

**AN INVESTIGATION INTO
RISK MANAGEMENT : RESPONSE IN
HANDLING BUILDING MATERIALS
ON CONSTRUCTION SITES IN KENYA**

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**A research project submitted in partial fulfilment
for the award of the degree, Master of Arts in
Construction Management**

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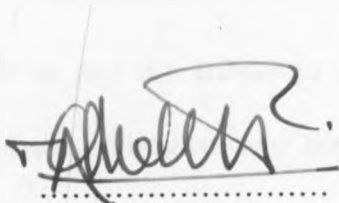


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DECLARATION

I, Tom Onyango Oketch, hereby declare that this research project is my original work and has not been presented for an award of a degree in any other University.

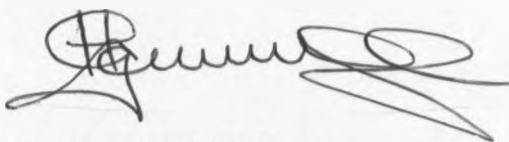


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Jehovah-Jireh “the Lord will provide”, literally enabled me to complete this work and to Him I am grateful.

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DEDICATION

I wish to dedicate this work to my wife, Patricia and our three children, Adonijah, Miriam and Albert for their encouragement, understanding, support and love throughout the course of doing this work.

ABSTRACT

The main aim of this study was to investigate risk management response in the handling of building materials on construction sites in Kenya.

In the building contract, the contractor's main obligation is to carry out and complete the works, where as, the employer is to pay the contractor the contract sum. The contract sum, comprises cost of materials, labour, plant, equipment, contractor's profit and overheads. It is the contractor's responsibility to ensure the sufficiency of his tender before entering into the contract. Construction sites are exposed to various risks such as workmanship, storage, transit, theft, damage etc, that may affect material handling and consequently, cost of production. In pricing his tender, the contractor is deemed to incorporate all the risks, which the building contract allocates to him.

Handling of building materials on construction sites is part of the production process, which commences with delivery of building materials to the construction site up to the point of fixing them in position. Material handling represents a major portion of total costs and may account for 10-80% of total cost, (Amrine, 1993). In the computation of the tender sum, the contractor normally allows a proportion of the material cost for material handling. This is normally based on the skill and past experience of the contractor. However, the eventual handling cost depends on the site organization and management.

It has been observed that theft of materials is prevalent on construction sites, (Omondi, 1992) and that is one of the major causes of loss of building materials on site. Waste is one of the most serious aspects of site production and little is done to avoid this financial loss, (Edmeads, 1972). Consequently, there is a likelihood that a contractor may meet losses arising from the handling of building materials.

Responses to these risks may be through contingency funding, insurance cover, risk reduction and/or retention.

The objectives of this study are to: -

- (i) identify the nature of risks involved in the handling of building materials.
- (ii) investigate the measures undertaken in risk response by contractors.
- (iii) establish the proportion of material loss on construction sites,
- (iv) recommend the appropriate measures of risk response.

The target population in the study comprised of construction sites within Nairobi City Council. A sample of 47 construction sites were studied. Primary data was collected through administering of questionnaires to contractors. Secondary data was obtained from books, journals, research papers and documented reports.

The primary data was analysed using frequencies, descriptive statistics (mean, mode etc) and the Spearman's rank correlation. The correlation analysis was applied to determine the relationship between the variables and hypothesis testing.

The types of risk on material handling were identified as storage, transit, workmanship, theft and damage. It was observed that most construction sites experienced loss of one material or the other. Risk retention was the most popular response measure considered at tender stage. It was observed that the final proportion of wastage on materials always exceeded the proportion allowed at tender stage.

The objectives of the study were fulfilled and risk transfer was recommended as the most appropriate method of risk response in controlling material losses on construction sites.

The contingency approach and subcontracting as a way of reducing material losses were suggested as areas of further study.

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LIST OF ABBREVIATIONS AND ACRONYMS

JBC	Joint Building Council
PVC	Poly Vinyl Chloride
FIFO	First in First Out
CIC-MHE	College Industry Council on Materials Handling Education
VAT	Value Added Tax

CHAPTER I

INTRODUCTION

1.1 BACKGROUND INFORMATION

The production process on a construction site involves several participants, materials, labour, plant and equipment. Construction sites are exposed to various risks that affect the cost of construction. The expenditure on building materials usually represents more than half the direct cost. There is likelihood that a contractor may incur a loss arising from handling of building materials on construction site. It is important that the various risks on construction sites are responded to by the most appropriate method.

The construction site is viewed as a factory in itself, where the end product is the building. The construction process involves design and production. The building team comprises several participants. The employer, architect, quantity surveyor, and the engineers form the design team. The contractor, sub-contractors and suppliers form the production team.

The building contract is between the employer and the contractor. The contractor's main obligation is to carry out and complete the works shown upon the contract drawings and as described by or referred to in the contract bills of quantities or specifications. In consideration, the employer, who is the other contracting party, is to pay the contractor the contract sum. The contract sum comprises cost of materials, labour, plant, equipment, contractor's profit and overheads.

Invariably, the contractor is selected through a tendering process. It is the contractor's responsibility to ensure the sufficiency of his tender before entering into the contract. In pricing his tender, the contractor is deemed to incorporate all the risks, which the building contract allocates to him.

The employer as promoter of the construction project, contracts the architect and other members of the design team to translate what the employer intends to build into drawings, specifications and to supervise the production process. Engineers provide information on the structures and the building services whereas, quantity surveyors provide estimates and information on the cost-effectiveness of various aspects of the construction project. Members of the design team enter into a contract of engagement with the employer. The contract of engagement stipulates the responsibilities of the consultants in rendering their services including the employer's obligations. The contractor does not have a contractual relationship with members of the design team. He, however, has a working relationship with them. The design team serves as the employer's agents in order to produce a finished product, which satisfies the employer.

The employer or the architect gives possession of the site to the contractor on, or before the date of commencement stated in the building contract. The contractor is required to commence the execution of the work and diligently proceed, completing on or before the date of practical completion stated in the building contract. The main obligation of the contractor is to carry out, superintend upon, complete the work and rectify any defects

appearing therein in accordance with the building contract to the reasonable satisfaction of the architect, unless it is legally or physically impossible to do so.

The specifications of all building materials and workmanship are included in the contract documents. All building materials reaching the construction site are basically 'in transit' as their destination is the point of fixing.

Suppliers may deliver building materials to the construction site and it is the contractor's responsibility to unload, store and protect against any damage or loss.

Construction sites are exposed to financial, political, physical and legal risks that affect the cost of construction. Samson (1959) asserts that the expenditure on building materials usually represents over 50% of the direct cost. Gobourne (1982) suggests materials account for 65% of the total cost. Hence, any loss or damage of building materials is of cardinal importance. Whereas, the terms and conditions in the building contract seek to identify and manage risks, there is a likelihood that a contractor may incur losses arising from the handling of building materials on construction site. Risk management involves the process of sharing risks.

1.2 PROBLEM STATEMENT

In the computation of the tender sum, a contractor normally allows a proportion of the material cost as a contingency against any anticipated material losses. During construction, site conditions may vary from what was predicted at tender stage.

Losses of building materials occur in almost every site. It has been observed that theft of materials is prevalent on construction sites, (Omondi, 1992) and that it is one of the major causes of loss of building materials on site (Shelfter, 1983).

Thairu (1999) observes that wastage of materials is a major problem on construction sites, and established that the levels of wastage of materials were high. Edmeads (1972) states that waste is one of the most serious aspects of site production and little is done to avoid this financial loss. The problem of wastage starts at the point of storage and continues right through to the point of fixing.

The general implication is that the amount of building material wastage on construction sites due to material handling is significant and may exceed the allowable levels thus resulting in losses to the contractor.

Material handling represents a major portion of production costs for every type of business. Reducing material handling costs allows a profit-oriented businessman to maintain a competitive edge. An effective materials handling system will lead to less time on site, less losses and instead higher savings in materials, (Chandler, 1978).

Skoyles (1974) states that there are two main factors of material handling which result to material wastage on a construction site. These are “careless handling of materials resulting in damage” and ‘multiple handling of materials resulting to waste due to excessive handling and transportation’. Material handling should be planned to coincide with other site activities.

Materials control project schedules and is inevitable for contractors that such losses of building materials or wastage would cause delays in construction. Delays in ordering materials to replace lost or damaged ones further lead to delays especially if the materials are for activities that lie on the critical path of the project.

In addition to the provision for liquidated and ascertained damages, which may be imposed on the contractor by the building contract, delay in completing building projects on time would make the contractor suffer by creating uncertainty. Delays usually affect the performance of a building project negatively through fluctuations in cost of building materials and labour.

Green (1968) defines risk as the uncertainty that exists as to the occurrence of some event that causes economic loss or gain. According to (Flanagam & Norman, 1993) formal and empirical risk management techniques have been used to identify, measure and respond to risks. However, risk management in building projects in Kenya still remains rudimentary, (Gichunge, 2000). Generally, the application of risk response at construction sites in Kenya is still informal and intuitive.

Responses to risks arising from handling of building materials may be through contingency funding, insurance covers, risk reduction and/or retention. Risk retention is the most common. Risk transfer by insurances is complex and requires thorough knowledge, which many contractors may not possess. The insurance policies are normally standard and tend to dictate the rules of the game. Where there is indemnity against loss, the cause of action does not commence until the loss has been established and investigated.

From the foregoing discussion, this study is guided by the following questions, which it attempts to answer.

1. What are the risks involved in the handling of building materials on construction sites?
2. What are the measures undertaken in risk response in the handling of building materials on construction sites?
3. What is the proportion of material loss on construction sites?
4. What are the appropriate measures of risk response?

1.3 OBJECTIVES

The overall aim of this study was to investigate risk management response in the handling of building materials on construction sites in Kenya. In order to achieve this aim, the composite objectives of the study are:-

1. To identify the risks involved in the handling of building materials on construction sites.
2. To investigate measures undertaken in risk response in the handling of building materials on construction sites.
3. To establish the proportion of material loss on construction sites
4. To recommend on the appropriate measures of risks response.

1.4 HYPOTHESIS

The proportion of building material losses increases as risk response measures in the handling of building materials decreases.

1.5 SCOPE OF THE STUDY

The study was carried out in Nairobi. Nairobi City, which has diverse construction sites with, the largest share of big building projects, amounting to over 70% of the national total output. Nairobi has several construction sites within close proximity. The construction sites or site organizations do not differ greatly with those in other towns. Nairobi is a favourable area of study due to resource constraints especially on time and finance. The study covers risk factors that occur in the handling of building materials during the construction stage.

The study focused on cement, sand and paint as building materials. These materials are chosen due to their extensive use at various stages of construction process. Cement, sand and paint are the main building materials used in wet construction that are incorporated and covered in the Joint Building Council (JBC) fluctuations list. The other building materials found in the JBC fluctuations list are aggregate, steel reinforcement bars, fabric mesh reinforcement, structural steel, concrete block, building stone, clay products, asbestos cement sheeting, iron sheets, vinylex floor tiles, Poly Vinyl Chloride (PVC) pipes, galvanised pipes, timber, concrete roofing tiles, bitumen and mastic asphalt. These materials are mainly used in dry construction.

Building materials used in wet construction tend to be associated with high wastage. This is supported by the level of allowances for building and shrinkages recommended by JBC fluctuations practice notes 2002/01. Cement, sand and paint would capture the varied forms of material wastage on construction sites.

1.6 SIGNIFICANCE OF THE STUDY

The significance of this study is to assist contractors and other stakeholders in the construction industry to improve on the handling of building materials on construction sites. This would improve productivity on construction sites and reduce construction costs. The results of this study would assist building consultants and contractors assess anticipated losses due to the handling of building materials with sufficient accuracy and objectivity. It would assist them in structuring effective methods of responding to the risks thereby minimizing the actual losses experienced. The JBC publishes practice notes

on the computation of cost fluctuations on building materials. It recommends percentages on cost to cover for wastes. The results of this study would be useful as a basis for reviewing such allowances for waste. Risks always occur on the construction site and this study would examine the contribution of risks involved in handling of building materials.

1.7 ASSUMPTIONS

1. The estimator is competent and his computation for allowable material wastage is reliable.
2. The estimator is pricing under competitive market conditions.
3. Changes in quantities due to variations have been taken into account.

1.8 DEFINITION OF TERMS

The words used herein shall be deemed to mean as stated below:

- Main contractor or Contractor:** A person or firm that has been awarded a contract for the construction and completion of a building.
- Client:** Employer, developer or building owner. He is the employer of the contractor and the members of the design team.
- Design team:** The Architect, Engineers and Quantity Surveyor engaged by the Employer for design and supervision of the construction of the building.

Building materials:	Materials delivered to a building site and to be incorporated as permanent works.
Site:	Building and construction site refers to space that the contractor has taken possession for the purposes of executing the building contract.
J.B.C:	Joint Building Council, Kenya.
Contract:	Building or construction contract refers to agreement and conditions of contract for building works. Published by J.B.C, April 1999 edition.

1.9 OUTLINE OF THE STUDY

CHAPTER I covers the introduction, background information and the problem statement in terms of risk management response in material handling on building sites, the objectives of the study, hypothesis, scope, significance, assumptions, definitions and the outline of the study.

CHAPTER II discusses literature review.

CHAPTER III covers research methodology used in this study.

CHAPTER IV presents data analysis and discussion of findings.

CHAPTER V covers the conclusion and recommendations based on the study findings, and areas for further research.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews past studies done relevant to the current study with the aim of identifying gaps. The chapter is divided into two broad themes of material handling and concept or risk and uncertainty.

2.2 MATERIAL HANDLING

Handling of materials on a construction site is part of material management, which has an important role in determining the efficient utilization of resources for the building. The handling of materials is a part of the production process, which commences with the deliveries on site up to the point of fixing in position. This is a continuous process that involves minimization of wastage during transportation and handling on site.

Material handling is the art and science of implementing movement in an economical and safe manner. It is not a new endeavour. The first humans who were created faced the problem of transporting both themselves and the materials they needed. Through the years people have learned to apply mechanical principles such as the wheel, lever and inclined surface to provide for easier, faster and safer movement.

History has recorded continual progress in material handling. In the Holy Bible reference, God told David he would not be the one to build the temple. Instead, the task

would be left to his son, Solomon. David made preparations for Solomon to carry out his task. He gathered funds and materials for the temple. In addition, he appointed stonecutters to prepare dressed stone, large amounts of iron to make nails for the doors and fittings, cedar logs, gold, silver and bronze.

In the ancient world, there were the construction of the pyramids in Egypt and the pre-Inca temple near Cuzco, Peru. These are ancient engineering marvels as stone weighing up to 20 tons were moved over 2000 feet high.

Material handling is common to all types of business; the construction site is no exception. Material handling activities can be found at all levels on a construction site. Handling starts with an individual work area, involving one person. A work centre requires movement between various employees. Materials then flow within individual work centres and then between work centers (Magad, 1995). Contractors with multiple facilities transport materials between various locations.

2.2.1 Material Handling Costs

Material handling represents a major portion of total costs for every type of business. Depending upon the nature of the industry and type of facility, material handling may account for 10-80 percent of total costs (Amrine, 1993). This may be more applicable in the manufacturing industry. In construction, this would be a high cost especially where minimization of total material handling costs requires a contractor to maintain a competitive edge. Material handling costs can be reduced by various approaches. One

method would be to directly reduce an existing expense item. For example, a contractor who uses forklift to move materials through the site can reduce its total lifting costs by replacing older forklifts with newer and highly productive ones. Another approach would be to invest in equipment that would reduce material handling activities by individual employees.

According to (Datta, 2003) it has been estimated that 20-50% of the labour cost are associated with handling and storage. There are many types of material handling equipment. In material handling every operation involves picking up, moving, lowering and sorting materials. The use of mechanized systems can be an effective means of cost reduction.

In order for the contractor to control material handling costs, he must identify the general sources of potential savings. The major sources of material handling costs are storage space, labour, inventory, security and waste.

- *Storage:* Improvements in storage utilization can reduce costs. The tendency is always for the contractor to build a bigger storage facility as a solution to apparent shortage of space.
- *Labour:* In labour intensive operations, there are many opportunities to reduce handling costs. The use of mechanized and automated systems can be an effective means of cost reduction. Mechanization also reduces the possibility of accidents. Manual handling is a common source of injuries.

- *Inventory:* A contractor would try to minimize inventories, as inventory reduction offers tremendous cost-reduction opportunities. For example, reduction in storage costs and site security.
- *Security:* Theft of building materials is prevalent on construction sites and it is the major cause of loss of building materials. Theft on construction site can be minimized by adequate security system provided by the contractor or hired from professional security firm.
- *Wastage:* Controlling damage to materials is one of the most common ways to reduce costs. Wastage of materials depends on the initial layout of the material handling system. The storage system has to consider the shelf life of stored items since some materials are more susceptible to spoilage than others. For others First in First Out (FIFO) station of stock ensures early dispersal of the older stock.

2.2.2 Material Handling Principles

Webster's New World Dictionary defines a principle as a fundamental truth, law, doctrine, or motivating force upon which others are based. There are basic material handling principles that would be the same irrespective of the industry. Datta (2003) has listed the following principles: -

- *Least handling is best handling:* Handling does not add value to the building. Keep handling costs to the minimum. Avoid rehandling and coordinate handling activities with suppliers and transporters.
- *Standardization of equipment:* Selection of equipment should allow flexibility and capability of performing multiple operations, but standardized. Establish and adhere

to standard container sizes. Specification of standard equipment reduces spare parts inventories and also reduces maintenance, repair and storage costs.

- *Specialized equipment kept to a minimum:* Generally, specialized equipment have high initial cost, including installation, maintenance and repair. Use equipment that can perform a variety of tasks under different conditions.
- *Volume dictates the method:* The most important criterion is the volume. The volume determines the method of handling.
- *Planning ahead:* Establish a plan that includes basic requirements and consideration of contingencies for all material handling and storage. Selection and procurement of material handling should be conducted in advance.
- *Length and number of moves:* There should be no “backtracking” of materials.
- *Equipment capacity:* Overloading of equipment causes undue wear, entails excessive maintenance and repair cost. Capacity rates should recognize human capabilities and limitations in order to reduce potential accident hazards.
- *Analysis of operation:* All operations must be analysed in order to simplify handling activities. Eliminate, reduce, or combine unnecessary movements and/or equipments. Minimize employee walking by strategic location of materials, equipment control etc.
- *Payload:* Compare the economic justification of alternative solution in equipment. Select a common, convenient, standard unit to ensure equitable comparisons. Compare methods on the basis of economic effectiveness as measured by expense per unit handled.

- *Straight flowline*: The shortest distance between two given points is a straight line.
- *Standardization of method*: Standardization of methods enables time to be fixed and wastage of time, labour and equipment eliminated. Develop written procedures that provide standard methods for all handling activities.
- *Short irregular moves*: Deployment of equipment on short non-repetitive moves may be more costly than manpower. If the load capacity does not exceed the manpower, it is economical to use manual labour for short and irregular moves.
- *Preposition of materials*: When loading and unloading, excessive work can be reduced if the layout is properly planned.
- *Loading and unloading*: The main activity of the material handling lies in loading and unloading. Wherever economical, loading and unloading should be done using mechanical devices such as cranes, hoists, forklifts etc. This principle reduces the possibility of loss, damage and accident hazards. In the process safety and protection is increased.

Magad (1995), the College Industry Council on Materials Handling Education department of (CIC-MHE) is an independent organization that prepares and provides information, materials and activities to support material handling. Education and research department of CIC-MHE supported by the Material Handling Institute, Inc., developed 20 principles of material handling. In addition to the above there are: -

- *Ecology principle*: Minimize adverse effects on the environment when selecting material handling equipments and procedures.

- *Computerization principle:* Consider computerization in material handling and storage systems, when circumstances warrant, for improved material and information control.

These principles represent the practice over a long period of time and to some extent they are merely application of common sense.

2.2.3 Material Wastage

Material wastage may be defined as the difference between the net measurement on drawings and the necessary allowance for any wastage that is unavoidable. Material wastage that is attributable to problems of poor material handling is due to one or a combination of the following factors: -

- Poor workmanship
- Construction errors
- Excessive use of materials e.g. mortar and concrete
- Breakage
- Poor storage
- Misdemeanour

Material handling on construction site is entirely the responsibility of the contractor.

Building materials wastage falls into two categories i.e. avoidable and unavoidable.

Avoidable waste can be controlled and reduced through sound site management.

Unavoidable waste refers to that part of material considered by the estimator to be normal to the production process. According to the Standard Method of Measurements of Building Works all quantities must be given net, as they will appear in the completed

building. The material waste must be reflected in the unit prices. The wastage allowance depends on the skill and experience of the estimator. This will also vary from firm to firm depending on the efficiency of the site foremen. Wainwright (1970) further classifies the unavoidable waste into six broad categories as follows: -

- *Conversion waste* - when cutting small timber scantlings from bulks of timber or logs.
- *Cutting waste* - when sheet materials have to be cut for a specific component e.g. plywood, block boards, plasterboard and felt.
- *Application waste* - occurs with most wet building materials such as plaster and other finishings. This includes wastage on many other materials such as bricks, tiles and timbers, which are cut to length.
- *Stockpile waste* - when most loose materials are dispersed on the site because of partial use e.g. aggregate, sand.
- *Residue waste* - occurs with paints, glues and other materials, which are normally delivered in containers, and are never completely used.
- *Transit waste* - occurs with brittle materials, which break on transit such as glass and tiles.

The extent of unavoidable waste is generally known within reasonable limits and is taken into account with some precision when tendering.

The standard for unavoidable wastage of building materials will depend upon various factors as indicated above including nature of work, type of material, method of application etc. Table 2.1 below, illustrates typical unavoidable wastage considered when estimating materials for housing.

No.	Type of Materials	Planned Wastage
1.	Cement	2%
2.	Sand	10%
3.	Aggregate	5%
4.	Concrete structural	2%
5.	Concrete blinding (lean)	10%
6.	Reinforcement steel bars	3%
7.	Reinforcement steel mesh	10%
8.	PVC sheeting	15%
9.	Steel for windows	7%
10.	Timbering in trenches	5%
11.	Stone Masonry	5%
12.	Marble lining	20%
13.	Wood for door frames	5 to 7.5%
14.	Wood for shutters	10%
15.	Wood for flooring/walling	5 to 10%
16.	Sheet roofing	2.1/2%
17.	Tile roofing	5%
18.	Floor tiling	2 to 5%
19.	Wall tiling	3%
20.	Pigments (for colours other than natural grey)	5%
21.	Paints	5%

Table 2.1: Construction Materials Wastage Planning Norms

Source: Mbaya (1997)

Hall (1972) suggests, generally, a percentage on the supply price varying between 2½% and 15%. This waste occurs after the materials have been unloaded and stored on site.

The avoidable waste is mainly caused by: -

- Designer's specification of non-standard materials
- Wrongful purchases
- Wastage in transportation
- Damages

- Poor storage resulting in deterioration, obsolescence
- Poor workmanship

The minimization of avoidable waste depends on site management.

Bulking and shrinkages

In wet construction, a reduction in bulk of the constituent materials takes place due to the finer material filling the interstices of the coarse aggregate, the compaction and the addition of water. Shrinkages in concrete for example would vary depending on the estimator.

Mixes	Bulking/Shrinkage allowance
1:4:8	50%
1:3:6	35%
1:2:4	25%
1:1½:3	15%
1:1:2	5%

Source: JBC (2002)

Shrinkage and bulking should be included by the estimator as planned wastage.

2.2.4 Site Management

Site management involves the process of organizing the resources i.e. plant, equipment, labour and materials in order to be efficient and cost effective during the production process. Site management tackles the sequence of activities at the site in order to minimize time wasting and material wastage. There should be improved efficiency and effectiveness towards the realization of the project goals and objectives. Material handling is an important aspect of site management because it would affect the flow of activities throughout the construction period. One should avoid multiple handling of materials, tools, plant, equipment or hindrance to the sequential flow of activities.

2.2.4.1 Site Organization

The following personnel would normally be needed on construction site:

- Site Manager
- Clerks of Works
- General Foremen
- Trades Foremen
- Store Keeper
- Operatives

Site Manager

Has the responsibility of managing the site activities on a specific site in order to obtain desired objectives. The site manager co-ordinates the work of the contractor and sub-contractors and instructs the operatives through the general foreman. The site manager is

also in charge of other issues on site such as recruitment of labour, health, safety and welfare of the workers, supply of materials etc. He/she also deals with daily correspondence on site. A site manager must have good relationship qualities and competence in analytical skills.

Clerk of Works

The client, through the architect, appoints the clerk of works. He/she therefore oversees the work on behalf of the architect. He/she can also issue instructions to the contractor via the site manager if so directed by the architect and also in accordance with the contract. The relationship between the clerk of works and the site manager is not direct, only functional.

General foreman

He/she receives instructions from the architect via the site manager and passes on the information to the supervisors. If there is any information they need from the design team the same channel of communication is used. He/she reports to the site manager.

Plant Manager

The plant manager is in charge of plant and equipment and also making sure that things are on site when needed in order to prevent idle plant and hence check costs. He/she ensures that the equipment and plant required are properly maintained and serviced and is of the capacity to carry out the tasks efficiently and effectively at all times. He/she reports to the site manager.

Trades Foremen

These are supervisors in charge of various trades in the building process for instance, masonry, concreting, carpentry, plastering, etc. Trades foremen are in charge of a particular group (gang) of workers who are involved in carrying out different tasks. Trades foremen must know the technical skills of the work they are supervising otherwise high quality would not be achieved. They must also know how to deal with the operatives, motivating them to finish their work. They report to the general foreman.

Storekeeper

The storekeeper is in charge of handing out materials and equipment and keeping inventory of all things that are in the store. He/she may also be in charge of the workers' welfare. He/she reports to the site manager.

Operatives

They carry out the actual work. They get instructions and directions from the trades foremen.

The following chart shows the relationship

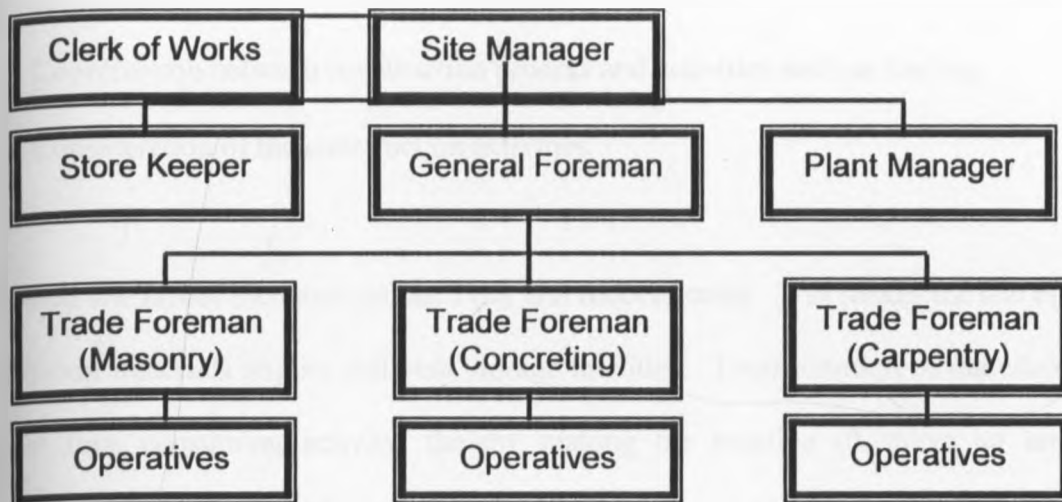


Figure 2.1: Site Organization chart

Source: Field Work (October, 2003)

2.2.4.2 Site Layout Plan

A contractor develops a site layout plan for efficient site management and handling of materials. The site layout shows the planned location of the various facilities. The site layout is planned such that it enhances maximum output and minimizes effort. Thus to develop a type of 'factory floor' on the site, all facilities required for construction are positioned to eliminate interference with flow of work. This increases productivity and reduces the risk of injury and wastage of materials

Various important aspects are considered in the development of the site layout plan including: -

- Materials, plant and people on site
- Storage on site for materials, plant and equipment

- Site access
- Site security
- Coordination between construction process and activities such as loading
- Consideration of the construction activities

A good site layout increases productivity and reduces costs. This makes the site efficient.

Different materials require different storage facilities. Transportation of materials is the most time consuming activity, thereby making the location of stores an important consideration. Due consideration should be given to the following: -

- How materials, people and equipment are going to be moved
- Storage of especially bulky materials
- Security – are there dark areas?
- Coordination between construction activity, stores and unloading areas.

2.2.4.3 Site Security

Security on construction sites should discourage internal pilferage as well as illegal entry.

The form of security should be such that there is a prompt and effective start each morning. Theft on construction sites can be frustrated by adequate security system provided by the contractor or hired from a professional security firm.

The provision of an accounting system reduces the loss of building materials and enables contractors to identify losses on construction site while work is in progress. A good accounting system is essential to identify the extent of losses as they occur and an

opportunity to reduce them. In order to determine the suitability of the system one has to consider the savings achieved against the cost of achieving them.

The systems can be enhanced through improved techniques in handling and storing materials. Site security has to be considered during tendering stages. The factors that need consideration would include number and location of guard posts, fencing, the number of workers in each shift, source and the number of guards required.

Construction sites for housing development suffer more than commercial and industrial development due to the large, ready market existing for all materials and fittings used. Housing development sites are often expansive in area and construction activity of one kind or another may take place on many units concurrently.

Preventive systems on construction sites do not stop the incidence of losses but delay the process. Thieves are generally reluctant in attacking guarded sites. The scheduling of delivery of materials is an important factor. Materials should be scheduled to arrive on site just in time for their use.

2.2.5 Receiving And Storage Of Materials

The materials are delivered on site either by the contractor, suppliers or transporters. The storekeeper receives, unpacks and checks them. He/she tally's with the delivery list and records any damage or shortage. The unpacking report on physical shortage is sent to the

supplier. The site agent inspects items thoroughly. The site supplies officer records entries for the receipt in the stores accounts.

On construction sites, many materials such as cement, paint, rubber, goods etc will carry with them the instruction for special care in handling and storing. The following are some of the determinants on the type of storage.

- How the materials are delivered on site e.g. silos for cement.
- Materials must be stored where they are easily accessible to both the people delivering and using.
- Storage must preserve quality and state at all times.
- Storage must avoid physical damage, usually due to stacking.
- Avoid chemical and insect attack.
- Avoid deterioration due to dampness and other vagaries of the weather.
- Guarantee security

Cement

Cement is delivered on construction sites either in bags or in bulk. Cement delivered in bags is properly sealed and marked with the manufacturer's name. On the site, the cement is stored in a weather-proof shed of adequate dimensions with a raised floor.

Each consignment is kept separate and marked so that it may be used in the sequence in which it is received. Bags found to contain cement, which has set or partly set are to be

completely discarded. Bags of cement are to be stored not more than 1.50 metres in height as stack of one on top of the other.

Cement delivered in bulk is to be stored in weather-proof silos provided by the contractor or the cement supplier.

Sand

Sand is delivered on construction sites and stockpiled on paved areas or boarded platforms in separate units to avoid intermixing. However, this practice is rarely adhered to. On most construction sites sand is stockpiled on the ground making it susceptible to adulteration and more waste.

Paint

Paint is supplied in tins. The paint tins are packed either in a carton or tray. The paint may be stored in stacks with a maximum height not exceeding 10 tins of 1 x 4 litres. The paint should be stored the right way up. The floor surface may be of concrete, timber or steel as long as there is no wetness. Paint can withstand temperatures up to 90 degrees centigrade. Normal room temperature is sufficient for storage. Adulteration of paint is strictly not permitted. Paint may be stored up to a period of one year after that it must be turned upside down to avoid any sedimentation. Each delivery on site should be kept separate and marked so that it may be used in the sequence in which it is received. On the site, paint is stored in a weather-proof shed.

2.2.6 Risk Management

Risk management is the identification, measurement and treatment of property, liability and personnel pure loss exposures, which can affect the cost beneficial, economic and effective operation of buildings, property and related facilities, (South African Property Education Trust, 2001).

Risk management in the handling of building materials involves identification, measurement and treatment of exposures to potential losses. This requires assessment of the effect of significant risks on the site and establishment of ways for dealing with them. These ways may involve transferring, retaining or allocating risks to various parties.

The principal purpose of building contract agreements is to apportion risks between the employer and contractor (Jaafari, 1996). This is achieved by inserting in the tender documents, the type of contract to be used in the execution of the work.

2.2.7 Risk Allocation In The Jbc Conditions Of Contract

Risks are allocated to the parties in the contract. The parties to the building contract are the employer and the contractor. The architect and other members of the design team are by extension agents of the employer. The terms of building contract allocate risks between the employer and the contractor. The building contract allows the transfer of risks by the employer to contractor and vice-versa depending on the circumstances. The parties to the contract should be aware of the risks that they are taking in the building contract.

The employer's major concern is that the project under construction is undertaken in the prescribed manner in terms of quantity, quality and time. The design team has therefore to employ all their resources in providing information to the contractor and supervising the work in order to satisfy the employer's criteria in the terms of reference. The contractor takes into account the magnitude of the work involved and provides resources for the construction of the same. The contractor's main concern is that he is paid amounts of monies owed to him when they fall due. The contractor is exposed to risks of different nature, which are derived from the building contract. For example: -

- *Lack of information:* In order to undertake the work as per the schedule, the contractor requires the project specification. This information may not be available on time. Consequently, any delay would have an effect on the handling of building materials.
- *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. Replacement of wasted materials would have financial implications.
- *Externalities:* Incidences like acts of God i.e. floods, fires etc and strikes by workers would greatly affect the performance of the contractor. Damaged materials would have to be replaced affecting project schedules and contractor's cash flow.

The other constructional risks the contractor faces may arise from factors such as weather, differing site conditions and resource availability.

2.2.7.1 Pure and Speculative Risks

Speculative risks have chances of making a profit or loss whereas pure risks have only a chance for loss. The JBC (1999) building contract proposes ways and means of managing both pure and speculative risks.

The losses that may be suffered due to damages of materials caused by fire or negligence of the contractor including other perils such as acts of God, inclement weather, inter alia are pure risks insurable under workman's compensation policy and the contractor's all risk policy. These pure risks are covered under clause 12-15, JBC (1999)

In the JBC (1999) building contract, there are clauses that are the source of speculative risks. These clauses are examined below: -

- *Clause 7 - Contract documents:* This clause defines the contract documents, which form the main source of information. Information plays a vital role in the three stages of risk management: identification, analysis and response. Information forms the basis of decisions and stimulates action.
- *Clause 8 - Contract bills and contract price:* This clause stipulates the method of measurement of the building works. The scope of work is defined in the preliminaries including other contractors' responsibility such as security of the works, storage of materials and protection of the works. The extent of unavoidable waste that is to be considered in the measurements of the works is also found in the bills of quantities.

- *Clause 22 - Architect's instruction:* The Architect's instruction issued could have the effect of either omission or addition to the contract thereby having a bearing on the materials on site.
- *Clause 23 – Specification of goods, materials and workmanship:* In the handling of materials, the contractor has to ensure that materials conform to the specification. Defective or damaged materials and improper storage of materials may cause the contractor to suffer loss.
- *Clause 27 – Subletting:* Upon giving notice and receiving approval, the contractor may sublet part of the works. The responsibility of handling materials under subcontract would then transfer to the respective subcontractor.
- *Clause 30- Variations:* This clause has an important bearing on speculative risks. Variations affect the handling of building materials. A contractor assumes a certain construction method when he prices his tender. Consequently, variations during construction would seriously affect the handling of building materials.
- *Clause 35 - Fluctuations:* Fluctuations in prices of materials and goods are covered in this clause. This clause is important since some contractors may decline to undertake building contracts, which do not allow for the operation of this clause. Wasted materials may be replaced at a higher cost than envisaged at tender stage.

2.3 CONCEPT OF RISK AND UNCERTAINTY

2.3.1 Introduction

Chambers, 20th century dictionary, defines risk as “chance of loss or injury”. The same dictionary defines uncertain as “not certain; not definitely known or decided; subject to doubt or question.

The Collin’s Dictionary defines risk as a possibility of incurring misfortune or loss or other event on which a claim may be made. 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. The probability of suffering loss may be difficult to determine at the inception of any undertaking. However, the contractor should be in a position to estimate the magnitude of a loss that is likely to occur.

Uher (1990) states 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).

Uncertainty is present on construction sites, irrespective of the size, complexity, and location, of the construction project. Risk stems from uncertainty, which in turn is caused by lack of information, (Flanagan and Norman, 1993).

This scenario is shown below: -



Figure 2.1: Uncertainty

Source: Flanagan and Norman (1993)

Certainty exists only when one can specify exactly what will happen during the period of time covered by the decision. This rarely happens on construction site.

A construction company operates in an environment where there are many uncertainties. Hence, the need to identify, analyse, and evaluate risks by converting uncertainty to risk.

Rosenbloom (1972) states 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. The knowledge of risk is a requisite for a construction company to survive in an unpredictable environment.

Risk transcends entire business life. A businessman should be knowledgeable on the subject of risk in order to counter the negative forces of risk. Crockford (1986) states that awareness of the potential risk is a major step towards meeting it. This is important since the awareness of the risk prepares the risk taker to make provision. The knowledge on the risk helps minimize the effect of the risk.

2.3.2 Classification Of 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 are: *pure* - or *specific risk*, which does not have potential gain and *speculative risk* - which denotes market risk. Speculative risk has a possibility of loss or gain. This risk covers the 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 2.2 below shows the three aspects of the subject of risk.

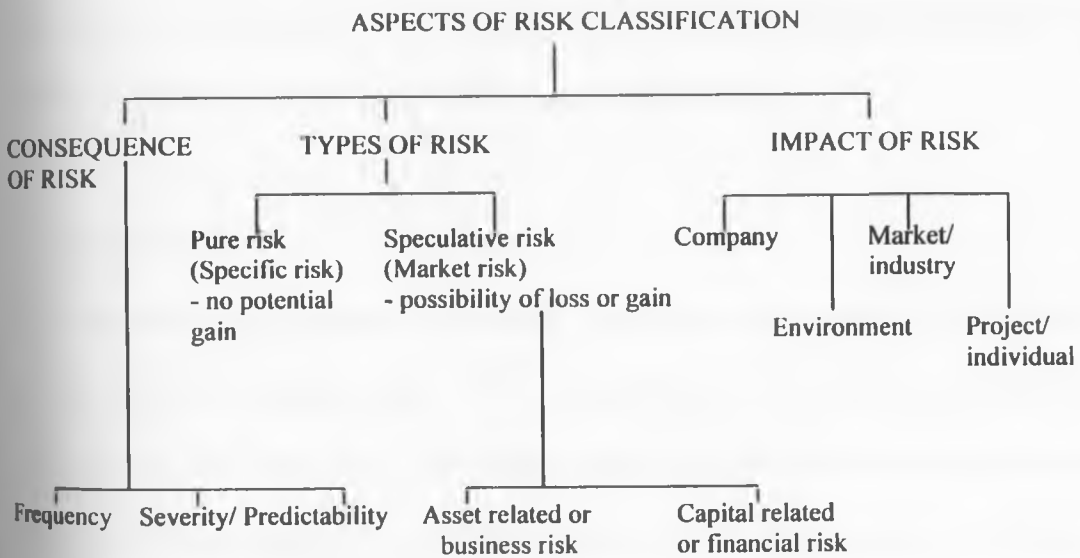


Figure 2.2: Aspect of Risk

Source: Flanagan and Norman (1993)

2.3.2.1 Speculative Risks

Speculative risk is present if either beneficial or adverse outcomes could stem from a specific event. Speculative risks have the notion that there is a possibility of gain or the

chance of a loss. All risks do not have to be avoided since there is a possibility of gain.

This notion acts as a motivator to contractors. This is what drives them to be in business.

Speculative risks arise from management decisions.

➤ **Management Risks**

Management decisions are always called upon from time to time. These decisions are made by managers whose decisions depend on the education background, training and available information. The necessary decision-making is acquired through education and training. Inaccurate decisions may lead a business enterprise to a loss. The handling of building materials is determined by decisions made by the site manager. It is prudent to evaluate the consequences of all management decisions. Management decisions may be affected by market, financial, production and political risks.

➤ **Market Risks**

The contractor is in business to earn profit. The final product should be delivered to the employer at an economic price. The economic price is based on the tender prices submitted by the contractor. The tender prices are themselves determined by market prices. Building materials are subject to market risks due to changes in general price level, taste and level of technology. The period between tendering and the production stage is a major component of market risks.

The fluctuations in the price of building materials create uncertainty as to whether the building would be constructed within the anticipated cost. The price of materials could

change due to forces of supply and demand or government action. The government regulates the customs and excise charges, tariffs, VAT or any other taxes or statutory duties included in the basic price of materials. These duties and taxes may vary from time to time causing changes in the price level of materials.

Fluctuations of building materials affect the cost of construction. It is not an easy task to predict future inflationary trends in any given market. A contractor should have sufficient information in order to make a prudent decision in the market.

➤ **Financial Risks**

The financial policy of a firm is determined by the decisions made on financial risks. Firms have to decide on the source of funds for their short term and long term needs, the amount of profit retained for the growth of the business and the amount declared as dividends. Money loses value with passage of time.

Retained profits are significant in the financial policy of a firm as they are a more preferable source of funds than external funding.

Investment decisions are exceedingly difficult to predict with confidence since the future is uncertain. Accurate decisions are necessary in order to minimize financial risks and avert undesirable consequences such as bankruptcy and liquidation.

➤ ***Production Risks***

Land, capital, labour and technology are the basic factors of production. Each factor plays an intricate part in the production process. Inadequate input of any of the factors affect the production composition resulting in lower production. Any production that does not yield marginal profits would create production risks. Firms are in business to make profit such that production risk that would drive them to losses would face closure.

➤ ***Political Risks***

The government serves as the major regulator of the Construction Industry. This is done through fiscal policies i.e. taxes, tariffs and import restrictions. Government action may create markets that are monopolistic in nature hence influencing the price market directly or protectionist for certain goods and services.

The political system adopted by the government could affect the operations of the labour force. Capitalistic systems produce competition and increased incentives for good remuneration of labour. Socialistic systems lack the competitive nature found in capitalism. The freedom of trade unionism also affects productivity. Political instability and labour unrest affect production. Construction sites where workers feel insecure and therefore in a state of fear are not in a position to be productive.

2.3.2.2 *Pure Risks*

Pure risks exist when there is a chance of loss but no chance of gain. This depends purely on chance.

A construction site may face perils that affect it and perhaps its neighbouring sites. Brealy and Myres (1985) categorize pure risks into two broad categories i.e. unique and market risks. The type of construction is significant in determining the perils that are peculiar to the site or its immediate neighbourhood. Fiscal policy of the government through taxation and protectionism may create economic perils, which affect the contractor at macro-level. Whereas unique risks may be eliminated by diversification, the impact of a government policy may be so great that diversification may not eliminate market risks. Unique and market risks have similar characteristics as those cited under speculative risks. According to Diacon & Carter (1981) and Gichunge (2000) there are at least five sources of pure risk:

1. *Physical damage to assets:* contractors generally have assets in the form of land, buildings, plant, machinery, motor vehicles, stocks etc. These assets may at times be damaged by fire, earthquake, storm, and flood. On construction sites the JBC contract conditions, require insurance of works against these perils to be taken. The magnitude of physical damage may cause a contractor to wind up his operations.

2. *Indirect or consequential losses:* Business transactions take place in an environment where the transaction costs are known. Losses may occur from transactions due to

unexpected changes in the economy. This can be illustrated by the economic recession found in Kenya following the now famous "Goldenberg scandal".

3. *Pecuniary Losses:* Firms are all prone to criminal acts such as fraud and theft by either staff or non-staff. Despite the controls that may be inherent with well-run companies, large sums of money may be fraudulently withdrawn. Unauthorized withdrawals would affect the cash flow position of the company and may lead to closure.
4. *Loss of assets due to responsibilities to others:* In the normal course of business transactions, firms and individuals commission agents to act on their behalf. In other instances business transactions are done through intermediaries. For example in the construction industry, the design team comprising of architects, engineers and quantity surveyors all act on behalf of the developer. Such agency relationship may cause the loss of assets belonging to the developer.
5. *Personnel losses:* These arise from the injury, sickness or death of employees. Considerable resources are spent on education and training of professional staff. Employees who have acquired professional staff are highly valued. The output of a firm depends on the calibre of employees. Death or disability of any professionally trained employee would be a major draw back. Normal operations of the firm are adversely affected by replacement of staff.

2.3.3 Risk As A Concept In Insurance

Risks have been defined as the chance of loss or injury. There is a possibility of incurring misfortune or loss. In any construction work, there is a probability that a contractor may suffer loss. The loss may be difficult to determine at tender stage. Despite this, the contractor should be in a position to estimate the magnitude of loss that is likely to occur.

Levey and Sarrat (1986) describe risk as 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 argument implies that risk depends on chance. However, it is said that one who is forewarned is forearmed. In any business, knowledge of risk is essential. Green (1978) says that being aware of risk enables one to consciously make adjustments in his operations. This would help to alleviate the impact of risk in operations.

The primary function of insurance is to transfer risk. Insurance transfers the financial consequence of the peril to the insurer. Risk forms central core of insurance. Insurance examines the magnitude of risk involved in a company. The information is used to fix the premium to be paid in order to cover the risk. Insurance generally looks at risks from the point of view of pure risks, which result in physical loss of property. The principle that the higher the risk, the more the premium to be paid by the insured applies.

Insurance is based on probability that loss may or may not occur. Where the probability is high, then insurance companies charge higher premiums.

Abrahamson (1984) states that in most works, the unexpected happens. He strongly supports the idea that risks are unexpected and that businessmen have to plan in order to manage risks effectively. Insurance uses historical data to make future projections. A prudent contractor should allow for risks in his plan. Risks are unexpected and what would distinguish one contractor from the other is the degree of preparedness for any eventuality. Strategic planning requires a good forecast of the future and taking all uncertainties into account. The profitability of the Company relies on their ability and effective strategic planning.

Houtte (1988) states that the common meaning of risk is the combined effect of the probability of the peril's occurrence and the magnitude of the peril mathematically expressed as:

$$\text{Risk} = \text{Hazard} \times \text{Probability of Occurrence}$$

This is the principle applied by insurance companies when determining the premiums. This becomes a reflection of the magnitude of the risk. When the hazard and probability are high, the premium would increase proportionately. The above model requires statistical data on the occurrence of past hazards in order to be operational.

Insurance uses the relevant historical data to determine possible outcomes. The actual outcome may differ from predicted outcomes. Hence, risk is viewed as unpredictable.

Gordon and Dickinson (1984) argue that risk is universally accepted as the uncertainty of loss.

Insurance mainly focuses on pure risks as opposed to speculative risks. This is evident on construction sites where the emphasis is on physical damage. Insurance does not address itself to speculative risk, which occurs on sites such as cost risks. The common insurance policies are on contractors' all risks and injury to third parties. Risks such as failure to complete on time and cost overruns are not covered.

2.3.4 Risk Management

Risk management is the identification, measurement, and treatment of property, liability and personnel pure loss exposures, which can affect the cost beneficial, economic and effective operation of buildings, property and related facilities, (South African Property Education Trust, 2001). The risk management process has five distinct steps i.e. identification, measurement, control, implementation and monitoring. The identification, measurement and treatment of exposures to potential accidental losses are almost always in situations where the only possible outcomes are losses or no change in the status quo. For example, the outbreak of the fire at City Hall, Nairobi, and the collapse of a cantilevered roof slab at Sunbeam Building in Nairobi. Most accidental losses may threaten the survival of some business, cause their profits to dip below acceptable levels or interrupt operations

All hazards and risks must be identified to establish what can go wrong and how it can happen on the construction site. After identification of the loss exposures, these exposures must be measured. The measurement includes a determination of:

- (i) The probability or chance that the losses will occur

- (ii) The impact the losses would have, should they occur
- (iii) The ability to predict that the losses will actually occur.

Appropriate control measures should be selected i.e.

- (i) Avoiding the risk,
- (ii) Reducing the chance that the loss will occur
- (iii) Transferring the risk to another party and
- (iv) Retaining or bearing the risk internally.

The purpose of risk management is to minimize losses. Risk management can also limit uncertainty to acceptable levels, thus reducing the costs of uncertainty itself.

Risk management involves identification of the significant risks, which may impair performance of a specific project, (Lewis and Carter, 1992). Failure to identify all the exposures of the firm means there will be no opportunity to deal with the unknown exposures intelligently. Risk management requires assessment of the effect of these risks on the site and the establishment of ways of dealing with them. These ways may involve transferring, retaining or allocating risks to the various parties and determination of appropriate allowances for risks. Risk management activities depend upon the firm's goals or objectives.

Gordon and Dickson (1984), also define risk management as the identification, evaluation and economic control of the risks, which threaten the assets, or earning

capabilities of an organization. Risk management is seen as a build up of three distinct stages: identification, analysis and response, (Raftery, 1994).

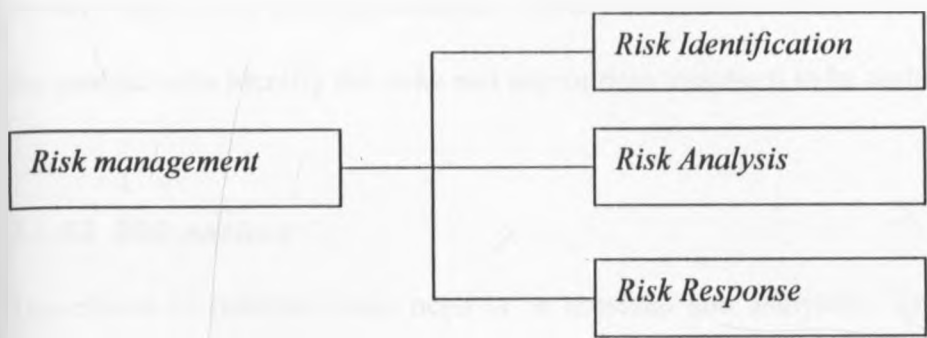


Figure 2.3: Risk management

Source: Raftery (1994)

For a risk management system to be successful, these three stages have to apply i.e Risk identification, Risk Analysis and Risk Response.

2.3.4.1 Risk identification

Identification of risk is undertaken before any process of risk management can be implemented. Risk identification is preceded by establishing what the firm wishes to achieve from the risk management process. These objectives include among others, survival following a catastrophic loss, stable earnings etc.

Risk identification attempt to identify all possible events, situations or activities that could cause or enhance losses. It involves physical inspection and examination of potential risks. The tools used to identify risks are organizational charts, flow charts and checklists. Risk identification provides a basis from which the appropriate organizational

structure can be formulated. The tendering procedure and the type of building contract allocates the risks. In preparation of the tender documents, the building contractor would identify risks in the building contract. On the construction site, it is the responsibility of the contractor to identify the risks and appropriate treatment to be undertaken.

2.3.4.2 Risk Analysis

The effects of potential risks need to be assessed and analysed. The analysis may be quantitative or qualitative. Qualitative approaches depend on existence of data that enables probabilities and consequences to be quantified. A quantitative approach involves the identification of a hierarchy of risks, their scope and potential dependencies, (CUP, 1993). The aim of the analysis is to calculate the impact of possible losses on the firm. It is necessary to examine: -

- (a) The frequency of loss
- (b) The possible size of each loss
- (c) The maximum possible loss

The frequency of losses

Some losses are extremely rare while others occur frequently. The average, expected or mean frequency of loss needs to be known. The probability distribution of loss and frequencies takes the form of a table showing the probability or chance.

Size of Losses

The probability distribution of loss size shows the chance or probability associated with each and every loss value from a given loss-making situation.

Technical risk usually relates to particular activity, easy to identify and can in most cases be quantified. The activity can further be analysed into small segments for assessment. This may help isolate the problem area. Each primary risk should be assessed for the nature and extent of the damage it could cause on construction site. The risk can simply be ranked as “high”, “medium” or “low” in order to indicate the size of the problem.

Using probability method may arrive at decisions on alternative options. This method involves computing the expected impact of events identified by multiplying their effect and the probability of their occurrence.

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 of 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 on their influence on the contractor's goals. Risk evaluation may be taken qualitatively or quantitatively. Severity and frequency of evaluation may be 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 best decisions can only be achieved when all available information is applied. Figure 2.4 overleaf illustrates the risk management process. The process has three main elements. Risk identification is concerned with identifying the possible causes of loss. Risk evaluation is concerned with measuring the impact of possible loss on the business by an assessment of the frequency of losses and their possible size in relation to the values at risk. Risk control is concerned with minimizing the adverse effects of loss. This can either be financial or physical.

2.3.4.3 Risk Response

Once the risk has been identified and its nature assessed, the final stage is to decide how best to deal with it. This is illustrated in figure 2.4. There are four alternatives.

- a) **Risk avoidance:** (Elimination) This is to eliminate completely the possibility of loss.
- b) **Risk reduction:** (Minimization) this is to undertake measures, which reduce either the frequency or the size of loss.
- c) **Risk retention:** This is when the firm decides to meet the losses (either in whole or part).
- d) **Risk transfer:** This is when the firm arranges for the whole or part of its losses to be paid by someone else.

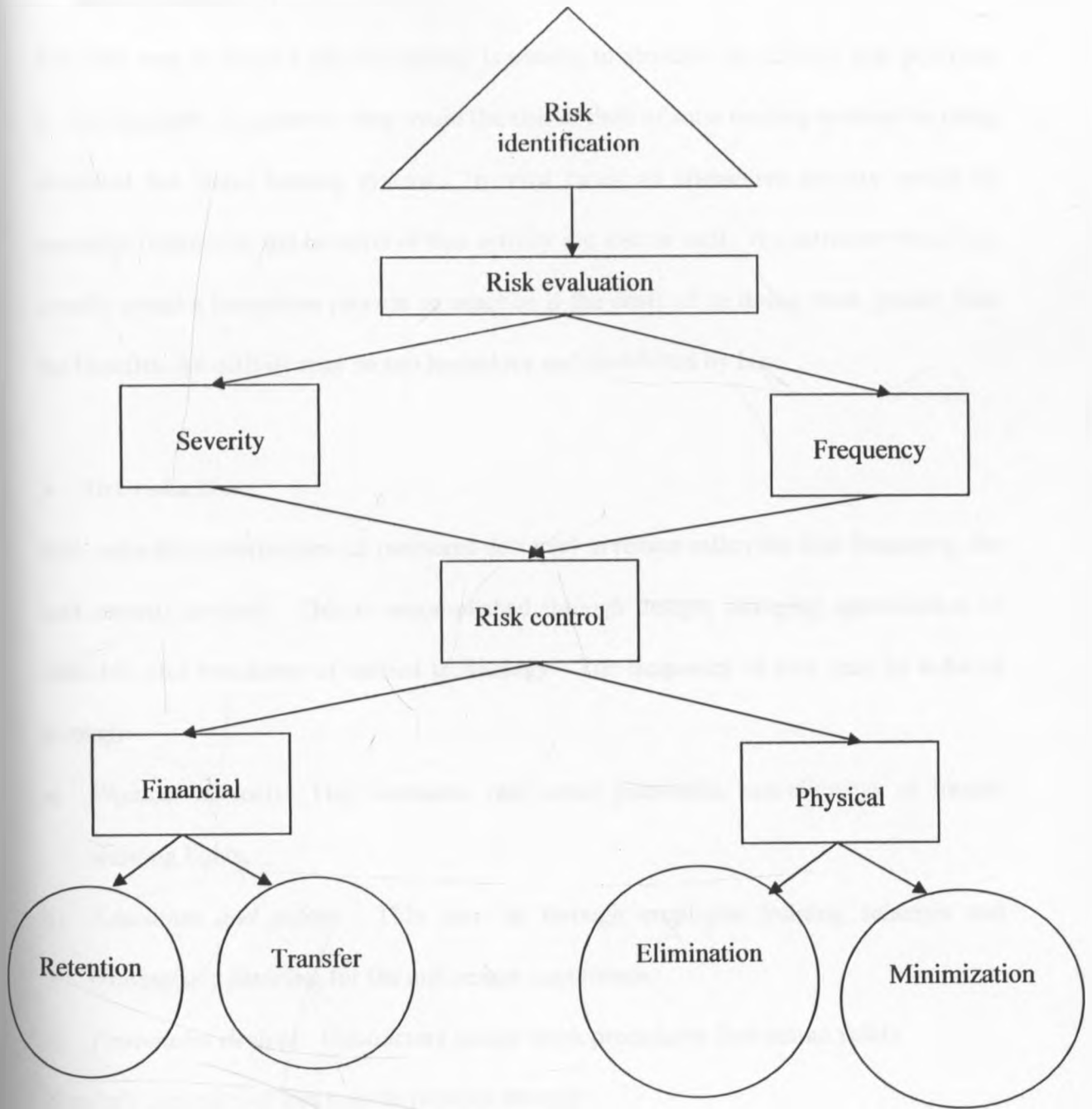


Figure 2.4: The Risk Management Process

Source: Gordon and Dickson (1984: 6/1)

➤ **Risk avoidance**

The only way to avoid a risk completely is usually to abandon the activity that generates it. For example, a contractor may avoid the risk of theft of solar heating systems by using electrical hot water heating system. In most cases no alternative activity would be available; moreover, the benefits of that activity are lost as well. A contractor would not usually avoid a hazardous process or practice if the costs of so doing were greater than the benefits. An activity may be too hazardous and prohibited by law.

➤ **Risk reduction**

Risk reduction incorporates all measures designed to reduce either the loss frequency, the loss severity or both. This is accomplished through design, changing specification of materials and avoidance of untried technology. The frequency of loss may be reduced through: -

- a) *Physical devices:* The contractor may erect guardrails, non-slipways or hazard warning lights.
- b) *Education and safety:* This may be through employee training schemes and contingency planning for the unforeseen occurrence.
- c) *Procedural devices:* Contractors design work procedures that ensure safety.

Similarly, severity of loss may be reduced through: -

- a) *Physical devices:* For example, sprinkler systems and firebreak walls for fire fighting.
- b) *Education and safety:* This may be training of first-aiders.
- c) *Procedural devices:* Establishing fire drills periodically.

➤ ***Risk retention***

A firm may choose risk retention due to statutory control, tax advantages, the expected size and frequency of losses, the variability of losses and the size of firm. Risk retention is suitable in cases of small infrequent losses. The firm's willingness to retain risk depends on the type of loss and their attitude to risk. If it is prepared to take risks in order to make profits it may well decide to retain risks internally. A cautious firm may decide not to retain losses since this is obviously more risky than to transfer them.

For example, if inflation is prevalent and cannot be predicted in a fixed price contract, a contractor may decide to retain the risk. The contractor would increase tender margins due to uncertainty in price fluctuations.

A common practice in the building industry is to assess a simple value estimate of risk using a contingency (Newton, 1992) and (Uher, 1996). The contingency approach is what the contractors use at tender stage. This approach does not adequately measure risk. The contingency allocations are based on global percentage of values. These depend on an estimator's perception of risks on construction site and the ability to transfer the risks.

➤ ***Risk transfer***

Risk transfer is the shifting of the responsibility for meeting one's own losses from oneself to someone else. This is achieved through insurance. By paying a premium the insured can transfer the risk of loss to the insurer. The policyholder purchasing full insurance can therefore substitute the unknown cost of losses for a known cost.

Insurance rarely provides a full compensation for losses. For example, no compensation is paid for use of management time or loss of good will. Speculative risks cannot be insured.

A contractor may be in a dilemma as to what the value of material would be claimed in a case of loss by theft. Further, where there is a claim against loss, the cause does not commence until the loss has been established and investigated. In most insurance policies, there would be excess that would be paid before a claim is processed. This tends to discourage claims on incidents whose values fall below the excess. For example theft of one or two bags of cement may not be claimed under the insurance, however, the overall aggregate through out the construction period may be a large sum of money.

Some of the advantages of insurance as a method of risk transfer include: -

- The insured can transfer the risk of unexpectedly large or frequent losses to the insurer.
- Known cost (the premium) can substitute for unknown and highly variable one (losses).
- Companies can offset the premium as an expense against corporation tax.
- Insurance acts to smooth out the payment of losses over time.

Transfer of pure risk may also be achieved through transfer of the activity creating potential losses. The transfer of the activity creating risk is most usually undertaken by subcontracting that activity – that is hiring another enterprise to do the job.

Subcontracting may involve sacrifice on the quality of workmanship. There would also be the cost of management and administration of the subcontractor.

2.3.5 Role of Information in Risk Management

Information is facts and data gathered in such a way that it is ready to be used in decision-making. Barton (1985) states that information represents data or knowledge evaluated for specific use. A fact relates to an event in real term whereas data is facts obtained through some research or observation.

Information is not useful unless it is communicated for application. Harrison (1987) says that information is the lifeblood, which flows into, out of and within an organization. The success or failure of an organization depends on the information available at the time of making any crucial decision. Organizations have their own means of getting information required. External source of information may become necessary if a firm was to be competitive in the market.

Generally, information in the building industry is poorly collated. The client is the prime mover as he originates the idea of a building. Through his design team, he comes up with space requirements and the quality of workmanship required for the building. The design team produces drawings, specifications and bills of quantities, which form basic information in the production process. Sub-contractors, like the main contractors are specialists in construction technology with the requisite training and experience in production process. Manufacturers and suppliers are also a great source of information in

respect to materials. They specify how materials are to be handled. The contract agreement between the main contractor and the employer defines the duties and obligations of the parties. This document has useful information for contract administration and management.

The contractor would want to use available information in decision making so as to optimise on resources. Human, capital and financial resources play a key role in entrepreneurship. Carnall (1988) states that entrepreneurs take risks, handle uncertainties, and make initial decision over objectives, the firm's direction and innovation. Contractors set objectives of what they want to achieve and ensure that information that would enable them achieve the objectives is available to be used on the site. The contractor, as a businessman, constantly has to make decisions. Decision making is risk taking. He has to examine the consequences of making the decision in the light of risks involved and expected returns. The more, the information available in decision making, the less the risk; decisions always relate to the future operations, which are themselves prone to uncertainties or risks.

CHAPTER III

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In order to meet the study objectives, this chapter addresses the fundamental issues of how the study was carried out.

3.2 RESEARCH DESIGN

This study was 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. A representative sample was selected based on the ease of access. Mugenda and Mugenda (1999) postulates, that a survey is an attempt to collect data from members of a population in order to determine the current status of that population with respect to one or more variables. The survey research design was preferred as no treatment or control was to be introduced on the construction sites.

In this survey, data was collected on the types of risk and their management in respect to handling of building materials on construction sites. Contractors with diverse experience in the construction field were interviewed.

3.3 POPULATION AND SAMPLE

The target population was defined as all building projects within Nairobi City. All constructions in Nairobi are under the control of the Nairobi City Council. The Council approves building plans for construction and monitors progress through periodic

inspections. The projects considered were either on going or recently completed (within six months). Nairobi was considered to be a sufficient representative of the other major towns in Kenya. Nairobi is the capital and the most active economic centre of the country.

The city of Nairobi was divided into four equal geographical zones. This was in order to reduce any bias due to diverse site conditions. The Nairobi City Council also controls construction development through permissible plot ratio and coverage. The permissible plot coverage determines how the anticipated permanent construction would cover the plot. This affects the site layout. The permissible plot ratio and coverage, changes as one moves from the city centre to the outskirts.

Random sampling was applied in the selection of the zone. The four zones were allocated the letters A, B, C and D. Four small pieces of paper were cut out and written on each of the letters A, B, C and D. The four pieces of paper were folded and put in a hat. One piece of paper was drawn at random. The selected zone became the sample area.

The construction sites were divided into three categories i.e.

- A: Open site having less than 50% of the plot covered by proposed permanent works.
- B: Moderate site having between 50 – 75% of the plot covered by proposed permanent works.
- C: Restricted site having more than 76% of the plot covered by proposed permanent works.

A sample of at least 60 construction sites was targeted. The target was limited in size by budget constraints. "Ordinarily, a sample size of less than 30 cases provides too little certainty to be practical" (Alrek and Settle, 1985) and therefore a target of 60 cases was above the practical minimum. The construction site was the sampling unit. Non-probability sampling was used to select the construction sites. A stratified sample would be most desirable due to the varied site conditions found in the population. However, development of the sample frame was not possible due to constraints in time and sparsity of construction sites. Up to date records of construction sites, which would have enabled probability sampling procedure to be applied, were not easily available from the relevant authorities. Convenient sample was also adopted due to the confidentiality the contractors attach to tendering and their accounts in general

The researcher assigned a quota of 20 construction sites to each of the categories described above. The potential respondent were contacted before beginning the inquiry itself. The researcher identified the category of the site through their respective plot ratios and coverage.

3.4 DATA COLLECTION

The data was collected from the contractors involved in active construction projects or recently completed (within six months) projects using questionnaires. The questions covered the types of risks and their management during construction. The required information was obtained from the contractor by the researcher or his assistants through

direct interview. Structured questions were asked for ease of administration of the questionnaires and analysis of data.

Three research assistants were engaged to collect the data. The personal presence of the researcher or his assistant was essential for data collection in order to get the right information. The research assistants had background knowledge in the construction industry. They were trained on how to administer the questionnaires. Appendix 'B' shows the questionnaires. A letter of introduction was given to the research assistants, as shown in appendix 'A'. The researcher edited the questionnaires.

3.5 DATA PRESENTATION

The data collected was presented with simple percentages to show the proportions of various results. A table was used to show the type of data collected, while graphs, pie charts and frequency polygons were drawn to show the distributions. Frequency polygon was considered because the three polygons could be superimposed and comparisons among the three distributions made more easily.

The dependent variable, the proportion of building material losses, was measured as; the difference between the final proportion of material losses and the allowable proportion of wastage at tender stage, as stated by each contractor. The proportion of material loss for each of the materials i.e. cement, sand and paint, was recorded and the mean was determined. The contractors did not keep proper records on the wastage of materials.

The independent variables i.e. risk response measures comprising elimination, minimization, retention and insurance were coded and transformed into an interval scale for statistical analysis. It was noted that at tender stage, the contractors proposed to use the risk response measures in the following descending order.

- Retention (most preferred)
- Minimization
- Insurance
- Elimination (least preferred)

The researcher coded the data on risk response measures. Each risk response measure was given a score of between 1 and 4 for least preferred and most preferred respectively,

i.e.: -

Retention	4
Minimisation	3
Insurance	2
Elimination	1

3.6 DATA ANALYSIS

The data collected was analysed using qualitative methods. Descriptive analysis (mean and standard deviation) of the proportion of building material losses and risk response measures in the handling of building materials was applied to determine the strength of relationship. Inferential statistics was applied in the testing of hypothesis. A significance test level of 0.05 was applied in testing the hypothesis using correlation procedure.

CHAPTER IV

DATA ANALYSIS AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

Out of the 60 sites targeted, 47 responses were realized. This represents approximately 78%, which was reasonable and representative for proceeding with the analysis. The good response from the contractors was attributed to their keenness to establish the cause of material losses on construction sites. There were few who were sensitive and suspicious to the questions.

4.2 CATEGORY OF CONSTRUCTION SITE

The questionnaire was designed such that the different categories of the sites were identified through their plot coverage. The class of contractors who were responsible for these sites were evenly distributed between classes "A" and "B". Experience in construction varied between 4-20 years. All the respondents had either active project on going or previously completed project from which the necessary data was drawn.

4.3 FINDINGS AND ANALYSIS

Method of Procurement

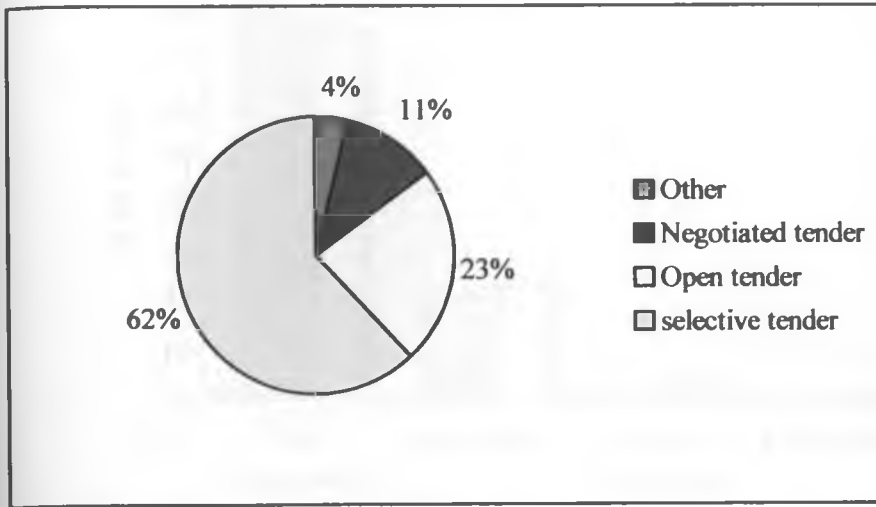


Figure 4.1: Method of Procurement

Source: Field survey, (October 2003)

Conditions under open tendering and selective tendering qualify as competitive. In 40 out of 47 or 85% of the sites, method of procurement was through competitive tendering. This is in line with the stated assumptions that the estimator would be pricing under competitive market conditions. The contractors were either registered with Ministry of Roads and Public Works in class A or B. The site organization and management were fairly comparative between each site. The requisite pre-tender information was considered to have been available to each contractor. However, the proportion of main contractor's work relative to other sub-contractors was not distinguished in the survey.

Relative Importance of Materials

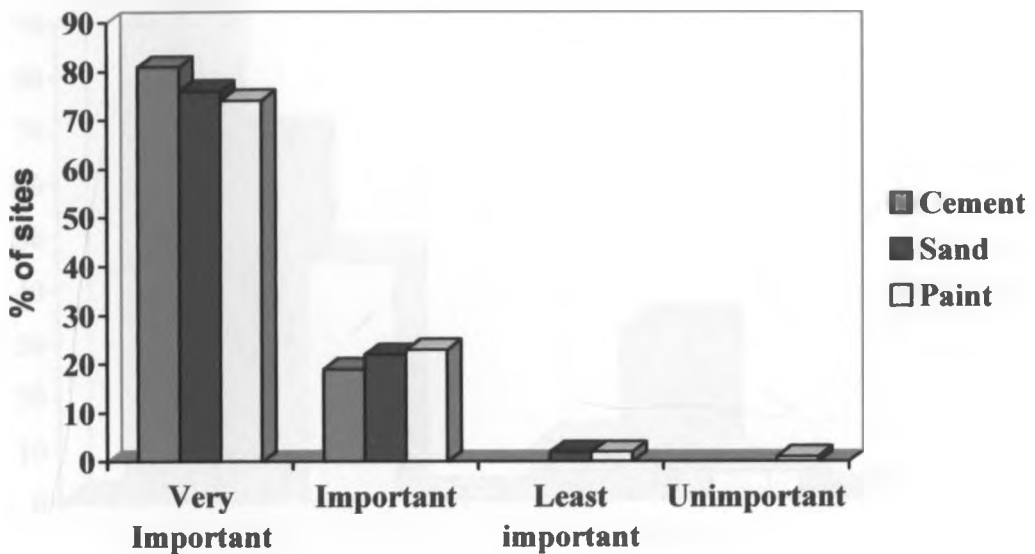


Figure 4.2: Relative Importance of Materials

Source: Field survey, (October, 2003).

In all 47 sites, the three materials under study were found to be important being more than 97% in comparison to other building materials. This confirmed the researcher's choice of these materials as to their importance and extensive use at various stages of construction process. The proportional contribution of cement, sand and paint in relation to the entire work on each site was not established. Cement, sand and paint are main materials involved in wet construction that also has high wastage values. Cement, sand and paint control project schedules and are mostly subject to claims on price fluctuations. The type of building contract would be significant.

Confirmation of Material Losses

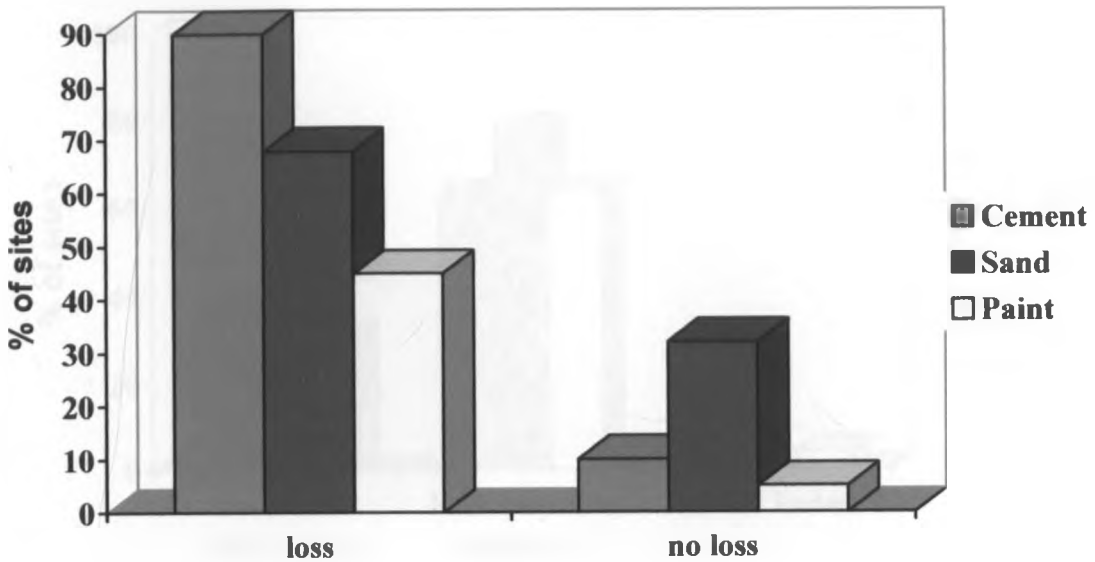


Figure 4.3: Material Losses

Source: Field survey, (October, 2003).

All the construction sites experienced a loss of one material or the other. At least 68% of the sites suffered loss of all the three materials. This confirmed the position stated in the problem statement that losses of building materials occur in almost every site. The loss observed implies that the allowable proportion of wastage on the materials and/or the risk response measures were in adequate. Accurate site records for computation of wastage may not have been available. Further, the contractor culture of always being inclined to report a loss may have been a factor.

No Losses on Site

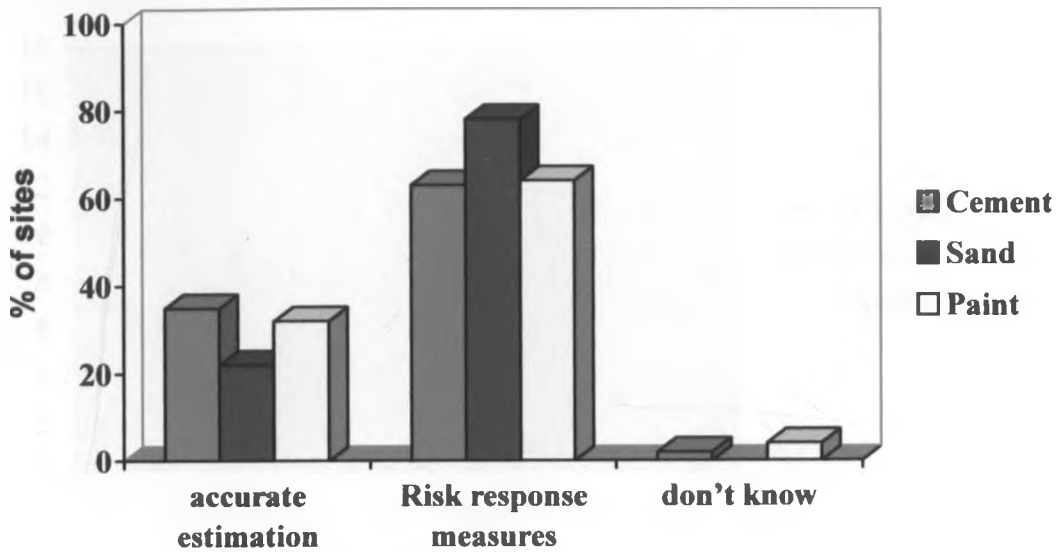


Figure 4.4: Reasons for no Losses

Source: Field survey, (October, 2003).

In the cases of materials under study, it shows that in approximately 63% of the cases, the sites did not experience material losses due to the risk response measures (i.e. minimization and retention) undertaken. Accurate estimation during tender stage accounted for approximately 32%. This shows that the risk response measures (i.e. minimization and retention) play a crucial role in determining the potential material losses on site. Contractor's relate to losses of materials on site in terms of security and damages. Not all incidences are reported in the site occurrence book. The risk response measures depends on the ability of the contractor being able to identify the risks at tender stage.

Allowable Proportion of Wastage on Materials

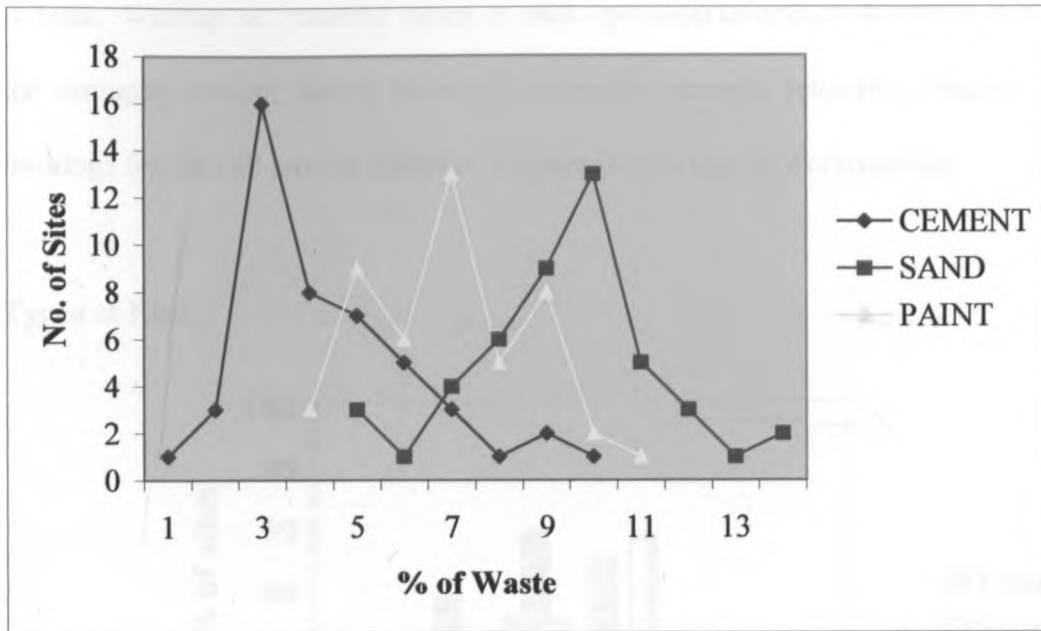


Figure 4.5: Allowable Wastage

Source: Field survey, (October, 2003).

In all the materials under study, the proportion of wastage of materials allowed at tender stage showed a similar pattern. The highest number of sites for each material tended towards the allowable wastage (Mbaya, 1997) and (Hall, 1972). This is possibly attributed to the competitive nature of the procurement method found at tender stage. The contractors tend to standardise the allowable wastage based on their respective tendering procedure irrespective of the site conditions. Due to confidentiality of the tendering procedure the disclosed percentages may not be an accurate representation of site situation. There are similarities in the shape of polygons for the three materials. Size of contracts for each site also has a bearing on the allowable proportion of waste. Large contracts enjoy economies of scale. The form of delivery of the materials has an effect

on wastage i.e. delivery of cement in bags would have a different effect to those delivered in bulk. Wastage on material varies in each operation or activity in which it is involved for example, cement that is involved in mortar, screeds, rendering, plaster, concrete, backings for tiles all having different wastage factors during workmanship.

Types of Risk

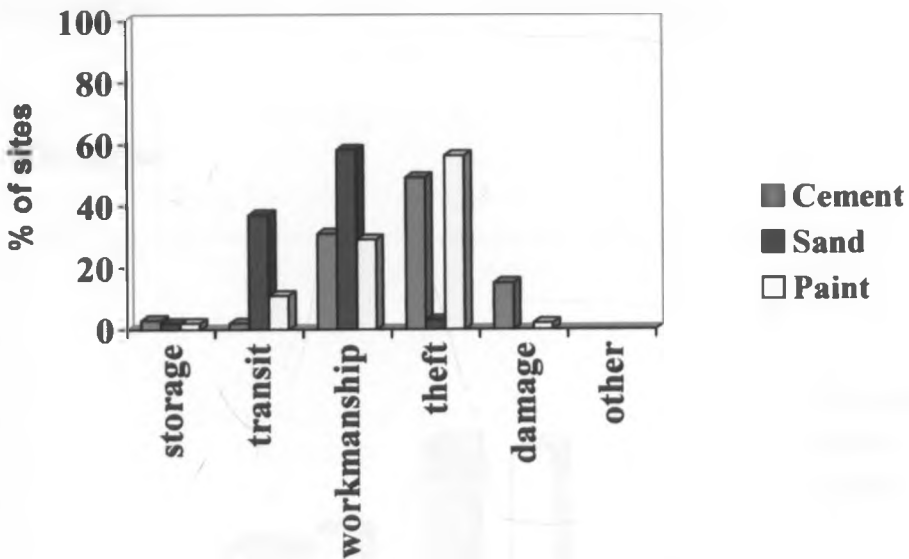


Figure 4.6: Types of risk

Source: Field survey, (October, 2003).

The main types of risk on construction site were found to be workmanship and theft of materials, both accounting for at least 61%. Material loss at storage was found to be negligible being approximately 2%. The other significant types of risk were transit and damage in case of sand and cement respectively. This implies that despite the good storage shown, theft still occurs possibly through lapses in management when the materials leave the store. The material losses due to workmanship may be attributed to

the site organization and management. The losses in workmanship were easily identified since abortive and defective works are both recorded in architect's instruction. Low losses in storage and damages may be attributed to material handling being planned to coincide with site activities. The proportion of main contractor's work to the sub-contractor's varies from site to site. Low volume of main contractor's work means risks are already transferred to sub-contractors. Due to packaging of material, losses of small units may not be recorded e.g. one or two tins of 1 x 4 litres of paint.

Risk Response Measures

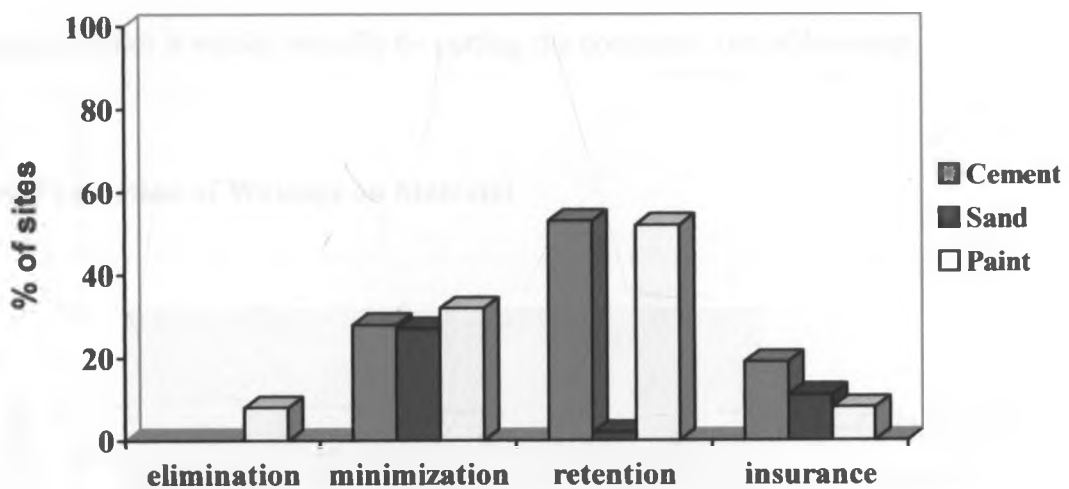


Figure 4.7: Risk Response Measures

Source: Field survey, (October, 2003).

Elimination (i.e. risk avoidance), minimisation (i.e. risk reduction), retention (i.e. risk retention) insurance (i.e. risk transfer).

In the majority of the sites, at least 52%, the contractors had considered retention as the response measure. This was followed by minimization being at 27%. An appreciable

number of construction sites had considered insurance for cement and sand being 19% and 11% respectively.

This implies that on most construction sites, the contractors preferred to meet the anticipated materials losses. This was possibly on the belief that they would make profit or choose retention due to other business advantages. The contractor's risk response measure was only in respect to his proportion of work in that particular site. It was observed that the main type of risk was found to be in workmanship, which is supported above by the contractor's preference of risk minimization and retention. There was no insurance against risk on workmanship other than sub-contracting. Elimination was unpopular since it would virtually be putting the contractor out of business.

Final Proportion of Wastage on Material

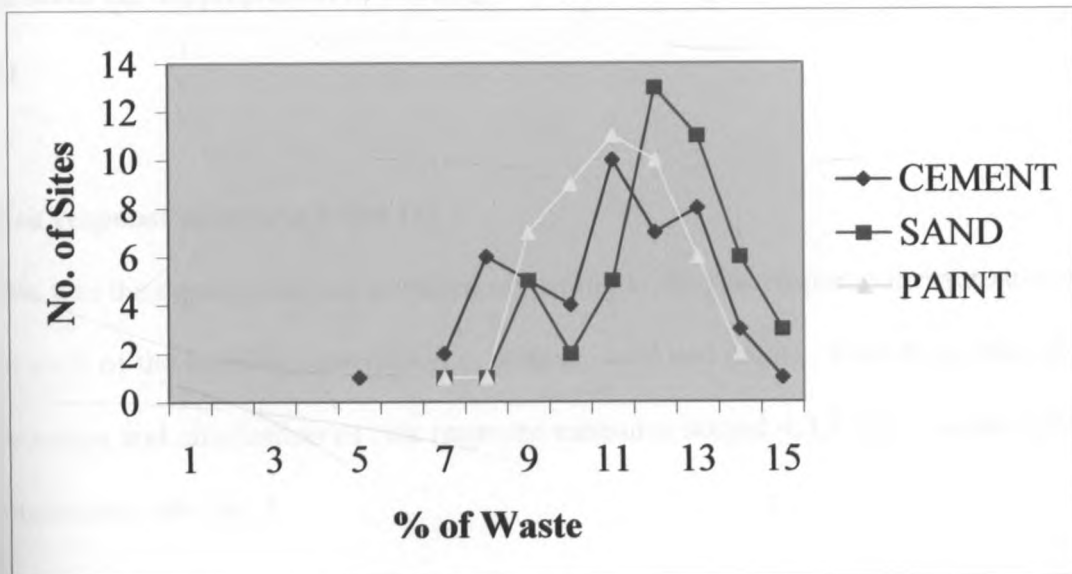


Figure 4.8: Proportion of Wastage

Source: Field survey, (October, 2003).

Generally, the proportion of wastage on material was found to be higher than the allowable proportion of wastage materials, (Mbaya, 1997). The proportion of wastage recorded during construction represented a more realistic situation. During construction the contractor was not under adversarial competitive situation found at tender stage. In most cases, wastage during construction was found to be higher than the allowable wastage at tender stage. This means the risk response measures i.e. risk reduction and retention considered at tender stage were not adequate to prevent the contractor from increasing losses. Variations in production process e.g. envisaged delivery of ready mixed concrete at tender stage and being varied to site mixing.

Correlation analysis

The correlation technique was used to analyse the degree to relationship between, the two variables i.e. the proportion of building material losses (y) and the risk response measures (x)

Risk response measures score (x)

This was the aggregate score obtained according to the risk response measure undertaken for each of the building materials (i.e. cement, sand and paint). Retention, minimisation, insurance and elimination as risk response measures scored 4,3,2 and 1 respectively e.g. construction site No. 1.

Building material	Risk response	Score
Cement	Retention	4
Sand	Minimisation	3
Paint	insurance	2
Total		9

Proportion of material losses (y)

The proportion of material losses was defined as the difference between “the final proportion of wastage on materials” and “the allowable proportion of wastage on materials” in respect of each building material. The indices represent the mean proportion of material losses for each site in respect of the building materials (i.e. cement, sand and paint) e.g. construction site no. 1

Building material	Final proportion of wastage	Allowable proportion of wastage	Proportion of material wastage
Cement	12	7	5
Sand	9	6	3
Paint	6	5	1
			$9 \div 3 = 3$

Spearman’s rank correlation method was used to work out the coefficient of rank correlation. This is a measure of correlation that exists between the two sets of ranks. It is a measure of association that is based on the ranks of the observations.

The scores attained in each site in respect to the risk response measures are replaced by their ranks, giving rank 1 to the highest value, rank 2 to the next least value and following that order, ranks are assigned for all values.

If two or more values happen to be equal, then the average of the ranks which should have been assigned to such values had they been all different, is taken and the same rank (equal to the said average) is given to concerning values (see appendix C).

Spearman's rank correlation

From appendix C,

Spearman's rank correlation coefficient, is worked out as under

$$\begin{aligned} r' &= 1 - \left\{ \frac{6 \sum di^2}{n(n^2 - 1)} \right\} \\ &= 1 - \left\{ \frac{6 \times 10,387.57}{47(47^2 - 1)} \right\} \\ &= 1 - \left\{ \frac{62325.42}{47 \times 2208} \right\} \\ &= 1 - 0.60 \\ &= 0.40 \end{aligned}$$

The correlation between risk response and the proportion of material losses on construction site is positive

Hypothesis testing

The sample in this study consists 47 sites, which is more than 30, the sampling distribution of 'r' is approximately normal with a mean of zero and a standard deviation of $\frac{1}{\sqrt{n-1}}$. Appropriate 'z' values under normal curve can be used for testing hypothesis about the population rank correlation and draw inferences, (Kothari, 2001).

Thus, since $n = 47$, the standard error of 'r' is: -

$$\begin{aligned}\sigma_r &= \frac{1}{\sqrt{n-1}} \\ &= \frac{1}{\sqrt{47-1}} \\ &= \frac{1}{6.78} \\ &= 0.15\end{aligned}$$

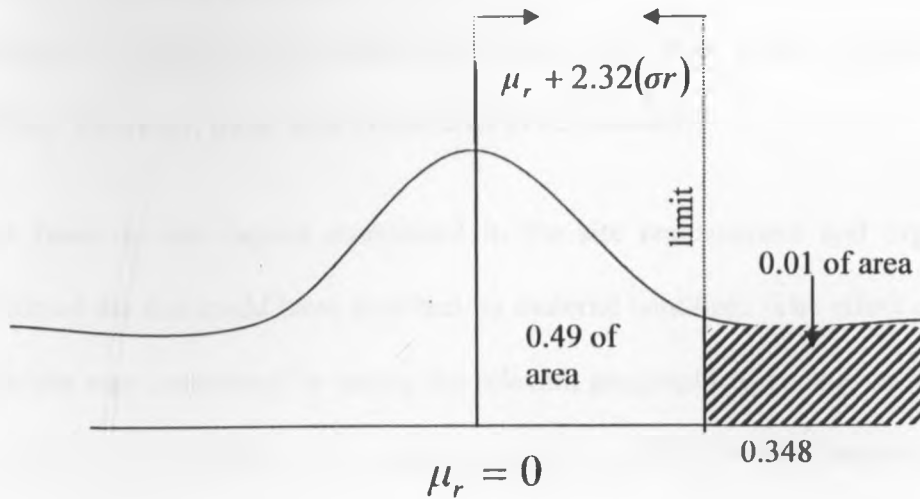
The hypothesis of this study is “the proportion of building material losses increases as risk response measures in the handling of building materials decreases”

Testing this hypothesis at 0.01 level of significance. The null hypothesis is that “there is no correlation between the proportion of building material losses and risk response measures in handling of building materials” i.e.

$$\mu_r = 0$$

The alternative hypothesis that there is positive correlation i.e. $\mu_r > 0$

Using 'z' values and one-tail test as indicated below



Thus, the limit of the acceptance region

$$\mu_r + (2.32)(\sigma_r)$$

$$0 + (2.32)(0.15)$$

$$= 0.348$$

Observed $r = 0.4$ and as such it comes in the rejection region and therefore, reject the null hypothesis at 1% level and accept the alternative hypothesis.

Hence, the correlation that the proportion of building material losses increases as risk response measures in handling of building materials decreases is positive. This supports the hypothesis of the study.

4.4 DISCUSSION

The major constraints in this study were finance and time. The study focussed on cement, sand and paint as building materials due to their extensive use in wet construction. Despite their relative importance in comparison to other building materials,

the type of building construction could have an effect on material handling. Material handling to a single storey residential house would vary from a multi-storey framed building. However, these were considered to be constant.

Apart from the site layout considered in the site management and organization, the location of the site could have an effect on material handling. The effect on the location of the site was considered by taking the relevant geographical zone as radiating from the city centre to the outskirts. The categorisation of construction sites and the assignment of a quota for each category aided in selecting a representative sample.

The proportion of allowable waste at tender stage may not be an accurate presentation due to the tendering process. In a bid to win, an estimator may not apply an accurate proportion of allowable waste. Material losses may also occur during construction and not get recorded. It was noted that construction sites with large contract sums were also associated with lower allowable waste at tender stage. Some of the collected data may be suspect due to the confidentiality the contractors have towards pricing.

Subcontractors were considered as part of the contractor's staff and not considered in the risk response measures. In the JBC (1999) contract agreement, the contractor is required to procure insurances against loss and damage to cover unfixed materials amongst others. All contractors considered the "contractor's all risk policy" to suffice for that purpose. There was no insurance cover specifically for materials on site. "Contractor's all risk policy" was not sufficient to cover all the losses related to the cement, sand and paint. The tendency for the contractors was to consider this cover as adequate such that they do

not consider taking out a separate policy to cover material losses. The scores in the risk response measures were determined by coding.

The general opinion of the contractors with regards to what could be done to alleviate problems of loss of materials was: -

1. Flexibility in subletting portion of work
2. Special custom made insurance policies to cover material losses
3. Improvement on the quality of workmanship.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents a summary of findings of the study and the resultant conclusions and recommendations in line with the objectives of the study.

5.2 CONCLUSION

The first objective of the study was to identify the risks involved in the handling of building materials on construction site. The types of risks observed were storage, transit, workmanship, theft and damage. The main type of risk was found to be in workmanship followed by theft of materials. Some material losses were also found in transit on site and damages. There was negligible risk noted through storage.

The second objective was to investigate measures undertaken in risk response in the handling of building materials on construction sites. The majority of construction sites showed that they preferred risk retention i.e. where the contractor meets the losses incurred. This was followed by risk reduction (minimization) i.e. where the contractor undertakes measures that reduce either the frequency or the size of material loss. Thirdly was risk transfer (insurance), where the contractor arranges for the whole or part of its material losses to be paid by someone else. Risk avoidance (elimination) was not popular, as the contractor would virtually be putting himself out of business. Risk avoidance is where the contractor completely eliminated the possibility of material loss. This may not be possible if he/she was to remain in business.

The third objective was to investigate the proportion of material loss on construction sites. It was found that at tender stage, the proportion of material loss allowed showed a similar pattern for cement, sand and paint. In all the construction sites, the final proportion of wastage on material was found to be higher than the allowable wastage at tender stage.

It was found that, despite risk retention being undertaken on most construction sites, material losses were experienced. It seems the contractors adopt this measure in the belief that they would make profits if they retain risks internally. However, risk retention may be suitable in cases of small infrequent losses. Material losses on construction sites are common. It is more risky for the contractor to retain material losses than to transfer them. The appropriate measure of risk response would be risk transfer. This way the contractor would shift the responsibility for meeting his own losses to someone else. The contractor may achieve this through insurance. Further, by paying a premium, the contractor would, therefore, substitute the unknown cost of material losses for a known cost.

Non-parameter test was used to test the hypothesis. The outcome of the hypothesis testing confirmed that, at 95% confidence level, the proportion of building material losses increases as risk response measures in the handling of building material decreases on construction sites. This outcome may represent the whole population and thus apply to all construction sites in Kenya. Quota sampling was used in the selection of the sample

units. The sample comprising of 47 units (i.e. 16 No. open site, 16 No. moderate site and 15 No. restricted site) was representative.

5.3 RECOMMENDATIONS

1. The main type of risk in handling of building materials was observed in workmanship. The appropriate risk response measure was found to be risk transfer. The contractor is directly responsible for workmanship through his employees. It is recommended that the contractor could reduce potential material losses through subcontracting.
2. The risk on workmanship is followed by theft of materials. Similarly, the appropriate risk response measure would be risk transfer. This way the risk is transferred to someone else at a known cost. It is recommended that hired professional security firms who would be held responsible for any losses of materials provide the site security.

5.4 AREAS OF FURTHER STUDY

The following areas are recommended for further study: -

1. The contingency approach as a way of controlling material losses on construction sites.
2. Subcontracting on construction sites as a way of reducing material losses.

REFERENCES

- Abrahamson, M. W. (1984). Risk Management *International Construction Law Review*, Vol. 1 April, 1984 Part E: 240-54.
- Alrek, L.P and Settle B.R. (1985). *The Survey Research Handbook*, IRWIN INC, Homewood, Illinois.
- Amrine, et al., (1993). *Manufacturing Organization and Management*, New Jersey. Prentice-Hall, Engelwood Cliffs.
- Barton, P. (1985). *Information Systems in Construction Management*, Bastford Academic and Educational, London.
- Brealy, R. and Myers (1985). *Principles of Corporate Finance*, Mc Grawhill, Singapore.
- Carnall, C. (1988). *Management Principles and Policy*, I.C.S.A Publishing Ltd. Cambridge, UK.
- Chandler, I. E. (1978). *Material Management on Building Sites*, Construction Press Ltd. Lancaster, England.
- Crockford, N. (1986). *An introduction to Risk Management*, Woolhead – Faulkner Ltd, Cambridge, U.K.

CUP, (1993). *Central Unit on Procurement, Guide Note 41 - Managing Risk and Contingency for Works Projects*, HMSO, London.

Datta, A. K. (2003). *Materials Management*, Prentice-Hall, New Delhi

Diacon, S. R. and Carter, R. L. (1981). *Success in Insurance*, P.H. Publishers, London.

Edmeads, D. H. (1972). *The Construction Site*, Estates Gazette Ltd. London.

Flanagan, F. and Norman, G. (1993). *Risk Management and Construction*, Blackwell Scientific Publications, Oxford, UK.

Gichunge, H. (2000). *Risk Management in the Building Industry in Kenya: An Analysis of Time and Cost Risks* Ph.D Thesis, University of Nairobi, Kenya.

Gobourne, J. (1982). *Site Cost Control in Construction Industry*, Butterworth Scientific. London

Gordon, C.A. and Dickson, M. (1984). *Introduction to Insurance*, C11 Book Production Consultants, Cambridge UK.

Green, M.R. (1978). *Risk and Insurance*, SW Publishing Co. Cincinnati, USA.

Hall, D. S. M. (1972). *Elements of Estimating*, B.T. Batsford. London.

Harrison, F.L. (1985). *Advanced Project Management*, Gower Publishing Co Ltd. Hants.

Houte, V.V. (1988). Professional Liability – Risks in Construction. *Building Research and Practise – The Journal CIB*

Jafari, A. (1996). “Twinning time and cost in incentive – based contracts”
Journal of management in engineering, ASCE July/August.

JBC, (1999). *Agreement and Conditions of Contract for Building Works* JBC, Nairobi

JBC, (2002). *Practise Notes*, JBC, Nairobi

Kothari, C.R. (2001). *Research methodology*, New Age International (P) Ltd.
New Delhi.

Levey H and Sanart (1986). *Capital Investment and Financial Decisions*, Prentice Hall
International, London

Lewis, J. C. and Carter, (1992). *Avoiding Conflict by Risk Management*, E and F N
Spon Ltd. London.

Magad, E. L. and Amos, J. M. (1995). *Total Materials Management*, Chapman and Hall.
New York USA.

Mbaya, J. S. (1997). *Construction Materials Management*, A Paper Presented at
Construction Management Workshop Organized by the Construction manpower
Development held at Silverspring Hotel Nairobi.

Mugenda, O. and Mugenda , A. (1999). A Research Methods: *Quantitative and
Qualitative Approaches*, Acts Press, Nairobi.

Newton, S. (1992). “ Methods of analysing risk exposure in the cost estimate of high
quality offices” *Construction Management and Economics*, Vol. 10:443-9.

Omondi, C.G. (1992). *An Investigation into the Contribution of Site Security to Losses of
Building Materials*, BA (Bldg Econ) Project Paper, University of Nairobi, Kenya.

Raflery, J. (1994). *Risk Analysis in Project Management*, E. and F N Spon Ltd. London.

Rosenbloom, J.S. (1972). *A Case Study in Risk Management*, Prentice Hall.
New Jersey USA.

Samson, R. C. (1959). Organization of building sites. *National Building Construction
Studies Special Report No.29*, HMSO, London.

- Shelfter, T.C. (1983). *Guide to Construction Contractors Survival*, Wely series (Lord).
- Skoyles, E.R. (1974). *Wastage of materials on building sites*,
- South Africa Property Education Trust, (2001). *Risk Management in Property*, Business Print Centre, Pretoria.
- Thairu, J. N. (1999). *An Assessment of Level of Wastage of Building Materials on Construction Sites*, BA (Bldg Econ) project paper, University of Nairobi, Kenya.
- Thompson, P.A. and Perry, J.G. (1992). *Engineering Construction Risks*, Thomas Telford. London.
- Toakley, A.R. (1991) "Risk Management Application Review". *Australian Institute of Building Papers* 6, 77-87, 1991.
- Uher, T.E (1990). *A general risk classification Model*, Australia Institute of Building papers 5 1990: 25-33.
- Wainwright, W.N. (1970). *Practical Builders' Estimating*, Hutchinson Educational Ltd. London.

APPENDIX A

Date:

TO WHOM IT MAY CONCERN

The holder of this letter is conducting a research on risk management of construction sites in Kenya, for the purpose of part fulfilment for the award of the degree of Master of Arts (Construction Management).

Your firm has been selected out of the firms involved in the construction industry to provide the information needed in this study. Your experience represents the experiences of many others participating in the construction 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 highly appreciate your assistance in facilitating this research.

Yours faithfully,

TOM ONYANGO OKETCH

APPENDIX B

QUESTIONNAIRE FOR BUILDING CONTRACTORS

BY

TOM ONYANGO OKETCHI

B.A. Build Econ (Hons) MAAK (QS) CIQSK. MCI.Arb

Department of Building Economics and Management

UNIVERSITY OF NAIROBI

DECLARATION

ANSWERS TO QUESTIONS CONTAINED IN THIS QUESTIONNAIRE SHALL BE TREATED AS 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.

CATEGORY OF CONSTRUCTION SITE

- A. Open
- B. Moderate
- C. Restricted

CLASS OF CONTRACTOR (Please circle)

A B C D E F G H

Experience in construction:..... Years

Date of completion of construction

Contract sum Kshs

1. Which type of tendering method was used to select you as a contractor for this project?

- (i) Open
- (ii) Selective
- (iii) Negotiated
- (iv) Other

2. How did you consider material losses of the following in comparison to all the building materials on site?

		Cement	Sand	Paint
(i)	Very Important			
(ii)	Important			
(iii)	Least important			
(iv)	Unimportant			

3. Did you experience any loss in the following materials?

- i) Cement - Yes/No
- ii) Sand - Yes/No
- iii) Paint - Yes/No

4. If your answer to No. 3 above is No, what would you attribute to this status?

		Cement	Sand	Paint
(i)	Accurate estimation			
(ii)	Risk response measures undertaken			
(iii)	Don't know			

5. What proportion of material cost did you allow for wastage at tender stage?

- i) Cement %
- ii) Sand %
- iii) Paint %

6. Indicate the risks that you considered in the handling of materials on site.

		Cement	Sand	Paint
(i)	Storage			
(ii)	Transit			
(iii)	Workmanship			
(iv)	Theft			
(v)	Damage			
(vi)	Other			

7. At tender stage, how did you propose to overcome the above risks?

		Cement	Sand	Paint
(i)	Elimination			
(ii)	Minimization			
(iii)	Retention			
(iv)	Insurance			

8. Upon completion of construction, what proportion of material losses did you attribute to wastage during construction?

- i) Cement %
- ii) Sand %
- iii) Paint %

9. In your opinion, what do you think should be done to address the problem of loss of materials?

.....

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APPENDIX C

CORRELATION ANALYSIS

Site No.	Risk response measures (Scores)	Proportion of material (Losses)	Rank	Rank	Rank Difference 'd _i ' (Rank X) - (Rank Y)	Difference Squared
	X	Y	X	Y		
1	9	3	11.06	1.00	10.06	101.20
2	7	9	38.14	34.00	4.14	17.14
3	7	8	38.14	29.20	8.94	79.92
4	7	5	38.14	8.09	30.05	903.00
5	10	5	1.10	8.09	-6.99	48.86
6	6	15	45.33	46.00	-0.67	0.45
7	6	17	45.33	47.00	-1.67	2.79
8	8	4	28.10	1.17	26.93	725.22
9	10	5	1.10	8.09	-6.99	48.86
10	6	12	45.33	39.25	6.08	36.97
11	10	4	1.10	1.17	-0.07	0.00
12	9	12	11.06	39.25	-28.19	794.68
13	7	10	38.14	35.25	2.89	8.35
14	9	8	11.06	29.20	-18.14	329.06
15	7	12	38.14	39.25	-1.11	1.23
16	8	5	28.10	8.09	20.01	400.40
17	9	7	11.06	23.17	-12.11	146.65
18	8	4	28.10	1.17	26.93	725.22
19	7	14	38.14	45.00	-6.86	47.06
20	9	10	11.06	35.25	-24.19	585.16
21	8	13	28.10	43.50	-15.40	237.16
22	8	4	28.10	1.17	26.93	725.22
23	9	7	11.06	23.17	-12.11	146.65
24	9	7	11.06	23.17	-12.11	146.65
25	10	5	1.10	8.09	-6.99	48.86
26	8	13	28.10	43.50	-15.40	237.16
27	10	5	1.10	8.09	-6.99	48.86
28	9	10	11.06	35.25	-24.19	585.16
29	10	5	1.10	8.09	-6.99	48.86
30	9	5	11.06	8.09	2.97	8.82
31	9	12	11.06	39.25	-28.19	794.68
32	9	7	11.06	23.17	-12.11	146.65
33	10	8	1.10	29.20	-28.10	789.61
34	8	6	28.10	19.25	8.85	78.32
35	10	4	1.10	1.17	-0.07	0.00
36	9	6	11.06	19.25	-8.19	67.08
37	9	7	11.06	23.17	-12.11	146.65
38	9	5	11.06	8.09	2.97	8.82
39	10	8	1.10	29.20	-28.10	789.61
40	8	6	28.10	19.25	8.85	78.32
41	9	5	11.06	8.09	2.97	8.82
42	8	8	28.10	29.20	-1.10	1.21
43	10	4	1.10	1.17	-0.07	0.00
44	7	10	38.14	35.25	2.89	8.35
45	9	7	11.06	23.17	-12.11	146.65
46	8	6	28.10	19.25	8.85	78.32
47	9	5	11.06	8.09	2.97	8.82
Total						10387.57

Source: Field Survey, (October 2003)