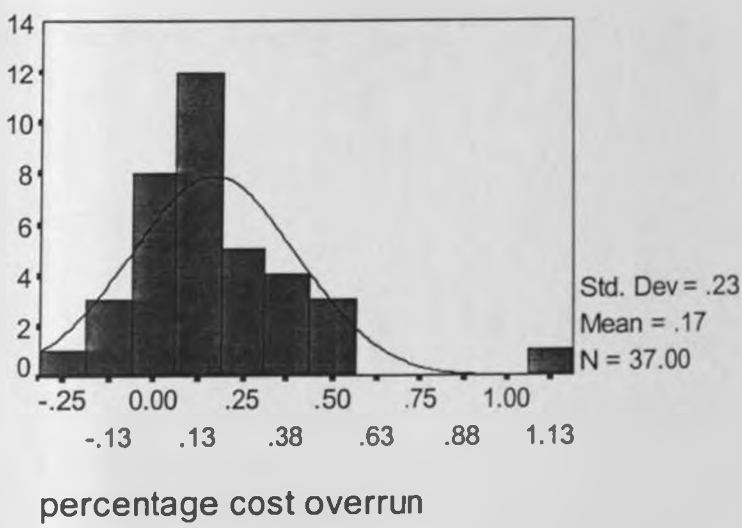
The mean percentage cost overrun (PCSTO) is relatively low (16.70%) and ranges between –27% and 107% as shown on Table 5.20. It has a positively skewed and leptokurtic (more peaked than the normal) distribution as shown on Figure 5.7.

Table 5.20 Descriptives of the Percentage Cost Overrun

Mean	.167	Median	.143	Mode	-.273
Std Dev	.234	Kurtosis	5.165	Skewness	1.536
Minimum	-.27			Maximum	1.07

* Multiple modes exist. The smallest value is shown.

Figure 5.7 Histogram of the Percentage Cost Overrun



This shows that in the population from which the sample was obtained, most projects took a shorter period than the mean of the periods. The mode is, therefore the best indicator of the most typical percentage cost overrun observed (see section 4.5).

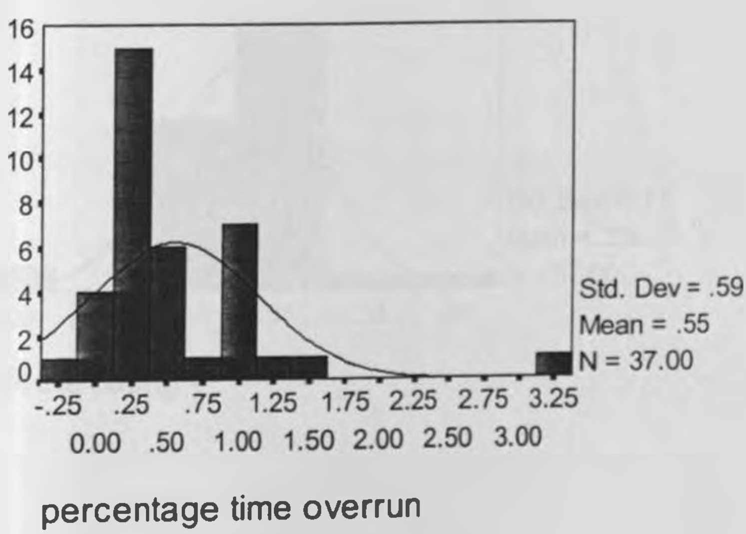
5.6.2 Time Overruns

The mean percentage time overrun is 55% and is significantly greater than the mean percentage cost overrun, which is 16.7%, implying that occurrence of risk factors normally impacts more heavily on the project time than on the cost. This is because extension of construction time does not always lead to an addition on the construction cost. Table 5.21 shows the descriptive statistics of this variable. The distribution thereof is also positively skewed and leptokurtic (see Figure 5.8) showing that the percentage time overrun observed in most of the projects was smaller than the mean time overrun (55%).

Table 5.21 Descriptives of the Percentage Time Overrun

Mean	.550	Median	.333	Mode	.333	Std Dev	.594
Kurtosis	9.427	Skewness	2.572				
Minimum	-.17	Maximum	3.15				

Figure 5.8 Histogram of the Percentage Time Overrun



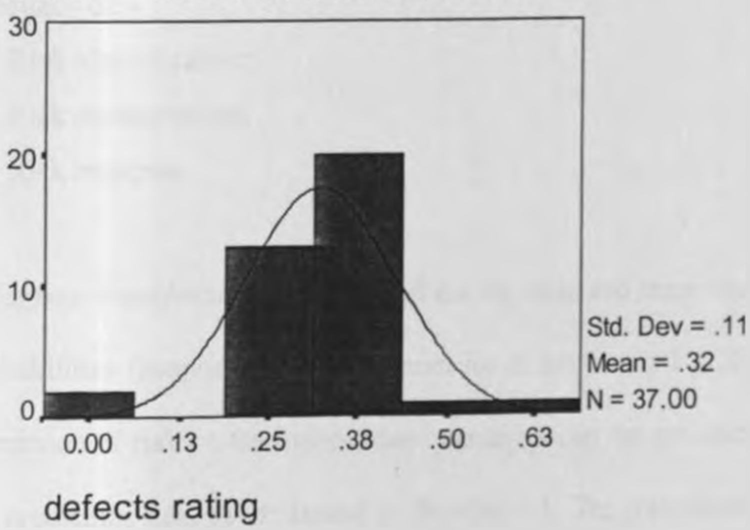
5.6.3. Poor Quality of Workmanship

The degree to which the quality of workmanship is poor is indicated by the incidence of defects in the building during the construction period and the defects liability period of the project. The mean defects rating (32.30%) is higher than the percentage cost overrun but lower than the percentage time overrun as shown on Table 5.22. This shows that occurrence of risk factors normally impacts less heavily on the specified quality than on the specified time. The distribution of the defects rating is leptokurtic but slightly negatively skewed, unlike the other two aspects of loss, as shown on Figure 5.9.

Table 5.22 Descriptives of Defects Rating

Mean	.323	Median	.333	Mode	.333	Std Dev	.105
Kurtosis	3.828	Skewness	-1.200				
Minimum	.00	Maximum	.57				

Figure 5.9 Histogram of Defects Rating



This indicates that the defects rating of most of the projects was higher than the mean of the ratings in the sample. The mode is still the best indicator of the most typical observation in this variable.

5.7 Test of Sub-hypotheses 1, 2 and 3

5.7.1 Introduction

This section presents the statistical relationship between the probability that loss (cost overrun or time overrun) occurs and the adequacy of the methodology of risk management. The relationship between quality risk and the methodology of risk management is not presented here because it was observed that quality experienced a minimal impact from occurrence of the six factors that influence building quality and indicate it, as described in Section 5.4.5.

The section presents only aspects of the regression procedures that are necessary for the testing of the hypotheses and the discussion of the results thereof. Full outputs of regression procedures are shown in appendix E.

5.7.2. Cost and Time Risks Regressed on Three Variables

Sub-hypotheses 1, 2 & 3 state that cost and time risks are determined by the adequacy of: -

- Risk identification;
- Risk measurement;
- Risk response.

A *logistic transformation* is applied on the cost and time risks because risks are probabilities (proportions) which must lie in the interval (1,0); an ordinary linear regression of risk on the independent variables can not produce a reliable equation for predicting risk, as explained in Section 4.5. The transformed data is shown in

Appendix D2. The transformed risks were then regressed on the three independent variables. The regression of the transformed risks on the three explanatory variables produces the results shown on Table 5.23.

The R^2 values are very small and are not statistically significant (the p - values are greater than 0.05). The regression coefficients are also not statistically significant.

Table 5.23 Regression of Logit (risk) on Three Variables

A. Regression of Logit (cost risk)

Dependent Variable -logit (cost risk) i.e. $\log_e$ {cost risk/(1- cost risk)}

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	1.903	0.130
Adequacy of risk identification	-2.154	0.262
Adequacy of risk measurement	1.089	0.609
Adequacy of risk response	-2.305	0.047
$R^2 = 0.2387$		0.074
Standard Error = 0.959		

B. Regression of Logit (time risk)

Dependent Variable -logit (time risk) i.e. $\log_e$ {time risk/(1- time risk)}

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	0.930	0.487
Adequacy of risk identification	-1.067	0.621
Adequacy of risk measurement	1.485	0.546
Adequacy of risk response	-1.530	0.195
$R^2 = 0.0966$		0.392
Standard Error =1.1356		

In these equations, the three explanatory variables (risk identification, measurement & response) explain a very small percentage of the variability in the risks. The research sub-hypotheses 1, 2 & 3 are therefore *rejected.*

Though the R^2 values are very small, studying scatter diagrams (not shown) of the standardized residuals (of the regression) against each of the independent variables does not reveal violation of any of the six basic assumptions of regression (see Section 4.5). A small value of R^2 suggests *interalia* that other explanatory variables, which could improve the comprehensiveness of the regression equation could have been left out of the regression model (Ferry & Brandon 1991; 268). This possibility is normally investigated by plotting the regression residuals against other variables that considered capable of improving the adequacy of the regression model. If the residuals *vary systematically* with the level of an additional predictor variable, then including the variable in the regression model is very likely to improve the adequacy of the model (Neter *et al* 1996; 109). Scatter plots of the regression residuals (not shown), were therefore used to investigate the possibility of cost and time risks being influenced by four other variables[†], namely: -

- Estimated contract sum – millions of Kshs (adjusted to 1999 cost index);
- Type of building in terms of the functional use;
- Type of client – whether private or public;
- Method of tendering - used in selecting the main contractor.

The residuals were observed to vary in a systematic manner with the contract sum.

[†] These variables had been observed during the data collection with a view to describing the basic characteristics of the projects studied but they had not been considered to influence time and cost risks in any significant way.

Also, a comparison of the means of risks in different groups of the categorical variables (type of building, type of client & method of tendering) exhibited some trends that suggested that the variables had some influence on the magnitude of risks and losses.

Table 5.24 shows the mean risks and overruns for different project sizes, and different types of clients, buildings and methods of tendering. From the Table, it can be seen that the mean risks and overruns generally increase with the project size, although projects in the category Kshs 101 - 200 million seem to experience the larger risks and losses than those in the category Kshs 201 - 300 million and above. The number of projects in the range Kshs 10 - 100 million is 30 No. whereas the ones in the range Kshs 101 - 200 million are 5 No. The latter group exhibits greater cost and time risk than the former. Risks in the former category are likely to be lower in accordance with the rule of averages, due to the larger number of projects in the group. Another possible reason for the difference in the risks between the lower and the higher groups is that the larger projects (Kshs 201 and above) are normally executed by larger, more experienced and more efficient professionals and contractors - who have better risk management practices - than the smaller projects.

The risks and losses are higher in public than in private projects. They are generally lower in projects that adopt selective tendering than in those that use open or negotiated tendering methods.

Table 5.24 Mean Risks for Different Project Sizes, Clients, Building Types and Tendering Methods.

		No. of projects	Cost Risk (probability)	Time Risk (probability)	Cost Overrun (millions of Kshs)	Percentage Cost Overrun	Time Overrun (weeks)	Percentage Time Overrun
Size of Project (in millions of Kshs)	10 - 100	30	0.3137	0.4042	5.2553	11.57	19.0333	47.72
	101 - 200	5	0.5042	0.6083	63.6029	52.13	64.1000	113.17
	201 - 300	1	0.0000	0.4167	-29.5263	-10.23	6.0000	8.57
	301 - 400	1	0.4000	0.4500	68.7910	18.73	24.0000	30.00
Client	Private	28	0.2987	0.4040	10.0317	15.90	21.5893	55.65
	Public	9	0.4148	0.5019	26.0055	19.01	35.2222	53.06
Type of Building	Residential	13	0.3205	0.4526	2.5909	10.08	24.5000	53.10
	Commercial	12	0.4000	0.4788	34.3402	29.10	40.7500	84.58
	Institutional	9	0.2714	0.3048	7.3706	12.15	10.5556	29.83
	Industrial	1	0.0000	0.4333	-1.5761	-6.24	4.0000	12.50
	Other	2	0.3667	0.4500	2.2072	16.47	7.5000	24.88
Method Of Tendering	Open	3	0.4778	0.5722	13.5498	15.88	31.1667	0.6250
	Selective	28	0.3060	0.3927	12.1494	14.81	21.6429	0.4475
	Negotiated	6	0.3528	0.5139	22.3510	25.66	37.0000	0.9921

The risks and overruns are generally higher in residential and commercial buildings than in institutional and other types of buildings. Commercial buildings have higher risks because of their relatively higher complexity, which may result in greater requirement in terms of co-ordination and additional mechanical services/equipment. These observations further confirm the suggestion (that the four variables influence the magnitude of risks and losses) given by examining the regression residuals. For this reason, the four variables have been added to the regression model.

Risks are lower in selective tendering because the method ensures the selection of a competent contractor who is financially stable as well as technically qualified. Open tendering may result to selection of a contractor who can not perform and hence enhancing the chances of higher risks. Public clients do not have viable project planning in regard to time scheduling and financial management and control. This results to lack of adequate provision for finances. Both consultants and contractors take too long to receive their payments to the detriment of the projects. Consequently, time and cost risks increase. This scenario is completely the opposite for private funded projects.

Project size is added as a continuous variable but the three are added as grouped variables. In order to include the three grouped variables (type of building, type of client & method of tendering) in the regression model, seven *dummy variables* were created out of the three grouped variables. Building projects were grouped into 5 types, clients into 2 types and methods of tendering into 3 types. The number of dummy variables created from the type of building, type of client and method of tendering are 4, 1 and 2 respectively, as explained in Section 4.5.

Only variables that can be conveniently measured *before or during the tendering stage* of a project are considered in the regression model because the objective of the regression analysis was to establish an equation that could be used to predict risks in projects before the start of the construction work. Therefore, one of the original independent variables – adequacy of risk response – was omitted from the regression model because it can not be estimated with sufficient accuracy at the pre-contract period. This leaves a total of 10 independent variables in the logistic regression model.

5. 7.3. Cost Risk Regressed on Ten Variables

Regressing logit (CR) on the explanatory variables gives the result shown on Table 5.25. All the ten explanatory variables have been entered into the model. The resulting R^2 value is 0.45478 and is about twice as large as the R^2 value (0.23872) in the model which used only the three indicators of the adequacy of risk management as the explanatory variables. A plot of the standardized regression residuals against the explanatory variable – contract sum - exhibits a fan-shaped pattern as shown on Figure 5.10. A plot of the residuals against any of the other eight explanatory variables shows that the residuals are randomly scattered and almost uniformly distributed around the zero axis of the graph.

Table 5.25. Regression of Logit (CR) on Ten Variables

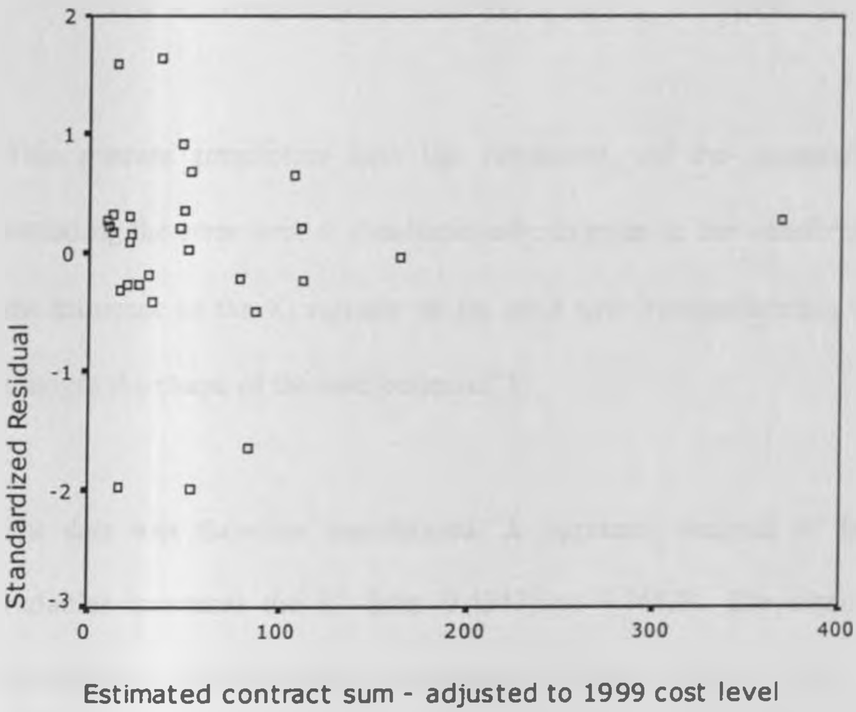
Dependent Variable - logit (CR)

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	2.617	0.137
Adequacy of risk identification	-4.518	0.035
Adequacy of risk measurement	3.611E-02	0.987
Estimated contract sum - in millions of Kshs, adjusted to 1999 cost index	2.384E-04	0.942
TYPE1: 1 if residential building 0 if otherwise	0.653	0.443
TYPE2: 1 if commercial building 0 if otherwise	0.437	0.629
TYPE3: 1 if institutional building 0 if otherwise	-0.514	0.561
CLIENT: 1 if private client 0 if public client	-0.302	0.532
TENDER1:1 if selective tendering 0 if otherwise	-0.477	0.425
TENDER2:1 if open tendering 0 if otherwise	0.509	0.541
$R^2 = 0.455$		0.143
Standard Error = 0.9473		
$-1.994 \leq Z$ residual ≥ 1.631		

NB: Variable TYPE4 (1 if institutional building, 0 if otherwise) is a constant (see Appendix D2) and it has been deleted from the analysis.

This indicates that there is no noticeable violation of the basic assumptions of regression, in respect of those eight variables. However, the fan-shaped plot on Figure 5.10 indicates violation of the assumption of the constancy of the error variance, in the regression model, in respect of the variable – Contract Sum (CE). The assumption is that the distribution of the residuals [$\in = y - f(x, \beta)$] in the regression is independent of the explanatory variable.

Figure 5.10 Residuals versus Contract Sum



A fan-shaped pattern in the plot indicates that the residual variability depends on the mean of the independent variable (Carrol 1988; 29, Chatterjee 1977, Neter *et al* 1996: 103) and makes the regression equation unreliable. In this case, the error variance decreases with increasing levels of the predictor variables.

To overcome this problem, Chatterjee (1977) suggests that all the variables in the regression model be transformed by dividing each of them by the explanatory variable that influences the error variance, as shown below: -

Original regression model:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots\dots\dots + \beta_n X_n + \epsilon$$

Let variable X_2 be the variable influencing the error variance; then, *New regression model:*

$$Y(1/X_2) = \alpha(1/X_2) + \beta_1(X_1/X_2) + \beta_2 + \ldots\ldots + \beta_n(X_n/X_2) + \epsilon(1/X_2)$$

This process transforms both the dependent and the independent variables, including the error term ϵ simultaneously. In essence, the transformation removes the influence of the X_2 variable on the error term by transforming it to ϵ/X_2, and changes the shape of the distribution of Y.

The data was therefore transformed. A regression analysis of the transformed variables increases the R^2 from 0.45478 to 0.76822. The significance of the regression coefficients is also increased, as shown on Table 5.26A.

Table 5.26. Regression of {Logit (CR)/CE} on the Transformed Variables

(A) All the variables entered

Dependent Variable - {Logit (CR)/CE}

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	0.006106	0.6824
Adequacy of risk identification/Estimated contract sum	-9.630055	0.0000
Adequacy of risk measurement/Estimated contract sum	0.558482	0.7428
Reciprocal of Estimated contract sum	6.200908	0.0002
TYPE1/Estimated contract sum	1.223515	0.0507
TYPE2/Estimated contract sum	0.579424	0.5936
TYPE3/Estimated contract sum	-0.216644	0.6553
CLIENT/Estimated contract sum	-1.090525	0.0034
TENDER1/Estimated contract sum	-0.901171	0.1840
TENDER2/Estimated contract sum	0.219860	0.8810
$R^2 = 0.76822$		0.0002
Standard Error = 0.03064		

(B) Most Significant Variables

Dependent Variable - {Logit (CR)/CE}

Independent variable	Regression coefficient	P - value (2-tail significance)
Constant	0.014717	0.1556
Adequacy of risk identification/Estimated contract sum	-10.09226	0.0000
Reciprocal of Estimated contract sum	6.484950	0.0000
TYPE1/Estimated contract sum	1.285439	0.0004
CLIENT/Estimated contract sum	-1.110664	0.0005
TENDER1/Estimated contract sum	-1.019816	0.0864
$R^2 = 0.75443$		0.0000
Standard Error = 0.02866		
$-1.7762 \leq Z$ residual ≥ 1.9968		

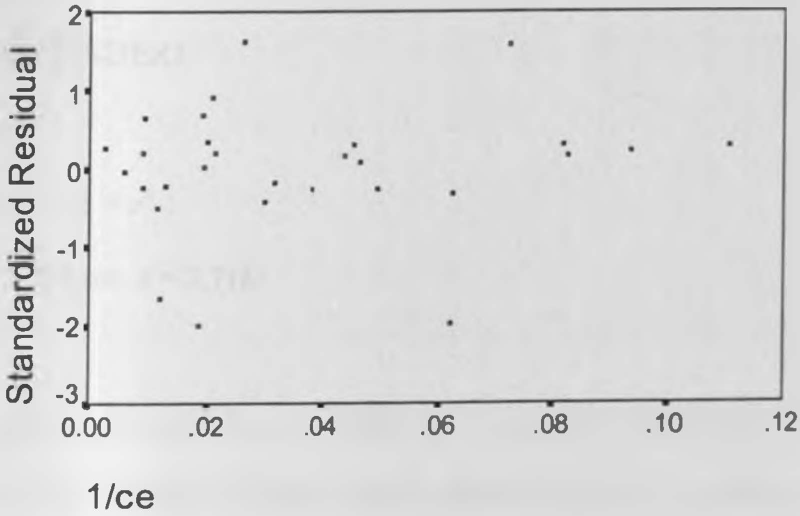
This means that in the new model, the independent variables explain more of the variability in the dependent variable than in the original model. Table 5.26A shows the first step of the *backward regression process* (explained in Section 4.5) in which all the explanatory variables are entered into the model. The process starts with all the variables then eliminates the least significant variables, one at a time, until the variables that give the most precise equation are left in the equation.

The final stage of the backward regression process is shown on Table 5.26B and is the one in which the minimum possible standard error can be achieved in this regression process. The standard error is the estimate of the standard deviation of the error term ($\in$) in the regression model, and the lower it is the more accurate is the prediction equation. Four of the variables have been removed from the equation and the standard error reduced from 0.03064 to 0.02866. Though the final

R^2 value is slightly lower (0.75443), the final equation is more precise than the first one.

A scatter plot of the residuals against the reciprocal of the contract sum (1/CE) on Figure 5.11 shows that the problem in the original model has been overcome by the transformation.

Figure 5.11 Residuals - {Logit (CR)/CE}-versus Reciprocal of Contract Sum



The standardized residuals are randomly distributed around the zero axis, and do not exhibit any noticeable pattern.

The regression equation can finally be written as follows: -

$$\{\text{Logit (CR)}\}/\text{CE} = 0.015 - 10.092\ (\text{ID/CE}) + 6.485\ (1/\text{CE}) + 1.285\ (\text{TYPE1/CE}) - 1.111\ (\text{CLIENT/CE}) - 1.020\ (\text{TENDER1/CE})$$

Multiplying out by CE,

$$\text{Logit (CR)} = 6.485 + 0.015\text{CE} - 10.092\ \text{ID} + 1.285\ \text{TYPE1}$$

$$- \ 1.111\ \mathrm{CLIENT} - 1.020\ \mathrm{TENDER1}$$

Logit (CR) = $\log_e$ *{CR/(1-CR) }; on some rearrangement,*

$$CR = (6.485 + 0.015CE - 10.092ID + 1.285TYPE1 - 1.111CLIENT$$

$$- 1.020\ TENDER1) \div \{1 + (6.485 + 0.015CE - 10.092\ ID + 1.285\ TYPE1 -$$

$$1.111\ CLIENT - 1.020\ TENDER1)\}$$

Or, writing

$$\eta = 6.485 + 0.015CE - 10.092ID + 1.285TYPE1 - 1.111CLIENT$$

$$- 1.020\ TENDER1$$

Then,

$$CR = e^{\eta} / (1 + e^{\eta})$$

Where: $e = 2.7183$

The relationship between p and logit (p) is generally sigmoidal but it is linear for values of p between 0.20 and 0.80 (Collett, 1991; 56). The above equation can therefore be interpreted as follows:-

1. The more adequate the risk identification (ID) the less the cost risk (CR). A unit increase in the adequacy of risk identification results in decrease of logit (CR) by 10.092 units. Note that in the study, ID is measured as a ratio and ranges between 0 and 1.
2. The greater the Contract Sum (CE) the more the cost risk. An increase in contract sum by Kshs 1 million increases logit (CR) by 0.015 units.

3. The constant 6.485 is the value of logit (CR) when values of all the other explanatory variables are zero. The constant does not have any particular meaning as a separate term in this equation because the scope of the equation does not include a case where all the independent variables are zero. The equation is formulated to apply to risks where the contract sum ranges from about Kshs 9 million to Kshs 400 million. The identification rating ranges from about 0.40 to about 0.90 units. These are the ranges of the data in the sample used to formulate the equation; prediction using the equation would be most accurate if it is done for measures lying within those ranges. The other independent variables can take values of zero because they are binary variables as described in section 5.7.2.

4. While the coefficients of the two continuous variables (ID & CE) indicate the slope of the predicted trendline, the coefficients of the binary variables represent the amount by which the trendline will be shifted along the y-axis if the binary variable is 1, without changing the slope of the line. It is the addition to or subtraction from the constant term. If the project is TYPE1 (i.e. residential), the cost risk is higher; logit (CR) is increased by 1.285. This means that for every level of (ID, CE), logit (CR) is higher by 1.285 if the project is residential (code 1) than if the project is not residential (code 0). It shows that a project involved in residential building is exposed to more cost risk than one involved in any other building type. Residential buildings have intricate finishing details. They demand more attention from both the consultants and contractors.

5. If the client is private (code1) logit (CR) is decreased by 1.111 units, meaning that there is less risk of cost overrun in private projects than in public ones.

6. If the tendering method is TENDER1 (selective – coded 1), logit (CR) is decreased by 1.020 units, meaning that selective tendering method normally results in a lower cost risk than either open tendering or negotiated tendering methods.

5. 7.3. Time Risk Regressed on Ten Variables

Regressing logit (TR) on the explanatory variables gives the result shown on Table 5.27. All the ten explanatory variables have been entered into the model. The resulting R^2 value is 0.39672 and is about four times as large as the R^2 value (0.0966) in the model which used only the indicators of the adequacy of risk management as the explanatory variables. A plot of the standardized regression residuals against the explanatory variable – contract sum - exhibits a fan-shaped pattern as shown on Figure 5.12.

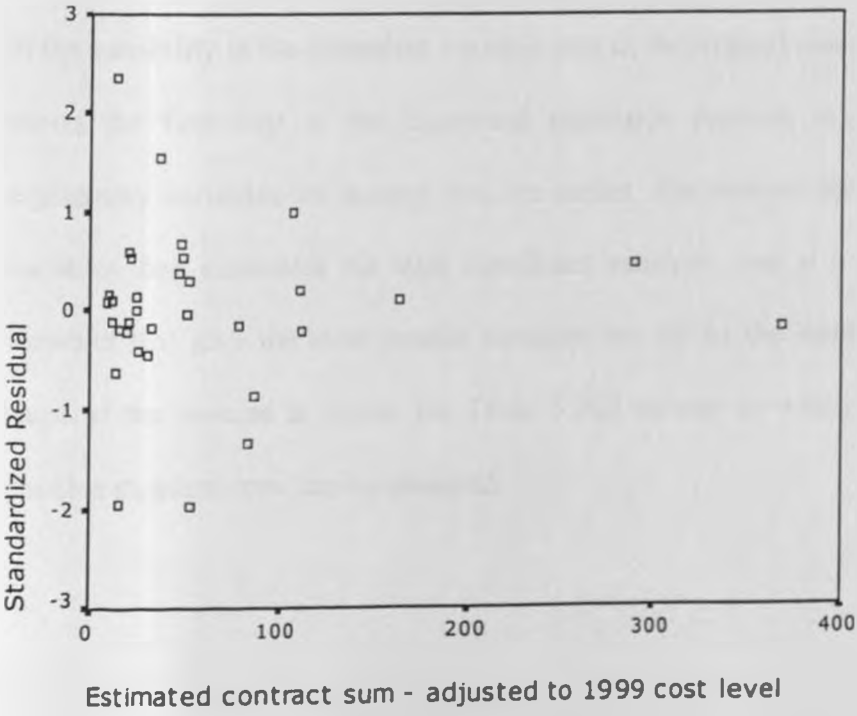
A plot of the residuals against any of the other nine explanatory variables shows that the residuals are randomly scattered and almost uniformly distributed around the zero axis of the graph. This indicates that there is no noticeable violation of the basic assumptions of regression, with respect to those nine variables.

Table 5.27. Regression of Logit (TR) on Ten Variables

Dependent Variable - logit (TR)

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	2.882	0.131
Adequacy of risk identification	-3.689	0.112
Adequacy of risk measurement	0.310	0.897
Estimated contract sum - in millions of Kshs, adjusted to 1999 cost index	9.430E-04	0.755
TYPE1: 1 if residential building 0 if otherwise	0.409	0.663
TYPE2: 1 if commercial building 0 if otherwise	0.172	0.863
TYPE3: 1 if institutional building 0 if otherwise	-0.763	0.443
TYPE4: 1 if industrial building 0 if otherwise	1.045	0.479
CLIENT: 1 if private client 0 if public client	-0.589	0.274
TENDER1:1 if selective tendering 0 if otherwise	-0.772	0.210
TENDER2:1 if open tendering 0 if otherwise	0.231	0.795
$R^2 = 0.397$		0.225
Standard Error = 1.0655		
$-1.980 \leq Z$ residual ≥ 2.342		

Figure 5.12 Residuals of Logit (TR) versus Contract Sum



However, the fan-shaped plot on Figure 5.12 indicates violation of the assumption of the constancy of the error variance, in the regression model, in respect of the variable – Contract Sum (CE). The assumption is that the distribution of the residuals [$\epsilon = y - f(x, \beta)$] in the regression is independent of the explanatory variable. A fan-shaped pattern in the plot indicates that the residual variability depends on the mean of the independent variable (Carrol 1988; 29, Chatterjee 1977, Neter *et al* 1996: 103) and makes the regression equation unreliable. In this case, the error variance decreases with increasing levels of the predictor variable. This behaviour is similar to the one observed in the last section – 5.7.2.

To overcome the problem, Chatterjee's (1977) transformation employed in section 5.7.2 (i.e. dividing each of the variables in the model by the explanatory variable that influences the error variance) is applied to the data. A regression analysis of the transformed variables increases the R^2 from 0.39672 to 0.64869. The significance of the regression coefficients is also increased, as shown on Table 5.28A. This means that in the new model, the independent variables explain more of the variability in the dependent variable than in the original model. Table 5.28A shows the first step of the backward regression process, in which all the explanatory variables are entered into the model. The process starts with all the variables then eliminates the least significant variables, one at a time, until the variables that give the most precise equation are left in the equation. The final stage of the process is shown on Table 5.28B as one in which the minimum possible standard error can be achieved.

Table 5.28. Regression of {Logit (TR)/CE} on the Transformed Variables

(A) All the variables entered

Dependent Variable - {Logit (TR)/CE}

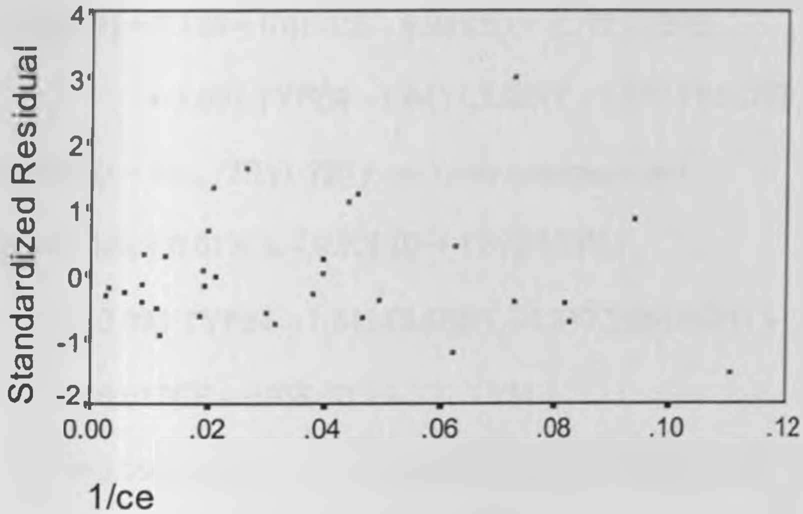
Independent variable	Regression coefficient	P - value (2-tail significance)
Constant	0.012243	0.4958
Adequacy of risk identification/Estimated contract sum	-9.004690	0.0015
Adequacy of risk measurement/Estimated contract sum	1.152883	0.5954
Reciprocal of Estimated contract sum	6.802721	0.0006
TYPE1/Estimated contract sum	0.945651	0.2155
TYPE2/Estimated contract sum	0.021200	0.9875
TYPE3/Estimated contract sum	-0.576028	0.3816
TYPE4/Estimated contract sum	2.473193	0.0911
CLIENT/Estimated contract sum	-1.692452	0.0008
TENDER1/Estimated contract sum	-1.302934	0.0868
TENDER2/Estimated contract sum	-0.405892	0.8341
$R^2 = 0.64869$		0.0029
Standard Error = 0.04167		

(B) Most Significant Variables

Dependent Variable - {Logit (TR)/CE}

Independent variable	Regression coefficient	P - value (2-tail significance)
Constant	0.016909	0.2042
Adequacy of risk identification/Estimated contract sum	-9.957982	0.0000
Reciprocal of Estimated contract sum	7.198738	0.0001
TYPE1/Estimated contract sum	1.372233	0.0021
TYPE4/Estimated contract sum	3.092540	0.0118
CLIENT/Estimated contract sum	-1.643169	0.0483
TENDER1/Estimated contract sum	-1.376883	0.2042
$R^2 = 0.61982$		0.0002
Standard Error = 0.03987		
$-1.5171 \leq Z$ residual ≥ 2.9965		

Figure 5.13 Residuals - {Logit (TR)/CE}-versus Reciprocal of Contract Sum



The standard error is the estimate of the standard deviation of the error term ($\in$) in the regression model, and the lower it is the more accurate is the prediction equation.

Four of the variables have been removed from the equation and the standard error reduced from 0.04167 to 0.03987. Though the final R^2 value is slightly lower (0.61982), the final equation is more precise than the first one. A scatter plot of the residuals against 1/CE on Figure 5.13 shows that the problem in the original model has been overcome by the transformation. The standardized residuals are randomly distributed around the zero axis, and do not exhibit any noticeable pattern. The regression equation can finally be written as follows: -

$$\{\text{Logit (TR)}\}/\text{CE} = 0.017 - 9.958\ (\text{ID/CE}) + 7.120\ (1/\text{CE}) + 1.372\ (\text{TYPE1/CE}) + 3.093\ (\text{TYPE4/CE}) - 1.643(\text{CLIENT/CE})$$

$$- 1.377\ (TENDER1/CE)$$

Multiplying out by CE,

$$\text{Logit}(TR) = 7.120 + 0.017CE - 9.958\ ID + 1.372\ TYPE1 + 3.093\ TYPE4 - 1.643\ CLIENT - 1.377\ TENDER1$$

Logit (TR) = $\log_e \{TR/(1-TR)\}$; on some rearrangement,

$$TR = (7.120 + 0.017CE - 9.958\ ID + 1.372\ TYPE1 + 3.093\ TYPE4 - 1.643\ CLIENT - 1.377\ TENDER1) \div \{1 + (7.120 + 0.017CE - 9.958\ ID + 1.372\ TYPE1 + 3.093\ TYPE4 - 1.643\ CLIENT - 1.377\ TENDER1)\}$$

Or, writing

$$\lambda = 7.120 + 0.017CE - 9.958\ ID + 1.372\ TYPE1 + 3.093\ TYPE4 - 1.643\ CLIENT - 1.377\ TENDER1$$

Then,

$$TR = e^{\lambda} / (1 + e^{\lambda})$$

Where: $e = 2.7183$

The prediction of cost risk using this equation is bound to be less precise than the prediction of cost risk using the equation developed in section 5.7.2 because the standard error in this equation is higher. Also this equation is less comprehensive than the cost risk equation because the R^2 value is lower. However, the influence of the independent variables is similar in both the equations.

The time risk equation can be interpreted as follows:-

1. The more adequate the risk identification (ID) the less the time risk (TR). A unit increase in the adequacy of risk identification results in decrease of logit (TR) by 9.958 units. Note that in the study, ID is measured as a ratio and ranges between 0 and 1.

2. The greater the Contract Sum (CE) the more the time risk. An increase in contract sum by Kshs 1 million increases logit (TR) by 0.017 units.
3. The constant 7.120 is the value of logit (TR) when values of all the other explanatory variables are zero. The constant does not have any particular meaning as a separate term in this equation because the scope of the equation does not include a case where all the independent variables are zero. The equation is formulated to apply to risks where the contract sum ranges from about Kshs 9 million to Kshs 400 million. The identification rating ranges from about 0.40 to about 0.90 units. These are the ranges of the data in the sample used to formulate the equation; prediction using the equation would be most accurate if it is done for measures lying within those ranges. The other independent variables can take values of zero because they are binary variables as described in section 5.7.2.

4. While the coefficients of the two continuous variables (ID & CE) indicate the slope of the predicted trendline, the coefficients of the dummy variables represent the amount by which the trendline will be shifted along the y-axis if the binary variable is 1, without changing the slope of the line. It is the addition to or subtraction from the constant term. If the project is TYPE1 (i.e.

residential), the cost risk is higher; logit (TR) is increased by 1.372. This means that for every level of (ID, CE), logit (TR) is higher by 1.372 if the project is residential (code 1) than if the project is not residential (code 0).

5. If the project is TYPE4 (i.e. industrial), the time risk is higher. For every level of (ID, CE), logit (TR) is higher by 3.093 if the project is industrial (code 1) than if the project is not industrial (code 0). It shows that a project involved in industrial building is exposed to more time risk than one involved in any other building type.

6. If the client is private (code1) logit (TR) is decreased by 1.643 units, meaning that there is less risk of time overrun in private projects than in public ones.

7. If the tendering method is TENDER1 (selective – coded 1), logit (TR) is decreased by 1.377 units, meaning that selective tendering method normally results in a lower time risk than either open tendering or negotiated tendering methods.

5.8 Test of Sub-hypothesis 4

5.8.1 Introduction

Sub-hypothesis 4 states that cost and time overruns are influenced by the risks thereof. This section presents the statistical relationship between the overruns and the risks. Cost overruns are measured in millions of Kshs while time overruns are measured in weeks. The risks (cost risk or time risk) are measured as probabilities (likelihood of the overrun).

The section presents only aspects of the regression procedures that are necessary for the testing of this hypothesis and the discussion of the results thereof. Full outputs of the regression procedures are shown in appendix E.

The regression of the overruns on the risks gives the results shown on Table 5.29. The regression coefficients of the risks and the R^2 values are statistically significant (p-values < 0.05). The research sub-hypothesis 4 is therefore *not rejected.*

Table 5.29 Regression of Overruns on Risks

B. Regression of Cost Overrun on Cost Risk

Dependent Variable -cost overrun (millions of Kshs)

Independent variable	Regression coefficient	P - value (2-tail significance)
Constant	-5.696	0.544
Cost risk	58.828	0.022
$R^2 = 0.154$		0.022
Standard Error = 27.1369		

B. Regression of Time Overrun on Time Risk

Dependent Variable -Time overrun (weeks)

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	-2.009	0.872
Cost risk	64.092	0.021
$R^2 = 0.156$		0.021
Standard Error = 28.7512		

It implies that in the population from which this data was obtained, cost and time overruns are influenced by the cost and time risks, respectively. However, the R^2 values are very small (0.154 and 0.156 for cost overruns and time overruns, respectively)). They imply that in these equations, the independent variable (risk) explains a very small percentage (about 15%) of the dependent variable (overrun).

The R^2 values are way below the minimum R^2 value (0.90), which Ferry and Brandon (1991; 267) recommend for a reliable prediction equation. The small value of R^2 suggests that either the relationship between the overruns and the risks is *not linear* or other explanatory variables that are likely to explain the variability of the overruns need to be added to the regression equation.

Using the method of scatter plots of the regression residuals (explained in Section 5.7), it was observed that the four additional variables (type of building in terms of the functional use, type of client and method of tendering), which had been observed to influence risks - besides the adequacy of risk identification, adequacy of risk measurement & the adequacy of risk response - also influenced the overruns. For this reason, the four additional variables have therefore been added to the regression model. The grouped variables have been converted to seven binary variables as explained in section 4.5, making the number of independent variables in the equation 9.

5.8.2 Cost Overrun Regressed on the 9 Variables

Regressing cost overrun on the nine explanatory variables gives an R^2 value of 0.5222 meaning the 9 variables together explain 52.22% of the variability in cost overrun, as shown on Table 5.30A. The standard error is 23.5524. Only three variables (cost risk, contract sum & type2) are left in the final stage of the regression process. The others are thrown out of the equation meaning that they are relatively insignificant in the regression model. Table 5.30B shows the final stage of the backward regression process. The R^2 value is slightly reduced to 0.4661 and the standard error reduced to 22.266. Plots of the regression residuals against the cost risk and the contract sum are shown on Figure 5.14. While the scatter diagram of the residuals against contract sum does not exhibit any noticeable pattern, the scatter diagram of the residuals against the cost risk is fan-shaped.

Table 5.30 Regression of Cost Overrun on 9 variables

(A) All the Variables

Dependent Variable - cost overrun - millions of Kshs

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	-8.607884	0.7642
Cost Risk (probability)	53.832175	0.0372
Estimated contract sum - in millions of Kshs, adjusted to 1999 cost index	0.134757	0.0345
TYPE1: 1 if residential building 0 if otherwise	-4.632570	0.8121
TYPE2: 1 if commercial building 0 if otherwise	21.584457	0.3100
TYPE3: 1 if institutional building 0 if otherwise	5.537597	0.7929
TYPE4: 1 if industrial building 0 if otherwise	14.677045	0.6379
CLIENT: 1 if private client 0 if public client	3.723765	0.7446
TENDER1:1 if selective tendering 0 if otherwise	-14.771243	0.2519
TENDER2:1 if open tendering 0 if otherwise	-22.542849	0.2520
$R^2 = 0.52215$		0.0175
Standard Error = 23.55243		

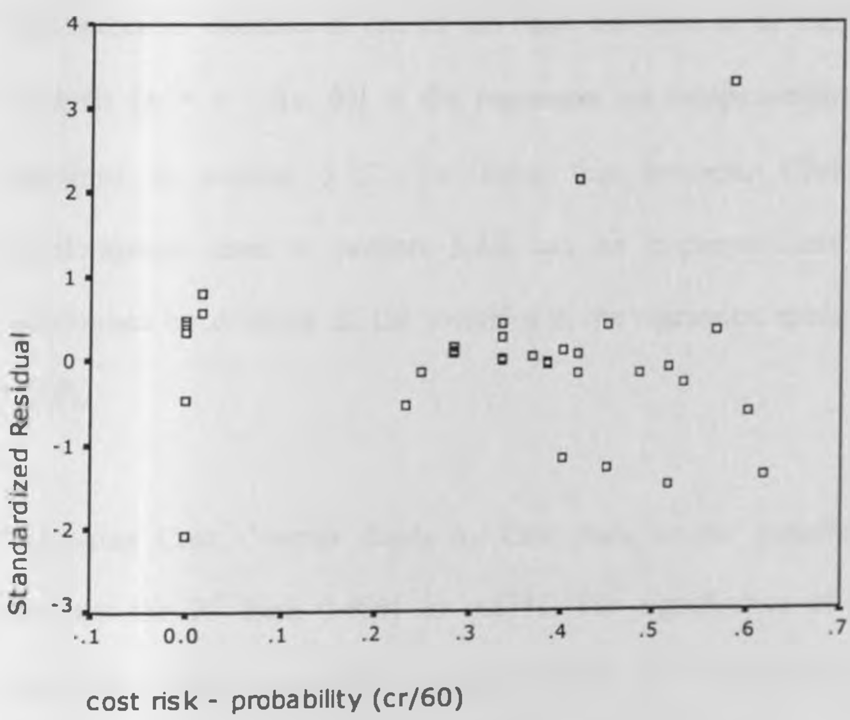
(B) Most Significant Variables

Dependent Variable - cost overrun - millions of Kshs

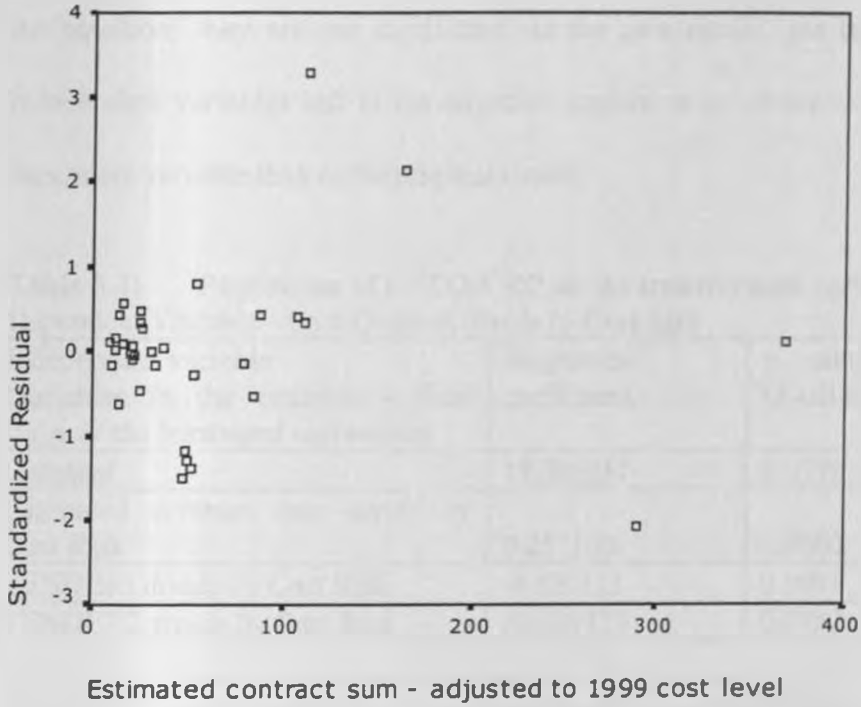
Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	-15.038837	0.0759
Cost Risk (probability)	43.310276	0.0456
Estimated contract sum - in millions of Kshs, adjusted to 1999 cost index	0.109822	0.0529
TYPE2: 1 if commercial building 0 if otherwise	23.718677	0.0149
$R^2 = 0.46614$		0.0003
Standard Error = 22.26637		
$-2.0746 \leq Z$ residual ≥ 3.2811		

Figure 5.14 Residuals of Cost Overrun versus Cost Risk & Contract Sum

(i) Cost Risk



(ii) Contract Sum



This indicates violation of one of the basic assumptions of regression: that the residuals [$\epsilon = y - f(x, \beta)$] in the regression are independently distributed, as explained in section 5.2.7. To solve this problem, Chatterjee's (1977) transformation used in section 5.7.2 can be employed here. The data is transformed by dividing all the variables in the regression model by Cost Risk (CRP).

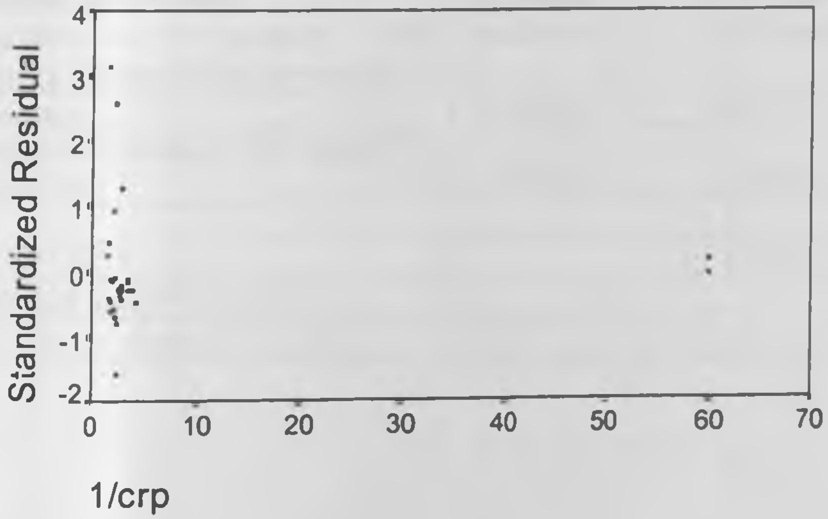
Regressing Cost Overrun *divide by* Cost Risk on the transformed variables increases the R^2 from 0.4661 to 0.8741. The significance of the regression coefficients is also increased, as shown on Table 5.31. The table shows only the final stage of the backward regression process in which only the most significant variables are left in the equation. Six of the explanatory variables are thrown out of the equation; they are not significant. In the new model, the three significant independent variables left in the equation explain more of the variability in the dependent variable than in the original model.

Table 5.31 Regression of CSTO/CRP on the transformed variables
Dependent Variable - Cost Overrun *divide by* Cost Risk

Independent variable (variables in the equation - *final stage of the backward regression)*	Regression coefficient	p - value (2-tail significance)
Constant	17.305251	0.0796
Estimated contract sum *divide by* Cost Risk	0.257100	0.0000
TENDERI *divide by* Cost Risk	-4.620123	0.0001
TENDER2 *divide by* Cost Risk	20.229324	0.0552
$R^2 = 0.87411$		0.0003
Standard Error = 44.09707		
$-1.5845 \leq Z$ residual ≥ 3.1270		

A scatter plot of the residuals against the *reciprocal of* Cost Risk on Figure 5.15 shows that the problem in the original model has been overcome by the transformation.

Figure 5.15 Residuals of CSTO/CRP versus the reciprocal of Cost Risk



The standardized residuals are randomly distributed around the zero axis, and do not exhibit any noticeable pattern. However, the regression coefficients are misleading. The sign of the coefficient of (TENDER2 *divide by* Cost Risk) suggests that cost risk is lower if the open tendering method is used than if other methods are used. This is contrary to the experience in the industry and the observations made in section 5.7.2 concerning cost risk. These results suggest that there is collinearity among the three significant independent variables (see section 4.5). A look at the correlations among the variables confirms this. The correlation between (Estimated contract sum *divide by* Cost Risk) and (TENDER1 *divide by* Cost Risk) is 0.8167. The other correlations are very small and insignificant.

To solve this problem, one of the two correlated variables - (TENDER1/CRP) – is omitted from the model. The regression process is then repeated, giving a more realistic equation as shown on Table 5.32.

Table 5.32 Regression of CSTO/CRP on the transformed variables after Removing Multicollinearity

Dependent Variable - Cost Overrun *divide by* Cost Risk

Independent variable (variables in the equation - *final stage of the backward regression)*	Regression coefficient	p - value (2-tail significance)
Constant	10.946467	0.3773
Estimated contract sum *divide by* Cost Risk	0.165749	0.0000
$R^2 = 0.75437$		0.0000
Standard Error = 59.27157		
$-2.9752 \leq$ Z residual ≥ 2.7292		

The resulting R^2 value is 0.7544. Also, the variable TENDER2/CRP removed from the equation leaving only one independent variable CE/CRP. There is no evidence of multicollinearity in the equation. The regression equation can therefore be written as follows: -

$$CSTO/CRP = 10.946 + 0.166(CE/CPR)$$

Multiplying out by CRP gives: -

$$CSTO = 10.946CRP + 0.166CE$$

5.8.3 Time Overrun Regressed on the 9 Variables

Regressing TMO on the nine explanatory variables gives an R^2 value of 0.2916 meaning that the nine variables together explain only 29.16% of the variability in time overrun in the linear model, as shown on Table 5.33. Plots of the regression residuals against the time risk and the contract sum are as shown on Figure 5.16.

While the scatter diagram of the residuals against contract sum does not exhibit any noticeable pattern, the scatter diagram of the residuals against the time risk is fan-shaped and indicates violation of a basic assumption of regression: that the residuals $[\in = y - f(x, \beta)]$ in the regression are independently distributed. This violation is similar to the one observed in section 5.8.2. To solve this problem, a transformation similar to the one employed in the relationship between cost overrun and cost risk can therefore be used, as described in section 5.7.3.

A scatter plot of the residuals against the reciprocal of Time risk (RECITRP) on Figure 5.17 shows that the problem in the original model has been overcome by the transformation. The standardized residuals are randomly distributed around the zero axis, and do not exhibit any noticeable pattern. However, the regression coefficients are distorted. The coefficient of the independent variable (CLIENT *divide by* Time Risk) in the final stage of the regression process suggests that a project commissioned by a private client (coded 1 – see section 5.7.2) experiences a higher time overrun (5.15 weeks on average) than a project commissioned by a public client (coded 0). This is contrary to the experience in the industry and the observations made in section 5.7.2 concerning time risk. These results suggest that there is collinearity among the independent variables.

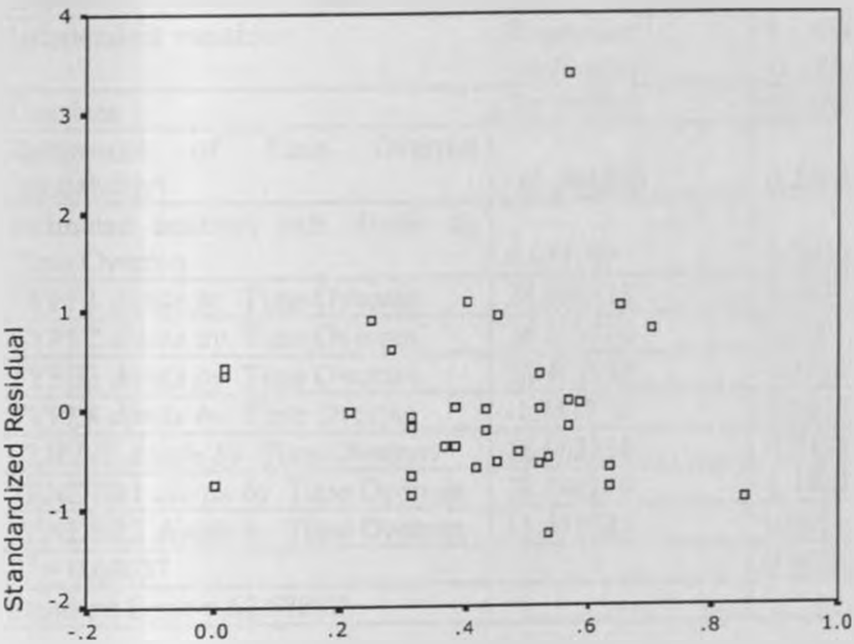
Table 5.33 Regression of Time Overruns on the 9 variables

Dependent Variable - time overrun (weeks)

Independent variable	Regression coefficient	P - value (2-tail significance)
Constant	-25.531654	0.5344
Time Risk (probability)	54.881209	0.1076
Estimated contract sum - in millions of Kshs, adjusted to 1999 cost index	0.001666	0.9828
TYPE1: 1 if residential building 0 if otherwise	18.067187	0.4728
TYPE2: 1 if commercial building 0 if otherwise	36.323717	0.1884
TYPE3: 1 if institutional building 0 if otherwise	10.432814	0.7038
TYPE4: 1 if industrial building 0 if otherwise	-2.561831	0.9477
CLIENT: 1 if private client 0 if public client	3.767165	0.8039
TENDER1:1 if selective tendering 0 if otherwise	4.502404	0.7938
TENDER2:1 if open tendering 0 if otherwise	4.484893	0.8565
$R^2 = 0.29163$		0.4006
Standard Error = 30.42293		
$-1.2627 \leq Z$ residual ≥ 3.3965		

Figure 5.16 Residuals of Time Overrun versus Time Risk & Contract Sum

(i) Time Risk



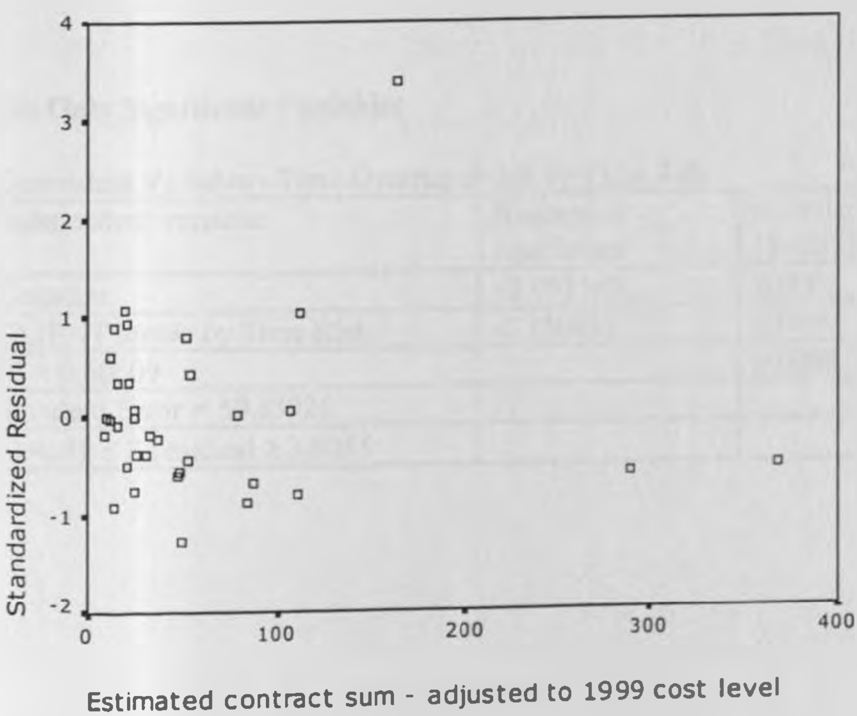


Table 5.34 Regression of TMO/TRP on the transformed variables

(A) All the Variables

Dependent Variable - Time Overrun divide by Time Risk

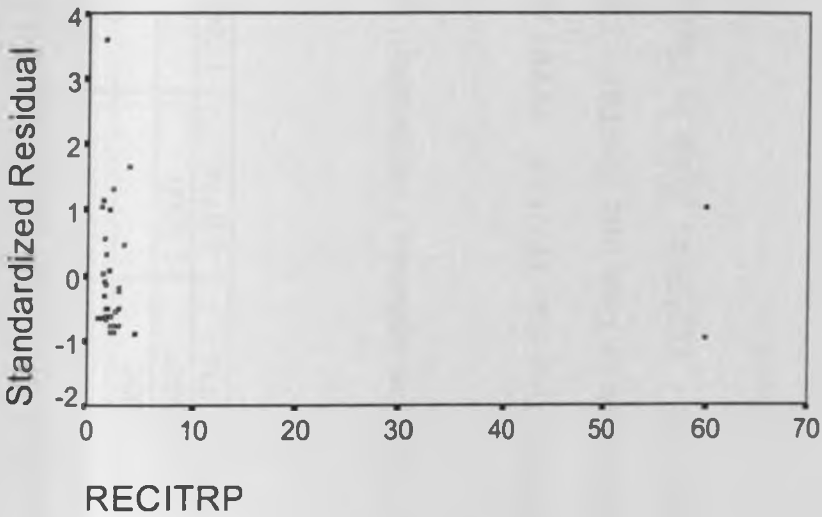
Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	39.707775	0.1482
Reciprocal of Time Overrun (probability)	-40.094590	0.2933
Estimated contract sum *divide by* Time Overrun	0.034108	0.3250
TYPE1 *divide by* Time Overrun	24.669313	0.3417
TYPE2 *divide by* Time Overrun	36.579710	0.2001
TYPE3 *divide by* Time Overrun	16.406558	0.5386
TYPE4 *divide by* Time Overrun	-1.781778	0.9618
CLIENT *divide by* Time Overrun	16.062256	0.2258
TENDER1 *divide by* Time Overrun	11.746280	0.4902
TENDER2 *divide by* Time Overrun	11.457023	0.6890
$R^2 = 0.68037$		0.0005
Standard Error = 62.57882		

(B) Only Significant Variables

Dependent Variable - Time Overrun *divide by* Time Risk

Independent variable	Regression coefficient	p - value (2-tail significance)
Constant	48.955150	0.0001
CLIENT *divide by* Time Risk	-5.150435	0.0000
$R^2 = 0.60609$		0.0000
Standard Error = 59.83926		
$-0.9689 \leq Z$ residual ≥ 3.6055		

Figure 5.17 Residuals of TMO/TRP versus 1/TRP



A look at the correlations among the variables confirms this. Table 5.35 shows that 11 of the 36 correlations among the variables are very strong ($r \geq 0.800$). To solve this problem, the following variables are omitted from the regression model: -

1. Estimated contract sum *divide by* Time Overrun
2. TYPEP3 *divide by* Time Overrun
3. CLIENT *divide by* Time Overrun
4. TENDER1 *divide by* Time Overrun

Table 5.35 Correlation Coefficients

	1/TRP	CE/TRP	TP1/TRP	TP2/TRP	TP3/TRP	TP4/TRP	CLNT/TRP	TEN1/TRP	TEN2/TRP
1/TRP	1.0000								
CE/TRP	0.8165*	1.0000							
TP1/TRP	-0.1826	-0.1920	1.0000						
TP2/TRP	-0.1635	-0.0064	-0.4341*	1.0000					
TP3/TRP	0.9977*	0.8104*	-0.2096	0.1783	1.0000				
TP4/TRP	-0.0453	-0.0623	-0.1202	-0.1024	-0.0491	1.0000			
CLNT/TRP	0.9970*	0.8081*	-0.1597	-0.2049	0.9951*	-0.0369	1.0000		
TEN1/TRP	0.9982*	0.8160*	-0.1831	-0.1590	0.9962*	-0.0389	0.9940*	1.0000	
TEN2/TRP	-0.0841	-0.0513	-0.0984	-0.0659	-0.0842	-0.0489	-0.0774	-0.0774	1.0000

Note: -

- * means that the correlation is statistically significant at 95% confidence level (See Appendix F for the actual levels of sinificance).
- 1/TRP - reciprocal of Time Risk; CE/TRP - Estimated contract sum *divide by* Time risk; TP1/TRP - TYPE1 *divide by* Time risk; TP2/TRP - TYPE2 *divide by* Time risk; TP3/TRP - TYPE3 *divide by* Time risk; TP4/TRP - TYPE4 *divide by* Time risk; CLNT/TRP - CLIENT *divide by* Time risk; TEN1/TRP - TENDER1 *divide by* Time risk; TEN2/TRP - TENDER2 *divide by* Time risk.

Table 5.36 Regression of CSTO/CRP on the transformed variables after Resolving Multicollinearity

Dependent Variable - Time Overrun *divide by* Time Risk

Independent variable *(final stage of the backward regression procedure)*	Regression coefficient	p - value (2-tail significance)
Constant	45.383795	0.0004
Reciprocal of Time Risk	5.217567	0.0000
$R^2 = 0.60519$		0.0000
Standard Error = 59.90745		
$-0.9799 \leq Z$ residual ≥ 3.5073		

The regression process is then repeated, giving a more realistic equation as shown on Table 5.36. The table shows the final stage of the backward regression process. Only one variable is left in the equation and the R^2 value is only slightly decreased to 0.6052. The regression equation can finally be written as follows: -

$$TMO/TRP = 5.2176/TRP + 45.3838$$

Multiplying out by TRP gives: -

$$TMO = 5.2176 + 45.3838TRP$$

5.9. Improving the Method of Risk Management in Kenya

An open - ended question was asked to both the consultants and the contractors, to give and explain their suggestions for improving risk management in building projects in Kenya. More than 50% of the respondents (consultants & contractors) were of the opinion that the method of risk management in the building projects could be improved by instituting a better method of risk identification in the industry. A large proportion (37.35%) did not give any suggestion for improving the method of risk management. This is perhaps because a significant number of key players in the industry are not aware of risk management.

Table 5.37 shows the suggestions given. The improvement of risk identification is suggested for both the contract between the client and consultant(s) and the contract between the client and the contractors.

Table 5.37 Suggested Ways of Improving Risk Management in Kenya

	Suggestion	Frequency (no. of respondents)	Per cent
1.	Better risk identification practice & procedure	44	53.01
2.	Better risk response	8	9.64
3.	No suggestion given	31	37.35
	Total	83	100.00

5.9.1. The Client's Brief

The respondents explained that better risk management should start with a clear and detailed client's brief (statement of the clients' requirements). The client in the building industry is seen to have been rather unclear in his original brief, resulting in variations in the contract. Sensitizing all the potential co-oporate and individual clients - through seminars, publishing in the local journals etc, was suggested as a possible way of improving the clients appreciation of the brief. While the consultants blame the client in respect of the brief, it can reasonably be argued that the adequacy of the brief is not solely the responsibility of the client.

It is likely that the problem of the inadequate brief arises from the lead consultant's failure to appreciate the nature of the client from the inception of the project. Training the consultants in developing and appreciating clients' briefs is likely to be a more practical way of improving this area, than sensitizing the clients themselves. This is because the consultants being building professionals are likely to receive a relatively better appreciation of the attributes (social, physiological, historical, financial etc.) of the client, that influence the brief, and that may hitherto have been lightly considered or totally ignored. Developing the client's brief is a field gaining ground as an area of specialization in countries such as the UK. This indicates that the client's brief should be given its seriousness in the building industry, since the client in Kenya requires as much attention and satisfaction as the client elsewhere in the world. This discipline could gain more ground if the subject of the client's brief is taught in the departments in the universities which deal with disciplines relating to the building industry in Kenya.

From these observations, it can be deduced that the method of developing the client's brief and the principles of risk management are very necessary subjects in the universities as well as the continuous professional development programs (CPD's) for the consultants in the Kenyan construction industry today. The subjects also need to be included in the curricula for the courses (especially degree programmes) taken by construction professionals, as stated earlier.

5.9.2. Engagement of Consultants

Engaging a lead consultant that is qualified and competent in managing the risks (of cost overruns, time overruns and poor quality workmanship) was also suggested. Such a consultant would involve all the participants in the risk management exercise and 'educate' the client on the implications of some of the risk factors that are likely to arise from him. All the necessary risk response measures would then be taken in time, based on adequate risk identification and evaluation.

Risk management is an element of the project planning and control, hence it should be explicitly stated as one of the services to be provided by the project manager, who is normally the lead consultant. This requires a professional such as a project manager, with education and training in project management. However, the existing method of engaging the consultant seems not to provide an environment that facilitates efficient provision of his service to the client. More often than not, the consultant's terms of reference are not well specified at his engagement. The contract between the client and the consultant has the risk of the consultant not being paid his professional fees, as described in section 5.2.1.

63.5% of the consultants agreed that the conditions of engagement (Cap 525 & MOW conditions) should be revised. Two main areas of revision suggested:

Professional idemnity cover and performance bond. Table 5.38 shows that more than 75% of the consultants consider these two areas to be very strong candidates for revision, implying that the areas are considered to be major sources of the inefficiency in risk management.

Table 5.38 Suggested changes in AAK & MOW conditions of engagement.

	Area of Change	Frequency (number of architects & quantity surveyors)	Per Cent
1.	Consultant to provide professional idemnity cover	41	78.8
2.	Client to provide bond committing him to pay professional fees.	40	76.9

If the consultant works under a risk of failing to receive his fees, he is likely not to work diligently. More than 50% of the consultants proposed the bank guarantee as the form of bond they wish the client would need to give. The following are other minor but seemingly important items suggested for addition to the conditions of engagement:-

- Client makes advance payments for professional fees;
- Client pays interest on delayed payments for fees;
- Schedule of fees to include services provided for arbortive works, special works etc, which are normally undertaken long after the contract is concluded;
- Scale fees to be revised or removed;
- The liability of the parties to the contract to be more adequately addressed.

The local professional bodies (AAK, IQSK etc) are challenged to institute this revision.

5.9.3. Feasibility Study

Most of the respondents pointed out that the risk identification process was rather inadequate and argued that this exercise would need to be handled at the feasibility study stage. A comprehensive feasibility study would reveal the risk factors likely to occur in the project at each of its various stages. It would consider interaction, technical, economic, social environmental and managerial factors that influence the project. The probabilistic factors are then noted with their associated probability and severity of occurrence in order to gauge the likely loss that could be occasioned by their occurrence. This would then be used to structure the most efficient method of response to the risks. It is, however, unfortunate that most clients do not pay fees for feasibility studies in Kenya. This issue should be addressed.

These risk management principles need to be enforced in Kenya. A change in the approach to contract procurement is offered as a way of providing an environment in which the risk management principles existing in the current theory and practice could effectively be enforced.

5.9.4. The Procurement System

The traditional contract (design then build) using the AAK or MOW conditions was considered less efficient than the non-traditional contracts by a majority of the respondents. 57.7% of the consultants and 74.10% of the contractors recommended use of the non-traditional conditions. While majority of the consultants proposed use of project management, majority of the contractors proposed use of Design and Build as shown on Tables 5.39 and 5.40.

Table 5.39. Other conditions Suggested by Consultants

	Conditions of Contract	Frequency	Percent
1.	Project management	20	38.50
2.	Turn Key	5	9.60
3.	Design & Build	3	5.80
4.	None of the above	18	34.60
5.	No response	6	11.50
	Total	52	100.00

Table 5.40 Other Conditions suggested by Contractors

	Conditions of Contract	Frequency	Percent
1.	Project Management	9	29.00
2.	Design & Build	13	41.90
3.	Management contracting	1	3.20
4.	None of the above	6	19.40
5.	No response	2	6.50
	Total	31	100.00

The reason given by the consultants for their preference of project management was that it is more efficient (in controlling cost, managing time and maintaining good quality workmanship) than the traditional contract. Contractors gave a similar reason for their proposing the design & build contract. They added that Design and Build normally encourages more serious consideration of the buildability of the project.

The overall average preference for project management (33.75) is higher than the overall preference for Design & Build (23.85%). Therefore, adopting project management in the mainstream construction is more likely to improve risk management than any other non-conventional contracts. The underlying factor that makes these two contracts more efficient than the traditional one is that they facilitate better communication, co-ordination and control in the project (Sidwel 1984). This in turn fosters the overall managerial efficiency of the project team. While a change to the non-traditional procurement systems was proposed, a significant average proportion (27% of the contractors & consultants) of the respondents argued that the traditional contract is still sufficient. Currently, the traditional contract mainly uses the AAK and MOW conditions whose efficiency in minimising risks were observed to be 71.30% and 44.83 respectively. This level of efficiency is definitely low and continued use of the conditions in their present form is unlikely to satisfy the building industry client.

Therefore, the conditions need to be revised to make them more efficient in facilitating communication, co-ordination and control of the project costs, time and quality of workmanship. The traditional stringent requirements for scheduling, specifying important things such as the method statement of the construction, level of detail required, the method of scheduling to be used and the frequency of schedule updates should be made part and parcel of the contract (Muli 1996). Inclusion of schedule based incentives (preferably bonus and bonus/penalty schemes) in the contract would also highly motivate contractors to complete the works on time (Abu-hijleh & Ibbs 1989, Stukhart 1984).

A requirement (in the contract between the client and the design consultant) that the design be complete before the drawings are used to make the bills of quantities could solve the problem of variations. This would facilitate realistic estimating of the contract sum, with minimum, if any, provisional sums and quantities. This is, however, possible if the client's brief is comprehensive and complete.

The 6 factors considered by consultants in awarding a contract to a tenderer (see Table 5.7) are evaluated intuitively in the mainstream building industry. A scientific approach to tender evaluation needs to be adopted in the industry. Such an approach would show the empirical relationship between these factors and the expected performance of the contractor.

5.9.5. Research and Development

About 10% of the respondents gave research and development as a possible solution to the problem of risks. This suggestion would include such things as:-

- establishing a suitable method for risk identification that adequately considers, *interalia*, the frequency of risks, their severity and types of building projects.

- establishing a data bank that would provide data on various aspects of risk management in building projects. One of the issues considered necessary was up to date data on the unit costs of various items of a building.
- disseminating the findings of current research in the field of risk management by publishing in journals, presenting the findings in seminars (CPD programs), etc.
- organising seminars to educate the players in the building industry on risk management. Training contractors on construction management skills was proposed as an area requiring urgent attention.

The local universities and the local professional bodies concerned with the built environment were said to be the most well suited to handle the issue of research and development.

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The seven objectives of this study have been achieved. The following conclusions can be made concerning the study findings: -

1. The management of risks in the Kenyan building industry is rather inefficient and exposes the client, consultants and contractors to various risks. The current Conditions of contract – main contract & contracts for engagement of consultants – are a major source of risk.

2. The adequacy of the criteria used for risk identification, measurement and response is estimated to be 67.1%, 27.6% and 63.5% (on average), respectively. Particularly, risk measurement is very inadequate and as a consequence of this, the adequacy of the response is lowered. The risk management approach in Kenya is mainly intuitive in nature. The 'risk manager'/project manager (who could be the client, lead consultant, or contractor) normally uses his personal intuition, which is based on past experience, to identify, measure and respond to risks.

3. The first four most important sources of cost and time risks in building projects during the construction period are:-

- extra work;
- changes in design;
- delays in the preparation of detailed drawings, and

- late instructions.

These factors normally occur in more than 50% of the building projects in this population. 'Defective materials' factor is the major cause of poor quality workmanship though it occurs in only 38.20% of the projects. The more frequent a risk factor is the greater is the severity of its impact on the project cost, time or quality.

4. Most of the factors that cause time risk also cause cost risk. The correlation between time overrun and cost overrun is 0.5429 and is statistically significant. The mean percentage time overrun (55%) is greater than the mean percentage cost overrun (16.7%). Also, time overrun is more likely to occur in a building project than cost overrun. The mean probabilities of time overrun and of cost overrun in a proposed building project are 0.430 and 0.329, respectively.

5. Sub-hypotheses No. 1 – 3 have been rejected. Test of the hypotheses shows that the adequacy of risk identification, measurement and response explain an insignificant proportion of the variability in the cost and time risks - 23.87% for cost risks and 9.66% for time risks. Consequently, the relationship between the risks and the adequacy of the risk management criteria has been *re-specified* by adding four other variables, which were not originally considered to be determinants of the risks in the research hypotheses. The additional variables are: the estimated contract sum, type of building, type of client and type of tendering. In the *re-specified* model the independent variables explain a very significant proportion (more than 60%) of the variability in the cost and time risks.

The *re-specification* produces two mathematical models for predicting the magnitude of risks in project cost and time, which can be expressed as follows:-

(i) Cost Risk (CR)

$$\mathbf{CR = e^{\eta} / (1 + e^{\eta})}$$

$$\eta = \mathbf{6.485 + 0.015CE - 10.092I + 1.285TP1 - 1.111CL - 1.020\ TD1}$$

$$R^2 = 0.7544$$

(ii) Time Risk (TR)

$$\mathbf{TR = e^{\lambda} / (1 + e^{\lambda})}$$

$$\lambda = \mathbf{7.120 + 0.017CE - 9.958\ I + 1.372\ TP1}$$

$$\mathbf{+ 3.093\ TP4 - 1.643\ CL - 1.377\ TD1}$$

$$R^2 = 0.6198$$

Where: CR – probability that cost overrun will occur

TR – probability that time overrun will occur

CE – contact sum in millions of Kshs

I – adequacy of risk identification [(measured as a proportion, in the interval (0 1)]

TP1 – type of building (residential =1, other =0)

TP4 – type of building (industrial=1, other =0)

CL – type of client (private = 1, public =0)

TD1 – method of tendering (selective = 1, other = 0)

e = 2.7183

R^2 - square of the multiple regression coefficient.

In these models, the independent variables explain 75.44% and 61.98% of the variability in cost and time risks respectively. The models can be used to predict the expected risks, which can be in turn used to predict the expected losses (overruns) as explained hereinafter. The predicted losses can then be used to as the basis on which the most effective risk response measures can be taken.

6. Sub-hypotheses No. 4 has not been rejected. Test of the hypothesis shows that risk has a significant influence on loss. The R^2 values for the model: loss = f (risk) have been observed to be statistically significant but rather low; they are 0.154 and 0.156 for cost overrun and time overrun respectively. This means that cost risk alone explains about 15% of the variability in the overrun. The small size of the two R^2 values means that predicting cost overrun using cost risk alone can not give a very reliable prediction. Consequently, the relationship between the losses and risks has also been *re-specified* by adding four other variables (the estimated contract sum, type of building, type of client and type of tendering), which were not considered to be determinants of the losses in the hypothesis, originally. This exercise increases the R^2 values giving better prediction models. The models can be expressed as follows:-

(i) Cost Overrun (CO)

$$\mathbf{CO = 10.946\ CR + 0.166\ CE}$$

$$R^2 = 0.7544$$

(ii) Time Overrun (TO)

$$\mathbf{TO = 5.2176 + 45.3838TR}$$

$R^2 = 0.6052$

Where: CO – cost overrun in millions of Kshs

TO – time overrun in weeks

CR – probability that cost overrun will occur

TR – probability that time overrun will occur

CE – contact sum in millions of Kshs

R^2 - square of the multiple regression coefficient.

In the above models, the independent variables explain 75.44% and 60.52% of the variability in cost and time risks respectively.

The R^2 values in the four prediction models are lower than the value (0.90) recommended by Ferry and Brandon (1991; 267) for a most reliable prediction model. This notwithstanding, the fact that the R^2 values are statistically significant gives *a realistic general view* of the relationships amongst the variables considered in the study.

6.2 Recommendations

1. The prediction models developed in the study should be *refined, tested and then used* in the mainstream building industry. They should be used to estimate the likely cost/time overrun and aid the members of the project team structure efficient measures to respond to the likely risks. The estimated time overrun should be used to structure a schedule-based incentive scheme which will motivate the contractor to work most diligently to complete the work on time.

For example, the contractor can be offered a bonus based on the number of weeks he completes the work before the target date. The predicted cost overrun should be used as the contingency sum that can be allowed for in the contract.

2. The AAK & MOW Conditions of the Contract should be revised in order to minimize the risks that arise from them. The contractor's method statement of how he intends to construct the project should be made one of the contract documents and be considered during the selection of the contractors.

3. The Conditions of Engagement of consultants (Cap 525) and MOW should also be revised to include:-
   - Interest on delayed payments of consultants' fees;
   - Client's bond committing him to pay the consultants' fees;
   - More adequate coverage of the duties and responsibilities of the parties to the contract;
   - Redress in case of non-performance.

4. The selective tendering method is the best approach to minimising the risks associated with the selection of a contractor. It should therefore be adopted in all the projects in the building industry in Kenya.

5. Fast track types of contract (project management, design & build etc - which have been observed to be more efficient than the traditional

contract) should be used in the mainstream building industry, especially in large projects. In the traditional type of contract, cost overrun is directly proportional to the contract sum, as shown in section 6.1. The mean size of the projects in this study is Kshs 75.63 million. Projects whose size is above this size should adopt the fast track methods.

6. Risk management should be made one of the key subjects in the university curricula in the construction professions – architecture, civil engineering, building economics etc. The subject should also be included in the programmes for the continuous professional development (CPD) in the building industry. This would enhance the discipline of project management.

7. A data base should be established by the local professional bodies (AAK, IQSK, ETC) and universities involved in the building industry, to provide adequate and reliable information that could be used in risk management.

8. Public clients should adopt a disciplinary system where project planning and prudent financial management are in place in order to improve their rating in risk management.

9. Open tendering has been found to produce higher degrees of risk than the other methods of tendering. It is advisable to use this method only when it is absolutely necessary.

However, the implementation of the study findings may encounter the following barriers: -

- *Resistance from professionals.* Some professionals such as architects, most of whom have hitherto been opposed to project management, are likely to pose a barrier in applying the findings of this study. Formal risk management is an integral part of project management.
- *The complexity of the prediction models.* This requires that the users of the models be well instructed in using them.
- *The accuracy of prediction.* The R^2 values of the prediction models are relatively low (the lowest is 0.6052 in predicting time overruns & the highest is 0.7544 in predicting cost overruns) compared to the value (minimum 0.9000) past researchers in prediction models recommend for a good model. This is perhaps because the sample size in the study was relatively small.

6.3 Areas for further Research

In the course of this study, it was observed that the following areas, which are related to the study, need further research: -

1. Testing the model developed in this study using real life projects, and undertaking a similar study using a larger sample size, more independent variables, better scales of measuring the variables and non-linear regression procedures, in order to improve the R^2 values in the prediction models to over 0.90. The model

2. Developing prediction models similar to the ones developed in this study, for predicting the quality risk and loss. The criteria used in the study for measuring quality risk and loss were limited to aspects of building quality that can be observed during the contract period. These criteria could not sufficiently harness the concept of quality because quality needs to be evaluated over a longer period of the life of the building. Also, the concept is likely to touch on many other fields - structural engineering, environmental economics, psychology etc – which could not adequately be covered in one study.

3. Developing a mathematical model for predicting the construction period. A basic assumption made in the measurement of time overrun in this study is that the targeted contract period was realistic and achievable. The overrun is therefore simply the difference between the actual contract period (at the end of the project) and the contract estimated at the start of the project. However, estimating the contract period in Kenya is mainly based on the estimator's intuition and past experience and the estimate thereof is very likely to be unrealistic (Mbatha, 1986). Using a more objective method of estimating the contract period is likely to decrease the magnitude of time overrun per unit of time risk.

4. Investigating the feasibility of fast track contracts such as design & build and management contracting in Kenya.

5. Developing a mathematical model for selecting the best tenderer (since this was not part of the study), empirically considering all the factors that are likely to influence his performance on the proposed project.

6. Investigating cost overruns covering the Fluctuations Clause in the Conditions of Contract, in order to establish the magnitude of contracts which should fall under this clause.

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APPENDIX A

Date: 7/4/99

TO WHOM IT MAY CONCERN

The holder of this letter is conducting a research on risk management of building projects in Kenya, for the purpose of part fulfillment for the award of the degree of Doctor of Philosophy of the university of Nairobi.

Your firm has been selected out of the firms involved in the building industry to provide the information needed in this study. You experience represents the experiences of many others participating in the building industry in Kenya.

Kindly provide the information required by completing the accompanying questionnaire. The information will be used for research purposes only and your identity will remain confidential.

We will highly appreciate your assistance in facilitating this research.

Yours faithfully,

HEZEKIAH GICHUNGE

APPENDIX B1

QUESTIONNAIRE FOR ARCHITECTS

By

Hezekiah Gichunge
B.A. (Bldg. Econ) Hons. Msc (Const. Mangt.) MAAK (Q.S)
Dept. of Building Economics and Management
UNIVERSITY OF NAIROBI.

DECLARATION
ANSWERS TO QUESTIONS CONTAINED IN THIS QUESTIONNAIRE SHALL BE KEPT CONFIDENTIAL.

Your assistance in the completion of this questionnaire will be highly appreciated.

Questionnaire Number: ....
Enumerator No:...
Date: D/M/Y ..../......................./....................................

INSTRUCTION

Please tick (√) the appropriate answer and give reasons or explanations where necessary.

Type of Project

(i)	Residential	-	Bungalow, maisonnetes, flats
(ii)	Commercial	-	Shops, offices, warehouses
(iii)	Institutional	-	School, college, hostels
(iv)	Industrial	-	Factory
(v)	Other (specify)	-	

Type of Client:

(i) Public
(ii) Private

Date of Tender Opening ....

Contract Period (fixed at the time of tender award) ....

Final Contract Period ....

Contract Sum Kshs. ....

Final Account Kshs. ....

Q1. a) Did you get an appointment letter from the Client when you got engaged in this project? Yes / No

b) If yes in 1 (a) above, did the letter specify any of the following?

i)	Type of services to be rendered	Yes / No
ii)	Type of Project	Yes / No
iii)	Type of Conditions of Engagement	Yes / No
iv)	Your obligations	Yes / No
v)	The Client's Obligations	Yes / No
vi)	Redress for failure to fulfill the obligations	Yes / No
vii)	Type of redress required in (vi) above	Yes / No

Q2. a) Under which of the following Conditions of engagement were you appointed?

i) Architects and Quantity Surveyor's Act Cap 525
ii) Ministry of Works Conditions of Engagement
iii) Any other, please specify;
....

b) In your opinion, do the conditions of engagement adopted in this project sufficiently address the issue of the liability between the parties to the Contract?
Yes / No.

c) Should professional indemnity and its magnitude be included in the conditions?
Yes / No.

d) Should the Employer provide a Bond to commit himself to the payment of professional fees?

Yes / No.

e) If your answer to question (d) above is 'yes', please specify what form the bond should take.

....

f) Do you think the conditions of engagement used in this contract should be revised?

Yes / No.

g) If your answer to question (f) above is yes, please indicate which areas require revision

1. ....
2. ....
3. ....
4. ....

h) Why do you think the above areas in 1(g) need revision?

1. ....
2. ....
3. ....
4. ....

Q3. a) At what stage of the project were you involved in the project?

1. Inception
2. Pre-Contract
3. Tender Stage
4. Post-contract
5. Final Account

b) State the professional services that you rendered in this project at all the stages in which you were involved in it?

1. ....
2. ....
3. ....
4. ....
5. ....

Q4. a) Which of the following information did you find necessary to consider in preparing a scheme design of this project?

1. Objectives of the project
2. Source of the project financing
3. Clients priority – profit margin
4. Future ownership of the building
5. Availability of the land
6. Services e.g. access to the site, water and electricity, sewers etc
7. Any other (please specify)

   ....

b) At the detail design stage, which of the following information did you have to produce detailed drawings?

1. Site investigation report
2. Final sizes of spaces
3. Quality of construction
4. Final cost estimate
5. Any other (please specify)

   ....

c) Was the information you had as stated in (a) and (b) above adequate to minimise time overruns, cost overruns and poor quality workmanship in the project?

Yes / No

Q5. a) Which of the following tendering methods did you use in the selection of the main contractor for this project?

1. Open
2. Selective
3. Negotiated.

b) Which of the methods of tendering do you consider most efficient in avoiding (or minimizing) delays, cost overruns and poor workmanship?

Tick in the table below:

Best tendering method in avoiding (or minimizing)	**Open**	**Selective**	**Negotiated**
a) Delays			
b) Cost overruns			
c) Poor workmanship			

Q6. Please pick a number from the scale below to indicate how important you consider the following factors to be, in awarding a contract to a tenderer.

Scale

Extremely unimportant	1	2	3	4	5	Extremely important

a) Size (cost value) of previous projects done ....
b) Report of past performance ....
c) Financial ability ....
d) Technical ability ....
e) Clients Recommendation ....
f) Any other, please specify
....

Q7. a) How was the construction period fixed in this project?

i) Fixed by the Architect
ii) Fixed by the Quantity Surveyor
iii) Tendered for competitively
iv) Any other, please specify:
----

b) Is there any standard system or method used in fixing construction period in the building industry currently? Yes / No.

c) If yes, please briefly describe the method
....
....
....

d) Do you consider the method you have described in 7(c) above effective?
Yes / No.

e) Which of the following factors do you yourself consider normally when fixing construction period?

i) Client's project objectives
ii) Completeness of Client's brief
iii) Size/cost of the project
iv) Complexity of the project (constructibility, shapes, storey heights etc).
v) Type of contract between the Contractor and Client.
vi) Specification
vii) Any other, please specify ...
....

Q8. a) Which of the following documents did you use in the contract?

i) Bills of Quantities
ii) Specifications & drawings
iii) AAK Conditions of Contract

iv) MOW Conditions of Contract.
v) Any other, please specify
----

b) What other information do you think would have been necessary to minimize the following occurrences in the project?

i) Time overruns...

....
....

ii) Cost overruns
....
....

iii) Poor Workmanship
....
....

At what stages during construction are the occurrences most prevalent in the projects you have been involved in:

i) Time Overruns
....
....

ii) Cost Overruns...
....
....

iii) Poor Workmanship
....
....
....
....

Q9. a) How efficient are each of the following conditions of contract in avoiding or minimizing delays, cost overruns and poor workmanship?

Pick a number from the Scale to show your opinion and indicate it in the table beside each condition of contract

Scale

Very inefficient 1 2 3 4 5 Very Efficient

	Time overruns	Cost overruns	Poor workmanship
1. M.O.W Conditions			
2. A.A.K Conditions			
3. Design & Build			
4. Turn Key			

b) The MOW contract and the AAK Contract (traditional) are the most commonly used conditions in Kenya. Would you recommend any of the other conditions in (a) above for use in the Kenyan building industry?

Yes / No.

If 'yes' please rank the three conditions in their order of preference. Put the number 1 next to the one you prefer most, number 2 by your second choice and so forth.

-Project Management ....
-Design Build ....
-Turn Key ....

d) Please give reasons for your ranking in (c) above
....
....
....

Q10. a) Please pick a number from the Scale to show how important each of the factors listed below is in causing delays and cost overruns in the project you have been involved in, in Kenya.

Scale

Extremely Unimportant 1 2 3 4 5 Extremely important.

i) Unexpected underground conditions
ii) Rain
iii) Shortage of materials
iv) Variations in design (omissions & additions)
v) Financing and payment of completed work
vi) Price fluctuations (materials & labour)
vii) Failure to stick to the conditions of contract
viii) Damages caused by fire, earthquake etc.,
ix) Delays in issue of site instructions
x) Delays by nominated subcontractors
xi) Delays by nominated suppliers
xii) Statutory obligations
xiii) Errors during construction.

b) Using the scale in (a) above please rate the importance of each of the following factors in causing poor workmanship/quality in the projects you have been involved in, in Kenya;

i) Defective materials
ii) Contractor's negligence
iii) Change of specifications
iv) Structural defects
v) Rain
vi) Nominated sub-contractors
vii) Others (specify)

Q11. a) What measures do you normally take in order to minimize the following occurrences in the projects you have handled?

i) Time overruns.

....

....

ii) Cost overruns

....

....

iii) Poor Quality/Workmanship.

....

....

b) Please give suggestions of other things that in your opinion should be done to minimize the occurrences.

i) Time overruns.

....

....

ii) Cost overruns

....

....

iii) Poor Quality/Workmanship.

....

....

Q12. The following are the existing methods of risk management in building projects:

1. Risk identification and evaluation at the feasibility study stage
2. Adequate preliminaries and preambles
3. Adequate contingency sum
4. Insurance cover
5. Financial appraisals during the construction period
6. Communication of the risks to all the members of the project team

a) Which of the above methods were employed in this project?

b) In spite of the methods of risk management, time and cost overruns are very persistent problems in the building industry today. Which of the following do you think are the reasons for this situation?
1. The methods do not adequately address the magnitude of the risks in building projects
2. The methods do not adequately address the frequency of the risks in building projects
3. The methods do not adequately address the type of the building projects
4. Any other (please specify) ....
....

c) Briefly describe how you normally identify sources of risks in building projects

....
....
....
....

d) Do you find the method of risk identification you have described in (c) above adequate for the management of the risks? Yes / No
Please explain your answer ....
....

e) Make suggestions on how the existing methods of risk management can be improved in order to make them more effective in the management of risks.

....
....
....
....
....
....

APPENDIX B2

QUESTIONNAIRE FOR QUANTITY SURVEYORS

By

Hezekiah Gichunge
B.A. (Bldg. Econ) Hons, Msc (Const. Mangt.) MAAK (Q.S)
Dept. of Building Economics and Management
UNIVERSITY OF NAIROBI.

DECLARATION
ANSWERS TO QUESTIONS CONTAINED IN THIS QUESTIONNAIRE SHALL BE KEPT CONFIDENTIAL.

Your assistance in the completion of this questionnaire will be highly appreciated.

Questionnaire Number: ....
Enumerator No:..
Date: D/M/Y .......................I.......................I....................................

INSTRUCTION

Please tick (√) the appropriate answer and give reasons or explanations where necessary.

Type of Project

(i) Residential - Bungalow, maisonnetes, flats
(ii) Commercial - Shops, offices, warehouses
(iii) Institutional - School, college, hostels
(iv) Industrial - Factory
(v) Other (specify) -

Type of Client:

(i) Public
(ii) Private

Date of Tender Opening ....

Contract Period (fixed at the time of tender award) ....

Final Contract Period ....

Contract Sum Kshs. ....

Final Account Kshs. ....

Q1. a) Did you get an appointment letter from the Client when you got engaged in this project? Yes / No

b) If yes in 1 (a) above, did the letter specify any of the following?

i)	Type of services to be rendered	Yes / No
ii)	Type of Project	Yes / No
iii)	Type of Conditions of Engagement	Yes / No
iv)	Your obligations	Yes / No
v)	The Client's Obligations	Yes / No
vi)	Redress for failure to fulfill the obligations	Yes / No
vii)	Type of redress required in (vi) above	Yes / No

Q2. a) Under which of the following Conditions of engagement were you appointed?

i) Architects and Quantity Surveyor's Act Cap 525
ii) Ministry of Works Conditions of Engagement
iii) Any other, please specify;
....

b) In your opinion, do the conditions of engagement adopted in this project sufficiently address the issue of the liability between the parties to the Contract?

Yes / No.

c) Should professional indemnity and its magnitude be included in the conditions?

Yes / No.

d) Should the Employer provide a Bond to commit himself to the payment of professional fees?

Yes / No.

e) If your answer to question (d) above is 'yes', please specify what form the bond should take.

....

f) Do you think the conditions of engagement used in this contract should be revised?

Yes / No.

g) If your answer to question (f) above is yes, please indicate which areas require revision

....
....
....
....

h) Why do you think the above areas in 1(g) need revision?

....
....
....
....

Q3. a) At what stage of the project were you involved in the project?

1. Inception
2. Pre-Contract
3. Tender Stage
4. Post-contract
5. Final Account

b) State the professional services that you rendered in this project at all the stages in which you were involved in it?

1. ....
2. ....
3. ....
4. ....
6. ....

Q4. a) Which of the following information did you have at the feasibility stage to prepare a cost estimate for the project?

1. Site investigation report
2. Type of the proposed building project
3. Size of the building project
4. Specification of the materials and workmanship required
5. Regional location of the site

6. Description of the access to the site
7. Services to the site e.g. water supply, electricity supply and sewers
8. Any other (please specify)..
....
....

b) Did you find the information provided in 4(a) above sufficient enough for you to prepare a realistic cost estimate?

c) Which of the following information did you have at the time of preparing the bills of quantities?
1. Type of contract to be used
2. Detailed Architectural drawings
3. Detailed structural drawings
4. Steel bar bending schedules
5. Prime costs of services installations from the services engineers
6. Estimate of the contingency sum

d) What was the amount of the contingency sum? Kshs ....

e) Which of the following factors did you take into account in arriving at the contingency sum?

1. Amount of details/information available
2. Type of the building project
3. Complexity of the building project
4. Ground conditions e.g. type of soil, slope of the site etc
5. Any other (please specify)

....
....
....

f) Please describe briefly how you accounted for the factors in 4(e) above
....
....
....

g) Was the contingency sum adequate to cover all the extra costs arising from the variations in the project? Yes / No

h) If 'No' in 4(g) above please explain the difference
....
....

....
....

Q5. a) Which of the following tendering methods did you use in the selection of the main contractor for this project?

1. Open
2. Selective
3. Negotiated.

b) Which of the methods of tendering do you consider most efficient in avoiding (or minimizing) delays, cost overruns and poor workmanship?

Tick in the table below:

Best tendering method in avoiding (or minimizing)	**Open**	**Selective**	**Negotiated**
a) Delays			
b) Cost overruns			
c) Poor workmanship			

Q6. Please pick a number from the scale below to indicate how important you consider the following factors to be. in awarding a contract to a tenderer.

Scale

Extremely unimportant 1 2 3 4 5 Extremely important

a) Size (cost value) of previous projects done ....
b) Report of past performance ....
c) Financial ability ....
d) Technical ability ....
e) Clients Recommendation ....
f) Any other, please specify
:..
....

Q7. a) How was the construction period fixed in this project?

i) Fixed by the Architect
ii) Fixed by the Quantity Surveyor

iii) Tendered for competitively
iv) Any other, please specify: ....

b) Is there any standard system or method used in fixing construction period in the building industry currently? Yes / No.

c) If yes, please briefly describe the method
....
....

d) Do you consider the method you have described in 7(c) above effective? Yes / No.

e) Which of the following factors do you yourself consider normally when fixing construction period?

i) Client's project objectives
ii) Completeness of Client's brief
iii) Size/cost of the project
iv) Complexity of the project (constructibility, shapes, storey heights etc).
v) Type of contract between the Contractor and Client.
vi) Specification
vii) Any other, please specify ...
....

Q8. a) Which of the following documents did you use in the contract?

i) Bills of Quantities
ii) Specifications & drawings
iii) AAK Conditions of Contract
iv) MOW Conditions of Contract.
v) Any other, please specify
....

b) What other information do you think would have been necessary to minimize the following occurrences in the project?

i) Time overruns...
....
....

iii) Cost overruns
....
....
....

iii) Poor Workmanship

....

....

....

c) At what stages during construction are the occurrences most prevalent in the projects
you have been involved in:

iv) Time Overruns

....

....

....

v) Cost Overruns

....

....

....

Poor Workmanship

....

....

....

Q9. a) How efficient are each of the following conditions of contract in avoiding or minimizing delays, cost overruns and poor workmanship?

Pick a number from the Scale to show your opinion and indicate it in the table beside each condition of contract.

Scale

Very inefficient 1 2 3 4 5 Very Efficient

	Time overruns	Cost overruns	Poor workmanship
1. M.O.W Conditions			
2. A.A.K Conditions			
3. Design & Build			
4. Turn Key			

b) The MOW contract and the AAK Contract (traditional) are the most commonly used conditions in Kenya. Would you recommend any of the other conditions in (a) above for use in the Kenyan building industry?

Yes / No.

If 'yes' please rank the three conditions in their order of preference. Put the number 1 next to the one you prefer most, number 2 by your second choice and so forth.

-Project Management ....
-Design Build ....

-Turn Key ....

d) Please give reasons for your ranking in (c) above

....
....
....
....

Q10. a) Please pick a number from the Scale to show how important each of the factors listed below is in causing delays and cost overruns in the project you have been involved in, in Kenya.

Scale

Extremely Unimportant 1 2 3 4 5 Extremely important.

i) Unexpected underground conditions
ii) Rain
iii) Shortage of materials
iv) Variations in design (omissions & additions)
v) Financing and payment of completed work
vi) Price fluctuations (materials & labour)
vii) Failure to stick to the conditions of contract
viii) Damages caused by fire, earthquake etc.,
ix) Delays in issue of site instructions
x) Delays by nominated subcontractors
xi) Delays by nominated suppliers
xii) Statutory obligations
xiii) Errors during construction.

b) Using the scale in (a) above please rate the importance of each of the following factors in causing poor workmanship/quality in the projects you have been involved in, in Kenya;

i) Defective materials
ii) Contractor's negligence
iii) Change of specifications
iv) Structural defects
v) Rain
vi) Nominated sub-contractors
viii) Others (specify)

Q11. a) What measures do you normally take in order to minimize the following occurrences in the projects you have handled?

i) Time overruns.

....

....

ii) Cost overruns

....

....

iii) Poor Quality/Workmanship.

....

....

b) Please give suggestions of other things that in your opinion should be done to minimize the occurrences.

i) Time overruns.

....

....

ii) Cost overruns

....

....

iii) Poor Quality/Workmanship.

....

....

Q12. (a) At which one of the following stages was the first estimate of this project prepared?

(i) Inception Stage ----------------

(ii) Feasibility Study Stage ----------------

(iii) Tendering Stage ----------------

(b) An important cost planning principle is to ensure that the first estimate is maintained without reducing the quality of the building design during the pre-contract period. Was this principle applied in this project?

Yes —————— **No** ——————

(c) If yes to (b) above please briefly explain what was done.

Q13. (a) What information do you think was necessary at the pre-contract stage in order to control cost in this project?

Q12 (b) What information/tools did you use during the construction period to control costs?

(c) Did you find the information/tools in (b) above effective?

Yes ------------------ No ----------------

(d) Please explain your answer in (c) above

Q14. (a) Do you consider the contract period for this project, fixed at the time of tendering to have been sufficient?

Yes ----------------------- No ----------------

(b) Please briefly explain your answer in 13 (a) above.

Q15. Please show the programmed time for each element and/or the extension of time awarded by the Architect in relation to each element of this project.

Element	Programmed construction time in weeks	Extension of time in weeks	Reason for the extension of time
Preliminaries			
Substructures			
Concrete superstructure			
Walling			
Roof			
Doors			
Windows			
Finishes			
Joinery fixtures			
External works			
P C & Provisional sums			
Contingency sum			
TOTALS			

Q16. Show elemental Contract costs and Final account sums for this project.

Element	Elemental contract cost in Kshs.	Elemental final account sum in Kshs.	Reason for the difference
Preliminaries			
Substructures			

Concrete superstructure			
Walling			
Roof			
Doors			
Windows			
Finishes			
Joinery fixtures			
External works			
P C & Sums Provisional			
Contingency Sum			
TOTALS			

Q17. Indicate whether there were any defects reported in regard to any of the elements in this project.

Element	Cracks/or other defects.	Condemnations.	Value in cost if any
Preliminaries			
Substructures			
Concrete superstructure			
Walling			
Roof			
Doors			
Windows			
Finishes			
Joinery fixtures			
External works			
P C & Sums Provisional			
TOTALS			

Q18. Please suggest what an Architect should do in order to minimise the following occurrences in a building project.

(i) Time overruns

(ii) Cost overruns

(iii) Incidences of poor quality/workmanship.

Q19. Please suggest what a Contractor should do in order to minimise the following occurrences in a building project.

(i) Time overruns

(ii) Cost overruns

(iii) Incidences of poor quality/workmanship.

Q20. Please suggest what a Quantity Surveyor should do in order to minimise the following occurrences in a building project.

(i) Time overruns

(ii) Cost overruns

(iii) Incidences of poor quality/workmanship.

Q21. The following are the existing methods of risk management in building projects:

7. Risk identification and evaluation at the feasibility study stage

8. Adequate preliminaries and preambles
9. Adequate contigency sum
10. Insurance cover
11. Financial appraisals during the construction period
12. Communication of the risks to all the members of the project team

c) Which of the above methods were employed in this project?

d) In spite of the methods of risk management, time and cost overruns are very persistent problems in the building industry today. Which of the following do you think are the reasons for this situation?

4. The methods do not adequately address the magnitude of the risks in building projects
5. The methods do not adequately address the frequency of the risks in building projects
6. The methods do not adequately address the type of the building projects

4. Any other (please specify) ....
....

e) Please make suggestions on how the existing methods of risk management can be improved in order to make them more effective in the management of risks.

....
....
....
....

APPENDIX B3

QUESTIONNAIRE FOR BUILDING CONTRACTORS

By

Hezekiah Gichunge
B.A. (Bldg. Econ) Hons, Msc (Const. Mangt.) MAAK (Q.S)
Dept. of Building Economics and Management
UNIVERSITY OF NAIROBI.

DECLARATION
ANSWERS TO QUESTIONS CONTAINED IN THIS QUESTIONNAIRE SHALL BE KEPT CONFIDENTIAL.

Your assistance in the completion of this questionnaire will be highly appreciated.

Questionnaire Number: ....
Enumerator No:..
Date: D/M/Y ..../......................./..................................

INSTRUCTIONS:
Please tick (√) the appropriate answer and give reasons or explanations where necessary.

TYPE OF PROJECT
i) Residential – bungalows, maissonnets flats
ii) Commercial - shops, offices, warehouses
iii) Institutions – school, college, hostels
iv) Industrial - factory
v) Others - specify

TYPE OF CLIENT
i) Public
ii) Private

CLASS OF CONTRACTOR (Please tick)
A B C D E F G H

Experience in construction: .... YEARS

Date of Tender opening

Contract period (fixed at time of tender award)......................(weeks)
Final Contract Period ....(weeks)

Contract Sum Kshs. ....

Final Account Sum Kshs. ....

Q1(a) Which of the following methods of tendering was used to select you as a contractor for this project?
1. Open
2. Selective
3. Negotiated

(b) Which of the methods in 1(a) above do you find most preferable to you when tendering for a job? ....

(c) Please give reasons for your answer in 1(b) above.
....
....
....

Q2 (a) Which of the following factors did you find important to consider in deciding whether or not to tender for this project?
Pick a number from the scale to show your ranking of the importance and indicate it beside each factor.

Scale

Extremely unimportant 1 2 3 4 5 Extremely Important

1. The consultants ....
2. Nature/type of project ....
3. Complexity (size/cost/shape) of the building ....
4. Capital outlay ....
5. Equipment ....
6. Type of client ....
7. Contract period ....
8. Location/place of the project ....
9. Type of contract ....
10. Any other
(specify)..
....
....
....

(b) Please give the reasons for your ranking in 2(a) above.
....
....

....

(c) Were you keenly interested in winning the tender
Yes………. No…….

(d) If your answer is yes to 2(c) above, what action did you take to realise your interest?

i) ....
ii) ....
iii) ....
iv) ....
v) ....

Q3(a) At which of the following stages were you involved in this project?
i) Inception
ii) Pre-contract
iii) Tendering
iv) Post-contract

(b) Would you have performed any better than you actually did in this project if you had been involved in it from the inception?
Yes………... No………..

(c) Please give reasons for your answer in 3(b) above
....
....
....
....
....

Q4(a) Which of the following documents were used for the contract?
i) Bills of quantities
ii) Specification and drawings
iii) A.A.K. conditions of contract
iv) M.O.W. conditions of contract
v) Any other (please specify)

(b) Consider the A.A.K. and the M.O.W. conditions of contract: which of the two would you prefer?
i) A.A.K. conditions of contract
ii) M.O.W. conditions of contract

(c) Please give reasons for your preference in question 4(b) above.
....
....
....
....

Q5.(a) Which of the following factors did you find important to consider in pricing your tender?
Pick a number from the scale to show your ranking of importance and indicate it beside each factor.

Scale

Extremely unimportant 1 2 3 4 5 Extremely important

i) Site conditions ....

ii) Performance bond ....
iii) Fluctuations in price of materials ....
iv) Fluctuations in price of labour ....
v) Equipment required ....
vi) Type of the project (housing offices, commercial) ....
vii) Project (size, cost and shape) ....
viii) Construction period ....
ix) Construction work already in hand ....
x) Head office overheads ....
xi) Construction site overheads ....
xii) (Regional) location ....
xiii) Type of client ....
xiv) Consultants ....
xv) Level of profit ....
xvi) Any other (please specify) ....
....
....
....

(b) State briefly what measures you took to prevent each of the factors in 5(a) above from increasing the cost of the project beyond what you had envisaged in your tender?

i) ....
ii) ....
iii) ....
iv) ....
v) ....
vi) ....
vii) ....
viii) ....
ix) ....
x) ....
xi) ....
xii) ....
xiii) ....
xiv) ....
xv) ....

xvi) ....

Q6(a) Was the project delayed beyond the contract period fixed at the tendering time?

Yes.................. No.....................

(b) If the answer to 6(a) above is 'Yes' how many weeks were you given for the extension of time .... weeks.

(c) Which of the following factors contributed to the delay.

Pick a number from the scale to show your ranking of the importance of the factors in delaying this project, and indicate it beside each factor.

Scale

Extremely unimportant 1 2 3 4 5 Extremely important

i) Underground conditions.........................
ii) Inclement whether................................
iii) Late site instructions............................
iv) Extra work.......................................
v) Changes in design...............................
vi) Delay in the settlement of payments...........
vii) Nominated sub-contractors......................
viii) Nominated suppliers............................
ix) Shortage of materials............................
x) Delay in construction details.....................
xi) Damages caused by fire or earth quake.........
xii) Any other (please specify)......................

(d) What action did you take to minimise the delays?

....
....
....
....
....
....
....
....

(e) Were you charged any damages for the delay in completion? Yes...... No..........

(f) If 'Yes' if 6(e) above, how much were you charged: Kshs. ....

Q7(a) Was the original contract sum exceeded during the construction

Yes............... No................

(b) Which of the following factors contributed to the cost over run?

Pick a number from the scale to show your ranking of the importance of the factors in bringing extra costs in this project.

Scale

Extremely unimportant 1 2 3 4 5 Extremely important

i) Unexpected underground ....
ii) Extra work ....
iii) Site instructions ....
iv) Changes in design ....
v) Delayed payments ....
vi) Nominated sub-contractors ....
vii) Nominated suppliers ....
viii) Fluctuations in prices of materials ....
x) Fluctuations in prices of labour ....
xi) Claim on loss and expense ....
xii) Errors in bills of quantities ....
xiii) Any other (please specify) ....

....

(c) What steps did you take to prevent the cost overruns during construction?

....

....

....

....

Q8(a) Which of the following occurred in this project during the construction or the defects liability periods?

Pick a number from the scale to show how often each factor occurred in the project during these periods.

Scale

5 Always
4 Often
3 Sometimes
2 Seldom
1 Never

Factors

i) Defective materials ....
ii) Cracks ....
iii) Leaks in the walls, roof etc ....
iv) Some works condemned by architect/engineers............
v) Defective design ....
vi) Any other (please specify)

....

....

....

(b) What action did you take to reduce the frequency of occurrence of the factors in question 8(a)
....
....
....
....

Q9(a) Have you undertaken work under any of the following conditions of contract?

i) Project Management Yes........... No...........
ii) Management contracting Yes..............No..........
iii) Design and Build Yes..............No.........
iv) Turn Key Yes..............No.........

(b) Would you recommend any of the above conditions of contract for extensive use in Kenya? Yes................No...............

(c) If 'Yes' in 9(b) specify which one
....

(d) Please give your reasons for your answer in 9(b&c) above.
1. ....
2. ....
3. ....

Q10 (a) Bills of quantities, conditions of contract (AAK or MOW conditions) and drawings are the three main contract documents used in Kenya. Have you found the information given in these documents sufficient enough to avoid (or minimise) delays, cost overruns or poor quality in your projects?
Yes..............No.................

(b) If No in 10(a) please state what further information you think should be included in each of the contract documents giving reasons for the same.

i) Bills of quantities

- Further information necessary

1. ....
2. ....
3. ....

- Reasons

1. ....
2. ....
3. ....

(ii) Contract conditions - AAK

- Further information necessary

1. ....
2. ....
3. ....

- Reasons

1. ....
2. ....
3. ....

(iii) Contract conditions - MOW

- Further information necessary

4. ....
5. ....
6. ....

- Reasons

1. ....
2. ....
3. ....

Q11(a) Is there any method you use for minimising delays, cost overruns or poor quality in buildings during construction?

Yes .... No ....

(b) If yes, in (a) above please briefly describe the method.

....

(c) If 'No' in (a) above please briefly describe the method you think could be used to minimise (or avoid) delays cost overruns and poor quality buildings?

....
....
....
....

(d) Do you find the method you have described in 11(b) above effective?

Yes......................... No...........................

(e) If your answer to 11(d) above is 'No' please describe briefly the method you suggest could be used to minimise (or avoid) delays, cost overruns and poor quality building?

....
....
....

Q12(a) Please give a suggestion of what you think an architect should do in order to minimise the following occurrences in a building project?

1. Delays
   i) ....
   ii) ....
   iii) ....

2. Cost Overruns
   i) ....
   ii) ....
   iii) ....

3. Incidence of poor workmanship/quality?
   i) ....
   ii) ....
   iii) ....

(b) Please give a suggestion of what you think quantity surveyor should do in order to minimise the following occurrences in a building project?

(i) Delays

....
....
....
....
....

ii) Cost overruns

....
....
....
....

iii) Incidences of poor workmanship/quality

....
....
....
....

(c) Please give a suggestion of what you think a contractor should do in order to minimise the following occurrences in any building project.

1. Delays
   i) ....
   ii) ....
   iii) ....
2. Cost Overruns
   i) ....

ii) ....
iii) ....

3. Incidence of poor workmanship/quality
   i) ....
   ii) ....
   iv) ....

Q13. The following are the existing methods of risk management in building projects:

13. Risk identification and evaluation at the feasibility study stage
14. Adequate preliminaries and preambles
15. Adequate contingency sum
16. Insurance cover
17. Financial appraisals during the construction period
18. Communication of the risks to all the members of the project team

f) Which of the above methods were employed in this project?

g) In spite of the methods of risk management, time and cost overruns are very persistent problems in the building industry today. Which of the following do you think are the reasons for this situation?

7. The methods do not adequately address the magnitude of the risks in building projects
8. The methods do not adequately address the frequency of the risks in building projects
9. The methods do not adequately address the type of the building projects

4. Any other (please specify) ....
....

c) Briefly describe how you normally identify sources of risks in building projects

....
....

d) Do you find the method of risk identification you have described in (c) above adequate for the management of the risks? Yes / No

Please explain your answer
....
....

f) Make suggestions on how the existing methods of risk management can be improved in order to make them more effective in the management of risks.

....
....
....

APPENDIX C

OVERALL CONSTRUCTION COST INDICES 1991 – 99

Year	Mean overall construction cost index
1991	940.625
1992	1060.225
1993	1627.625
1994	1800.925
1995	1932.400
1996	2018.750
1997	2137.50
1998	2237.50
1999	2337.50

Source: Computed from Republic of Kenya -Statistical Abstracts (1991-96). The indices for 1996-99 had not yet been published by the time of this study. These were therefore, estimated by a linear extrapolation of the 1991-95 indices.

APPENDIX D1

CODE LIST FOR THE VARIABLES

1	ID	Identity of the project
2.	CLIENT	Type of Client
3.	TYPE	Type of building
4.	CONSUM	Contract sum - unadjusted - millions of shs.
5.	FASUM	Final account Sum - unadjusted - millions of Kshs.
6.	DATE	Tender opening date.
7.	INDEX	Overall const. Cost index at tender opening date
8.	ESTIME	Estimated construction time (wks)
9.	ACTTIME	Actual construction time in weeks
10.	TENDER	Tendering method
11.	CPFIX	How contract period was fixed:
12.	CSTO	Cost overrun - millions of Kshs.
		CSTO = FA - CE
13.	PCSTO	Percentage cost overrun
		CSTO / CE
14.	TMO	Time overrun – weeks
		ACTTIME - ESTTIME
15.	PTMO	Percentage time overrun.
		TMO / ESTTIME
16.	DEF	Occurrence of defects on a 30-point scale
17.	DEFRT	defects rating
		DEF / 30
18.	OL	Overall loss
		(PCSTO + PTMO + DEFRT) ÷ 3
19.	IDAQSC	Stages of involvement of arch. QS and contractor
20.	IDIFS	Information given by feasibility study
21.	IDID	Information considered in design
22.	IDBQ	Information available for preparing BQ
23.	IDCS	Information used in computing the contingency sum.

24.	IDTD	Tender documents used.
25.	IDAT	Factors considered in awarding the tender
26.	IDENT	Adequacy of risk identification on 45 point scale
		IDAQS + IDIFS + IDID + IDBQ + IDCS + IDTD + IDAT
27.	IDENTRT	Rating of adequacy of risk identification
		IDENT / 45
28.	MES	Adequacy of risk measurement on a 10 point scale
29.	MEASRT	Rating of adequacy of risk measurement.
		MEASRT /10
30.	RACS	Was the contigency sum adequate?.
31.	RARFC	Were the anticipated risks fully communicated?
32.	RAPP	Were the preliminaries & preambles adequate?
33.	RFACP	Any financial appraisals done during the contract period?
34.	RMAI	Any specific measures taken by contractor to avert the impact of the risks?
35.	RERF	Effectiveness of response to risks - on a 5 point scale
36.	RES	Adequacy of risk response on 10-point scale
37.	RESRT	Rating of the adequacy of risk response
		RES /10
38.	FUNDER	Whether unexpected underground conditions occured
39.	FWEATH	Whether inclement weather occurred
40	FLNSTR	Whether late site instructions occurred
41	FEXTRA	Whether extra work occurred
42	FDES	Whether changes in design occured
43	FPAY	Whether delays in settlement of payment occurred
44	FSUBCON	Whether nominated subcontractors contributed to delays / cost overruns.
45	FSUPPL	Whether nominated suppliers cotnributed to delays / cost overruns.
46	FMAT	Whether shortage of main contractor's materials occured.
47	FDRWGS	Whether delays in prepr of detailed dwgs occurred

48	FPERILS	Whether perils - fire, earthquakes etc - occurred
49	FOTHERS	Whether other factors - contractual claims, industrial disputes, etc - occurred.
50	CSUNDER	Severity of 'unexpected' underground conditions on cost
51	CS WEATH	Severity of 'inclement whether on cost
52	CSINSTR	Severity of late instructions on cost
53	CS EXTRA	Severity of extra work on cost
54	CSDES	Severity of charges in design on cost
55	CSPAY	Severity of delays in payments on cost
56	CSSUBCON	Severity of nominated subcontractors on cost
57	CSSUPP	Severity of nominated suppliers on cost
58	CS MAT	Severity of shortage of materials on cost
59	CS DRWGS	Severity of delays in detailed drawings on cost
60	CS PERILS	Severity of perils - fire, earthquakes etc - on cost
61	CS OTHERS	Severity of other factors, contractual claims, industrial disputes etc - on cost
62	TS UNDER	Severity of unexpected underground conditions on time
63	TS WEATH	Severity of inclement weather on time
64	TSINTR	Severity of late instructions on time
65	TSEXTRA	Severity of extra works on time
66	TSDES	Severity of changes in design on time
67	TSPAY	Severity of delayed payments on time
68	TS SUBCON	Severity of nominated subcontractors on time
69	TS SUPP	Severity of nominated suppliers on time
70	TS MAT	Severity of shortage of materials on time
71	TS DRWGS	Severity of delays in detailed drawings on time
72	TSPERILS	Severity of perils - fire, earthquakes etc - on time
73	TSOTHERS	Severity of other factors - contractual claims, industrial disputes, etc - on time
74	FDEMAT	Whether defective materials occurred
75	FCRACKS	Whether cracks occurred

76	F LEAKS	Whether leaks - in roof, walls, etc - occurred
77	FCONDEMN	Whether some works were condemned
78	FDEDES	Whether design was defective
79	FOTHERS	Whether other defects occurred
80	QSDEMAT	Severity of defective materials on quality
81	QSCRACKS	Severity of cracks on quality
82	QSLEAKS	Severity of leaks in walls, roof etc on quality
83	QSCONDEMN	Severity of condemned works on quality
84	QSDEDES	Severity of defective design on quality
85	QSOTHERSD	Severity of other defects on quality
86	TRP	Risk of time overrun ($\sum$ severities on time) $\div 60$
87	CRP	Risk of cost overrun ($\sum$ severities on cost)$\div 60$
88	QRP	Risk of poor quality ($\sum$ severities on quality)$\div 30$
89	CE	Estimated contract sum adjusted to 1999 cost index - in millions of Kshs. CE = CONSUM X (2337.50 $\div$ INDEX)
90	FA	Final account sum adjusted to 1999 cost index - in millions of Kshs.

APPENDIX D2

THE FIELD DATA

id	client	type	consum	fasum	date	index	estime	actime
1.00	private	commerci	19.99	20.99	16.06.94	1800.93	24.00	20.00
2.00	private	residential	20.86	17.00	02.10.95	1932.40	59.00	89.00
3.00	public	commerci	66.02	103.13	14.12.90	940.63	150.00	300.00
4.00	public	residential	28.98	31.55	04.06.97	2137.50	48.00	54.00
5.00	public	commerci	41.00	43.40	17.07.96	2018.75	40.00	72.00
6.00	private	others	9.20	12.11	04.08.96	2018.75	32.00	43.00
7.00	private	institutional	11.74	12.68	08.04.98	2237.50	27.00	54.00
8.00	private	residential	21.70	28.50	03.12.95	1932.40	18.00	24.00
9.00	public	institutional	11.95	10.69	15.01.96	2018.75	24.00	32.00
10.00	public	institutional	7.49	7.82	13.12.95	1932.40	26.00	27.00
11.00	private	industrial	23.09	21.65	08.10.97	2137.50	32.00	36.00
12.00	private	residential	32.00	35.00	03.08.98	2237.50	42.00	64.00
13.00	private	residential	20.00	26.00	03.04.97	2137.50	35.00	50.00
14.00	private	institutional	36.50	42.00	14.08.98	2237.50	30.00	40.00
15.00	private	commerci	40.25	44.61	03.12.95	1932.40	52.00	78.00
16.00	private	residential	264.00	237.00	09.04.97	2137.50	70.00	76.00
17.00	private	commerci	48.14	52.60	13.07.98	2237.50	60.00	70.00
18.00	private	residential	18.46	24.81	09.04.96	2018.75	50.00	104.00
19.00	public	commerci	79.80	95.00	06.11.98	2237.50	14.00	20.00
20.00	private	institutional	9.33	10.77	01.08.94	1800.93	36.00	40.00
21.00	private	others	35.63	36.10	02.10.92	1060.22	26.00	30.00
22.00	private	commerci	88.00	128.43	07.06.95	1932.40	60.00	113.00
23.00	public	commerci	34.99	52.00	02.07.91	940.63	48.00	60.00
24.00	private	residential	14.67	15.32	25.06.97	2137.50	48.00	64.00
25.00	private	residential	18.77	21.31	18.09.95	1932.40	40.00	80.00
26.00	private	commerci	45.00	93.00	02.04.91	940.63	26.00	108.00
27.00	private	residential	14.00	16.00	07.12.93	1627.63	60.00	116.00
28.00	public	commerci	283.00	336.00	28.04.94	1800.93	80.00	104.00
29.00	public	commerci	40.00	48.00	06.06.94	1800.93	52.00	130.00
30.00	private	residential	48.22	55.25	07.10.97	2137.50	50.00	64.00
31.00	private	residential	28.50	36.00	06.06.88	600.00	52.00	63.50
32.00	private	commerci	11.10	11.44	17.10.97	2137.50	15.00	35.00
33.00	private	institutional	12.40	12.33	19.07.94	1800.93	35.00	40.00
34.00	private	institutional	44.77	52.66	06.11.95	1932.40	58.00	65.00

a:\pr-general risks.sav

id	client	type	consum	fasum	date	index	estime	actime
35.00	private	institutional	27.50	37.00	23.11.92	1060.22	44.00	53.00
36.00	private	residential	11.42	8.30	13.03.95	1932.40	40.00	82.00
37.00	private	institutional	77.50	97.28	09.02.93	1627.63	60.00	84.00

	tender	cpfix	csto	pcsto	tmo	ptmo	def	deftt	ore
1	selective	tendered f	1.30	.05	-4.00	-.17	10.00	.33	.22
2	negotiated	fixed by ar	-4.67	-.19	30.00	.51	8.00	.27	.59
3	selective	tendered f	92.20	.56	160.00	1.00	7.00	.23	1.80
4	selective	tendered f	2.81	.09	6.00	.13	11.00	.37	.58
5	selective	tendered f	2.78	.06	32.00	.80	10.00	.33	1.19
6	selective	tendered f	3.37	.32	11.00	.34	12.00	.40	1.06
7	selective	fixed by Q	.98	.08	27.00	1.00	9.00	.30	1.38
8	negotiated	other	8.23	.31	6.00	.33	13.00	.43	1.08
9	selective	tendered f	-1.46	-.11	8.00	.33	14.00	.47	.69
10	selective	tendered f	.39	.04	1.00	.04	9.00	.30	.38
11	selective	tendered f	-1.58	-.06	4.00	.13	11.00	.37	.43
12	negotiated	other	3.13	.09	22.00	.52	11.00	.37	.98
13	selective	tendered f	6.56	.30	16.00	.43	13.00	.43	1.16
14	selective	tendered f	5.75	.15	10.00	.33	11.00	.37	.85
15	negotiated	fixed by ar	6.26	.11	26.00	.60	.00	.00	.61
16	selective	tendered f	-29.53	-.10	6.00	.09	12.00	.40	.38
17	selective	tendered f	4.66	.09	10.00	.17	10.00	.33	.69
18	selective	tendered f	7.36	.34	54.00	1.08	12.00	.40	1.82
19	selective	tendered f	15.88	.19	6.00	.43	.00	.00	.62
20	selective	tendered f	1.86	.15	4.00	.11	7.00	.23	.50
21	open	tendered f	1.05	.01	4.00	.15	8.00	.27	.43
22	selective	tendered f	48.30	.46	53.00	.88	10.00	.33	1.68
23	selective	tendered f	42.27	.49	12.00	.25	7.00	.23	.97
24	selective	tendered f	.71	.04	16.00	.33	10.00	.33	.71
25	selective	fixed by Q	3.08	.14	40.00	1.00	9.00	.30	1.44
26	negotiated	other	119.28	1.07	82.00	3.15	17.00	.57	4.79
27	negotiated	fixed by ar	2.87	.14	66.00	.93	9.00	.30	1.38
28	selective	tendered f	68.79	.19	24.00	.30	8.00	.27	.75
29	open	tendered f	10.38	.20	78.00	1.50	12.00	.40	2.10
30	selective	tendered f	7.69	.15	14.00	.28	11.00	.37	.79
31	open	fixed by ar	29.22	.26	11.50	.22	12.00	.40	.88
32	selective	tendered f	.37	.03	20.00	1.33	10.00	.33	1.70
33	selective	tendered f	-.03	-.01	5.00	.14	9.00	.30	.44
34	selective	tendered f	9.55	.18	7.00	.12	9.00	.30	.60

tender	cpfix	csto	pcsto	tmo	ptmo	def	deft	ore
selective	tendered f	20.94	.35	9.00	.20	10.00	.33	.88
selective	tendered f	-3.78	-.27	42.00	1.05	7.00	23	1.01
selective	tendered f	28.41	.26	24.00	.40	10.00	33	99

ldaqsc	ldifs	ldld	ldbq	ldcs	ldtd	ldat	ldent	ldentrt
3.00	3.00	6.00	2.00	2.00	3.00	5.00	24.00	.53
3.00	7.00	8.00	4.00	3.00	3.00	5.00	33.00	.73
3.00	4.00	7.00	2.00	5.00	3.00	5.00	29.00	.64
4.00	6.00	7.00	5.00	2.00	3.00	6.00	33.00	.73
4.00	6.00	5.00	5.00	.00	3.00	5.00	27.00	.60
3.00	.00	6.00	3.00	1.00	3.00	5.00	21.00	.47
4.00	3.00	5.00	3.00	1.00	2.00	5.00	23.00	.51
5.00	7.00	8.00	5.00	.00	3.00	6.00	34.00	.76
4.00	3.00	5.00	4.00	3.00	3.00	5.00	27.00	.60
4.00	3.00	7.00	4.00	2.00	3.00	5.00	28.00	.62
4.00	6.00	11.00	5.00	2.00	3.00	5.00	36.00	.80
4.00	5.00	4.00	4.00	3.00	3.00	6.00	29.00	.64
4.00	5.00	6.00	4.00	3.00	3.00	6.00	31.00	.69
4.00	5.00	5.00	6.00	5.00	3.00	6.00	34.00	.76
4.00	7.00	12.00	6.00	3.00	3.00	5.00	40.00	.89
5.00	7.00	10.00	5.00	3.00	3.00	5.00	38.00	.84
4.00	5.00	2.00	5.00	4.00	3.00	5.00	28.00	.62
4.00	.00	4.00	6.00	3.00	3.00	5.00	25.00	.56
4.00	4.00	2.00	2.00	2.00	3.00	5.00	22.00	.49
4.00	3.00	5.00	4.00	.00	3.00	5.00	24.00	.53
3.00	8.00	11.00	5.00	3.00	2.00	5.00	37.00	.82
4.00	6.00	7.00	3.00	3.00	3.00	5.00	31.00	.69
3.00	4.00	5.00	5.00	3.00	3.00	5.00	28.00	.62
4.00	6.00	6.00	6.00	1.00	3.00	5.00	31.00	.69
4.00	5.00	6.00	5.00	3.00	3.00	5.00	31.00	.69
3.00	.00	2.00	5.00	4.00	3.00	5.00	22.00	.49
3.00	.00	7.00	5.00	4.00	3.00	5.00	27.00	.60
4.00	4.00	8.00	6.00	3.00	3.00	5.00	33.00	.73
3.00	4.00	8.00	5.00	3.00	3.00	5.00	31.00	.69
4.00	4.00	6.00	5.00	3.00	3.00	5.00	30.00	.67
4.00	4.00	10.00	5.00	3.00	3.00	6.00	34.00	.76
4.00	4.00	6.00	2.00	3.00	3.00	5.00	27.00	.60
4.00	5.00	8.00	6.00	4.00	3.00	5.00	35.00	.78
4.00	4.00	8.00	6.00	4.00	3.00	6.00	35.00	.78

	ideasc	idifs	idid	idbq	idcs	idtd	idat	ident	identt
	4.00	6.00	7.00	6.00	4.00	3.00	6.00	36.00	.78
	4.00	3.00	5.00	6.00	3.00	3.00	6.00	30.00	.67
	4.00	6.00	7.00	6.00	4.00	3.00	6.00	36.00	.78

	mes	measrt	racs	rarfc	rapp	rfacp	rmal	rerf	res
1	3.00	.30	1.00	1.00	1.00	1.00	1.00	5.00	10.00
2	3.00	.30	1.00	1.00	1.00	1.00	1.00	4.00	9.00
3	3.00	.30	.00	1.00	1.00	1.00	.00	1.00	4.00
4	3.00	.30	.00	1.00	1.00	1.00	1.00	4.00	8.00
5	1.00	.10	.00	.00	1.00	1.00	1.00	1.00	4.00
6	3.00	.30	.00	.00	1.00	.00	1.00	2.00	4.00
7	3.00	.30	.00	1.00	1.00	1.00	1.00	1.00	5.00
8	1.00	.10	.00	1.00	1.00	1.00	1.00	2.00	6.00
9	3.00	.30	1.00	1.00	1.00	1.00	1.00	4.00	9.00
10	3.00	.30	.00	1.00	1.00	1.00	1.00	5.00	9.00
11	3.00	.30	1.00	1.00	1.00	1.00	1.00	5.00	10.00
12	3.00	.30	1.00	.00	1.00	1.00	.00	2.00	5.00
13	3.00	.30	1.00	.00	1.00	1.00	.00	3.00	6.00
14	3.00	.30	.00	1.00	1.00	1.00	1.00	3.00	7.00
15	4.00	.40	1.00	1.00	1.00	1.00	1.00	3.00	8.00
16	3.00	.30	1.00	1.00	1.00	1.00	1.00	5.00	10.00
17	4.00	.40	.00	.00	1.00	1.00	1.00	4.00	7.00
18	1.00	.10	.00	.00	1.00	1.00	1.00	1.00	4.00
19	3.00	.30	.00	1.00	1.00	1.00	1.00	4.00	8.00
20	1.00	.10	.00	.00	1.00	1.00	1.00	4.00	7.00
21	4.00	.40	.00	.00	.00	1.00	1.00	5.00	7.00
22	1.00	.10	.00	.00	1.00	1.00	1.00	1.00	4.00
23	3.00	.30	.00	.00	1.00	1.00	1.00	2.00	5.00
24	1.00	.10	.00	.00	.00	1.00	1.00	4.00	6.00
25	3.00	.30	.00	.00	1.00	.00	1.00	1.00	3.00
26	3.00	.30	.00	1.00	1.00	1.00	1.00	1.00	5.00
27	3.00	.30	.00	.00	1.00	1.00	1.00	1.00	4.00
28	3.00	.30	.00	.00	1.00	1.00	1.00	3.00	6.00
29	3.00	.30	.00	.00	1.00	1.00	1.00	1.00	4.00
30	3.00	.30	.00	1.00	1.00	1.00	1.00	3.00	7.00
31	3.00	.30	.00	1.00	1.00	1.00	1.00	3.00	7.00
32	3.00	.30	.00	.00	1.00	.00	1.00	1.00	3.00
33	3.00	.30	1.00	1.00	1.00	1.00	1.00	5.00	10.00
34	3.00	.30	.00	.00	1.00	1.00	1.00	4.00	7.00

	mes	measrt	racs	rarfc	rapp	rfacp	rmal	rerf	res
35	3.00	.30	.00	.00	1.00	1.00	1.00	3.00	6.00
36	3.00	.30	1.00	.00	1.00	1.00	1.00	2.00	6.00
37	3.00	.30	.00	.00	1.00	1.00	1.00	2.00	5.00

	resrt	funder	fweath	finstr	fextra	fdes	fpay	fsubcon	fsuppl
1	1.00	no	no	no	no	no	no	no	no
2	.90	yes	no	no	yes	yes	yes	yes	yes
3	.40	yes	no	no	yes	no	no	yes	yes
4	.80	yes	no	no	no	no	no	no	yes
5	.40	yes	no	yes	yes	yes	no	yes	yes
6	.40	yes	no	yes	no	no	yes	yes	yes
7	.50	no	no	no	yes	no	no	no	no
8	.60	no	no	yes	yes	yes	no	no	no
9	.90	yes	yes	yes	yes	yes	yes	yes	yes
10	.90	no	no	no	yes	no	yes	no	no
11	1.00	no	no	yes	yes	yes	no	no	no
12	.50	no	no	yes	yes	yes	yes	yes	yes
13	.60	no	no	yes	yes	yes	yes	yes	yes
14	.70	no	no	yes	yes	yes	no	no	no
15	.80	yes	yes	yes	yes	yes	no	yes	no
16	1.00	yes	yes	no	yes	no	no	yes	yes
17	.70	yes	yes	yes	no	yes	no	yes	yes
18	.40	no	no	no	yes	no	yes	yes	yes
19	.80	no	no	no	yes	yes	no	no	no
20	.70	no	no	no	no	no	yes	no	no
21	.70	no	no	yes	no	yes	no	no	yes
22	.40	yes	yes	yes	yes	yes	no	yes	yes
23	.50	no	no	no	yes	no	yes	no	no
24	.60	no	no	no	yes	yes	no	no	no
25	.30	yes	no	yes	yes	yes	yes	no	no
26	.50	yes	no	yes	yes	yes	yes	yes	yes
27	.40	no	no	yes	yes	yes	no	no	no
28	.60	yes	yes	yes	yes	no	no	no	no
29	.40	yes	yes	yes	yes	yes	yes	yes	no
30	.70	no	no	no	yes	yes	no	yes	yes
31	.70	yes	yes	yes	yes	yes	yes	yes	yes
32	.30	.	.	.	.	.	.	.	.
33	1.00	no	no	no	no	no	no	no	no
34	.70	no	no	no	no	no	no	no	no

rsrt	funder	fweath	finstr	fextra	fdes	fpay	fsubcon	fsuppl
.60	.	.	.	.	.	.	.	.
.60	no	no	no	no	no	no	no	no
.50	.	.	.	.	.	.	.	.

fmat	fdrwgs	fperils	fothers	csunder	csweath	csinstr	csextra	csdes
no	no	no	no	.00	.00	.00	.00	.00
no	yes	no	no	.00	.00	.00	.00	.00
yes	no	no	no	1.00	.00	2.00	5.00	5.00
no	yes	yes	no	4.00	.00	3.00	2.00	4.00
yes	yes	no	no	4.00	.00	4.00	5.00	4.00
no	yes	no	no	3.00	.00	4.00	5.00	1.00
no	no	no	no	2.00	.00	3.00	3.00	3.00
no	no	no	no	2.00	.00	4.00	4.00	5.00
yes	yes	yes	no	4.00	.00	5.00	5.00	5.00
no	yes	no	no	1.00	.00	4.00	3.00	2.00
no	yes	no	no	.00	.00	.00	.00	.00
no	yes	no	no	1.00	.00	5.00	5.00	5.00
no	yes	no	no	1.00	.00	5.00	6.00	6.00
no	yes	no	no	.00	.00	5.00	5.00	5.00
no	yes	no	no	.00	.00	5.00	5.00	5.00
no	yes	no	no	.00	.00	.00	.00	.00
no	yes	no	no	5.00	.00	3.00	3.00	5.00
no	no	no	no	2.00	.00	2.00	4.00	4.00
no	yes	no	no	.00	.00	4.00	5.00	6.00
no	no	no	no	2.00	.00	3.00	3.00	3.00
no	yes	no	no	1.00	.00	2.00	4.00	3.00
no	no	no	no	5.00	.00	3.00	4.00	3.00
no	no	no	no	.00	.00	5.00	6.00	6.00
no	no	no	no	1.00	.00	1.00	5.00	5.00
no	yes	no	no	4.00	.00	4.00	2.00	3.00
no	yes	no	no	2.00	.00	5.00	5.00	5.00
no	no	no	no	1.00	.00	4.00	4.00	4.00
no	no	no	no	5.00	.00	4.00	5.00	2.00
yes	yes	no	no	5.00	.00	5.00	5.00	3.00
no	no	no	no	2.00	.00	4.00	5.00	5.00
yes	no	no	no	5.00	.00	4.00	3.00	4.00
.	.	.	.	.	.	.	.	.
no	no	no	no	.00	.00	1.00	.00	.00
no	no	no	no	.00	.00	.00	1.00	.00

	fmat	fdrwgs	fperils	fothers	csunder	csweath	csinstr	csextra	csdes
35	.	.	.	.	.	.	.	.	.
36	yes	yes	no	no	.00	.00	.00	.00	.00
37	.	.	.	.	.	.	.	.	.

cspay	cssubcon	cssupp	csmat	csdrwgs	csperils	csothers	tsunder	tsweath
.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	5.00	1.00
1.00	5.00	1.00	5.00	.00	.00	.00	4.00	2.00
1.00	1.00	1.00	2.00	.00	.00	2.00	5.00	1.00
2.00	3.00	3.00	2.00	.00	.00	4.00	5.00	2.00
3.00	3.00	4.00	2.00	.00	.00	4.00	5.00	2.00
2.00	2.00	2.00	2.00	.00	.00	1.00	1.00	2.00
1.00	1.00	1.00	1.00	.00	1.00	.00	2.00	2.00
3.00	3.00	3.00	5.00	.00	.00	3.00	5.00	3.00
3.00	1.00	1.00	1.00	.00	.00	1.00	1.00	2.00
.00	.00	.00	.00	.00	.00	.00	1.00	1.00
1.00	3.00	3.00	1.00	.00	.00	1.00	1.00	1.00
1.00	3.00	3.00	1.00	.00	.00	1.00	1.00	1.00
1.00	3.00	2.00	1.00	.00	.00	.00	1.00	1.00
.00	5.00	4.00	.00	.00	.00	.00	5.00	4.00
.00	.00	.00	.00	.00	.00	.00	4.00	3.00
1.00	3.00	3.00	2.00	.00	.00	2.00	5.00	3.00
3.00	5.00	3.00	4.00	.00	.00	4.00	2.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00
2.00	1.00	2.00	1.00	.00	.00	.00	1.00	1.00
1.00	1.00	2.00	1.00	.00	.00	.00	1.00	1.00
2.00	3.00	3.00	2.00	.00	.00	2.00	5.00	4.00
5.00	.00	.00	.00	.00	.00	.00	1.00	1.00
1.00	1.00	1.00	1.00	.00	.00	1.00	1.00	1.00
5.00	1.00	1.00	1.00	.00	.00	2.00	5.00	2.00
3.00	5.00	5.00	3.00	.00	.00	2.00	3.00	2.00
2.00	2.00	2.00	2.00	.00	.00	2.00	2.00	1.00
1.00	1.00	1.00	2.00	.00	.00	3.00	5.00	3.00
5.00	5.00	1.00	3.00	.00	.00	5.00	5.00	4.00
2.00	4.00	4.00	4.00	.00	.00	2.00	2.00	2.00
4.00	5.00	3.00	4.00	.00	.00	2.00	5.00	4.00
.	.	.	.	.	.	.	.	.
.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00	.00	.00	.00	.00	.00	.00	.00

	cspay	cssubcon	cssupp	csmat	csdrwgs	csperils	csothers	tsunder	tsweath
	.	.	.	.	.	.	.	.	.
	.00	.00	.00	.00	.00	.00	.00	.00	.00
	.	.	.	.	.	.	.	.	.

tsinstr	tsextra	tsdes	tspay	tssubcon	tssupp	tsmat	tsdrwgs	tsperils
.00	.00	.00	.00	.00	.00	.00	.00	.00
1.00	5.00	4.00	5.00	4.00	4.00	1.00	3.00	1.00
2.00	6.00	2.00	2.00	6.00	5.00	5.00	2.00	.00
1.00	1.00	2.00	2.00	2.00	3.00	1.00	3.00	1.00
3.00	5.00	6.00	2.00	4.00	4.00	3.00	6.00	.00
3.00	2.00	2.00	3.00	4.00	4.00	2.00	3.00	1.00
2.00	3.00	1.00	2.00	1.00	1.00	1.00	2.00	1.00
3.00	5.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00
5.00	5.00	6.00	6.00	3.00	5.00	5.00	6.00	6.00
1.00	3.00	1.00	3.00	2.00	1.00	1.00	3.00	1.00
5.00	5.00	5.00	1.00	1.00	1.00	1.00	4.00	1.00
5.00	5.00	5.00	3.00	4.00	3.00	1.00	5.00	1.00
4.00	4.00	5.00	3.00	4.00	3.00	1.00	6.00	1.00
5.00	5.00	5.00	1.00	1.00	1.00	1.00	4.00	1.00
6.00	4.00	6.00	.00	3.00	.00	.00	6.00	.00
2.00	3.00	2.00	1.00	2.00	3.00	1.00	3.00	1.00
3.00	2.00	5.00	1.00	3.00	3.00	3.00	3.00	1.00
2.00	4.00	4.00	3.00	5.00	3.00	4.00	.00	.00
.00	5.00	5.00	1.00	1.00	1.00	1.00	4.00	1.00
1.00	1.00	2.00	3.00	1.00	1.00	1.00	1.00	.00
4.00	2.00	3.00	1.00	1.00	3.00	2.00	4.00	1.00
4.00	5.00	3.00	2.00	4.00	4.00	2.00	1.00	1.00
1.00	5.00	1.00	6.00	1.00	1.00	1.00	1.00	1.00
1.00	5.00	4.00	1.00	1.00	1.00	2.00	1.00	1.00
3.00	5.00	4.00	4.00	1.00	1.00	2.00	4.00	.00
3.00	5.00	5.00	5.00	5.00	5.00	2.00	3.00	1.00
3.00	3.00	4.00	2.00	2.00	2.00	2.00	2.00	1.00
4.00	5.00	2.00	1.00	1.00	1.00	2.00	2.00	1.00
4.00	5.00	4.00	5.00	5.00	1.00	4.00	3.00	1.00
2.00	4.00	5.00	2.00	4.00	4.00	2.00	1.00	1.00
5.00	3.00	4.00	4.00	5.00	3.00	3.00	2.00	.00
.	.	.	.	.	.	.	.	.
.00	1.00	.00	.00	.00	.00	.00	.00	.00
.00	1.00	.00	.00	.00	.00	.00	.00	.00

	tsinstr	tsextra	tsdes	tspay	tssubcon	tssupp	tsmat	tsdrwgs	tsperils
35	.	.	.	.	.	.	.	.	.
36	2.00	1.00	3.00	.00	.00	.00	4.00	5.00	.00
37	.	.	.	.	.	.	.	.	.

sothers	fdemat	fcracks	fleaks	fcondemn	fdedes	fotherd	qsdemat	qscracks
.00	yes	no	no	no	no	no	3.00	2.00
.00	yes	no	no	no	no	no	3.00	2.00
.00	no	no	no	no	no	no	1.00	2.00
.00	yes	no	no	yes	no	no	3.00	2.00
.00	yes	no	no	yes	no	no	3.00	1.00
.00	yes	no	no	yes	yes	no	3.00	2.00
.00	no	no	no	no	no	no	2.00	2.00
1.00	no	yes	yes	yes	no	no	2.00	3.00
.00	yes	yes	yes	yes	yes	no	3.00	3.00
.00	yes	no	no	no	no	no	2.00	2.00
.00	no	no	no	no	yes	no	2.00	2.00
.00	no	yes	no	no	no	no	2.00	4.00
.00	no	yes	no	yes	no	no	2.00	4.00
.00	no	no	no	no	yes	no	2.00	2.00
.00	no	no	no	no	no	no	.00	.00
.00	yes	no	no	yes	no	no	3.00	2.00
.00	no	no	no	yes	no	no	2.00	1.00
.00	yes	yes	yes	no	no	no	3.00	5.00
.00	no	no	no	no	no	no	.00	.00
.00	no	no	no	no	no	no	1.00	2.00
.00	no	no	no	no	no	no	2.00	1.00
.00	yes	no	no	no	no	no	3.00	2.00
.00	no	no	no	no	no	no	1.00	2.00
.00	no	no	no	no	no	no	1.00	1.00
.00	no	no	no	yes	yes	no	1.00	1.00
.00	yes	yes	no	yes	yes	no	3.00	4.00
.00	no	no	no	yes	no	no	2.00	1.00
.00	no	no	no	no	no	no	2.00	2.00
1.00	yes	no	no	no	yes	no	3.00	2.00
.00	no	no	yes	yes	no	no	2.00	1.00
.00	yes	no	yes	no	yes	no	3.00	2.00
.	.	.	.	.	.	.	.	.
.00	no	yes	no	no	no	no	2.00	3.00
.00	no	yes	no	no	no	no	2.00	3.00

	sothers	fdemat	fcracks	fleaks	fcondemn	fdedes	fotherd	qsdemat	qscracks
35	.	.	.	.	.	.	.	.	.
36	.00	no	no	no	no	no	no	1.00	1.00
37	.	.	.	.	.	.	.	.	.

	qtasks	qscondem	qsdedes	qsotherd	timerisk	costrisk	qltyrisk	ce	fe
1	1.00	2.00	2.00	.00	.00	.00	2.81	26.96	27.24
2	1.00	1.00	1.00	.00	16.59	.00	2.22	25.23	20.56
3	2.00	1.00	1.00	.00	15.62	12.20	1.69	164.07	266.27
4	1.00	3.00	2.00	.00	3.91	8.85	3.16	31.69	34.50
5	2.00	3.00	1.00	.00	18.73	13.85	2.84	47.47	50.25
6	1.00	3.00	3.00	.00	13.91	12.50	3.40	10.65	14.02
7	1.00	2.00	2.00	.00	7.82	9.44	2.47	12.28	13.[illegible]
8	3.00	4.00	1.00	.00	11.08	10.44	3.47	26.25	34.47
9	3.00	3.00	2.00	.00	21.82	15.88	3.69	13.84	12.39
10	1.00	2.00	2.00	.00	8.70	8.20	2.47	9.06	9.46
11	2.00	2.00	3.00	.00	13.73	.00	2.85	25.26	23.67
12	2.00	1.00	2.00	.00	17.41	13.09	2.73	33.43	36.56
13	2.00	3.00	2.00	.00	16.16	13.09	3.44	21.87	28.[illegible]
14	2.00	2.00	3.00	.00	13.73	12.17	2.85	38.13	43.[illegible]
15	.00	.00	.00	.00	15.88	13.50	.00	48.69	63.96
16	2.00	3.00	2.00	.00	11.56	.00	3.31	288.70	259.18
17	1.00	4.00	2.00	.00	14.38	12.50	2.94	50.29	54.96
18	3.00	.00	1.00	.00	12.85	12.85	2.87	21.38	28.73
19	.00	.00	.00	.00	10.41	8.73	.00	83.37	99.25
20	1.00	2.00	1.00	.00	5.94	8.79	1.90	12.11	13.98
21	1.00	2.00	2.00	.00	10.94	8.17	2.23	78.54	79.59
22	2.00	1.00	2.00	.00	16.20	12.44	2.60	106.46	155.35
23	2.00	1.00	1.00	.00	9.11	11.17	1.69	86.96	129.[illegible]
24	1.00	1.00	1.00	.00	9.53	9.09	1.31	16.04	16.75
25	1.00	3.00	3.00	.00	15.35	10.14	2.48	22.70	25.79
26	2.00	3.00	3.00	.00	18.70	16.53	4.01	111.83	231.11
27	1.00	3.00	2.00	.00	11.44	10.86	2.59	20.11	22.98
28	1.00	2.00	1.00	.00	12.73	10.85	2.23	367.32	436.1[illegible]
29	2.00	2.00	3.00	.00	13.46	15.55	3.19	51.92	62.[illegible]
30	3.00	3.00	2.00	.00	13.79	14.85	2.88	52.73	60.42
31	3.00	2.00	2.00	.00	17.29	14.88	3.10	111.03	140.25
32	.	.	.	.	.	.	.	12.14	12.51
33	2.00	1.00	1.00	1.00	.74	.53	2.26	16.09	16.01
34	2.00	1.00	1.00	.00	.74	.74	2.26	54.16	63.71

	qsleaks	qscondem	qsdedes	qsotherd	timerisk	costrisk	qltyrisk	ce	fa
35	.	.	.	.	.	.	.	60.53	81.57
36	1.00	1.00	3.00	00	7.05	00	1.78	13.81	10.03
37	.	.	.	.	.	.	.	111.30	[illegible]

	cr	crp	tr	trp	qr	qrp
1	.00	.00	.00	.00	10.00	.33
2	.00	.00	34.00	.57	8.00	.27
3	25.00	.42	34.00	.57	7.00	.23
4	20.00	.33	22.00	.37	11.00	.37
5	31.00	.52	38.00	.63	10.00	.33
6	29.00	.48	31.00	.52	12.00	.40
7	20.00	.33	17.00	.28	9.00	.30
8	20.00	.33	23.00	.38	13.00	.43
9	36.00	.60	51.00	.85	14.00	.47
10	17.00	.28	19.00	.32	9.00	.30
11	.00	.00	26.00	.43	11.00	.37
12	25.00	.42	34.00	.57	11.00	.37
13	25.00	.42	32.00	.53	13.00	.43
14	22.00	.37	26.00	.43	11.00	.37
15	24.00	.40	31.00	.52	.00	.00
16	.00	.00	25.00	.42	12.00	.40
17	27.00	.45	32.00	.53	10.00	.33
18	31.00	.52	27.00	.45	12.00	.40
19	14.00	.23	19.00	.32	.00	.00
20	17.00	.28	13.00	.22	7.00	.23
21	15.00	.25	23.00	.38	8.00	.27
22	27.00	.45	35.00	.58	10.00	.33
23	20.00	.33	19.00	.32	7.00	.23
24	17.00	.28	19.00	.32	5.00	.17
25	23.00	.38	31.00	.52	9.00	.30
26	35.00	.58	39.00	.65	15.00	.50
27	23.00	.38	24.00	.40	9.00	.30
28	24.00	.40	27.00	.45	8.00	.27
29	37.00	.62	42.00	.70	12.00	.40
30	32.00	.53	29.00	.48	11.00	.37
31	34.00	.57	38.00	.63	12.00	.40
32	.	.	.	.	.	.
33	1.00	.02	1.00	.02	10.00	.33
34	1.00	.02	1.00	.02	9.00	.30

cr	crp	tr	trp	qr	qrp
.	.	.	.	.	.
.00	.00	15.00	.25	7.00	.23
.	.	.	.	.	.

APPENDIX E

REGRESSION ANALYSES

Table 5.25. Regression of Logit (CR) on Ten Variables

Independent Variable(s)

1.	IDENTRT	rating of the adequacy of risk identification
2.	MEASRT	rating of the adequacy of risk measurement
3.	CE	Estimated contract sum - adjusted to 1999 cost index
4.	TYPE1	residential building
5.	TYPE2	commercial building
6.	TYPE3	institutional building
7.	TYPE4	factory building
8.	CLIENT	type of client
9.	TENDER1	selective tendering
10.	TENDER2	open tendering

Multiple R	0.67437
R Square	0.45478
Standard Error	0.94731

------------------ Regression Coefficients ------------------

Variable	Coefficient
IDENTRT	-4.518352
MEASRT	-0.036113
CE	2.38442E-04
TYPE1	0.653368
TYPE2	0.436649
TYPE3	-0.514358
CLIENT	-0.302228
TENDER1	-0.476846
TENDER2	0.509432
(Constant)	2.617115

Residuals Statistics:

	Min	Max
*ZRESID	-1.9941	1.6313

NB: Variable TYPE4 is a constant (see Appendix D2) it is deleted from the analysis.

Table 5.26. Regression of {Logit (CR)/CE} on the Transformed Variables

(A) All the variables entered

Dependent Variable.. LCRPDCE (logit crp)/ce

Variable(s) Entered on Step Number

1..	TEND2DCE	tender2/ce
2..	TP3DCE	type3/ce
3..	CLNTDCE	client/ce
4..	TP2DCE	type2/ce
5..	TP1DCE	type1/ce
6..	MSDCE	measrt/ce
7..	TEND1DCE	tender1/ce
8..	IDDCE	identrt/ce
9..	RECICE	1/ce

Multiple R	0.87648
R Square	0.76822
Standard Error	0.03064

F = 6.99729 Significance of F = .0002

------------------ Regression Coefficients -----------------

Variable	B	SE B	Beta	T	Sig T
IDDCE	-9.630055	1.825763	-3.087790	-5.275	0.0000
MSDCE	0.558482	1.677218	0.089749	0.333	0.7428
RECICE	6.200908	1.322005	3.456169	4.691	0.0002
TP1DCE	1.223515	0.586674	0.472654	2.086	0.0507
TP2DCE	0.579424	1.067490	0.081590	0.543	0.5936
TP3DCE	-0.216644	0.477680	-0.132230	-0.454	0.6553
CLNTDCE	-1.090525	0.326060	-0.591723	-3.345	0.0034
TEND1DCE	-0.901171	0.653693	-0.562496	-1.379	0.1840
TEND2DCE	0.219860	1.449171	0.018695	0.152	0.8810
(Constant)	0.006106	0.014695		0.415	0.6824

(B) Most Significant Variables

Multiple R	0.86858
R Square	0.75443
Standard Error	0.02866

F = 14.13191 Signif F = .0000

------------------ Coefficients of the Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
IDDCE	-10.092262	1.463939	-3.235992	-6.894	.0000
RECICE	6.484950	1.172691	3.614484	5.530	.0000
TP1DCE	1.285439	0.309810	0.496576	4.149	.0004
CLNTDCE	-1.110664	0.275632	-0.602650	-4.030	.0005
TEND1DCE	-1.019816	0.569210	-0.636553	-1.792	.0864
(Constant)	0.014717	0.010025		1.468	.1556

------------- Variables not in the Equation -------------

Variable	T	Sig T
MSDCE	.504	.6193
TP2DCE	.812	.4254
TP3DCE	-.937	.3589
TEND2DCE	.229	.8211

Residuals Statistics:

	Min	Max
*ZRESID	-1.7762	1.9968

Table 5.27. Regression of Logit (TR) on Ten Variables

Dependent Variable.. logit (TR)

Independent Variable(s)

1.	IDENTRT	rating of the adequacy of risk identification
2.	MEASRT	rating of the adequacy of risk measurement
3.	CE	Estimated contract sum - adjusted to 1999 cost index
4.	TYPE1	residential building
5.	TYPE2	commercial building
6.	TYPE3	institutional building
7.	TYPE4	industrial building
8.	CLIENT	type of client
9.	TENDER1	selective tendering
10.	TENDER2	open tendering

Multiple R	0.62986
R Square	0.39672
Standard Error	1.06550

F = 1.44672 Signif F = .2250

------------------ Regression Coefficients ------------------

Variable	*Coefficient*
IDENTRT	-3.689439
MEASRT	0.310296
CE	9.42994E-04
TYPE1	0.409228
TYPE2	0.172000
TYPE3	-0.763497
TYPE4	1.045308
CLIENT	-0.589465
TENDER1	-0.771582
TENDER2	0.231479
(Constant)	2.882130

Residuals Statistics:

	Min	Max
*ZRESID	-1.9800	2.3417

Table 5.28. Regression of {Logit (TR)/CE} on the Transformed Variables

(A) All the variables entered

Dependent Variable.. LTRPDCE (logit trp)/ce
Independent Variable(s)
1.. TEND2DCE tender2/ce
2.. TP4DCE type4/ce
3.. TP3DCE type3/ce
4.. CLNTDCE client/ce
5.. TP2DCE type2/ce
6.. TP1DCE type1/ce
7.. MSDCE measrt/ce
8.. TEND1DCE tender1/ce
9.. IDDCE identrt/ce
10.. RECICE 1/ce

Multiple R	.80541
R Square	.64869
Standard Error	.04167

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	10	.07053	.00705
Residual	22	.03820	.00174

F = 4.06223 Signif F = .0029

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
IDDCE	-9.004690	2.478267	-2.597308	-3.633	.0015
MSDCE	1.152883	2.139295	.164666	.539	.5954
RECICE	6.802721	1.697388	3.345355	4.008	.0006
TP1DCE	.945651	.741555	.361189	1.275	.2155
TP2DCE	.021200	1.373383	.002570	.015	.9878
TP3DCE	-.576028	.645216	-.300153	-.893	.3816
TP4DCE	2.473193	1.399766	.292554	1.767	.0911
CLNTDCE	-1.692452	.434947	-.820031	-3.891	.0008
TEND1DCE	-1.302934	.726933	-.723233	-1.792	.0868
TEND2DCE	-.405892	1.914931	-.029215	-.212	.8341
(Constant)	.012243	.017675		.693	.4958

(B) Most Significant Variables

Multiple R	.78729
R Square	.61982
Adjusted R Square	.53209
Standard Error	.03987

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	6	.06739	.01123
Residual	26	.04134	.00159

F = 7.06477 Signif F = .0002

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
IDDCE	-9.957982	2.024475	-2.872275	-4.919	.0000
RECICE	7.198738	1.557890	3.540104	4.621	.0001
TP1DCE	1.372233	.401936	.524120	3.414	.0021
TP4DCE	3.092540	1.141428	.365816	2.709	.0118
CLNTDCE	-1.643169	.382410	-.796153	-4.297	.0002
TEND1DCE	-1.376883	.664548	-.764281	-2.072	.0483
(Constant)	.016909	.012983		1.302	.2042

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
MSDCE	.257452	.185204	.023225	.942	.3550
TP2DCE	.059109	.080425	.024901	.403	.6901
TP3DCE	-.347351	-.247892	.024621	-1.279	.2125
TEND2DCE	-.009329	-.013980	.024528	-.070	.9448

Residuals Statistics:

	Min	Max
*ZRESID	-1.5171	2.9965

Table 5.30 Regression of Cost Overrun on 9 variables

(A) All the Variables

Dependent Variable.. CSTO cost overrun - millions of Kshs

Independent Variable(s)
1.. TENDER2 open tendering
2.. TYPE2 commercial building
3.. TYPE4 industrial building
4.. CE Estimated cotract sum - adjusted to 1999 cost index
5.. TYPE3 institutional building
6.. CRP cost risk - probability of cost overrun
7.. CLIENT type of client
8.. TENDER1 selective tendering
9.. TYPE1 residential building

Multiple R	.72260
R Square	.52215
Standard Error	23.55243

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	9	14547.29542	1616.36616
Residual	24	13313.20465	554.71686

F = 2.91386 Signif F = .0175

------------------ Variables in the Equation ----------------

Variable	B	SE B	Beta	T	Sig T
CRP	53.832175	24.398462	.359301	2.206	.0372
CE	.134757	.060127	.358725	2.241	.0345
TYPE1	-4.632570	19.277594	-.078645	-.240	.8121
TYPE2	21.584457	20.809351	.352750	1.037	.3100
TYPE3	5.537597	20.856930	.078220	.266	.7929
TYPE4	14.677045	30.792896	.086629	.477	.6379
CLIENT	3.723765	11.299102	.057390	.330	.7446
TENDER1	-14.771243	12.580936	-.218884	-1.174	.2519
TENDER2	-22.542849	19.204853	-.223366	-1.174	.2520
(Constant)	-8.607884	28.371089		-.303	.7642

(B) Most Significant Variables

Multiple R	.68274
R Square	.46614
Standard Error	22.26637

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	12986.76035	4328.92012
Residual	30	14873.73972	495.79132

F = 8.73133 Signif F = .0003

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
CRP	43.310276	20.761640	.289073	2.086	.0456
CE	.109822	.054500	.292347	2.015	.0529
TYPE2	23.718677	9.180933	.387629	2.583	.0149
(Constant)	-15.038837	8.180717		-1.838	.0759

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
TYPE1	-.083070	-.093368	.538497	-.505	.6174
TYPE3	.068368	.086274	.740354	.466	.6445
TYPE4	.071953	.093604	.790256	.506	.6165
CLIENT	.086803	.104027	.703653	.563	.5776
TENDER1	-.076544	-.102773	.790223	-.556	.5822
TENDER2	-.103684	-.136675	.783135	-.743	.4635

Residuals Statistics:

	Min	Max
*ZRESID	-2.0746	3.2811

Table 5.31 Regression of CSTO/CRP on the transformed variables

Dependent Variable: CODCRP - CSTO divide by CRP
Independent Variable(s)

1.. TEN2DCRP tender2/crp
2.. CEDCRP ce/crp
3.. TP2DCRP type2/crp
4.. TP1DCRP type1/crp
5.. CLNTDCRP client/crp
6.. TEN1DCRP tender1/crp
7.. TP3DCRP type3/crp
8.. RECICRP 1/crp
9.. TP4DCRP type4/crp

Multiple R	.93494
R Square	.87411
Standard Error	44.09707

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	337551.84372	112517.28124
Residual	25	48613.78900	1944.55156

F = 57.86284 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
CEDCRP	.257100	.023671	1.347234	10.862	.0000
TEN1DCRP	-4.620123	.977045	-.590908	-4.729	.0001
TEN2DCRP	-20.229324	10.057647	-.145081	-2.011	.0552
(Constant)	17.305251	9.470595		1.827	.0796

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
RECICRP	.230584	.036864	.003188	.181	.8581
TP1DCRP	-.078127	-.211895	.320927	-1.062	.2987
TP2DCRP	.090467	.237262	.283375	1.197	.2432
TP3DCRP	.221348	.051523	.006516	.253	.8026
CLNTDCRP	.015269	.004994	.012536	.024	.9807

Residuals Statistics:

	Min	Max
*ZRESID	-1.5845	3.1270

Table 5.32 Regression of CSTO/CRP on the transformed variables

After Removing Multicollinearity

Dependent Variable.. CODCRP csto/crp

Independent Variable(s)
1. CEDCRP ce/crp
2. TEN2DCRP tender2/crp

Multiple R	.86854
R Square	.75437
Standard Error	59.27157

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	291311.40373	291311.40373
Residual	27	94854.22898	3513.11959

F = 82.92100 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
CEDCRP	.165749	.018202	.868544	9.106	.0000
(Constant)	10.946467	12.195633		.898	.3773

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
TEN2DCRP	-.084566	-.170568	.999268	-.883	.3855

Residual Statistics

	Min	Max
*ZRESID	-2.9752	2.7292

Table 5.33 Regression of Time Overruns on the 9 variables

Dependent Variable.. TMO time overrun - weeks

Independent Variable(s)

1.. TENDER2 open tendering
2.. TYPE2 commercial building
3.. TYPE4 industrial building
4.. TRP time risk - probability (tr/60)
5.. CE Estimated contract sum - adjusted to 1999
6.. CLIENT type of client
7.. TYPE3 institutional building
8.. TENDER1 selective tendering
9.. TYPE1 residential building

Multiple R	.54002
R Square	.29163
Adjusted R Square	.02599
Standard Error	30.42293

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	9	9144.87882	1016.09765
Residual	24	22213.30500	925.55438

F = 1.09783 Signif F = .4006

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
TRP	54.881209	32.827423	.338695	1.672	.1076
CE	.001666	.076550	.004180	.022	.9828
TYPE1	18.167187	24.907033	.290706	.729	.4728
TYPE2	36.323717	26.827464	.559546	1.354	.1884
TYPE3	10.432814	27.119191	.138905	.385	.7038
TYPE4	-2.561831	38.662947	-.014253	-.066	.9477
CLIENT	3.767165	15.006084	.054726	.251	.8039

TENDER	4.502404	17.038723	.062887	.264	.7938
TENDER2	4.484893	24.539999	.041887	.183	.8565
(Constant)	-25.531654	40.506269		-.630	.5344

Residuals Statistics:

	Min	Max
*ZRESID	-1.2627	3.3965

Table 5.34 Regression of TMO/TRP on the transformed variables

(A) All the Variables

Dependent Variable.. TODTRP tmo/trp

Independent Variable(s)
1.. TEN2DTRP tender2/trp
2.. CEDTRP ce/trp
3.. TP2DTRP type2/trp
4.. TP4DTRP type4/trp
5.. TP1DTRP type1/trp
6.. CLNTDTRP client/trp
7.. TEN1DTRP tender1/trp
8.. TP3DTRP type3/trp
9.. RECITRP 1/trp

Multiple R	.82485
R Square	.68037
Adjusted R Square	.55530
Standard Error	62.57882

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	9	191725.90476	21302.87831
Residual	23	90070.49544	3916.10850

F = 5.43981 Signif F = .0005

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T

RECITRP	-40.094590	37.281884	-5.978108	-1.075	.2933
CEDTRP	.034108	.033916	.211691	1.006	.3250
TP1DTRP	24.669313	25.410929	.325455	.971	.3417
TP2DTRP	36.579710	27.728159	.392961	1.319	.2001
TP3DTRP	16.406558	26.282450	2.529789	.624	.5386
TP4DTRP	-1.781778	36.782085	-.007627	-.048	.9618
CLNTDTRP	16.062256	12.905645	2.427899	1.245	.2258
TEN1DTRP	11.746280	16.752024	1.770869	.701	.4902
TEN2DTRP	11.457023	28.265560	.069546	.405	.6890
(Constant)	39.707775	26.538225		1.496	.1482

(B) Only Significant Variables

Multiple R	.77852
R Square	.60609
Adjusted R Square	.59338
Standard Error	59.83926

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	170793.55069	170793.55069
Residual	31	111002.84951	3580.73708

F = 47.69788 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
CLNTDTRP	5.150435	.745752	.778517	6.906	.0000
(Constant)	48.955150	11.120184		4.402	.0001

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
RECITRP	.292109	.035765	.005905	.196	.8459
CEDTRP	.260654	.244659	.347052	1.382	.1772
TP1DTRP	.044899	.070621	.974493	.388	.7009
TP2DTRP	.146337	.228211	.958003	1.284	.2090
TP3DTRP	-.438380	-.069225	.009822	-.380	.7066
TP4DTRP	-.098864	-.157414	.998642	-.873	.3896

TEN1DTRP	.503148	.087587	.011937	.482	.6336
TEN2DTRP	-.063376	-.100674	.994007	-.554	.5835

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*ZRESID	-.9689	3.6055	.0000	.9843	33

Table 5.36 Regression of CSTO/CRP on the transformed variables

After Resolving Multicollinearity

Dependent Variable.. TODTRP tmo/trp

Independent Variable(s)
1.. TEN2DTRP tender2/trp
2.. TP4DTRP type4/trp
3.. RECITRP 1/trp
4.. TP2DTRP type2/trp
5.. TP1DTRP type1/trp

Multiple R	.77794
R Square	.60519
Adjusted R Square	.59245
Standard Error	59.90745

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	170540.43890	170540.43890
Residual	31	111255.96130	3588.90198

F = 47.51883 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
RECITRP	5.217567	.756894	.777940	6.893	.0000
(Constant)	45.383795	11.325734		4.007	.0004

------------- Variables not in the Equation -------------

APPENDIX F

CORRELATION ANALYSIS

Table 5.35 Correlation Coefficients

	1/TRP	CE/TRP	TP1/TRP	TP2/TRP	TP3/TRP	TP4/TRP
1/TRP	1.0000	.8165	-.1826	-.1635	.9977	-.0453
	(33)	(33)	(33)	(33)	(33)	(33)
	P= .	P= .000	P= .309	P= .363	P= .000	P= .802
CE/TRP	.8165	1.0000	-.1920	-.0064	.8104	-.0623
	(33)	(33)	(33)	(33)	(33)	(33)
	P= .000	P= .	P= .284	P= .972	P= .000	P= .731
TP1/TRP	-.1826	-.1920	1.0000	-.4341	-.2096	-.1202
	(33)	(33)	(36)	(35)	(34)	(36)
	P= .309	P= .284	P= .	P= .009	P= .234	P= .485
TP2/TRP	-.1635	-.0064	-.4341	1.0000	-.1783	-.1024
	(33)	(33)	(35)	(35)	(33)	(35)
	P= .363	P= .972	P= .009	P= .	P= .321	P= .558
TP3/TRP	.9977	.8104	-.2096	-.1783	1.0000	-.0491
	(33)	(33)	(34)	(33)	(34)	(34)
	P= .000	P= .000	P= .234	P= .321	P= .	P= .783
TP4/TRP	-.0453	-.0623	-.1202	-.1024	-.0491	1.0000
	(33)	(33)	(36)	(35)	(34)	(36)
	P= .802	P= .731	P= .485	P= .558	P= .783	P= .
CLNT/TRP	.9970	.8081	-.1597	-.2049	.9951	-.0369
	(33)	(33)	(33)	(33)	(33)	(33)
	P= .000	P= .000	P= .375	P= .253	P= .000	P= .839
TEN1/TRP	.9982	.8160	-.1831	-.1590	.9962	-.0389
	(33)	(33)	(33)	(33)	(33)	(33)
	P= .000	P= .000	P= .308	P= .377	P= .000	P= .830
TEN2/TRP	-.0841	-.0513	-.0984	-.0659	-.0842	-.0489
	(33)	(33)	(36)	(35)	(34)	(36)
	P= .642	P= .777	P= .568	P= .707	P= .636	P= .777

(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed

Variable	Beta In	Partial	Min Toler	T	Sig T
TP1DTRP	.063570	.099471	.966666	.548	.5881
TP2DTRP	.110844	.174033	.973252	.968	.3408
TP4DTRP	-.092384	-.146877	.997950	-.813	.4225
TEN2DTRP	-.058272	-.092411	.992932	-.508	.6149

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*ZRESID	-.9799	3.5073	.0000	.9843	33

APPENDIX F

CORRELATION ANALYSIS

Table 5.35 Correlation Coefficients

	1/TRP	CE/TRP	TP1/TRP	TP2/TRP	TP3/TRP	TP4/TRP
1/TRP	1.0000 (33) P= .	.8165 (33) P= .000	-.1826 (33) P= .309	-.1635 (33) P= .363	.9977 (33) P= .000	-.0453 (33) P= .802
CE/TRP	.8165 (33) P= .000	1.0000 (33) P= .	-.1920 (33) P= .284	-.0064 (33) P= .972	.8104 (33) P= .000	-.0623 (33) P= .731
TP1/TRP	-.1826 (33) P= .309	-.1920 (33) P= .284	1.0000 (36) P= .	-.4341 (35) P= .009	-.2096 (34) P= .234	-.1202 (36) P= .485
TP2/TRP	-.1635 (33) P= .363	-.0064 (33) P= .972	-.4341 (35) P= .009	1.0000 (35) P= .	-.1783 (33) P= .321	-.1024 (35) P= .558
TP3/TRP	.9977 (33) P= .000	.8104 (33) P= .000	-.2096 (34) P= .234	-.1783 (33) P= .321	1.0000 (34) P= .	-.0491 (34) P= .783
TP4/TRP	-.0453 (33) P= .802	-.0623 (33) P= .731	-.1202 (36) P= .485	-.1024 (35) P= .558	-.0491 (34) P= .783	1.0000 (36) P= .
CLNT/TRP	.9970 (33) P= .000	.8081 (33) P= .000	-.1597 (33) P= .375	-.2049 (33) P= .253	.9951 (33) P= .000	-.0369 (33) P= .839
TEN1/TRP	.9982 (33) P= .000	.8160 (33) P= .000	-.1831 (33) P= .308	-.1590 (33) P= .377	.9962 (33) P= .000	-.0389 (33) P= .830
TEN2/TRP	-.0841 (33) P= .642	-.0513 (33) P= .777	-.0984 (36) P= .568	-.0659 (35) P= .707	-.0842 (34) P= .636	-.0489 (36) P= .777

(Coefficient / (Cases) / 2-tailed Significance)
" . " is printed if a coefficient cannot be computed

-- Correlation Coefficients (Cont'd) -

	CLNT/TRP	TEN1/TRP	TEN2/TRP
1/TRP	.9970 (33) P= .000	.9982 (33) P= .000	-.0841 (33) P= .642
CE/TRP	.8081 (33) P= .000	.8160 (33) P= .000	-.0513 (33) P= .777
TP1/TRP	-.1597 (33) P= .375	-.1831 (33) P= .308	-.0984 (36) P= .568
TP2/TRP	-.2049 (33) P= .253	-.1590 (33) P= .377	-.0659 (35) P= .707
TP3/TRP	.9951 (33) P= .000	.9962 (33) P= .000	-.0842 (34) P= .636
TP4/TRP	-.0369 (33) P= .839	-.0389 (33) P= .830	-.0489 (36) P= .777
CLNT/TRP	1.0000 (33) P= .	.9940 (33) P= .000	-.0774 (33) P= .669
TEN1/TRP	.9940 (33) P= .000	1.0000 (33) P= .	-.1171 (33) P= .516
TEN2/TRP	-.0774 (33) P= .669	-.1171 (33) P= .516	1.0000 (36) P= .

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed