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HEALTH AND SAFETY RISK MANAGEMENT IN BUILDING CONSTRUCTION SITES IN TANZANIA: The Practice of Risk Assessment, Communication and Control

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Cover:
The cover photo shows a typical working environment of the workers in construction sites. Photo taken by the Author

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ABSTRACT

The construction industry is an important part of the economy in many countries and is often seen as a driver of economic growth especially in developing countries. Owing to its relatively labour intensive nature, construction works provide opportunities for employment for a wide range of people skilled, semi-skilled and unskilled. Despite its importance, construction industries are considered risky with frequent and high accidents rates and ill-health problems to workers, practitioners and end users. However, knowledge on how health and safety risks are managed on Tanzanian construction sites is limited. This study therefore, aims to find out the current practice of health and safety risk assessment, risk communication and risk control in Tanzanian context. In pursuing this objective, the case study strategy was adopted whereby two construction sites in Dar es Salaam were selected through convenience sampling.

The findings of the study show that all responsibility on risk management is with the contractor, and it is carried out only during construction phase. The study also show that no systematic method is used for risk assessment, but rather risks are assessed based on individual judgement guided by experience, educational background and existing regulations. Meanwhile, risk information is communicated through toolbox meetings, informal discussions, and controlled by using personal protective equipment (PPE). The study also reveals that, the regulatory system, the organisation/company system, the individual system and the work environment have impact on health and safety risk management. Further findings of this study show that, site location, site configuration, procurement system and complexity of design are the main challenges hampering health and safety risk management. The study recommends the necessity of incorporating of key project stakeholders such as client and design team and other consultants in managing health and safety risk.

Key Words

Health and safety risk, Risk Management, Risk Communication, Risk control, Construction Sites, Practice, and Process.

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LIST OF ACRONYMS

AQRB - Architect and Quantity Surveyor Registration Board

AQSRA - Architects and Quantity Surveyors Registration

BOT - Build Operate and Transfer

CRB - Contractors Registration Board

EALRA - Employment and Labour Relations Act

HEEPO - Human, Equipment, Environment, Product and Organization

HSE - The Health and Safety Executive

ILO - International Labour Organisation

MCC - Millennium Challenge Corporation

MKUKUTA - National Strategy for Growth and Reduction of Poverty

NOHSC - National Code of Practice

NCC - National Construction Council

OSHA - Occupational Safety and Health Agency

PPE - Personal Protective Equipment

PPRA - Public Procurement Regulatory Authority

SSOW - Safe System of Work

QRA - Quantitative Risk assessment

WHO - World Health Organisation

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CHAPTER ONE

BACKGROUND INFORMATION

1.1 Statement of Problem

Recently, Tanzania's construction industry has experienced considerable growth in construction activities especially in Dar es Salaam city. The high rate of urbanisation has heightened demand by residential and commercial consumers of Dar es Salaam services which has increased the number of construction activities. This is therefore has provided employment opportunities for wide range of labourers, both skilled, and the urban poor who do not have many skills (Well and Hawkins, 2007). The construction industry is an important part of the economy in Tanzania, often seen as the driver of economic growth. Typically, in 2010 the Tanzania construction industry contributed 8.0% to the national GDP, compared with 7.9% in 2009. The industry also employed 9% of the workforce in Tanzania (National budget 2011/2012).

Despite its importance, construction sites have been regarded as very risky areas where construction workers are subject to fatalities and ill- health problems. Many building construction activities are inherently risky to health and safety such as working at height, working underground, working in confined spaces and close proximity to falling materials, handling loads manually, handling hazardous substances, noises, dusts, using plant and equipment, fire and exposure to live cables. In Tanzania, construction sites have been ranked as the second most dangerous place in which to work after mines (Mbuya and Lema, 2002; International labour organization (ILO), 2005). Moreover, deaths, permanent disabilities and severe injuries have been on the increase for building workers through major accidents and poor working conditions. This unfortunate scenario has been a monumental threat to the productivity and the overall performance of construction projects as well as diminishing the labour force and the economy of the country. How to reduce the accidents and ill-health problems at construction sites in Tanzania has been a challenge for a long time.

To address the aforementioned issue, risk assessment, communication and control has been argued to be a focal point for reducing accidents and ill-health problems on construction sites (Kirchsteiger 2005; Smith et al. 2006; Jung et al, 2008). Through risk assessment, communication and control, risk can be managed; minimized, shared, transferred or accepted

(Lingard and Rowlison, 2005). Moreover, risk assessment determines the degree of risk employees face from exposure to health and safety hazard at work and can help establish what is necessary to control the risk and protect health (HSE, 2004). Similarly, through risk assessment, communication and control, project participants are informed and educated about risk and protective action, attitude and concerning the perception of risk, and warned about disasters and how to manage emergencies (Argenti and Forman, 2002).

Risk assessment, communication and control have been the cornerstone of health and safety legislation in many countries (ILO, 2005). In Tanzania particularly, the Occupational Health and Safety Act, 2003, the Contractors Registration Board (CRB) Act 2010, and the Employment and Labour Relations Act (EALRA) No. 6/2004, require all employers to assess the health and safety risks to workers and any other person who may be affected by their undertaking. However little is known regarding the industry's response and in particular the practice employed for health and safety risk assessment and communication. It is not well known how people deal with hazards, how risk information is processed and evaluated, and how the received information affects perception of risk, evaluation, behaviour change and what parties are involved. The lack of such information and experience has limited the intervention process of improving health and ensuring a safe work environment on construction sites in Tanzania.

1.2 Research Issue

In Tanzania, as in many developing nations, data on health and safety risk assessment, communication and control in construction management is inadequate. The author was unable to find any work specifically relating to health and safety risk management in the construction industry designed specifically for the Tanzanian context. Literature around the world has identified several leading occupational health and safety risk assessment methods and models, (Baradan and Usmen,2006; Hallowell, 2008; Gurcanli and Mungen, 2009; Fung et al, 2010; Aneziris et al, 2010; Rozenfeld et al, 2010; Wu et al, 2010; Fera, 2009; Marhavilas et al 2011). However, all of these studies have been carried out in developed countries. None among the existing studies has been done to suit developing countries and Tanzania in particular. Petts (2001) points out that the most effective risk assessment and communication process has to relate to the local environment, the economic and social priorities of a country; hence the necessity for studying the Tanzanian context.

The literature further shows that current risk methods for assessing occupational health and safety risks are complex and require high computer literacy, which presents a challenge to carrying out effective risk assessment and communication, especially in developing countries where human and physical resources are inadequate. This study therefore seeks to answers the question on how health and safety are managed on building construction sites in developing countries. This study therefore will contribute to the sound management of occupational health and safety risks in the Tanzanian construction management and risk management fields. Thus the findings will be informative for the actors on project construction management such as project supervisors, designers, project managers, construction managers, the procurement system, project investments, project insurances/actuarial perception, project economics, institutional and regulatory bodies concerning the practice of health and safety risk management.

1.3 Main Objective and Research Questions

This study focuses on the practice employed for health and safety risk assessment, communication and control at construction sites in Dar es Salam, Tanzania. The main objective is to map out the current practices employed for health and safety risk assessment, communication and control on Tanzanian construction sites with a view to develop pre-conditions necessary to improve health and safety risk situations in construction sites. To achieve this objective the following are research questions which this study will answer.

1. What is the nature of the health and safety risks in the Tanzanian construction industry?
2. What methods and tools are used for health and safety risk assessment, communications and control on Tanzanian construction sites?
3. What factors influence and hinder risk assessment, risk control and risk communication on construction site in Tanzania?

1.4 Relevance and Motivation for the Study

The issue of workplace health and safety is extremely relevant, since by failing to adhere to its principles, it affect moral, legal proceeding and financially both social, psychological and economics of the society. Workers on construction sites are exposed to extremely high risks, since working conditions are constantly changing, various construction equipment and

mechanisms are used, and workers of various professions/professional levels are involved. How to organise the work to ensure a safe and healthy work environment is crucial.

Furthermore, improving the health and safety risk management of the construction projects has repeatedly been shown to save lives, time, and money, and to increase business goodwill and good reputations (Rwamamara, 2007; Kikwasi 2010). At the same time, the right to safe and healthy working conditions in construction industry has been a central issue in the global campaign where current health and safety laws and regulations have separate sections specifically for the construction industry (ILO 2005; ILO, 2007; CRB, 2010). Meanwhile, safer and healthier working conditions make an important contribution to poverty alleviation and sustainable development as construction is labour intensive, particularly in developing countries (Charles et al 2007).

This study is in line with Tanzania's development strategies, which recognise that the construction industry is central to the economic development of the country. To achieve the strategies, the Tanzania construction industry policy was introduced whereby health and safety in construction is emphasized. Meanwhile other strategies include Tanzania Vision 2025, which is aimed at achieving sustainable human development with all the prerequisites for a middle-income country by the year 2025, the National Strategy for Growth and Reduction of Poverty (MKUKUTA**),** Employment and Decent Work Agenda and the Millennium Development Goals.

From the researcher's experience working in the construction management field, the knowledge of the actual practice of risk assessment and communication of health and safety on construction site is very important. As a graduate in Building Economics, this has provided the author with a strong foundation for understanding the importance of construction management especially the cost of labour issues in the construction industry. However, in author's professional practice, especially in preparation of the tender documents and the tender evaluation process, the issue of health and safety has been observed not have been given its due significance. It has been always hard to judge if the conditions of contracts have made enough provisions for health and safety management. This has caused her a concern about how health and safety is managed on construction sites. Understanding the process it is necessary in providing basis for establishing the cost of health and safety on construction sites

while at the same time estalibishing efficient intervention for managing health and safety at construction sites.

Furthermore, author's master's programme in Construction Management provided a strong foundation concerning the importance of labour-based construction methods. The master's thesis evaluated its impact on poverty alleviation and established that accidents and poor working conditions impaired labour-based construction methods. Moreover, advanced knowledge on the health and safety risk management in construction sites contributes to the author's academic and professional engagement in Tanzania construction sites.

1.5 Definitions of the Key Terms

The field of risk management is faced with difficulties in defining and agreeing on principles. Risks are dealt with differently across different countries, industries and sectors and fields. Terms, definitions and interpretations are as varied as the number of sources providing them. There are no agreed unified definitions of risk, risk analysis, assessment and management. There are often misconceptions. Different terms, for example "risk analysis" and "risk assessment", are often used interchangeably (Lingard and Rowlinson, 2005).

1.5.1 Health

Health is the general condition of a person in mind, body and spirit, usually meaning to be free from illness, injury or pain. The World Health Organization (WHO) defined health in its broader sense in 1946 as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 2006). In this study health means being free from illness, injury or pain which can be caused by construction activities.

1.5.2 Safety

Safety is related to external threats, and the perception of being sheltered from threats. According to the business Dictionary, safety is defined as a relative freedom from danger, risk, or threat of harm, injury, or loss of personnel and/or property, whether caused deliberately or by accident. Safety can also be defined as the control of recognized hazards to achieve an acceptable level of risk. In this study, safety means freedom from danger, harm, and injury to the person involved in construction activities.

1.5.3 Hazards

A hazard is the potential for harm. In practical terms, a hazard is often associated with a condition or activity that, if left uncontrolled, can result in an injury or illness. HSE (2004) define hazard as any source of potential damage, harm or adverse health effects on something or someone under certain conditions at work. Basically, a hazard can cause harm or adverse effects (to individuals as health effects or to organizations as loss of property or equipment). In this study hazard mean anything which has the potential to cause harm to people on construction sites.

1.5.4 Risk

Risk has been traditionally defined as a measure of the probability and severity of adverse effects (Haimes, 2009). Rowel (1982) provides that risk is related to hazard whereby risk becomes the hazard level (hazard severity) combined with the likelihood of the hazard leading to hazard consequence. Valsamakis et al (2004) define risk as a variation in actual outcome from the expected one, which implies the presence of uncertainty. The general concept of all definitions of risk provides that risk is a danger of unwanted and unfortunate events.

For the purpose of this study risk is a probability of occurrence (likelihood) of an event and the magnitude of its consequence (Kaplan and Garrick, 1981; Mondarres et al 1999)

Risk= (S, P, C): where S= Scenario leading to hazard
P= Probability of occurrence
C= Consequence (severity)

1.5.5 Accident and Injury

The terms accident and injury refer to separate phenomena, mutually interrelated as cause and effect (exposure and outcome) (Andersson, 1999). The terms ‘accident’ and ‘injury’ are hereby used in accordance with the definition adopted at the first World Conference on Accident and Injury Prevention (WHO, 1989); that is, an accident is an unintentional event which results or could result in an injury, whereas injury is a collective term for health outcomes from traumatic events (Andersson, 1999). Rejda (1992) defined an accident as a "sudden, unforeseen and unintentional" event, which may result in physical harm to a person and/or damage to a property.

The use of the term ‘accident’ in this thesis is based on an event which cause physical harm or damage to the body resulting from an exchange, usually acute, of mechanical, chemical,

thermal, or other environmental energy that exceeds the body's tolerance. An event which has the potential to damage property is not considered in this thesis.

1.5.6 Risk Assessment

The Health and Safety Executive (HSE), (1998) defined risk assessment as a process that identifies the hazards associated with particular activities/tasks, evaluates the effects of exposure to these hazards and implements the measure needed to control the risk of injury/ill health to as low a level as possible. In addition, risk assessment has been defined as a structured process that identifies both the likelihood, and extent, of adverse consequences arising from a given activity, facility or system (Kaplan and Garrick, 1981; Gillett, 1998). The assessment of risks informs risk control decisions, the implementation of which is monitored and reviewed to ensure that risk is controlled and remains within tolerable limits (Lingard and Rowlinson, 2005). Assessing risks allows someone to prioritize the action to be taken to control them. In other words, risk assessment is about deciding who might be harmed and then judging how likely it is something goes wrong, and how serious the consequences could be (Mondarres et al, 1999)

In this study risk assessment is the process that identifies the hazards associated with particular activities/tasks on construction sites, evaluates the effects and estimate hazard of exposure to these hazards as indicated in Figure 2.3.

1.5.7 Risk Communication

The notion of risk communication refers to a social process by which people become informed about hazards, are influenced to change their behaviour and are enabled to participate in decision-making about risk issues (Bohrnmann, 2000). This definition was elaborated by (Caccia, 2009) as an interactive process of exchange of information and opinions among individuals, groups and institutions, often involving multiple messages about the nature of risk or expressing concern, opinions or reactions to risk messages or to the legal and institutional arrangements for risk management. HSE (2010) defined it as an open two-way exchange of information and opinion about risk, leading to a better understanding and better decisions. Morrow (2009) comments that risk communication deals with actual risks, the perception people have of them and their thoughts and comments. Hampel (2006) contend that risk communication requires a common set of signs and symbols, common moral

understanding, experiences and values. In this study risk communication is an interactive process of exchange of information and opinions among individuals, groups, and institutions, often involving multiple messages about the nature of the risk or expressing concern, opinions or reactions to risk messages or to the legal and institutional arrangements for risk management.

1.5.8 Risk Control

Risk control is a technique that utilizes findings from risk assessments (identifying potential risk factors in a firm's operations, such as technical and non-technical aspects of the business, financial policies, and other policies that may impact the well-being of the firm), and implementing changes to reduce risk in these areas (Lingard and Rowlinson, 2005).

1.5.9 Risk management

Risk management is an integral component of good management and decision-making at all levels. In construction having a perception of risk management is an integral part of construction management. Rejda (1992) defines risk management as "executive decisions concerning the management of pure risks, made through systematic identification and analysis of loss exposures and the search for the best methods for handling them". Barnard (2005) defines risk management as the identification and evaluation of actual and potential risk areas as they pertain to the company as a total entity, followed by a process of either termination, transfer, acceptance (tolerance) or mitigation of each risk. HSE (2010) Considered risk consultation and communication as the part of risk management.

However, the definition of risk management for this research is that a systematic process for the identification and evaluation of hazards, implement the control measure and communicate the hazards to the parties involved as indicated in Figure 2.3.

1.6 Scope and Limitation of the Research

The research is confined to health and safety risks in two large construction sites in Dar es Salaam. The characteristics of a large sized project were subsequently classified by Contractors Registration Board as project with value of Tsh 1,201,000,000 and above and must be done by contractors of classes one to three. Projects in the range of Tsh 0-1,200,000,000 have been excluded because they are less interesting from this study as the aim was to find the rich performing health and safety risk management. When a project

increases in volume, the organisation and health and safety risk also increases. Meanwhile risk management concept from other sources such as organisation, culture and project conditions are only included as a contextual and theoretical framework. Other risk such as contractual risks and financial risks were excluded on this study. Due to time and financial limit, only two sites were selected for this study.

1.7 Outline of the Report

Chapter one introduces the theme based on risk assessment and communication in construction sites. It provides problem statement, research issue, objective and research questions of the study, relevance of the study and definition of the key concept. Chapter two gives the theoretical and conceptual framework of risk assessment, communication and risk control. Chapter three deal with the health and safety situation on construction sites. Chapter four describe Tanzanian construction industry and the situation concerning health and safety risks. Chapter five discusses the research methodology that is used to answer the research questions.

Chapter six presents the analysis of data from the pilot study. Chapter seven and eight present findings from case study. While chapter seven present finding analyses from Vijana site, chapter eight present findings analysis from kaluta site. A synthesis of the cross-case study is made in Chapter nine. Chapter ten draws conclusions and makes recommendations for future works.

1.8 Chapter Summary

This chapter outlined the research issue, giving its background based on the existing challenges of the high number of accidents and ill-health problems at the construction sites due to the high level of health and safety risk. The chapter also outlined the objectives of the research, justification for it and definition of the key concept. The chapter ends by giving an outline of the report on the whole research study. The next chapter will discuss theoretical and conceptual framework used in this study.

CHAPTER TWO

THEORETICAL AND CONCEPTUAL FRAMEWORK

This chapter provides the theories used for this research. A construction site involves a lot of activities and participants, and to understand the process and the interacting elements there is a need to understand the whole system. System thinking has been used in this study to show the setup of construction projects on construction sites and the flow of information having an impact on risk assessment and communication. From the system thinking perspective, construction projects have been guided by regulations and system which influences risk assessment and communication. In addition, some social aspects from social theories of risk and risk management are discussed in this chapter to give a richer context for understanding factors contributing to risk management.

2.1 System Thinking

A system is considered to be a complex whole in which the components continually affect each other over time and operate toward a common purpose (Checkland, 1990; Olsson and Sjostedt, 2004). These elements can be best understood in the context of their interactions and also their relationship with other systems rather than in isolation (Mohamed, 2004). Systems thinking recognize the multiple, mutual and recursive causation that exists in a complex, dynamic system thereby acknowledging that a change in one area of the system can have a drastic influence on other parts of the system. Stephenson (1991) defines a construction system as the composite of people, procedures, plant and hardware working within a given environment to perform a given task. Following this line of thinking, construction sites are complex system involving multiple and mutual components. Thus construction sites have multiple participants such as clients, design teams and contractors, who have different roles from conceiving to commissioning a typical construction project. Construction are guided and regulated by different regulatory boards, professional societies, policies and regulations in both the designing and construction process.

Mohamed (2004) states that the foundation on which safety management systems are based is that all project participants (clients, designers, subcontractors, contractors) be included in considering safety systematically, stage-by-stage from the outset of the project. Figure 2.1

represents the typical setup of a construction project on a construction site and its composition in Tanzania based on traditional procurement as conceptualized by the researcher.

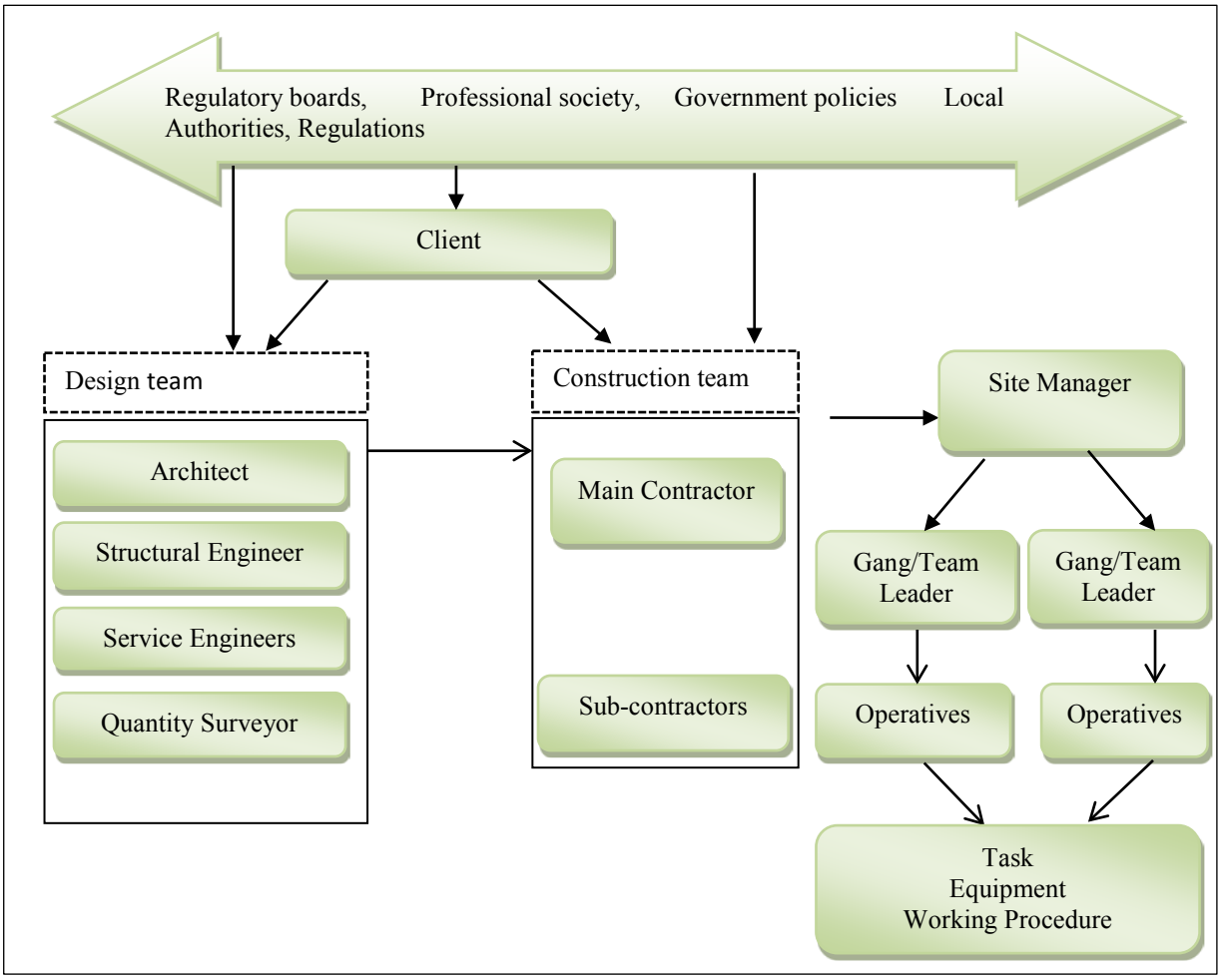

Figure 2.1: Construction project composition on a construction site based on traditional procurement in Tanzania (Author's view)

Systems theory understands risk as a fundamental social construct that is closely linked to the particular rationalities of societal subsystems. The setup of construction projects in construction sites is based on the hierarchical nature of the system where there are levels and sublevels that influence one another. A construction site is a system that is the part of a larger system such as the building industry in which the process of risk management is undertaken. The building industry is part of the wider system that operates and is influenced by the nature of the specific country, such as the political and market context and its regulations. Risk assessment and communication will follow the same trend in relation to the market and political context, and regulations.

Similarly, construction sites operate and are influenced by the nature of the client, the client's brief, the design process and procurement system, which also influence risk assessment and communication. On the other hand, the nature of the construction firm and its management system also influence the construction process, while at the same time influencing risk assessment and communication. Meanwhile individuals on the site, such as site managers, foremen and workers, as well as the work environment, influence the process of risk assessment and communication.

From the systems perspective, individuals within a system do not make decisions or take action solely on their own as their decisions are motivated and driven by other factors within the system at other levels. Thus, individuals on the construction site will make decisions depending on the political system and regulations in the county, the nature of the client, the nature of project and the way project has been designed, the design team, the management culture of the firm and the work environment itself.

Figure 2.2 represents the hierarchical nature of the construction process, which influences risk assessment and communication.

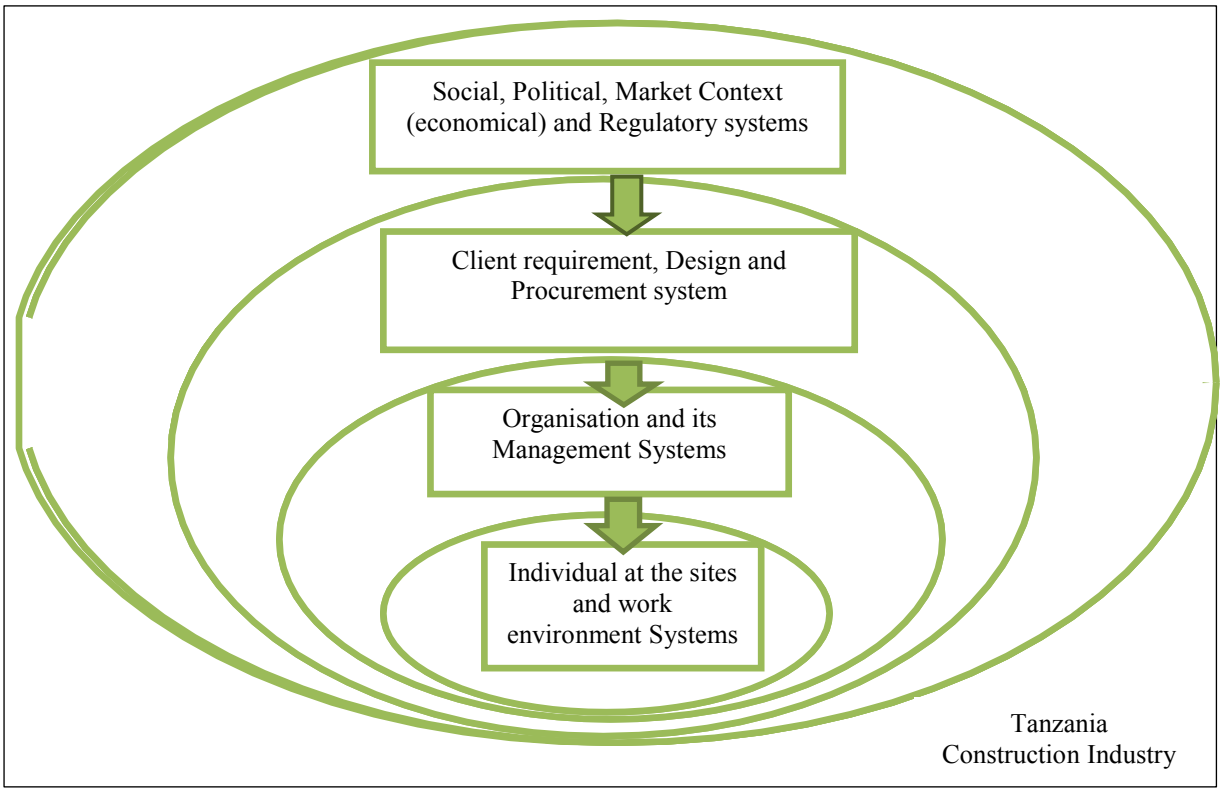

Figure 2.2: Hierarchical' nature of construction process on a construction sites. (Author's view)

2.2 Risk Theories

Generally risk assessment, communication and control has been conceptualised under three broad approaches each contributing different but overlapping perspectives on the assessment, communication and control of risk namely, the technical/engineering, psychological and social-cultural approaches. Details of these approaches are discussed in the following sections.

2.2.1 Technical or Engineering Risk Approach

Technical or engineering and economic approaches to risk emphasise the role of scientific and technological expertise in defining, assessing, communicating and controlling risk. This approach is identified as "realist" or "materialist" given the underlying ontology of hazard as real and material. In this thinking, risk is considered as a quantity, which can be estimated and expressed by a mathematical relation, with the help of real accidents' data recorded at a work site. The main argument of this approach is based on the probability theory, which assumes that future states can be defined. Thus, all component parts are known which can be predictable and their relationships are understood (Holmes et al 1998). Risk analysts argue that the level of risk should be measured in terms of the probability (relative likelihood) of possible outcomes (in a given period) and the measure of magnitude (seriousness) of the consequences of those outcomes (Marhavilas and Koulouriotis, 2011)

Based on this argument, risk is assessed by assigning quantitative figures to the likelihood and consequences of an identified risk. The mode of risk communication in this approach is one-way or top-down whereby the transmission of the risk message is from a particular expert to a non-expert audience (Hampel, 2006). Risk control is achieved through the application of measures in a hierarchical order of effectiveness, termed the control hierarchy (Mathews, 1993). The principle of the control hierarchy is that control measures targeting hazards at source and aiming to change the external work environment are understood to be more effective than those that aim to change the behaviour of exposed workers (Holmes et al 1998).

Many probabilistic and statistical risk assessment methods are available from the technical approach such as Failure Modes and Effect Analysis (FMEA), Failure Modes and Criticality Analysis (FMCA), actuarial approaches and Probabilistic Risk Assessment (PRA). However, these methods often fall short as they allow the incorporation of subjective and/or vague terms and rely heavily on statistical information that may not be available. This is particularly

evident in the construction industry, because there is no systematic recording of relevant safety information (Faber and Stewart, 2003; Nilsen and Aven, 2003). On the same note, social scientists have been questioning objective thinking of risk in this approach (Pidgeon, 1997, Slovic, 2000). These authors argued that objective thinking does not reflect the less predictable human and organizational components of a complex system. Thus, accidents happen they are usually the result of complex interactions between people, their social arrangements and technical hardware. In line with these arguments, the main criticism of the technical/engineering approach is how can it surface and address questions of value that are inherently embedded in the judgment of the risk analyst and how can it convey scientific information to the non-expert.

2.2.2 Psychological Risk Approach

The Psychological approach to risk examines individual cognitive perceptions of risk to explain risk judgements. Thus the approach focuses on the individual perspective, investigating perceptions, attitudes, behaviour and underlying beliefs and values that are incorporated in an individual's assessment of risk (Pidgeon, 1997). Psychometrics studies have found differences between expertise and risk judgements and they point to a concept of risk that is multidimensional and considerably more complex than the statistical or actuarial concept of the technical analyst (Slovic, 1987; Lindell and Earle, 1983; Kuyper and Vlek, 1984).

The main argument in this approach is that the way risks are assessed, judged and communicated depends greatly on how an individual involved in the process perceives risk. Consequently, perception of risk is the central focus of risk assessment and communication (Pidgeon, 1997; Slovic, 2000). When an individual does an estimate of probabilities, it is the experience and heuristics of that person that are used. The way a person perceives the world is also the way the same person makes judgement, evaluates information and make decision. According to Hale and Glendon (1987), the perception of assessing and controlling risk is a determining factor in these judgments. The authors argue that the processes of risk judgment are initiated by a qualitative decision as to whether the risk is controllable by human intervention.

Risk perception studies utilising risk rating methods have identified qualities of risk that influence risk judgements and decisions (Slovic, 1987). These include knowledge about the risk-the extent to which the risk is known and personal control of the risk-the degree to which personal qualities and skills can be used to protect the individual. The quality of personal control of risk has emerged as an important dimension in risk-rating studies of lay judgements on technological and environmental risks (Slovic, 1987; Lindell and Earle, 1983; Kuyper and Vlek, 1984). However, the main critics of the psychological approach to risk have failed to address broader social contexts of risk judgements and argued that social contexts influence the perception of risk (Rayner, 1992; Douglas and Wildavsky, 1982). The concept of risk perception is applied in this research to show how individuals on the construction sites perceive different health and safety risks there. Construction sites are inherently exposed to a lot of health and safety hazards and their assessment and communication will depend on how individuals perceive those risks.

2.2.3 Socio-Cultural Risk Approaches

The socio- cultural approach explores how meanings of risk are constructed within social groups and how a person understands and perceptions of risk are shaped by social factors and experiences. The main argument of this approach is that risk assessment, judgment and communication are not formed independently from the social context. They are part of an evolving social debate about feelings, knowledge, power relations, past experiences, and the culture of the society (Rayner, 1992; Douglas and Wildavsky, 1982). The social theory of risk has been adopted in this approach and both individualism and contextualism play an important role.

Based on the social perspective, the individualism paradigm has been based on the knowledge and personality perspectives. Thus people respond to risk on the basis of the knowledge, information they have and the individual traits (Trimpop and Zimlong 2006). In line with this argument, the experience and knowledge of construction project participants are vital for assessing the level of risk. Therefore, the opinions of experts with many years' experience in construction projects serve as the major input for risk analysis when historical data is insufficient or unavailable.

On the other hand the contextualism paradigm is based on the social structure, institutional form and cultural elements. The main argument of this view is that social institutions and

organisations have an important influence on how risks are produced and perceived (Douglas and Wildavsky, 1982). Thus, people normally evaluate risk and make decisions in relation to their whole life situation. As pointed out by Summerton and Berner (2003), an individual's perception of risk is influenced by the arguments concerning hazards prevalent in a particular society at a certain time. They state, and I quote:

"an expression of socially located beliefs and world views that to a large extent stem from the individual's situated position and experiences within social hierarchies, institutions and groups" (Summerton and Berner, 2003:7).

Based on the organisational perspective, it has been argued that all organisations operate with a variety of beliefs and norms with respect to hazards and their management, which might be formally laid down in rules and procedures, or more tacitly taken for granted and embedded within the culture of everyday working practices (Steve, 2006). Some studies on health and safety management have shown that the relationship between employers and employees is unequal because employers have more power to control the conditions of work, including hiring and firing, than employees (Lingard and Rowlison, 2005).

For instance, in the legal context, occupational health and safety laws in many countries place the primary responsibility for health and safety on employers whose degree of willing compliance with occupational health and safety law may vary according to their conception of risk relation to health and safety. Gunningham (1984), for example, argues that an employer may find it more cost effective to leave health and safety risks uncontrolled than to pay accident related costs, for example, the loss of skilled personnel and workers' compensation premiums. Whilst employers may find benefits in hazardous workplaces, employees experience these as risks to health and safety. On the other hand, Breakwell, (2007) argue that, a key factor in risk assessment and communication is the extent to which the manager and/or communicator is known and trusted by the targeted stakeholders. He states: "...the efficacy of any communication will be driven by the extent to which the communicator is trusted" (Breakwell 2007: 243).

Based on the three broad approaches to risk, the present thesis attempts to broaden the perspective on risk assessment and communication by applying the probability concept of engineering, as well as the psychological and socio-cultural perspectives. The aim is to place an individual on the construction site in focus but in his/her context, working in technical and

economic external institutions and influenced by the attitudes and norms of an organisation or group.

2.3 Risk Management System

There are no fixed rules about how occupational health and safety risk assessment, communication and control should occur. However, there are some general principles that should be followed. Several researchers have developed risk assessment methodologies to suit their requirements (HSE, 2004; Lingard and Rowlinson, 2005; Huges and Ferret, 2011). However, regardless of the differences in approaches or industries, most of the risk assessment methodologies are similar in terms of basic principles and contain the key components described in Figure 2.3 that include work analysis, hazard identification, risk estimation and risk evaluation. Some risk assessment methodologies include risk control as part of risk assessment, but this study considers that risk control is a separate part from risk assessment.

The complexity of risk assessment, risk communication and risk control depends to a major extent on factors such as the size of the organization, the workplace situations within the organization, and the nature, complexity, and significance of the risks to which the organization is exposed (Rwamamara, 2007). However it has been argued that, it is critical that risk should be assessed at every stage in the life of a construction project, and that the input of key stakeholders and project participants is sought (HSE, 2004; Lingard and Rowlinson, 2005). These authors further state that, involving designers in health and safety risk assessment exercises can provide opportunities to "design out" features of a building or structure that pose a threat to health and safety of crews during the construction phase. In the same vein, Rwamamara (2007) commented that an effective risk management process should be managed by a cross-disciplinary team, and be supported by free and open communication and consultation between the project stakeholders. Figure 2.3 presents risk management system focusing on risk assessment, risk communication and risk control in construction

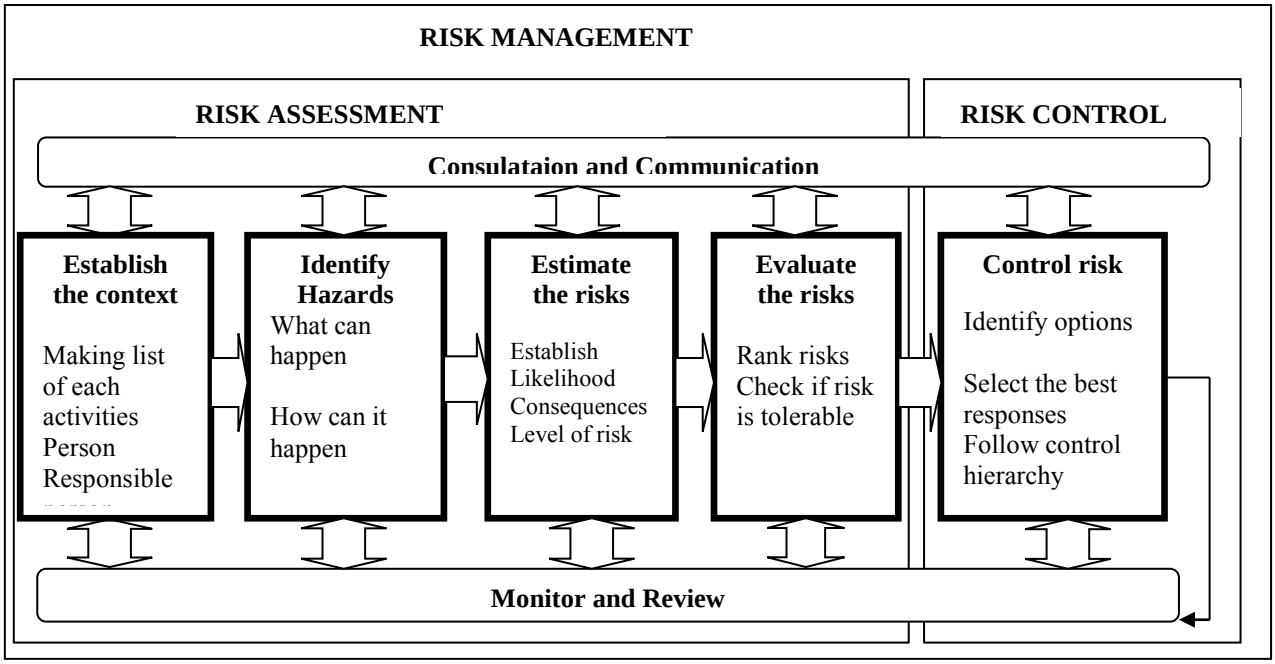

Figure 2.3 Health and safety risk assessment, control and communication. Source: adopted and modified from the Australian and New Zealand Standards Management (2004)

Figure 2.3 presents the four stages of risk assessment, which are establishing the context, identifying the risk, estimating the risk, evaluating the risk and controlling/responding to the risk. Assessing risk is a step-wise process consisting of interrelated but distinct phases. Thus the context must be established first before the hazard is identified. The same is true for estimation of the risk stage, in that it cannot start until finishing identification of the hazard stage. Figure 2.3 also indicates that risk assessment, risk communication and risk control is not a linear process that is undertaken once. It is cyclical in nature where at each stage there is communication, monitoring and a review of the process. The cyclical nature is particularly important in the constantly changing construction environment, in which new or emergent risks must often be assessed, and the changing construction environment in which new or emergent risks must often be assessed and controlled. The following sections discuss the details of each stage of management.

2.3.1 Establish the context.

The first stage in the process of risk assessment is to establish the context of the work or analysis of the work activities. At this stage the work activities can be analysed by making a list of the tasks that are relevant to each area of responsibility, such as excavations, concreting, brick/block layering, scaffolding, handling, loading and unloading, roofing, steel

fixing and transport. This should include all activities that take place, the people involved in those activities, the equipment they use and the different locations they work in.

Various types of information might be used in this initial exercise, including organizational charts and records, interviews and a 'walk-through' survey of the work areas involved. One of the most effective ways of ensuring that all activities are listed is to walk around the workplace and see what is going on as it is possible that a hazard could be overlooked without a site visit (Huges and Ferret, 2011).

2.3.2 Hazard Identification.

Having established the tasks the assessor(s) must then identify what hazards are present, who might be harmed and how. Hazard identification is aimed at determining potential risks associated with any given assignment to be performed by an employee. In addition, it involves identification of locations and processes associated with the risk, as well as employees who are exposed, or people who might be exposed to it such as visitors, employees or contractors. It has been argued that risk identification is the most important stage of the risk assessment (Carter and Smith, 2006). In risk identification "HEEPO, which stands for Human, Equipment, Environment, Product and Organization" has been used (Carter and Smith, 2006; Huges and Ferret, 2011). Thus hazard identification should consider hazards associated with humans, such as hazards from equipment, hazards from the work environment, for example, the condition of the site, hazards from the product such as the design and specification of the materials, hazards from the organization such as management styles and leadership.

According to HSE (2004), it is emphasized that the process of hazard identification should encompass the whole work system. The process of hazard identification is based on direct observation of the site and all available hazard data, as well as observations made on the walk-through survey. Detailed information on equipment and raw materials, systems of work and human factors should be available, together with a sketch of the working area.

There are a number of tools and techniques for identifying the health and safety hazard which have been categorized in three groups as: intuitive, inductive or deductive. However, generally, the methods include brainstorming, expert opinion, structured interviews, questionnaires, checklists, historical data, previous experience, testing and modelling and

evaluation of other projects (Simu, 2007, Carter and Smith, 2006; Lingard and Rowlinson, 2005). Empirical studies of risk management practice show that checklists and brainstorming are the most usable techniques for identifying hazard (Simu, 2007, Lyons and Skitmore 2004, Lingard and Rowlinson, 2005; Huges and Ferret, 2011). Table 2.1 summarizes the methods and tools used to identify hazard as given by Huges and Ferret, 2011

Table 2.1: Methods of identifying hazards and hazardous situations

METHOD	EXAMPLE
Intuitive	Brain storming
Inductive "What could go wrong?" "What if…?"	Failure mode and effect analysis (FMEA) Hazard and operability study (HAZOP) Analysis of potential problems Action error analysis Job Safety Analysis (JSA) Key points/checklists Event Tree Analysis (ETA)
Deductive "How can it happen?"	Fault Tree Analysis (FTA) Accident analysis

(Adapted from Huges and Ferret, 2011and modified)

2.3.3 Risk Estimation and Characterization

In this step of the process, risks are estimated from the hazards identified in the preceding stage. The consideration is made concerning how many people are exposed to each hazard and for how long. Thus, the probability and severity of harm that can be caused by a hazard is considered. To establish the probability and severity of harm, it has been argued that the estimator should have an appreciation of the flow of the typical workday activities of construction activities. Meanwhile, knowledge of the regulations and safety standards under which the facility operates is also important, as some of the regulations provide guidelines on how risk should be assessed and some potential hazards which may be encounter at construction sites. Furthermore, experience is also important as some expert judgement may be required to estimate risk (Lingard and Rowlinson 2005).

Based on the methods used to determine or estimate probability and severity, it has been argued that they are divided into qualitative terms, quantitative terms and semi-quantitative terms (Ayyubu, 2003; Lingard and Rowlinson, 2005; Huges and Ferret, 2011). Qualitative estimate uses descriptive terms to define the likelihood and consequences of risk events. The process relies on an individual's collective judgment in assessing the magnitude of the risks considered, which often uses risk identification terms of low, medium or high risk

characteristics. To rank various risks in order of importance, a risk matrix [1] has been used. (Jeong et al, (2010) argued that the matrix is typically used to compare risk levels for different events and to set priorities for taking action. They further emphasise that the greater the magnitude of risk, the greater the efforts that should be made to control it and the greater the urgency to control the risk and take action. Table 2.2 shows the Matrix for estimating qualitative risk.

Table 2.2 Risk matrix table for qualitative approach and risk rating

Likelihood		Consequences				
		1	2	3	4	5
		Negligible injuries	Minor injury	Moderate	Major injury	Fatality
A	Very Likely	A1	A2	A3	A4	A5
B	Likely	B1	B2	B3	B4	B5
C	Possible	C1	C2	C3	C4	C5
D	Unlikely	D1	D2	D3	D4	D5
E	Rare	E1	E2	E3	E4	E5

Risk Rating: Extreme; High; Moderate; Low

Source: Adopted from Bowden et al 2001 and modified

Table 2.2 shows the simple ranking mechanism of the matrix, indicating different levels of risks such as negligible injury as level 1, minor injury as level 2, moderate injury as level 3, major injury as level 4, or fatality as level 5. Similarly likelihoods can be determined as: very likely —level A, likely—level B, possible—level C, unlikely—level D, or rare—level E. Furthermore, Table 2.2 indicates that there are 25 potential risk combinations and the risk outcomes have been divided into four risk levels (ratings) namely, Extreme, High, Moderate and low. From this rating, the extreme situation indicates there are fatal consequences which should be tackled first while low rating indicates there is negligible injury which requires first aid. However, it has been observed that the qualitative approach has some limitations, such as it is not easy to incorporate the effects of risk reduction measures within the risk matrix, and neither method is easy to use to assess cumulative hazards, in particular at facilities where a large number of hazards exist.

Quantitative risk estimation (QRA) uses numerical values to express both the consequences and likelihood of a given event. It involves the use of intensive mathematical equations and

[1] Risk matrix table is a matrix that is used during risk estimation to define the various levels of risk as the product of the harm probability categories and harm severity categories

modelling to rank risk that is an extension of the low, medium and high ranks, and describes risk as the frequency of injury or death (Bowden et al 2001; Ayyub, 2003; Marhavilas and Koulouriotis, 2008). The risk is calculated considering the potential consequences of an accident, the exposure factor and the probability factor (Marhavilas and Koulouriotis, 2008). Meanwhile, a risk matrix is also used for quantifying risk as in the case of the qualitative approach. However, only numbers are used to inform judgment on both probability and the consequences. Table 2.3 shows the matrix for estimating quantitative risk.

Table 2.3: Matrix for quantitative approach for estimating and rating risk

	Hazard probability ratings					
Severity of consequences ratings	**1**	**2**	**3**	**4**	**5**	**6**
1	1	2	3	4	5	6
2	2	4	6	8	10	12
3	3	6	9	12	15	18
4	4	8	12	16	20	24
5	5	10	15	20	25	30
6	6	12	18	24	30	36

	Unacceptable	18-36
	Undesirable	10-16
	Acceptable with controls	5-9
	Acceptable	1-4

Source: adopted from Marhavilas & Koulouriotis, 2008 and modified

Table 2.3 indicates the matrix risk-assessment technique where six levels of risk matrix are identified. It indicates that as both the severity and probability increase, the risk is higher. Table 2.3 also shows the risk rating where the higher numbers indicate higher risk and the situation is unacceptable. QRA is generally considered to be most useful for quantifying off-site risk; for example transportation of construction material, industrial production materials (Prefarication materials), however, it can be useful in assessing on-site risk if sufficient details and an understanding of the reality of people's responses to accidents are included (Hughes and Ferrett, 2011).

On the other hand, the semi-quantitative risk assessment approach provides an intermediate level between the textual evaluation of qualitative risk assessment and the numerical evaluation of quantitative risk assessment, by evaluating risks with a score. It has been argued that semi-quantitative method is used more for estimating risks than the quantitative method (Lingard and Rowlinson, 2005; Marhavilas and Koulouriotis, 2008). Semi-quantitative risk assessment is most useful for providing a structured way to rank risks according to their

probability, impact, and for ranking the effectiveness of risk-reduction actions. This is achieved through a predefined scoring system that allows one to place perceived risks into categories, where there is a logical and explicit hierarchy between them. Semi-quantitative risk assessment offers the advantage of being able to evaluate a larger number of risk issues than quantitative risk assessment because a full mathematical model is unnecessary.

2.3.4 Risk evaluation

The purpose of risk evaluations is to decide whether or not a risk is tolerable (Lingard and Rowlinson, 2005; Huges and Ferret, 2011). If the risk is regarded as acceptable as indicated in Tables 2.2 and 2.3, it may be enough to control the risk instead of reducing it. However, if the risk is regarded as unacceptable different risk reduction options have to be analyzed and compared so that the best risk reduction option can be identified. The evaluating stage of the risk-assessment process involves assessing the team making decisions on the most appropriate risk control strategies.

Once a level has been established for the risk estimated, the levels are compared with previously established risk criteria to create a prioritized list of risks to be controlled. It may become an important task to identify and select the relevant specific risk criteria for specific estimated risks in a specific country and/or industry. Selecting risk criteria may also depend on the results of the risk analysis and how risks are estimated. There are different principles described in the literature for evaluating risk and it is important that the principle used is openly communicated and accepted by the stakeholders involved. The evaluation principles form the basis for defining risk tolerability (Barnard, 2005).

3.3.5 Risk control

A control measure is part of a facility, including any system, procedure, process or device that is intended to eliminate hazards, prevent hazardous incidents from occurring or reduce the severity of consequences of any incident that does occur (Lingard and Rowlinson, 2005.). Control measures may be proactive, in that they eliminate, prevent or reduce the likelihood of incidents, or they may be reactive, in that they reduce the consequences of incidents (Huges and Ferret, 2011)

The information on control measures can be obtained from Codes of practice, Industry or trade associations, specialists, and other publications including those of manufacturers and

suppliers. In the occupational health and safety context, risk control is categorised according to hierarchy, often simply called the "risk control hierarchy." This hierarchy helps people to decide on which risk control to implement. Risk control options at the top of the hierarchy are preferred more than those at the bottom of the hierarchy. The preferred options are the most effective means of controlling risks because they are much less reliant on people to do something and they can protect a larger number of people. Therefore, control measures should be considered and adopted in the order presented. Figure 2.4 represents the risk control hierarchy.

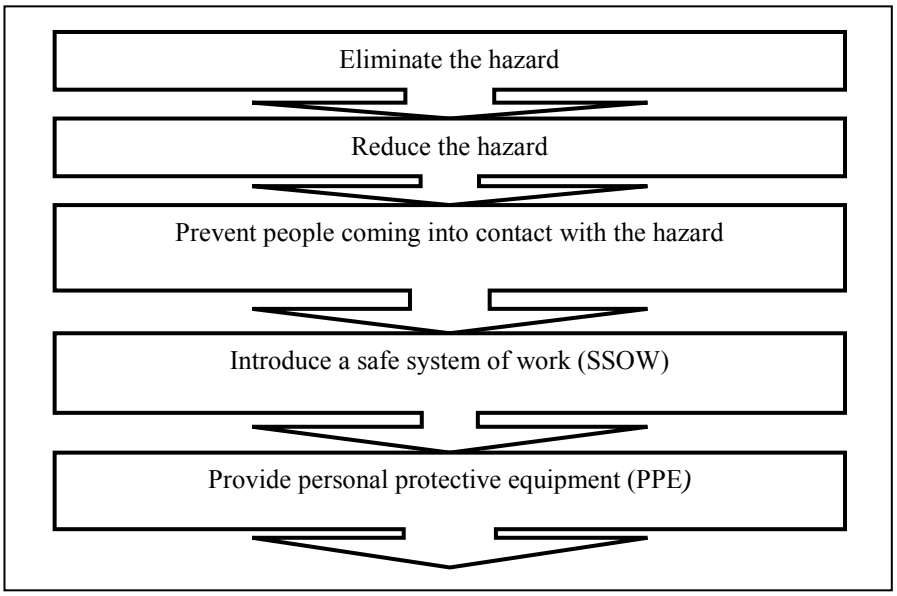

Figure 2.4: Risk control hierarchy: Source Lingard and Rowlinson, 2005.

The risk control hierarchy consists of five stages of control risk as portrayed in Figure 2.4. The first stage is elimination of the hazard. At this stage hazard is totally eliminated. For example, the mechanization of tasks to remove manual handling or closing a road to traffic when repairing a road are the most effective and preferred ways of controlling a risk because the hazard is no longer present. However, it is difficult to eliminate all unsafe conditions, and therefore elimination is not always possible (Marhavilas and Koulouriotis, 2008).

The second stage is reducing the hazard or making a substitution. At this stage the risk is controlled by reducing it or substituting it with lesser hazards, such as using less toxic paint or carrying a lighter load when handling manually. The third stage is isolation where risks are combated at source and access to the hazard is prevented, such as guarding machinery or installing barriers and fences, and installing edge protection to open edges on landings, stairways and fixed platforms, sound enclosures and circuit breakers.

The fourth stage is introducing a safe system of work (SSOW). This stage uses information such as written procedures and safe systems of work, instruction, training and supervision. It ensures that employees understand what they must do and when, how they must do it and what activities are prohibited. These are work practices that alter the way the work is done in order to reduce the risk of hazardous tasks. Providing personal protective equipment (PPE) is the last stage in the Risk control hierarchy. It has been argued that PPE should be opted only as the last resort and only after all other measures have been implemented (HSE, 1999; Huges and Ferret, 2011).

3.3.6 Consultation and Communication

Consultation and communication is both a key component of the risk management process and a major beneficial side effect. Risk management decision makers have both legal and moral responsibility to provide information to people exposed to risks. Successful risk management relies on achieving a high level of creative input and involving all parties in achieving a successful outcome of the project or business process being addressed. According to Hampel, (2006) risk communication is not a task where bits of information are transported from the sender to the recipient of the communication but a process, where both sender and recipient interact in order to develop a common frame for an understanding of the problem. In both the planning and execution of the risk management process, it is essential to ensure that all those who need to be involved are given an adequate opportunity to do so and are kept informed of developments in arriving at an understanding of the risks and the measures taken to deal with them. One important part of risk communication is how to present the risk information.

Slovic (2001) pointed out that different ways of presenting the same risk information can lead to different evaluations and decisions, even though they are logically equivalent. Risk research has shown that the basic understanding of risks differs within societies. The fact that people's perception of risk differs is one of the reasons why risk communication is complicated. According to Bohrnmann (2000), effective communication depends greatly on the characteristics of the messages distributed, the conveying authority, the receiving audiences and the context in which the communication process occurs. This communication must be understandable by the audience and may require the use of photographs, diagrams or a translator. On construction sites different tools can be used to send information, such as

induction training, handbooks, team briefings, toolbox talks, supervision meetings or other management meetings, specific or general instruction or training sessions and hands-on training (HSE, 2010). People in interaction with each other tend to communicate in different ways, either formally or informally Bohrnmann (2000). Formal communication is communication that is spontaneous, structured, interactive and rich, conveyed through communication channels while informal communication is interaction between individuals without rules, or hierarchy (Ibid).

2.4 Research Conceptual Framework

From systems thinking, risk management sytem and adoption of the three approaches of risk, four main variables that can enhance the risk management process on construction sites are revealed. These parameters are the institutional system, organisational system, individual system and work environment system. Furthermore each system has sub-variables. Figure 2.5 summarises the research conceptual framework showing the main variables and sub-variables

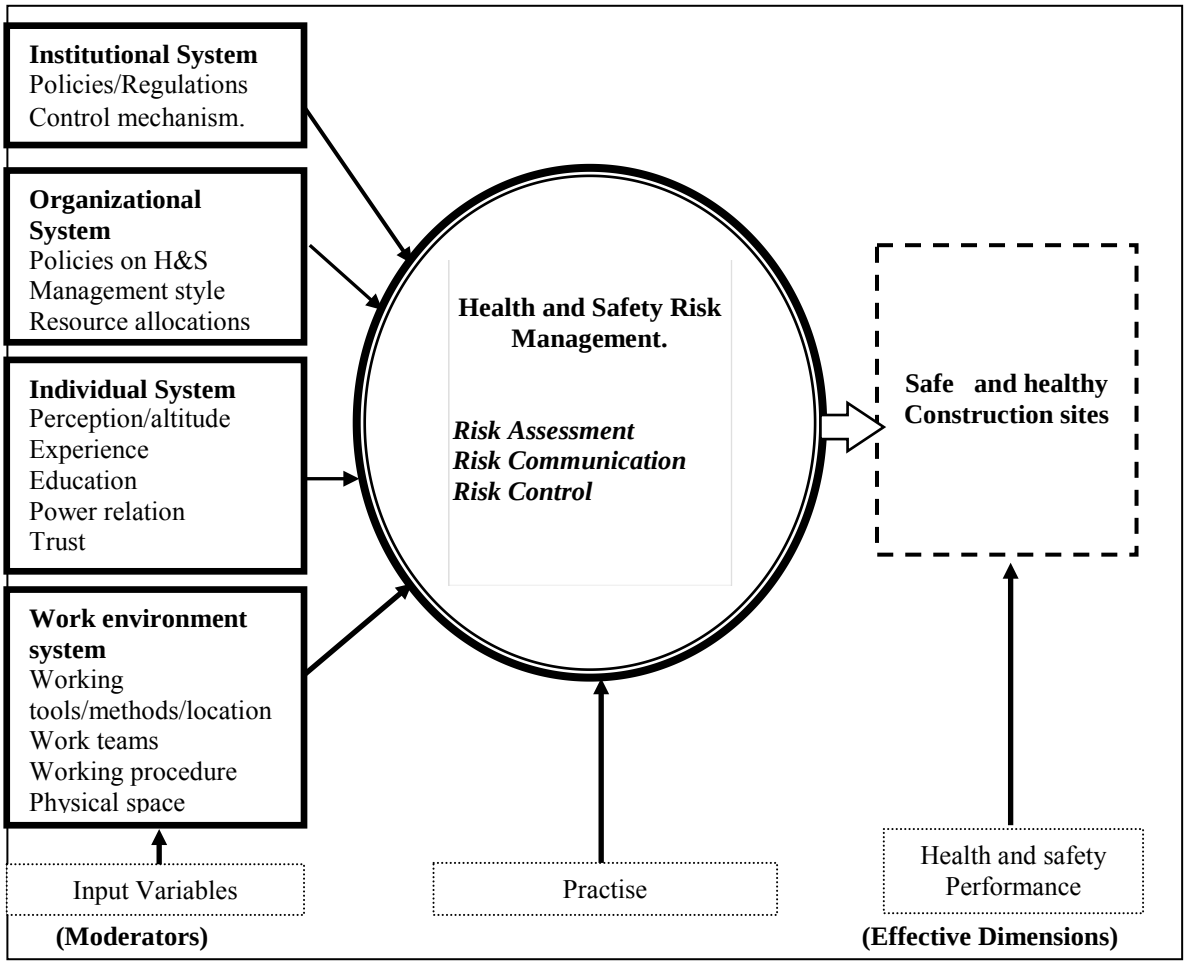

Figure 2.5: Research Conceptual Framework (Source: author's view**)**

Figure 2.5 provides the conceptual framework of the research. The figure shows that health and safety risk management is influenced by the institutional system of a specific country, organisational system/culture, individual system and work environment. The details of each system are given in the following sections.

2.4.1 Institutional Systems

The process of risk assessment and communications is shaped with the institutions. Institutions are settled habits of thought common to the generality of man, which impose restrictions by defining the legal, moral, and cultural boundaries that separate legitimate from illegitimate activities. Institutions shape behaviour by constituting the set of acceptable interpretations and actions available to social actors. Thus they comprise the norms, regulations and control mechanism. This study considered the regulatory approaches to establish how rules, laws and sanctions facilitate the process of assessing, communicating and controlling health and safety risk on construction sites. Meanwhile, the study focused also on how the institutions such as the Occupational Safety and Health Authority (OSHA) and the Contractors Registration Board (CRB) guide the day-to-day functioning of health and safety risk management on construction sites.

2.4.2 Organisational/ Firm System

An organisation is also one of the main actors in the risk assessment and communication process. Considering a construction company, the construction site is a subset of management from the company level. Senior management is in the best position to demonstrate its commitment to, and provide leadership in, the development and implementation of health and safety risk management programmes to meet legislative requirements. This condition happens when the organisational culture facilitates health and safety risk assessment and communication. Thus, management demonstrating its commitment to establish and meeting health and safety targets, provides the necessary resources, both human and financial, and educating their employees on health and safety issues. This study therefore considered the organization policy on health and safety, resource allocation (human and financially) and commitment training in health and safety on the construction sites as the variables.

2.4.3 Individual System

Individual factors are particular behaviours that individuals bring to the process of risk assessment and communication. Judgements and decisions have been pointed out as the most

critical part of risk assessment and communication. Thus individuals making decisions especially on the best way of controlling risk require a good understanding of the nature of the work and the health and safety risks they experience. On the other hand, how individuals are trusted and power relations at the construction site influence communication and control of risk. From this perspective, individual factors this study focuses on include individual experience in the construction industry and risk assessment, educational background, his or her perception of a particular on risk, power relations and trust with respect to other people on the site.

2.4.4 Work Environment System

The work environment is the situation in which the individuals are working. The construction site is a complex system with a lot of stakeholders working together to accomplish the construction project. This complex system also some information being passed from one team (design) to another (construction), which is required for risk assessment and communication. Meanwhile the physical space, the working procedure (site operation), tools and methods used and resources available are factors influencing risk assessment and communication. This study considers the physical space, instruments, tools and equipment as well as the working team and working procedures as factors in the work environment system.

2.5 Chapter Summary

In this chapter, theories relating to risk assessment and communication at construction sites have been presented. Systems thinking and three approaches to risk theories are discussed. The chapter also discussed the process and methods of risk assessment, risk communication and risk control on construction sites. It advocates that risk should be assessed at every stage in the life of a construction project, and that it should involve the input of key stakeholders and the project participants. The research conceptual framework is also provided. The main argument presented in this chapter is that the process of risk assessment and communication is a social construction influenced by values, regulatory factors, (such as regulations and standards), cultural factors, organisational factors, such as the commitment of senior managers and directors of the company), individual factors, such as perception, past experience, trust and power relations, and work environment factors, such as tools, resources working group and physical space. The next chapter presents the situation health and safety of Tanzanian construction industry.

CHAPTER THREE

HEALTH AND SAFETY SITUATIONS ON CONSTRUCTION SITES

This chapter discusses health and safety situations on construction sites. The chapter commences by discussing the situation of health and safety risk globally, sources of accidents and ill-health problems on construction sites. The chapter ends by discussing the types of different hazards found in construction sites.

3.1 Global Situation of Health and Safety Hazard on Construction Sites

Construction health and safety risks are always a grave concern for both practitioners and researchers all over the world. Thus, construction has been regarded as the most hazardous place in which to work with a high level of health and safety risks (ILO, 2005, Lingard and Rowlison, 2005; Smallwood et al 2008). ILO estimates that at least 60,000 fatal accidents happen in a year on construction sites around the world, which is one in six of all fatal work-related accidents. In the same vein, occupational health and safety statistics presented by different researchers (Lingard and Rowlison, 2005, Smallwood et al, 2008, Hinze, 2008), revealed that, the injury and fatality rate in construction projects is very high in comparison with other sectors of industry in the majority of countries.

Moreover, it has been acknowledged that 25–40% of fatalities in the world's occupational settings are contributed to by construction (ILO 2005). Based on fatality statistics, different countries show that the construction industry produces 30% of fatal industrial accidents across the European Union (EU), yet it employs only 10% of the working population. In the United States of America (USA) the sector accounts for 20% of fatal accidents and only 5% of employment, and in Japan construction fatalities account for 30-40% of industrial fatal accidents (ILO, 2005). In the developing world, the risks associated with construction work are much greater. Available data would suggest they are 3–6 times greater (Jason, 2008). In comparison with developed countries, construction sites in developing countries are ten times more dangerous (Hämäläinen et al. 2006). Other research conducted in developing countries corroborates evidence of this relatively high proportion of accidents on construction projects (ILO 2001, Murie 2007). However, there is a challenge of reporting accidents in developing countries (ILO, 2005). From this perspective, health and safety is a global issue which needs a

different approach to solve it. Improving health and safety in the construction industry therefore continues to remain a priority.

3.2 Sources of Accidents and Ill-health Problems on Construction Sites

In order to understand the sources of accidents and subsequent injuries, researchers have attempted to develop theories of why accidents occur. Accidents are viewed as originating from a technical or human error (Chi et al, 2005; Murie 2007). The multiple accidents causation theory postulates that there are many contributory causes leading to an accident (Heinrich 1931). The causes are categorized into behavioural and environmental factors. Behavioural factors include attitudes, skills and knowledge. Environmental factors include worksite hazards and procedures that contribute to injuries (Taylor et al., 2004). A similar view is held by Lubega et al. (2001), who found that the causes of construction accidents in Uganda include a lack of knowledge about safety rules, engaging an inexperienced workforce, and lack of respect for safety.

Tam et al. (2004) concurs with this view and suggests that the main factors affecting safety in China were managers' poor safety awareness, lack of training, reluctance to commit resources to safety, and reckless operations. Furthermore, Dejus (2007) conducted a study in the Lithuanian Republic and identified that the major reasons for serious and mortal accidents are inexperienced employees, lack of qualifications and understanding risk on a construction site. Rahim et al. (2008) carried out a survey in Malaysia to identify the causes of accidents on construction sites; they found that unsafe methods, including incorrect procedures, knowledge level, and disobeying procedures are the most frequent reasons for accidents on construction sites.

In addition to these causes, Holt (2001) argued that, secondary causes of accidents centred on management pressures, such as financial restrictions, lack of commitment, inadequate policy and standards, deficient knowledge and information, restricted training and task selection, and poor quality control systems. He further emphasised that incomplete structural connections, temporary facilities, tight work areas, varying work surface conditions, continuously changing work-sites, multiple operations and crews working in close proximity are common causes of construction-related deaths and injuries.

To conceptualize the literature (above) on sources of accidents and ill-health problems on construction sites, it is observed that the causes of construction accidents can generally be classified into the five most influential factors namely, site conditions, equipment and materials, human, management and job factors (building/task itself). Figure 3.1 represent a summary of the sources of health and safety risk on construction sites.

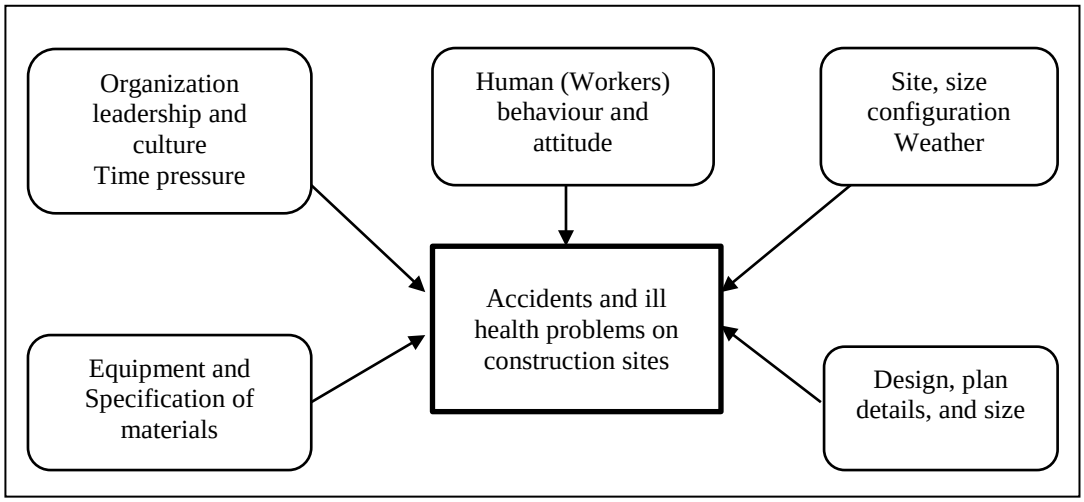

Figure 3.1 Summary of source of health and safety risk on construction sites. Source, authors view

Figure 3.1 indicates the five main sources of accidents on construction sites. The sources include site conditions such as the nature and physical layout of the work, location and weather, equipment and materials specification such as paint and asbestos that have the potential to cause ill-health problems. The human factor includes human behaviour, competence, attitude and management such as leadership and safety culture of the organization. The job factors include the nature of the task, design, detail, duration and the size of the structure itself.

3.3 Types of Health and Safety Hazards on Construction Sites

Various researchers have divided health and safety hazards into two categories, namely the physical injury hazards and the Ill-health hazards (Davies and Tomasin, 1996, HSE, 1998, Murie, 2007). Hazard of physical injury include death concequnces. Hazard of ill-health can only be notified after a long period and shall cause sickness or death after a certain period of time (Murie, 2007). The following are common hazards on construction sites irrespective of the physical injury or ill-health problems.

3.3.1 Height

The main hazards associated with working at height are people and objects falling onto people below. Falls from height have been viewed as the one of the most frequent killers of the workers on construction sites. Statistics indicate that nearly 1,000 construction workers are killed each year at their work places. Of these, one-third or over 300 deaths are a result of construction site falls (ILO, 2005). The study from different countries for example, New Zealand, indicates that, falls from heights are the leading cause of occupational injuries on construction sites (Bentley et al., 2006). In China's construction industry, falls account for approximately 51% of injuries (Yung, 2009). In Hong Kong, work-related falls from heights represented more than 47% of all fatal incidents (Chan et al., 2008). Chi and Wu (1997) reported that more than 30% of fatalities in Taiwan can be attributed to falls. As a result, falls are the most costly occupational hazard in many countries. Common construction site falls include roof-related falls, crane falls, scaffolding falls, elevator shaft falls, falls resulting from holes in flooring, and falling objects. These may occur as a result of inadequate edge protection, or from objects in storage being poorly secured. Workers at risk of falling from a height include painters, masons, decorators and window cleaners and those who undertake one-off jobs without proper training, planning or equipment (Murie, 2007).

3.3.2 Slips and Trips

Slips and trips are seen as the most common workplace hazards and contribute to over a third of all major injuries (Hughes and Ferret, 2011). Over 10,000 workers suffered serious injury because of a slip or trip last year. They occur in almost all workplaces and 95 % of major slips result in broken bones (HSE, 2004). According to statistics from the Health and Safety Executive (HSE), slips and trips are the single most common cause of injuries at work, and account for over a third of all major work injuries (HSE, 1998). They cost employers over £512m a year in lost production and other costs and account for over half of all reported injuries to members of the public.

The study done by Lipscamb et al (2008) on the USA revealed that slips account for 18% of all injuries and 25% of workers' compensation payments. Slips contributed to 85% of falls on the same level and over 30% of falls from height as well as a significant number of musculo-skeletal injuries sustained after slipping (Ibid). They can also be the initial cause of a range of other types of accidents, such as falls from heights. Slips and trips are caused when materials are scattered everywhere haphazardly, the floor is wet or greasy, inappropriate footwear is

worn, mainly by casual employees and visitors, something large or heavy is being carried, reducing one's balance, and when the lighting is poor.

3.3.3 Equipment, Machinery, Tools and Transport

Vehicles are necessary for transporting goods and people. However, many people die and are injured due to being struck and crushed by equipment and machinery at construction sites, especially by reversing machinery, site machinery falling in the excavation area, machines overturning due to travelling down a steep slope, and material falling from construction equipment especially haulage trucks, hitting people behind it or nearby (HSE, 2004). Crush injuries can have a wide range of serious effects, including fractures, internal injuries, head and brain injuries, and back injuries. In some cases, a crush injury may result in amputation and permanent disability of the affected worker.

Meanwhile, many people are injured due to being chopped and cuts by equipment and hand – held working tools such as chisels, screwdrivers, knives, saws, harmers, nails and drilling machines. The greatest hazards posed by hand tools results from misused and improper maintenance.

3.3.4 Electricity

Electricity is widely used on construction sites but has the potential to be very hazardous with possible fatal results. Someone coming into contact with a live electrical conductor will get a shock that may lead to injuries or even death. In the UK, for example, 2% of all fatalities at work are caused by electric shocks (Huges and Ferrett, 2011). Most injuries and deaths from electricity are due to, using poorly maintained electrical equipment, working near overhead high tension lines or domestic electricity supplies, contact with underground power cables during excavation work and working without appropriate safety gear.

3.3.5 Fire

Fire is one of the many hazards that construction workers could face on site. Although fire hazards are not seen as such as a high risk compared with falling from a height and slipping, tripping and falling, fire hazards need to be considered at all stages of the building process (HSE, 2000). Every year on many construction sites, workers are killed or injured as a result of fire. There are about 400 construction fires annually in United Kingdom (UK) and about 100 of them cause over £50,000 worth of damage and can result in the incomplete dislocation

of the project schedule **(**Hughes and Ferret, 2011). Fires on site are caused by braising work carried out by plumbers, gas lines for underground work, power lines, power leads and tools, machinery requiring petrol and diesel, and hazardous chemicals.

3.3.6 Manual Handling

Manual handling is defined as the movement of a load by human effort alone (Hughes and Ferret, 2011**).** It can include any activity requiring the use of force exerted by a person to lift, push, pull, carry or otherwise move or restrain any moving or stationary object (HSE, 1998). It has been argued that lifting bricks, cement blocks and cement bags weighing 50 kilos has been regarded as risky activities on construction sites (Hughes and Ferret, 2011). Back injuries and emasculatory disorders, sciatica, hernias and slipped discs are often the most serious of construction site injuries (Ibid). In the study by Smallwood (2008) it was revealed that in construction, 25% of injuries are back injuries. Almost 30% of all construction workers complain of back pain that requires over thirty days off. The average number of days of work missed by a construction worker is higher than in other fields of employment.

3.3.7. Noise

Occupational noise-induced hearing loss is defined as hearing impairment arising from exposure to excessive noise at work, which is also commonly known as industrial deafness the NOHSC National Code of Practice (2004). Exposure to hazardous noise levels is so widespread as to be routine, and occupational deafness is very common among building workers. Some activities on construction sites are notoriously noisy, for example, rock breaking during demolition work or the operation of a jack hammer. The use of vibrating wacker plates, electric tools, explosive powered nail guns and vibrators during concrete pours; all cause specific noise problems for the operators and workers in the vicinity in relation to maintaining their hearing ability. Noise comes from the operation of plant, machinery and power tools, the movement of vehicles and deliveries of materials (HSE, 1998).

3.3.8 Chemicals Substances:

Construction activities involve using chemicals which pose health and safety risks to workers. For example solvents of many different kinds are used in paints, varnishes, pesticides used to treat timber, bonding agents, lacquers and adhesives (HSE, 1998). At the construction site, workers might be exposed to chemicals by breathing them in, ingestion and absorption through the eyes or skin (Murie, 2007). Chemicals at work sites can cause headaches, eye

irritation, dizziness, faintness, sleepiness and affect judgment and coordination. They can damage to the central nervous system and can harm the skin, liver, kidneys and cardiovascular system. Some solvents increase the likelihood of cancer (Huges and Ferrett, 2011). Solvents can also cause reproductive problems. They can reduce fertility and cause birth defects and miscarriages (Murie, 2007). Some paints and varnishes, bonding agents and resins, can cause asthma and dermatitis. Welding fumes – which may include a cocktail of metal fumes, can cause serious health problems in the long term. The respiratory system is affected and, as chemicals are absorbed, they can slowly affect the brain and internal organs (Huges and Ferrett, 2011).

3.3.9 Dust:

Dust is a common hazard on roads and building works at many sites. The health risks associated with a dusty jobs depend on the type of dust (physical, chemical and mineralogical), which will determine its toxicological properties, and hence the resulting health effect; and the exposure, which determines the dose. If dust is released into the atmosphere, there is a good chance that someone will be exposed to it and inhale it. If the dust is harmful, there is a chance that someone will suffer an adverse health effect, which may range from some minor impairment to irreversible disease and even life-threatening conditions (Huges and Ferrett, 2011). There are higher death rates from respiratory disease and from lung and stomach cancers in dusty trades. At construction sites cement, silica and wood dust and dust from medium-density fibre board poses particular risks.

3.3.10 Aggression, Violence and Bullying

Aggression and violence occurs when people are verbally abused, threatened or assaulted in circumstances relating to their work. At construction sites aggression and violence are manifested through the use of foul language and physical attacks (HSE, 1998). Where there is aggression and violence, human dignity is debased. Violence and aggression may come from superiors or workmates. Bullying occurs when workers feel that they are being singled out for unfair treatment by a boss or colleague. For example, a worker is constantly criticized instead of being instructed, being demoted and being shouted at by workmates or superiors. Aggression, violence and bullying can contribute to other risks such as stress (Huges and Ferrett, 2011).

3.4 Chapter Summary

This chapter discussed the situation of health and safety risks globally, revealing that health and safety is a global issue needing efforts to address it. The chapter discussed the sources of accidents and ill-health problems on construction sites, revealing that they are caused by factors such as job site conditions, equipment and materials, humans, management factors and job factors. The chapter outline different types of hazards existing on construction sites.

CHAPTER FOUR

TANZANIA CONSTRUCTION INDUSTRY, RESPONSIBILITIES AND HEALTH AND SAFETY LEGISLATIVE.

After discussing the situation, source and types of health and safety on construction sites in the preceding chapter, this chapter provides a background to the Tanzania construction industry with a specific focus to the structure and its characteristics, the construction process and key actors in construction projects. The chapter also discusses health and safety performance, and the institutional and legal framework relating to health and safety risks on Tanzanian construction sites.

4.1. Location and Environmental Condition of Tanzania

The United Republic of Tanzania is a developing country that lies south of the equator in East Africa. It borders the Indian Ocean to the east, and has land borders with eight countries, anticlockwise from the north: Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo (across Lake Tanganyika), Zambia, Malawi and Mozambique. The climatic condition is tropical with high humidity on the coast and temperate in the highlands. There are two main rain seasons throughout the country: the long season from mid-March to May, and the short rains fall during November, December, and January. The coolest months are June to October, and the warmest are December to March. The climatic condition has an impact on construction activities as during heavy rains there are fewer of them.

The United Republic of Tanzania covers 945,000 sq km (365,000 sq miles), with a population of 42 million people with a per capita income of $210 US dollar per annum. About 33% of the population lives in urban areas, such as Dar es Salaam, Mwanza, Mbeya and Arusha, with Dar es salaam being the most populated city, accommodating 10% of the total national population and 35% of the urban population (UN-HABITAT 2008). Figure 4.1 provides a Map of Tanzania showing the boundaries and main cities

Figure 4.1: Map of Tanzania showing the boundaries and main cities.(Dar es salaam has been selected area for this study) Map from http://www.nationsonline.org/oneworld/map/tanzania-administrative-map.htm visited on November 21

4.2 Tanzanian Construction Industry and Economic Development

The Tanzanian construction industry continues to be one of the key sectors in the economy. In 2010 the construction sector grew at a rate of 10.2%, compared with 7.5% in 2009 and contributed 8.0% to the national GDP, compared with 7.9% in 2009. The industry also employed 9% of the workforce in Tanzania (National budget 2011/2012). Meanwhile Tanzania construction sectors have been a vital for human settlements. To say the least, this industry produces the very fabric of cities and towns as in the case of Dar es slaam and other areas. They would simply not exist without construction. Also, the construction industry is one of the major providers—and in many instances the primary provider—of work in urban areas, especially for the poor. Further to direct employment in construction sites, the industry provides a large magnitude of other jobs, such as in the production of building materials and

equipment, post-construction maintenance, It is also worth noting that, in parallel to their jobs in formal building activities, a large number of construction workers render an important service to other groups of low-income people, through support to self-help building.

4.3 Structure and Characteristics of Construction Services in Tanzania

The construction industry in Tanzania is divided into three major service groups. These are groups that offer professional services, groups that offer support services and groups that offer construction services. The generic organizational chart for the Tanzanian Construction industry is shown in Figure 4.2.

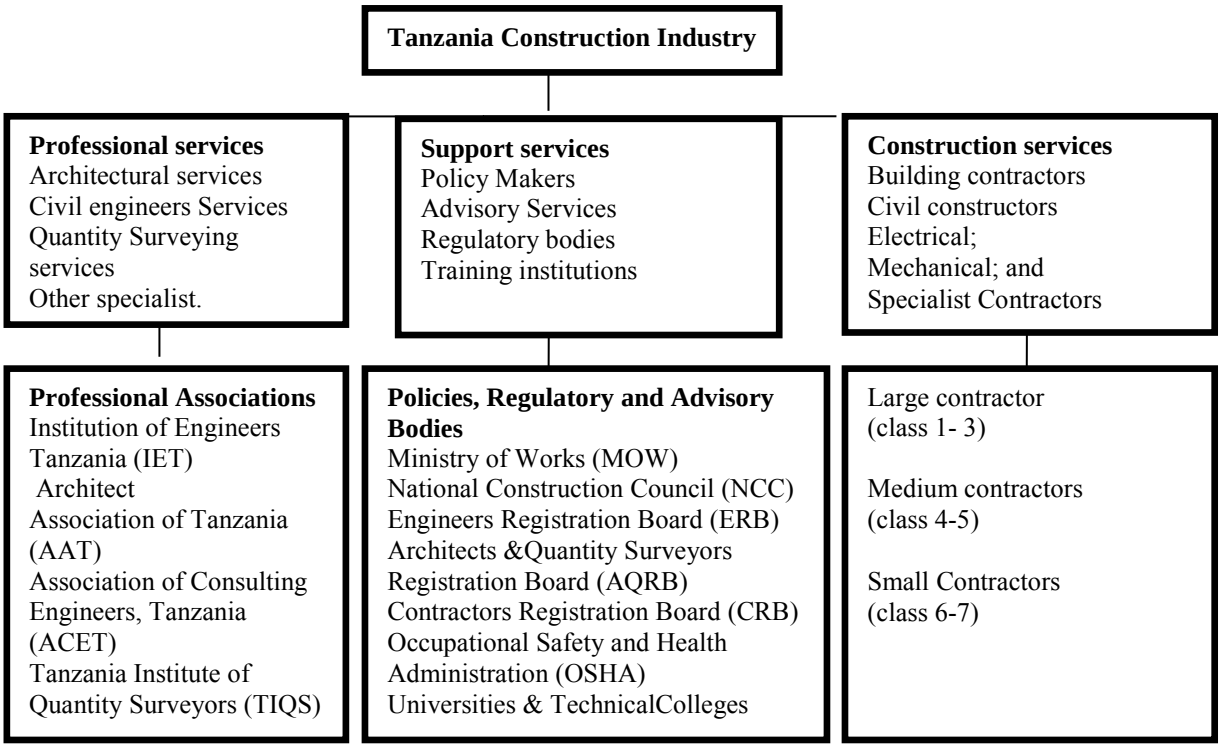

Figure 4.2: Organization of Services in the Tanzanian Construction Industry (Adopted from Mbuya, and Lema, 2002) and modified

Figure 4.2 shows that the construction industry is divided into three service groups; the first group comprises professional service such as architectural, quantity surveying, civil engineering, electrical and other specialist services. The second group comprises the support services which include regulations and advisory institutions that monitor professional constructions to ensure that they run systematically as per their objectives. The third group comprises the construction services which include all kinds of contractors. In this group, contractors have been classified into seven classes as per Tanzania Contractor's Registration Board, where classes 1-3 is categorized as large contractors, classes 4 and 5 as medium contractors and classes 6 and 7 as small contactors. In this system of classification, there is a

class limit of the construction projects in terms of their value and size. While class one does not have a value or type/size project limit, class seven is limited to single storey buildings not exceeding 75,000 US dollar value (CRB, 2008).

Tanzania's construction industry is characterized by a high level of labour-based activities on construction sites. The industry is dominated by small and medium sized contactors operating in the domestic market. The Contractors Registration board (CRB, 2008) disclosed that in the contracting community, 4,135 contractors were registered in Tanzania in 2007, both local and foreign, of which 3% are foreign and 97% are locally registered. All foreign contractors are class one and 94% of the local contractors belong to class's five to seven, as indicated in Table 4.1

Table 4.1: Number of Contractors registered in Tanzania (2007)

Type	**Class of Registration**									**Total 2007**
	I			**II**	**III**	**IV**	**V**	**VI**	**VII**	
	Local	**Foreign**	**Total**							
Building	33	23	56	15	13	65	236	245	1219	**1849**
Civil	15	25	40	12	24	51	236	429	1009	**1801**
Electrical	8	16	24	3	3	19	64	36	229	**378**
Mechanical	3	10	13	0	1	6	12	7	42	**81**
Temporary	0	26	26							**26**
Total	59	100	159	30	41	141	548	717	2499	4135

Source: CRB, 2008

Table 4.1 indicated that 1849 contractors are registered to do building work, with the majority being classes five, six and seven, which are medium to small contractors. Very few are in classes one, two and three, which are the large contactors. In terms of market share, the construction industry is dominated by foreign firms. Based on the value of registered construction projects in Tanzania in 2007 as shown in Table 4.2, the market share of foreign contractors was 70.4% while local contractors comprised only 29.6%.

Table 4.2: Value of registered projects in Tanzania (2007)

	Number of projects registered	Value of projects registered (in USD)
Local Contractors	448	182,016,129
Foreign Contractors	34	433,629,023
Total	472	615,645,616

Source: CRB: 2008

4.4 Construction Process and the Key Participants in Tanzania

The construction process in Tanzania is fragmented and complex, as it is made up of numerous projects of various sizes, managed by a number of different players and stakeholders as indicated in Figure 2.1 throughout its life cycle. The construction process in Tanzania was inherited from the British system of construction, which involves a number of stages that are distinct or may overlap depending on the nature of the construction and the procurement methods[2]. Basically, various procurement systems are used in Tanzania. They include traditional procurement methods, design and build**,** Project management and Build, Operate and Transfer (BOT). For a typical building project based on the traditional procurement system (which is mostly used in Tanzania) the construction process is divided into four main stages, namely, briefing, design and procurement, construction and operation and maintenance (Ntiyakunze, 2011). Figure 4.3 presents the construction stages.

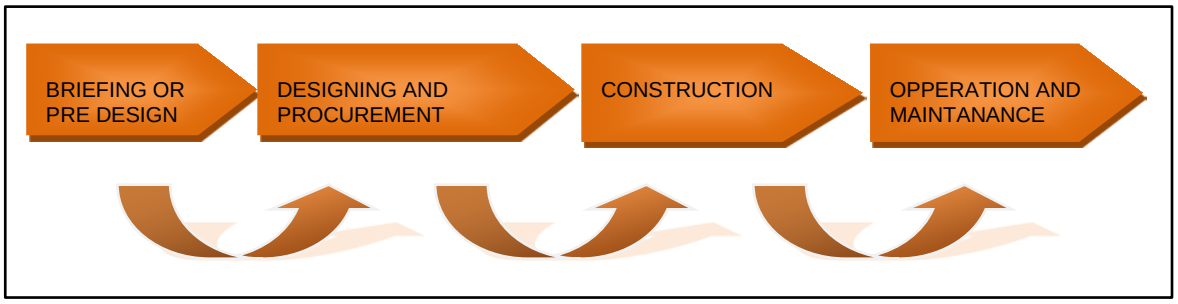

Figure 4.3. Construction project stages (source, Authors' view)

Figure 4.3 shows the four construction stages, which are distinct but depend on each other. The briefing stage is often regarded as the early stage in the construction process during which the client's requirements are written down in a formal document. The brief then provides a fixed reference point for the subsequent design of the building by the designers. At the design and procurement stage the architect will produce the architectural design, and the engineers will produce the engineering design according to the client's requirements from the briefing stage. Meanwhile at the same stage the quantity surveyor will prepare a bill of quantities and cost estimates. All arrangements for getting contractors will be made at this

[2] Traditional procurement, there is clear separation between design and construction responsibility.
Design and build, design and construction responsibility are contracted by a single entity or contractor.
Project management: the project manager is the client's representative with the authority to supervise and control the entire planning and building operation from acquisition of the site to completion of the project and settlement of the accounts (Ramus, 1993).
Build Operate and Transfer (BOT): the government awards mostly to a group of investors a concession for development, operation, management and commercial exploitation of a particular project (UN Commission, 1996)

stage. At the construction stage, the contractors will produce a building according to the cost and drawings from the design stage. At the operations stage, the building produced by contractor will be operated and maintained.

The communication and responsibility of each actor depends on the project procurement system. Based on the traditional procurement approach predominantly used in Tanzania, the key participants in a building project are the client/financier, contractors, sub-contractors, designers consisting of architect, engineers (structural, civil and service engineers), quantity surveyor, and a project manager may be involved in some projects. These parties come together to form a temporary organization to undertake the project in hand for a specific period (Ntiyakunze, 2011). The summary of the key project participants and their responsibilities is given in Figure 4.4

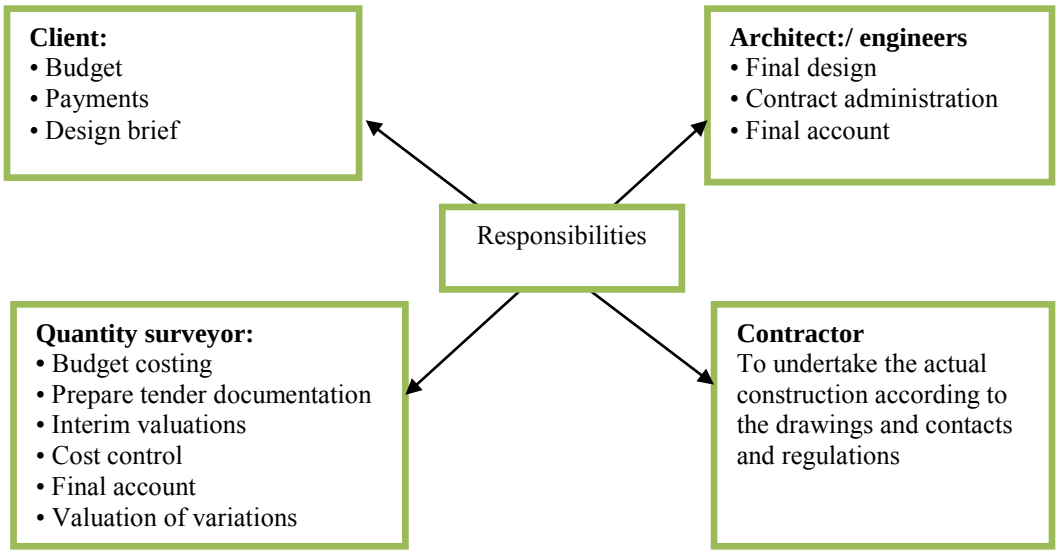

Figure 4.4: A summary of key project participants and their responsibilities. Source authors', view.

4.4.1 Client / Employer

The client is the owner or developer of a building project, leading the process of stating its requirements. The client's responsibility is to ensure that the funds are available for the project and to make payments, to set out the health and safety requirements and therefore to choose contractors who will comply with them. Under the traditional procurement system, the client enters into a contract with the design team (consultants) for the design work and supervision of construction works, and a separate contract with a general contractor for construction works, while in relation to design and build procurement the client enters into a contract with a contractor to design and construct.

4.4.2 Architect

The professional architect provides a design service for clients and strives to produce a design that meets the needs of the client. The architect provides the drawings of the buildings, which show all necessary details (dimensions, materials to be used, location of fixtures) to the contractors. The Tanzanian Architects and Quantity Surveyors Registration Act No 4 (AQSRA) of 2010 provide that every building should be designed and supervised by an architect. The architect is appointed by the client and normally is the leader of the building design team (AQRB Form of Agreement, Terms and Conditions for appointment of an Architect, 2000 edition). Based on health and safety risk, designs provided by the Architect may affect the construction, work methods, work posture, and the requirement of equipment and plant, which increase the number of accidents and ill-health problems on construction sites. In Tanzania, all health and safety responsibility has been given to contractors, not to designers.

4.4.3 Quantity Surveyor

The quantity surveyor is another member working with the design team. The quantity surveyor's role mainly is as a building cost advisor that includes forecasting the cost of the project, preparing tender and contract documents, preparing and controlling project expenditure and conducting a valuation of various aspects of the project. The Quantity Surveyor's responsibility for health and safety is based on the tender document, whereby the health and safety issue could be one of the criteria for evaluation, as a per typical condition of the contract be it that of the Public procurement Act (PPRA), National Construction Council (NCC) East African condition of contract or the World Bank.

According to architect and Quantity Surveyor Board (AQRB) Form of Agreement, Terms and Conditions for appointment of a quantity surveyor, 2000 edition), a quantity surveyor may be employed directly by the client/employer of the project or by the design team leader to work on behalf of the client in a building project. On the other hand quantity surveyors are also employed by building contractors to work on project matters relating to the cost of the contract.

4.4.4 Engineers

Engineers are members involved in the design process. Different engineering disciplines are required in building projects such as civil, structural, mechanical and electrical engineering.

The engineers in line with their areas of specialization are responsible for the design and supervision of their respective areas of expertise. Engineers as in the case of quantity surveyors may be directly employed by the client or may be employed by the design team leader to work on behalf of the client. However, engineers also are employed by building contractors to work on their behalf in particular to supervise and manage construction works.

4.4.5 Contractors

The contractor is a member of a building project that carries out the actual physical construction of the structure. The contractor is fully responsible for finishing the project work on time, according to the cost and quality stipulated in the contract. He is also responsible for health and safety management. However, depending on the complexity of the project, some parts of the work may require specialized skills, for instance, electrical, plumbing and air conditioning installations that may demand the involvement of a specialist or sub-contractor in a project. To accomplish his/her task, the contractor has a number of actors on the construction site, including site managers, supervisors and workers. The construction site manager is responsible for coordinating the work schedules and deliveries, and making sure the building site is run efficiently, including health and safety management, while gang supervisors work with workers to make sure all tasks are accomplished on time, according to the quality agreed to, and workers have the duty to perform the actual task.

4.5 Health and Safety Risk Performance in Tanzanian Construction Industry

Construction in Tanzania as in many countries in the world comes high in the comparative list of accidents and ill-health problems. Statistically, little information is available on the number of accidents rate that happen on construction sites annually. It has been observed that most accidents and ill-health problems are not reported (Mombeki, 2005). However, the limited information available indicates that Tanzania's construction industry is responsible for about 10.1% of all occupational accidents, 9.6% of fatalities, 12.2% of partial disabilities and 7.4% of minor injuries (Kitumbo et al 2001). The construction industry has been ranked the second highest in terms of injuries, after mine (Mbuya and Lema, 2002)

A survey done by the Contractors Registration Board (CRB) in 2001 on 63 sites revealed that there had been three fatal accidents; 33 sites had experienced accidents such as being cut by sharp edges, punctured by nails, hit by hammers and bruises; 27 sites had recorded accidents from the falling of objects and tools; and 23 had recorded accidents from the handling of tools

and equipment and/or plant (Mwombeki, 2005). In ensuring enhanced compliance of the Contractors Registration Act of 1997 and its By-laws, the Board has implemented a Default Point System, which seeks to raise compliance. The default points were issued to persistent defaulters in non-performance, safety and health compliance or which results in taking the appropriate corrective action when the requisite default points have been accumulated. So far 166 Contractors have been assessed and those who have accumulated default points have been warned. The analysis made on 2008 indicated that there had been some improvement in occupational health and safety compliance compared with seven years ago, as indicated in Figure 4.5.

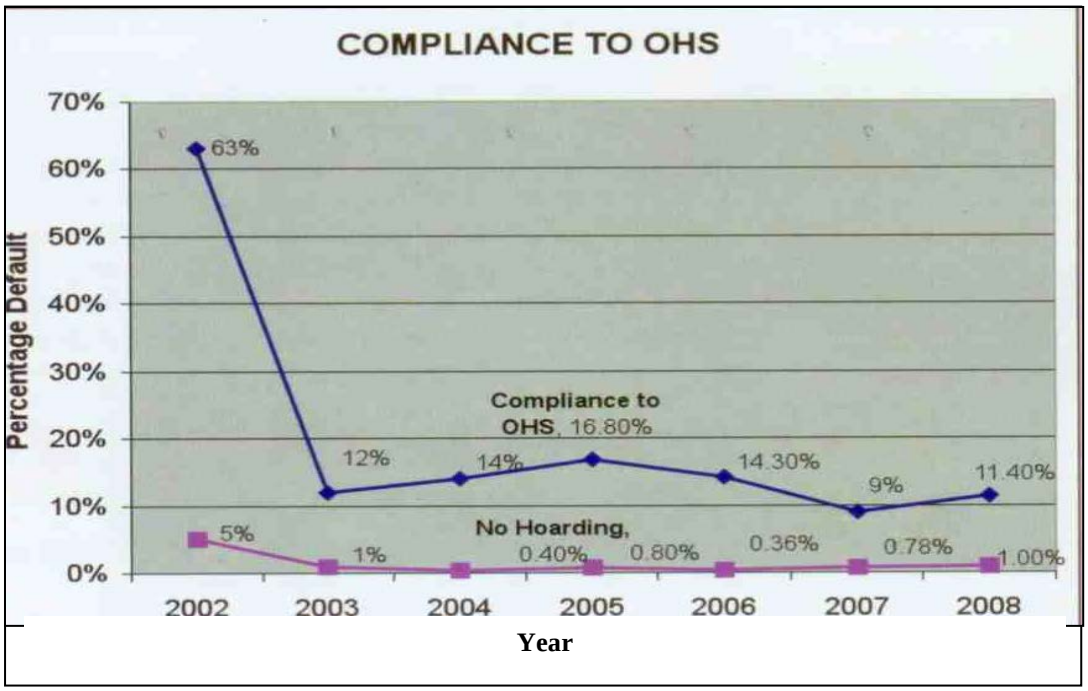

Figure 4.5: The number of default to health and safety. Source CRB, 2009

Figure 4.5 shows that the number of defaults on occupational health and safety on construction sites has dropped in the last ten years. However, it is noted that there is a steady drop from 2002 and 2003 as the actual survey was done 2001 and defaults point was issued from 2002 which increase awareness of the contractors. Meanwhile it was observed from Figure 4.5 that there is no steady flow in reducing the number of defaults from year 2004 to 2008.

Regarding the reduction in default numbers, in a similar vein, the audit report of the Millennium Challenge Corporation (MCC) of 2010 on the situation of construction projects in Tanzania revealed that the contractors were not fully complying with the Health and Safety Management Plan. Thus, the report noted that contractors did not provide proper induction

safety training, adequate equipment, or welfare facilities to workers on the site, although these were all required in the contractor's Health and Safety Management Plan. Part of its efforts to manage health and safety risks for projects funded by MCC requires contractors to develop, implement and comply with a site-specific Health and Safety Management Plan. MCC also requires contractors to comply with local labour laws (MCC, 2010).

4.6 Institutional and Legal Framework for Health and Safety in Tanzania

4.6.1 Historical perspective

In Tanzania, occupational health and safety legislation was inherited from the British legal and institutional framework at the time when Tanzania was a British colony. The health and safety of all workers, regardless of employment duration, were covered by the Workmen's Compensation Ordinance (WCO) of 1949, the Factories Ordinance, which was fairly comprehensive in safeguarding workmen's lives and the Employment Ordinance of 1957 that catered for the care and welfare of employees. The act was passed in 1958 during colonial rule. The ordinance failed to cover all workplaces and all categories of workers since it had a narrow definition of a workplace and it recognized factories as the only criteria for a work site to qualify as a 'workplace'. No work sites without a factory were regarded as workplaces. Construction sites were not regarded as workplaces and so their activities were not regulated by health and safety ordinances.

In a move toward off existing problems at workplaces, such as construction sites, the Tanzanian government formed an autonomous agency in the Ministry of Labour that was established in 1997 with a view to ensuring the health and safety of workers and a safe work environment in a more effective and efficient manner. The so-called Occupational Safety and Health Authority (OSHA) was set up with the aim of improving occupational health and safety practices for the wellbeing of workers at their workplaces. The Government also enacted the Occupation Safety and Health Act of 2003, which repealed the factory ordinance of 1985.

4.6.2 Current Health and Safety Legislation covering Tanzanian Construction sector

Both international and local institutions govern the safety and health at construction sites. The international ones include the International Labour Organization's (ILO) conventions. Tanzania has been a member of ILO since 1962. Some of the most important ILO conventions on health and safety in the construction industry are the ILO Convention No. 155

of 1981 on Occupational Health and Safety and the ILO Convention No. 167 of 1988 on Occupational Health and Safety in the construction industry. However local legal institutions are constituted under the government. Government institutions responsible for ensuring that occupational health and safety standards are maintained at construction sites fall under five ministries; the Ministry of Labour and Employment, the Ministry of Health, the Ministry of Works and Infrastructure, the Ministry of the Environment and the Ministry of Local Government. The ministries are responsible for policy formulation and departments under them implement the policies.

The Occupational Health and Safety Authority (OSHA) have sole responsibility for occupational health and safety. Other public departments and agencies with some health and safety responsibilities include the Labour Department, Contractor's Registration Board, National Construction Council, Public Procurement Authority, Municipalities, the Environmental Protection Agency and Occupational Health Services Unit. Figure 4.6 shows the administration of health and safety management in Tanzania.

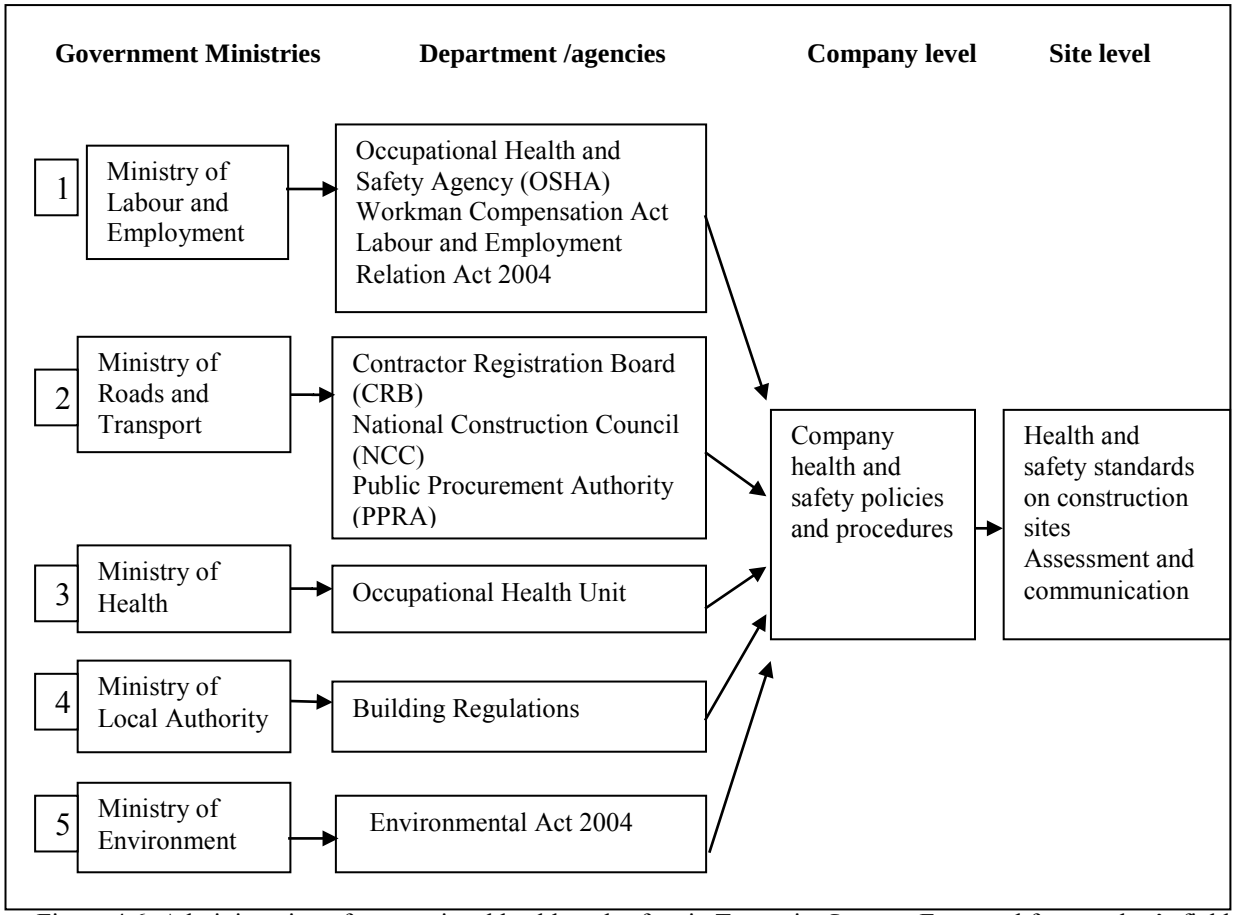

Figure 4.6: Administration of occupational health and safety in Tanzania: **Source**: Extracted from author's field notes, organisational structures, annual reports and laws establishing the departments.

Figure 4.6 indicates five Ministries governing health and safety at construction sites. It also shows departments under the Ministries dealing specifically with health and safety. The presentation of the institutions is arranged according to the level of their contribution to health and safety administration. Whilst the Ministry of labour and employment is considered the main institution with a lot of regulations concerning health and safety at workplaces, the Ministry of the environment is considered least in its contribution to health and safety at construction sites.

From the ministries and departments there are several legal regulations governing health and safety in the construction sector. These regulations include The Occupational Safety and Health Act 2003, The Contractor's Registration Board Act 2010 (CRB), the Employment and Labour Relations Act, 2004 and The Workers Compensation Act, 2008. The details of each act are discussed in the following sections.

4.6.2.1 The Occupational Safety and Health Act 2003.

The occupational health and safety Act 2003 is the main legislation governing occupational health and safety practices in Tanzania. It requires all workplaces to be registered under OSHA so that they can be identified and recognised (section 16(1) and rules section 5 (1)). The act requires all employers (the employer is the contractor) to conduct risk assessment and communicate to workers what hazards exist and the control measures. Employers are also required to provide welfare facilities such as sanitary, convenient and safe drinking water, washing facilities, places for sitting and first-aid facilities. It requires all organisations to have in place an effective health and safety policy, to appoint health and safety officers and workers' health and safety representatives at workplaces with more than 20 employees, and to establish health and safety committees where there are more than 50 employees. The Act requires employers to conduct thorough pre-placement, periodic and exit occupational medical examinations for fitness of employment. The Act also has a penalty if one does not follow the regulations, such as a fine less than five million Tanzanian shillings or imprisonment for a term not exceeding six months. In case of death or serious injury, because of default by the employer, he/she is liable to a fine of not less than ten million (10,000,000/=Tosh equivalent to 6250 Us Dollars) or imprisonment for a term not exceeding two years or both.

4.6.2.2 The Contractor's Registration Board Act, 1997 then 2010 (CRB)

The Contractor's Registration Board (CRB) was established by section 3 of the Contractors Registration Act No.17 of 1997 in Tanzania, which was amended and new act was formulated in 2010. The mission of CRB is to regulate and develop a competitive and sustainable contracting industry with capable contractors who deliver quality work and observe safety when pursuing economic growth. The key functions of the board are to register, regulate and promote the activities and conduct of all contractors in Tanzania. Clause 4(m) of the Contractors Registration Act, 2010 that established the Contractors Registration Board clearly mentions that one of the functions of the board is to ensure that all construction sites have health and safety procedures it is a requirement that the construction project must be registered under the CRB. The act requires all construction sites to be boarded, all employers to maintain at every construction site an accident register book, in which all accidents and incidents are recorded, to provide appropriate safety gear to every person on site, to provide fire-fighting equipment on site and to provide welfare facilities such as clean, safe and sufficient drinking water, water for washing, toilets and changing rooms. The Act also provides a penalty if one does not follow the regulations on health and safety as indicated in Table 4.3

Table 4.3 Summary of specified offences and penalties related to health and safety

Rules	Nature of offence	Penalty
Rule 20(3)(4)	Failure to maintain an accident Register book at site	0.1% of contract sum or Tosh 100,000/= whichever is higher
Rule 20 (9)	Failure to provide hoarding at site	0.5% of contract sum or Tosh 200,000/= whichever is higher,
Rule 20 (11)	Failure to provide appropriate PPE's	Tosh 20,000/= per person
Rule 20 (12)	Failure to provide fire fighting equipment and hygienic facilities such as washroom, WC, clean eating-place, drinking water	Tosh 50,000/=

Source: CRB Act 1997

4.6.2.3 Employment and Labour Relations Act, 2004

The application of the Employment and Labour Relations Act of 2004 covers some social aspects relating to construction sites. The purpose of the Act is to make provisions for core labour rights, to establish basic employment standards, to provide a framework for collective bargaining, and to prevent and settle disputes, among others. The Act prohibits child and forced labour, guarantees freedom of association, establishes minimum wages according to the sector, regulates working hours and administers different types of leave, such as annual leave, sick leave, and parental leave. The act defines clearly the responsibilities and

entitlements of both employers and employees, including the freedom of forming trade unions, which is the only way the construction industry, can demand their rights and build links among them. It also sets penalties and lays the grounds for disputes for both Employees and Employers.

4.6.2.4 The Workers Compensation Act, 2008

This Act lays down the procedures for any worker, who gets injured while working, to be compensated, specifically if the injury or death has been caused by the irresponsibility of the employer. In fact, the Act aims to encourage safety and Health at workplaces including construction sites.

4.6.2.5 Public Procurement Regulatory Authority (PPRA)

The Public Procurement Act, 2004(2011) gives legal power to the authority to safeguard all public procurement entities including the construction sector. This is clearly reflected in the PPRA Conditions of Contract clause 22 that is about health and safety. Furthermore, clause 22.1 of these conditions makes it mandatory for the Contractor to take reasonable precautions to maintain the health and safety of his/her employees. Sub-clause 2 of the same clause of these conditions requires the contractor to provide first-aid facilities. The conditions in sub-clause 3 require the contactor to notify the employer of the details of any accident as soon as practicable.

4.6.2.6 The National Construction Council (NCC)

The National Construction Council Act 1979 mentions the function of the Council among others as “to promote the development of the construction industry in Tanzania”. However, this Act lacked a clear and direct approach on health and safety issues. Moreover, due to its importance in the construction industry, the issue was clearly defined as one of the key functions of NCC in the NCC (Amendment) Act of 2007, whereby health and safety was included. Similarly, both Standard forms of Agreement and General Conditions of Contract for works (NCC, 2000) clause 10.5 require a Contractor to take full responsibility for the adequacy, stability and safety of all site operations and methods of construction. Also clause 17.1 of the same conditions concerning the issue of health and safety from the housekeeping management perspective goes beyond the contractor’s control by including the Employer’s involvement through insurance cover with regard to the injury or death of people on the site and of third parties (public). In addition, clause 18 of the NCC form of Contract requires the

parties to indemnify each other regarding claims that include personal injury and death caused by one's act or omission (NCC, 2000).

4.7 Chapter Summary

This chapter discussed the Tanzania construction industry, with specific focus on health and safety performance, the construction process, key actors in construction projects, and the institutional and legal framework. It revealed that the construction process in Tanzania is fragmented and health and safety performance is poor as the industry is ranked as the second most dangerous industry in which to work. On the other hand the Tanzania construction industry has a well structured legal system on health and safety issues, as there are legal institutions and regulations governing health and safety in the construction sector and other sectors of the economy as well. The next chapter discuss research design and methodology used for this study.

CHAPTER FIVE

RESEARCH DESIGN AND METHODOLOGY

This chapter presents the research strategy used in this study. It reviews the basic research approaches available, which include the quantitative, qualitative and mixed methods approach. Thereafter the chapter discusses the method opted in this study and its justification. The case study method was opted in this study. The research design is illustrated followed by a discussion of case selection and the methods used for data collection. The chapter ends with a discussion of the validity and reliability issues relating to case studies and how they were taken care of. The research is designed in two major parts, the pilot study and the main study

5.1 Research Approach

Research approach has been defined as a systematic and logical procedure for solving a problem with the support of facts (Yin 2003). Paton, (2002) and Stake,(2000) argue that research involves the diagnosis of information and the selection of relevant interrelated variables about which valid and reliable information is gathered, recorded and analyzed. Meanwhile, Fellows and Liu, (2003) provide that there are two principal approaches to research namely; qualitative and quantitative. Nevertheless, Creswell (2003) identified a third approach which he calls the mixed method approach. The following section discusses the details of each method.

5.1.1 Quantitative Research Approach

The quantitative research method adopts a deductive and objective view, which is characterized by tangible data such as counts, weight, mass, and other physical measures (Fellows and Liu, 2003). It usually includes the investigation of frequencies and different measurable variables with the aim of explaining a certain phenomenon. Its fundamental features are cause-and-effect thinking, hypotheses and questions, and the use of measurements, and it is inclined to be deductive, in other words it tests theory (Yin, 2003). Quantitative research is generally based on two research methods namely survey and experimentation. A survey involves either interviewing or administering questionnaires to a sample of research respondents. In experimentation, observations of the phenomenon of interest occur under deliberately controlled conditions produced by the researcher.

The advantage of the quantitative approach is that it measures the reactions of a great many people to a limited set of questions, thus facilitating comparisons and statistical aggregation of the data, and so the results can be generalised.

5.1.2 Qualitative Research Approach

Qualitative research on the other hand, adopts the inductive and subjective view of knowledge of the real world. It views individuals or organizations in a holistic manner rather than isolated variables and hypotheses. Cresswell, (2003) observed that qualitative data provide depth and details through direct quotations and a careful description of programmes, situations, events, people, interactions and observed behaviours. Yin (2003) states that the qualitative method gives the respondent the opportunity to speak freely, which can provide important data that would not be obtained by the quantitative method. Creswell further considers that the qualitative inquiry employs different knowledge claims, strategies of inquiry and methods of data collection and analysis. Among the strategies associated with the qualitative approach are case study, content analysis, ethnography and observation, as well as grounded theory, historical and phenomenological research. This study opted for the case study approach in the qualitative strategy of inquiry as opposed to the other strategies, based on the justification that is subsequently explained.

5.1.3 Mixed Research Approach

The mixed research approach is a combination of both quantitative and qualitative approaches to data collection, the analysis of data and other phases of the research process (Creswell and Clark 2007; Morgan 2006). The assumptions underlying the mixed approach represent bipolar extremes, whereas it tends to emphasize both the inductive–subjective–contextual approach and deductive–objective–generalizing approach (Morgan 2006). This approach tends to base knowledge claims on pragmatic grounds, whereby research problems can be understood better by employing both methods rather than by using only one method (Creswell, 2003). The mixed method approach involves collecting both numeric and text information, either simultaneously or sequentially, so as to best understand research problems, with the final database representing both quantitative and qualitative information (Creswell and Clark, 2007).

To a certain extent, this study has used the mixed approach, with the survey method (the quantitative approach) being used for the pilot study, while the main data collection adopted the qualitative approach using the case study method. The adoption of the survey method

enabled the getting of information on the perceptions of site managers, gang supervisors and operatives concerning the various health and safety risks to help risk categorisation. After the perceptions of risk were categorised, the high risk issues were selected for in-depth study (case study), to see how they are identified, communicated and controlled.

However, the fact that the quantitative approach was purposely used for the afore-mentioned reason, this study cannot be regarded as being under the mixed method approach. The final database on risk assessment and the communication process on construction sites are furthermore represented by qualitative information only, hence disqualifying using the mixed method. In addition, the distinct advantages of a case study in addressing questions of an exploratory nature as explained by (Yin 1994), outweigh the benefits inherent in the mixed methods approach.

5.2 Method Adopted by this Study and Justification

This study used the case study approach. Case study research is a strategy aimed at understanding an event in its real-life context over which the researcher has no control (Yin, 2003). Yin (2009) argues that the case study is used to address research questions on 'How' and 'why', as such questions deal with operational links needing to be traced over time, rather than merely frequencies or incidences.

The nature of this thesis is exploratory, as it investigates the phenomena of health and safety risk management on construction sites. It seeks to develop a clear understanding of how health and safety risks are managed at construction sites. It seeks to explore how risk is assessed, and how it is communicated and controled at construction sites and what factors are associated with the process of risk management at construction sites. The study aims to paint a picture of risk assessment and the factors influencing it. As this study focuses on contemporary events, no control is required over the event under investigation, and the nature of the research question is largely based on "how". Hence the Case Study Method is considered by the author as the one most appropriate for the study.

5.3 The Research Design

The research design is determined by considering how to link the research questions with data collection and analysis of the results. Nachmias and Nachmias (1993) define research design as the programme that guides the investigator in the process of collecting, analyzing and

interpreting observations. In other words, Yin (2003) considers it an action plan for getting from one point to another (from here to there where here is the question to be answered and there is the conclusion to be drawn. The research design hence focused on gaining an understanding of the practice of health and safety risk assessment and communication on construction sites. It is designed in two parts, summarized in figure 5.1. The first part involves the pilot study and the second part involves the main research (case study)

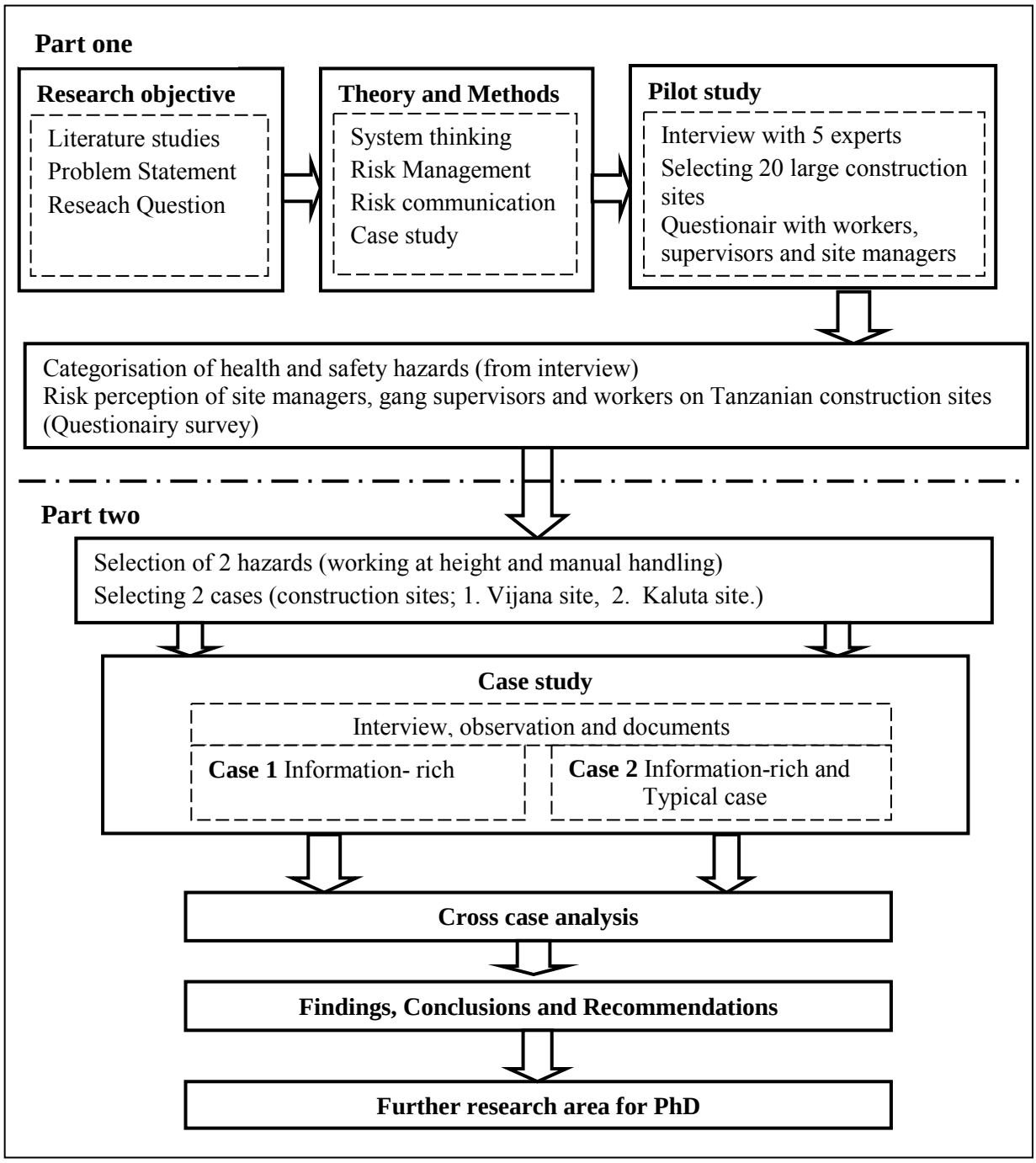

Figure 5.1: The research design of the study, Source (author's view)

Figure 5.1 indicates that there are two parts to the research design, whereby part one deals with formulation of the research problem and the theoretical framework and the pilot study, while part two deals with the main study (case study). The following section discusses the stage of each part of the research design.

5.3.1 Problem Identification and Literature Review

Stage one of the research design deals with identifying the problem and formulating the theoretical and conceptual framework through the literature review. Nachmias and Nachmias (1993) describe a research problem as an intellectual stimulus calling for an answer in the form of scientific inquiry. They point out that the problem must be empirically grounded, and clearly and specifically articulated. For this study, the problem statement is grounded in the existing challenges of poor working conditions and high accident rates as a result of health and safety risks at construction sites in Tanzania despite the various mitigation efforts made. Specifically this study seeks to address how health and safety risks are assessed, communicated and controlled on construction sites in Tanzania and what factors influence or hinder the process of risk management.

The literature review was carried out during the whole research period. An essential early stage of this research was to search for and to examine potentially relevant theories and literature. Through the reviewed literature, the researcher provides the reader with a summary of the extent of knowledge and the main issues regarding the topic, which also provides the rationale for the research being undertaken (Fellows and Liu, 2003).

The main literature of this study originated from the field of management, narrowing down to the area of health and safety management, risk management and risk communication. Literature further narrowed down to the specific area of risk management on construction projects, that is health and safety risk management. The literature research delimits basically all research done outside the field of risk management on construction projects. The literature searches for articles were complemented by searches in libraries in Sweden and Tanzania through Libris and at the university library at Chalmers University of technology and Ardhi University in Tanzania .The main sources for this literature research are literature databases, such as Ebsco, Emerald, Elsevier Science Direct, Bygg Dok, Compendex and Google Scholar.

5.3.2 Interview Survey Methods (Pilot Study)

The other stage of the research design was an interview survey. Interviews were conducted with five (5) experienced construction managers, who gave their views on critical health and safety risks and their source on construction sites. (An experienced site manager is one who has been site manager on a larger construction site for at least five years). Convenient sampling was used to get site managers, who were obtained from the Contractors Registration Board and through architects and quantity surveyors who work in the supervision team on construction sites. This approach was adopted because it was not known if the health and safety of risks theorized in the literature also applied to Tanzanian construction sites. To ensure consistency, all interviews were conducted by the researcher herself, were voice recorder and later transcribed. The nature of the interview was exploratory and unstructured as the purpose was to obtain the ideas of the interviewees on the nature of the health and safety risks on construction sites in Tanzania. Exploratory interviews do not have fixed questions, though it is important to have a list of general topics or areas on which they should be conducted (Oppenheim, 2004).

In this study the objective of the interview was to find out how much they understand about health and safety risks, the areas /sources of health and safety risks and how those risks can be handled. The results were recorded and analyzed as shown in section 6.1 and Table 6.1. The information obtained was used for the third stage (questionnaire survey).

5.3.3 Questionnaire Survey (Pilot study)

The questionnaire survey was a stage of part one of the research design. In this stage the aim was to determine the perception of the key project participants of the critical risks identified in the second stage (above). As the literature pointed out, risk assessment and communication greatly depends on how people involved in the process perceive risk, and so this stage was important to find out how key participants perceive various health and safety risks. Twenty ongoing large construction sites based in Dar es Salaam were selected for the survey through purposive sampling. The selected construction sites were multi-storey buildings with more than 10 storeys. Twenty (20) Site managers, 30 supervisors, and 240 workers (from 20 construction sites) were asked to rank the probability of occurrence of the eight critical risks identified in stage two on a 1-5 Likert scale. 1= very likely to occur, 2= likely to occur, 3= moderate, 4= not likely to occur, and 5= never likely to occur.

Other parts of the questionnaire were designed to obtain the profile of the respondents in terms of their level of involvement in construction, their gender, employment status, level of education, construction-related qualifications and experience, exposure to injury and illness, exposure to construction health and safety training and information. The data were analyzed using SPSS. This stage helped to categorize the health and safety risks perceived by Tanzania construction site workers. Since construction health and safety risks are many, this categoralisation helped the researcher to select the most critical risks for further investigation through the case study approach. The results of the survey are discussed in Chapter six sections 6.2.

5.4 Case Study

Part two of the research design involved an in-depth study on how most critical hazards (working at height and manual handling as established in part one) are identified, analyzed, evaluated, controlled and communicated on construction sites. For this part the case study approach was used. Two large building construction sites, Vijana and Kaluta construction sites were selected as the case study. Both cases are ongoing construction projects situated in the centre of Dar es Salaam city. The two sites were selected on the basis of being information rich (Patton, 2002; Yin 2003).

5.4.1 Case Study Area

The cases were selected in Dar es Salaam, Tanzania, which is one of the fastest growing cities in Sub-Saharan Africa. It is a cosmopolitan city with a complex social, cultural and economic environment and approximately four million inhabitants (UN-Habitat, 2010). It has been regarded as the main destination as regards rural-urban migration in Tanzania, consequently leading to a great demand for housing and other infrastructure. In terms of buildings, Dar es Salaam city has been dramatically transformed from having largely low-lying single storey buildings in the 1970's to an increasingly dense collection of multi-storey buildings developed within a tight and unchanging plot and street structure (Moshi, 2011). This dramatic transformation has increased the growth of construction activities as well as health and safety risks on construction sites. By virtue of its cosmopolitan nature and the fact that it has advanced on many large construction activities, Dar es Salaam presented itself as a potentially profitable study area.

5.4.2 Case Selection Process

To get potential cases for further scrutiny, a preliminary survey was carried out to map potential large construction sites in Dar es Salaam. Since all construction projects are registered under the Tanzania Contractor's Registration Board, it was easy to get a list of ongoing construction sites in Dare es Salaam. From the list, potential projects were identified and a physical survey was done to see the nature and stage of the projects. During this time the questionnaire survey was used to examine the perception of project participants of various health and safety risks arising from the selected projects. The criteria for selecting the construction sites are indicated in Table 5.1. Then information-rich cases were selected through purposive sampling. However, it is worth noting that, case studies apply purposeful sampling aimed at an in-depth understanding of the phenomenon in question (Flyvbjerg, 2001; Stake, 1995). Similarly, (Patton, 2002) argues that:

"Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research, thus the term purposeful sampling" (Patton, 2002:46)

Table 5.1 Case selection Process

Step	Activity/ criterion	Information/How	Remarks
1	Identify all large building site in Dar es Salaam (on-going projects) Value of 1,500,000,000 Tosh or ($ 2,500,000US)	List was obtained from Tanzania Contractors Registration Board	35 projects
2	Visit projects sites and make selection **(**Questionnaire survey and observation**)**	Stage of the projects (has multiple activities) Number of employees (more than 20) Duration of the project(min 12 month) Storey's of building (10 storeys and above) Project environment is independent If the firm has in place health and safety policy, The site has health and safety officer	20
3	Selecting the case.	Considering the case with information rich (extreme case) Considering moderate case. (Convenient sampling).	2 sites were selected

5.4.3 Multiple Case Study Method and Unity of Analysis

This study opted to use two cases due to the nature of research issue, which it was thought could be better addressed by using more than one case. Stake (2006) argued that the central issues in deciding which cases should be selected for the study include the relevance of the cases to the research problem and the possibility of them providing opportunities to learn

about its complexity and context. Meanwhile Yin (1994) considers that the evidence from multiple case studies is more compelling, hence making it more robust. Furthermore, the investigation did not have features that justified the use of a single case study - such as an unusual or rare case, or a critical or revelatory case. As the research issue in this study is health and safety risk management on construction sites, construction sites are unique in terms of size, complexity, site environment and different management. Stake (2006) pointed out that the importance of using multiple cases is that it is possible to examine how a phenomenon behaves in different work environments.

In line with Stake, the author opted to select two cases in order to understand how risk assessment, risk communication and risk control are practised there. Case one was considered as it could provide rich information. The second case was selected as a moderate or typical case to represent the majority of sites with the same nature in Dar es Salaam. Meanwhile, based on the stated aim and research question of this research the logical unit of analysis were individuals on construction sites. These individuals are site managers, gang supervisors, the health and safety committee, and the operative and design team (project supervision).

5.4.4 Data Collection Techniques within the Case.

The study used various sources of evidence that Yin (1994) considered complementary and beneficial to the case study approach, such as interview, observation and documentary review to address the problem of limitations inherent in various methods of data collection (Creswell, 2003). Figure 5.2 presents the different data collection tools used for this study.

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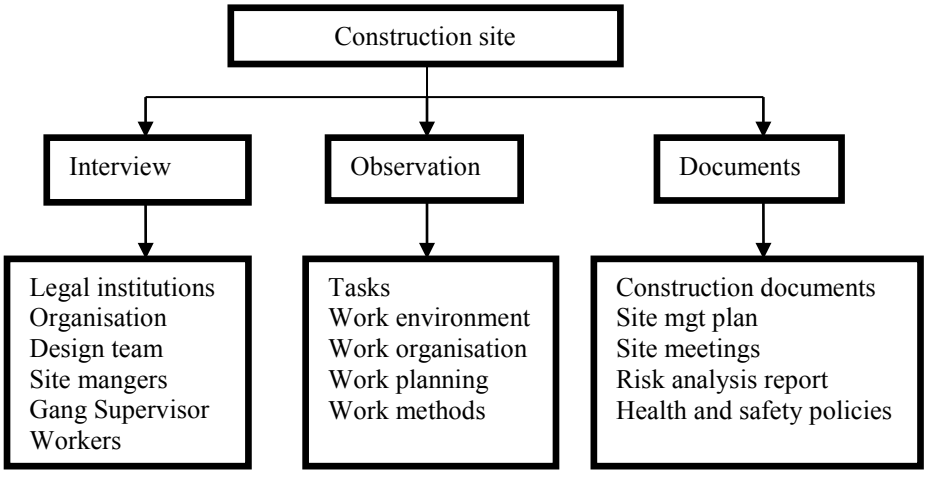

Figure 5.2: Data collection techniques. (Source authors' view)

Figure 5.2 indicates the three main research techniques used in this study, namely, interview, observation and documentary review. However, it was also important for the researcher to consider ethical issues, such as the protection of privacy and confidentiality of respondents; also the freedom of people to participate in the observation and/or interview session. This is a key requirement for case studies involving contemporary human affairs (Yin, 2009). Thus, the consent was sought of site managers, operatives, organisations and institutions dealing with health and safety in construction. A research permit was obtained from the company. , The consent was sought by oral agreement of individuals on construction sites before observing their working procedure and taking photographs. Table 5.2 indicates the data collection research matrix.

Table 5.2 Data collection matrix

S/N	System	Variable	Method	Data
1	Institutional system	Regulations,	Interviews, documentary review	Legal practices in health and safety risk management.
		Institutional Structure	Interviews	Power relations: management,
		Control mechanism	Interview and documentary review	Control methods and enforcement technique.
2	Organisation system	Management style	interviews	Involvement, resource allocation
		structure	Interviews and documentary review	Organisation structure, power relation
		Company policy	Interviews and documentary review	Health and safety policy
		Communication	Interviews	Methods/ tool and Communication channel
3	Individual system at construction sites	Education, Experience	Interview	Demographic information
		Perception	Interview	Feeling about the risk
		Responsibility	Interview and observation	Different roles of individuals regarding risk assessment, communication and control
4	Work environment	Working tools/methods Work teams Working procedure Physical space	Observation	Methods of working Team cooperation Working procedures Site space.

Interviews

In-depth interview was the primary data collection method used in this study. Yin, (2003) argues that interviews are a very effective method of gathering a large volume of data. As a method it can be used for both positivist and phenomenological research. When used in positivist research it is normally used with closed questions. When used in phenomenological research interviews are normally unstructured or semi–structured with open-ended questions. Because this research was phenomenological in nature, various forms of interviewing were adopted, such as formal and less formal, semi-structured and open-ended interviews.

In-depth interviews were conducted by the author with three levels of informants. The first levels were individuals involved at the construction sites, who were the site manager, gang supervisors, Health and safety committee, operatives and design team (supervision team). The main issue regarding this group was to look at their role in terms of risk assessment, communication and control. The interview was less formal as it was adjusted according to the activity and role of each group.

The second level of interview was conducted with the organisation/company management, to find out how it facilitates the process of health and safety risk assessment, communication and control. Interviews were conducted with the directors of the organisation. The third level of informants comprised legal authorities, which included the Occupation Health and Safety Authority (OSHA) and the Contractors Registration Board. The main information required from this group concerned how are they facilitate and enforce health and safety risk management at construction sites. All interviews were conducted in Swahili. Most of them were tape recorded, transcribed and translated into English.

Observation

Observation was another method chosen for the research study. According to Stake (1995), the qualitative case study researcher spends the majority of the time personally in contact with the activities and operations of the case. Observational techniques are therefore very relevant for those doing case study.

The present study adopted the non-participant observation technique. The researcher was introduced to staff on project sites on the first visit, which gave her the opportunity to develop rapport with both site management staff and operatives. Observation was made in order to describe the physical features of the construction sites, job site organisation, work practices,

the equipment and tools being used, the nature of activities performed on the construction sites, workers' risk behaviour, such as adhering to rules and wearing PPE and how communication took place on the sites. Recording of observations involved writing field notes and taking photographs.

Documents

Documentary review formed part of the data collection methods. Information on the legal and institutional aspects of health and safety management was retrieved from documents such as by-laws, Acts, correspondence and reports from the institutional and construction sites. Meanwhile documents such as organisational policy, site meeting proceedings, risk analysis reports and site plan were reviewed. Analysis of these sources helped to triangulate the findings based on primary data.

5.5 Reliability and Validity

It has been argued that reliability and validity are challenges in qualitative research. Yin (1994) provides three tests for measuring the quality of research designs: internal validity, external validity and reliability. Internal validity is concerned with the question of whether a conclusion that incorporates a causal relationship between two or more variable holds water (Bryman, 2004). External validity is concerned with whether the research findings are generalisable beyond the specific research context *(Ibid).* Reliability exists when the operations of a study such as the data collection procedures can be repeated with the same results.

This study therefore ensured the validation and reliability of the research in various ways. By utilising different approaches – survey, case study, talking and question-and-answer sessions, as well as using the same unit of analysis - the researcher was able to cross-check one result against another thereby increasing the reliability of the research findings. Triangulation also ensured the use of many sources of evidence, including observation, assessment of documents and multiple interviews (Stoecker, 1991) as a means of minimising data collection and analysis constraints. A data collection matrix was prepared in order to collect relevant information to address the research problem. The matrix presents the key research variables, sources of information and data collection instruments. In this way it was easy to cross-check whether the information collected was related to the stated research variables.

5.6 Chapter Summary

The chapter discussed the three approaches to research, namely, the quantitative, qualitative and the mixed method. This study opted to use the case study method to achieve its objective. The justification for using the case study to gather empirical data was discussed. The research design was also shown to have two parts - part one comprising an extensive literature review and the conducting of a pilot study and part two being the main fieldwork, whereby each case would be analysed, there would be a cross-data analysis and, last but not least, the conclusion would be provided. The next chapter discuss the empirical finding from pilot study.

CHAPTER SIX

FINDINGS FROM PILOT STUDY

This chapter presents the nature of health and safety risk on Tanzania construction sites and provides an overview of how site managers, supervisors and workers perceive those risks. The first part of this chapter provides the results from the interviews held with five site managers on the types and sources of accidents and ill-health problem on Tanzania construction sites. The second part provides the results from the questionnaire survey of site managers, gang supervisors and workers on how they perceive the health and safety hazards identified by the interview survey.

6.1 Interview Results

As indicated in the research methods in section 5.3.2, interviews were held with five experienced site managers on the nature and source of health and safety hazards at Tanzania construction sites. The results are indicated in Table 6.1

Table 6.1: Summary of areas of health and safety hazards and its consequences on Tanzania construction sites

	Type of health and safety hazards	Hazards Consequence	Possible source of health and safety hazard consequences
1	Working at a height	Falling from height	Carelessness of the workers(reluctant to use safety belts) Improperly fixed scaffolding Not using PPE (not supplied by management or supplied but workers not wearing it) Collapse of the formwork Unprotected edge Ignorance of workers about of risk Weather, exposed too much to the sun for a long time
2	Falling object, poor housekeeping	Hit by falling object Trip and fall	Over crowded sites, Confined sites, Unprotected feet (safety shoes) Culture and ignorance (most workers have very low education level) Unreliable income (willing to risk no matter what) lighting might be a problem, sometimes car lights have been used to light up the sites)
3	Manual handling	Muscles pain, back pain	Manual handling Working for long time, twisting, bending Crowded sites for movement/equipment Carrying heavy loads,
4	Equipment/Plant/ Tools	Crushed/hit/cut by object such as equipment, car, working tools and plants	Wrong operating attitude of the users, improper maintenance

5	Chemicals	Health problems such as headaches, eye irritation, dizziness, faintness, sleepiness and affect judgment and coordination	Material specification, cement and paints, fumigation pesticide, timber treatment chemicals
6	Dust	Health problem such as respiratory disease	Present on sites where demolition, excavation, concrete mixing takes. Plastered walls scored ready for painting
7	Noises	Health problem such as hearing loss	Equipment noise, activity noise such as excavation, drilling, welding, piling, roofing. Most of the workers (concreting) Grinding, cutting, mixing concrete, piling and workers noise workers(concreting)
8	Bending and twisting	masculo-skeleto disorder	Bending and twisting for long time, too much manual handling, ,
9	Fire	Injuries due to fire	Poor housekeeping
10	Bullying, Stress	Health problems due to stress and bullying	Stress works, management, working time, pressure from the work

Table 6.1 presents the most common health and safety hazards and their source on construction sites. The results indicated that these types of health and safety hazards include working at height, Manual handling, machinery and equipment, fire, noise and dust and bullying. The findings are in the same as those found out by Davies and Tomasin, 1996; HSE, 1998; Murie, 2007; Irizarry and Abraham, 2006.

From the results in Table 6.1, the hazard consequences ranked by site managers from one to ten according to their probability of occurrence. The results are indicated Table 6.2

Table 6.2: Health and safety hazard consequences as ranked by site managers

	Type of health and safety hazards consequences	**Ranking**
1	Falling from height	8
2	Hit by falling object, trips and fall	7
3	Back pain, muscular pain, due to manual handling	6
4	Health problem caused by chemicals	5
5	Health problem caused by dust	5
6	Health problem caused noise	5
7	Crushed moving equipments, cuts by equipments and hand-led tools	4
8	Health problem caused by too long bending and twisting	4
9	Injury from fire and other disaster	3
10	Covered by earthwork during excavation of basement and trenches	2
11	Bullying and stress	1

Table 6.2 indicated that the probability of falling from height was ranked as the important hazard consequence as it had the highest score of eight (8), while the second consequence

was a hit by falling object , trips and fall, number three was back pain, muscular pain due to manual handling. Health problem due to chemicals, dust and noise had the same score of five (5). Health problem due to bullying and stress were the least risk as they scored one. The finding indicates that there is high probability of falling from height due to the fact that most of most workers in are exposed much to the height especially on high rise buildings. Hazard consequences scored four (4) and above were selected for the questionnaire survey.

6.2 Results from Questionnaire Survey

The questionnaire survey was conducted with site managers, gang supervisors and workers as discussed in section 5.3.3. The results are discussed in the following sections.

6.2.1 Demographic characteristics of the respondents

All respondents (240) were men as most activities on construction sites are done by men in Tanzania. Respondents' ages ranged between 20 and 45 years, with the majority (135 or 56.3%) being 25 years to 35 years old, followed by 105 (43.8%) respondents ranging between 36 and 45 years of age. There were no respondents aged above 46. The finding contradicts the study done by Irizarry and Abraham (2006) on the perception of risk among iron workers in Australia, who found that the majority of their respondents were over 40 years of age. In the current study the majority (56%) ranged between 25 and 35 years of age. This study shows that, since most activities on construction sites in Tanzania are done manually, one needs to be physically strong, and so they are not activities that older men would want to do. The respondents' nature of employment and their employers are presented in Figure 6.1.

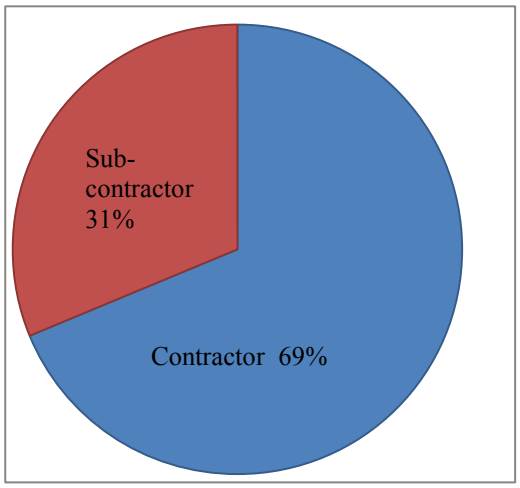

Figure 6.1 Employers on the construction sites

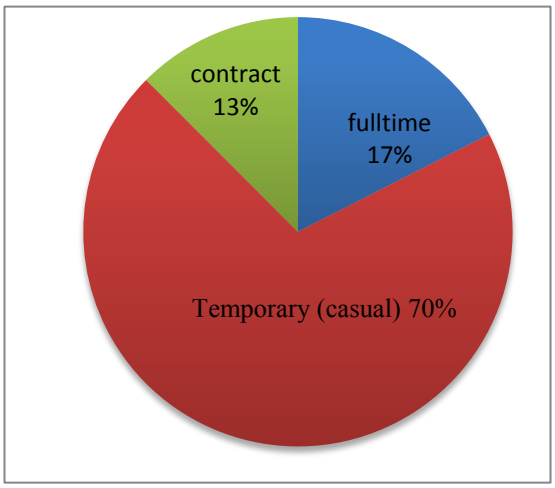

Figure 6.2: Nature of employment on construction sites

Figure 6.1 indicates that the majority of the workers (69%) were employed by the main contractor while 31% were employed by sub-contractors. The majority (70%) were casual employees, only 17% were full-time employees and 13% were employed on a contract basis. These results are consistent with the study done by ILO, (2005) on the nature of large construction sites in Tanzania. The study found that the majority of workers were employed on a casual basis. The nature of workers' employment has been raised as the one of the challenges to implementing health and safety standards on construction sites. Figure 6.3 provide the workers' education background.

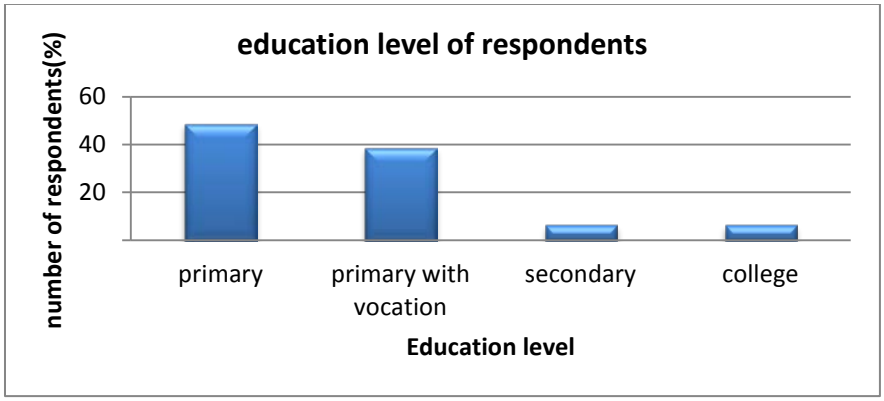

Figure 6.3: Educational background of the respondents

Figure 6.3 indicates that almost half of the respondents (48.7%) had only primary education, followed by 38.7% who had primary education with vocational training, 6.3% each had lower secondary education and university education. This result revealed that the majority of workers have a very low level of education, which can be a challenges to communication and the way they perceive health and safety risks. Respondents were asked to indicate their experience in construction activities, the results are indicated in Figure 6.4.

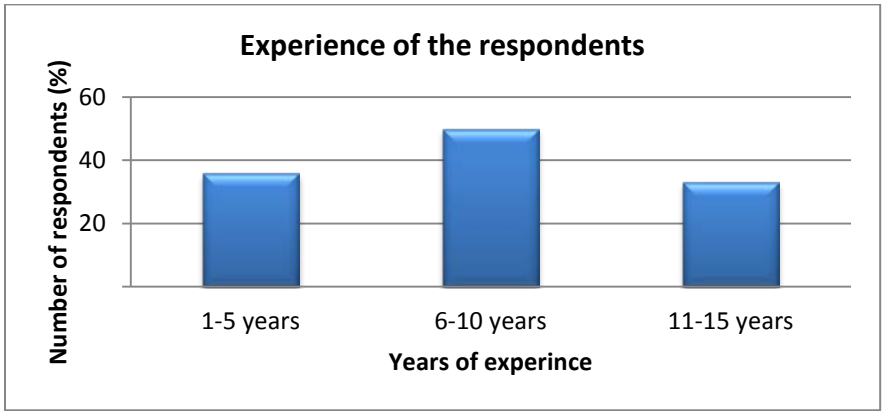

Figure 6.4: Experience of the respondents in construction sites

Regarding their experience, half of the respondents (50%) have 6 to 10 years' experience in construction, followed by 36% with 1 to 5 years' experience. Only 14% have experience of more than ten years. The results show that although the majority of workers have had little education their level of experience is varied about average of 6-10 years.

6.2.2 Knowledge of health and safety risks on construction sites

Workers were asked about their knowledge of health and safety risks on construction site, and the results are indicated in Table 6.3.

Table 6.3: Knowledge on health and safety risks

A	**Workers**	Number of respondents	Frequency of respondents	
			Yes	No
1	Have you ever received any training relating to health and safety on construction sites?	240	60 (25%)	180(75%)
3	Have you ever been involved in a major accident while performing your task?	240	70 (29%)	170(71%)
4	Have you ever been injured (minor) while performing your tasks?	240	189 (79%)	53 (21%)
5	Do you think that wearing Personal Protective Equipment affects productivity?	240	218 (90%)	22 (10%)
B	**Site managers/gang supervisors**			
1	Have you ever received any training relating to health and safety on construction sites?	50	30 (60%)	20 (40%)
3	Have you ever seen one of your workers being involved in a major accident while performing his/her task?	50	40(90%)	10 (10%)
4	Have you ever seen one of your workers being injured while performing his/her tasks?	50	50(100%)	0
5	Do you think that wearing Personal Protective Equipment (PPE) affects productivity?	50	15(17%)	35(83%)

Table 6.3 shows that the majority of workers (75%) have not received any formal health and safety training, possibly causing the 29% major accident while performing their tasks and 79% to have been injured. This finding suggests that the majority of workers have had no formal health and safety training, so that to some extent they have been subject to either major accidents or minor injuries, Having an accident or being injured it could be argued would shape their perception of health and safety risks. However, the majority of workers (90%) believe that wearing PPE affects their productivity. This is interesting because the same workers would not make use of PPE to prevent accidents, especially when time is pressing. These findings tally with those in the study by Mombeki, (2005) on compliance on Tanzania

construction sites, where she found that the majority of workers never wore PPE, using the excuse of loss of productivity.

On the other hand (60%) of site managers and supervisors have received health and safety training, and have witnessed their workers being involved in accidents and sustaining injuries. 17% of the supervisors believe that wearing PPE negatively affects workers' productivity. This is a challenge as if PPE is used as a control tool; supervisors may allow workers to work without PPE when time is pressing.

6.2.3: Risk perceptions

Site managers, gang supervisors and workers were asked to indicate qualitatively the probability of health and safety problems occurring when working in a hazardous situation. The Likert scale was used where 1 = very likely to occur, 2 likely to occur, 3= moderate, 4= not likely to occur, and 5, Not likely to occur at all (never). The results are as indicated in Figures 6.5 and 6.6.

Figure 6.5: Risk perception of the workers

It may be clearly seen in Figure 6.5 and Figure 6.6 that both groups (workers and supervisors) indicate that probability of falling from a height is the most likely to occur on construction sites, followed arm pain, back pain and muscle pain due to manual handling. Meanwhile both

workers and supervisors indicate that hearing loss and respiratory illness from dust occur moderately. The findings indicate that there is a high chance of falling from height if there is no control measure. Meanwhile the nature of construction activities are exposing workers to more on manual handling, therefore the chance for workers to get back and muscle pain is high.

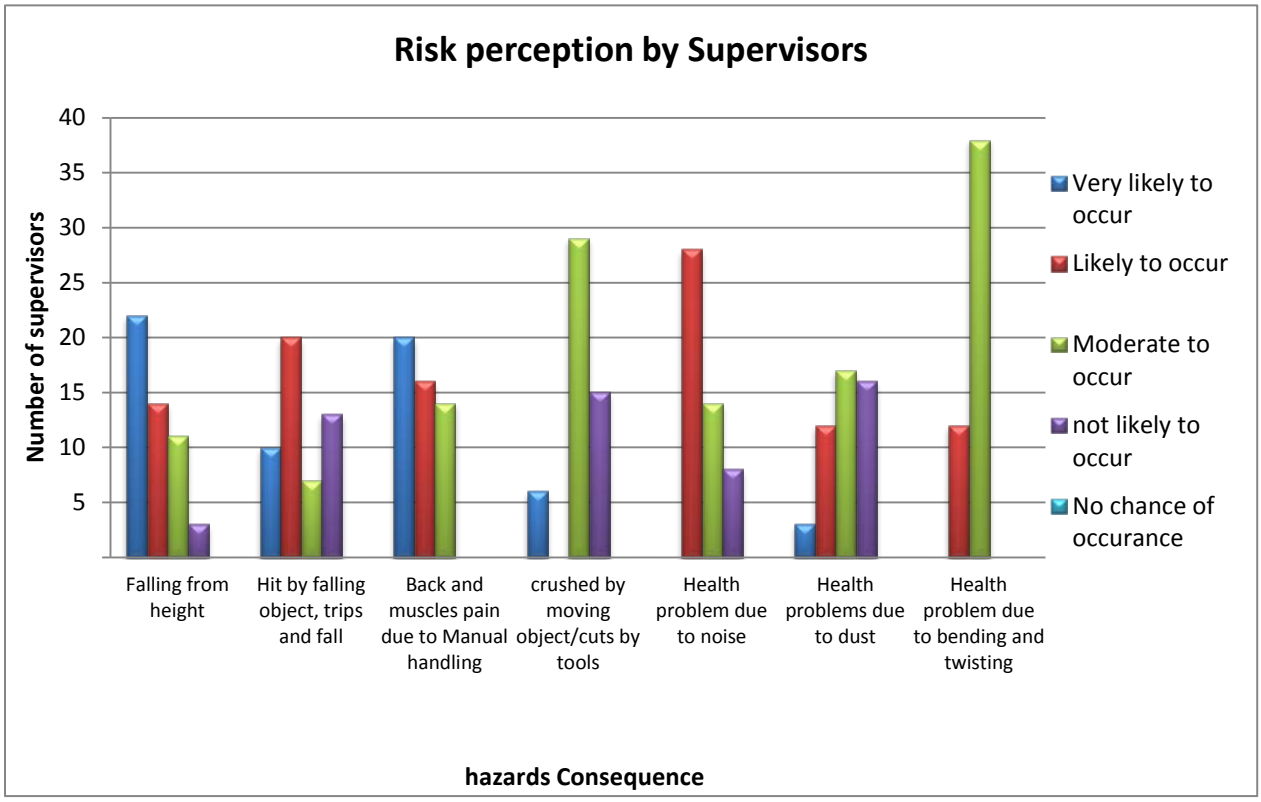

Figure 6.6: Risk perception of the supervisors

6.2.4: Hazard Consequences Categorization

This categorization is performed so as to determine which hazard consequence is perceived as higher by both group supervisors and workers. In hazard categorization, hazard consequence were calculated according to the number of respondents who indicated that the probability of occurrence were very likely to occur and likely to occur. The results have been grouped into categories. Category A indicates hazards consequence highlighted by over 150 respondents. Category B contains hazard consequences highlighted by 100-149 respondents. Category C represents hazards consequences mentioned by 50-99 respondents, and Category D contains hazard consequences mentioned by under 50 respondents. The results are indicated in Table 6.5

Table 6.5 Hazards consequences category as perceived by workers and supervisors.

	Hazards consequences	Respondent	Category
1	Falling from height	171	**A**
2	Muscle pain, Back pain and injury due manual handling	152	**A**
3	Health problem due to noise	126	**B**
4	Hit by falling object	118	**B**
5	Health problem due to dust	107	**B**
6	Health problem due to bending and twisting	71	**C**
7	Crushed by moving equipment and cuts by working tools	36	D

Key to the hazard consequence categories
A: Highest hazard consequence category
B: Second hazard consequence category
C: Third hazard consequence category
D: Fourth hazard consequence category

Table 6.5 indicates that the probability of occurrence of falling from a height and back and muscles pain due to manual handling hazards were perceived by many respondents, which fall under category A. Meanwhile the probability of getting health problems due to dust and noise and probability of hit by falling objects were in the B category. Health problem due to too long bending and twisting fall under category C and crushed by moving object falls under category D. While no hazard consequences should be completely ignored, priority should be given to reducing the risks associated with these Categories A and B hazards, which indicated more than 60% of the respondents. From this perspective, hazard consequence in category A was used for in-depth study in the case study.

6.3 Chapter Summary

The results presented above provided an outline of the nature of health and safety risks on Tanzania construction sites. The main health and safety hazards include working at a height, falling objects, manual handling hazards, noise, dust and bending and twisting and equipment.

Workers and supervisors were asked to indicate their perception of identified hazards based on the probability of occurrence of the hazard consequences. Among these hazards consequences, falling from a height and muscle and back pain due to manual handling were perceived to be highly likely by workers and supervisors, while crushed by a moving object and health problem due to too much bending and twisting were perceived to be less likely.

CHAPTER SEVEN

FINDINGS FROM VIJANA SITE

This chapter presents the results of the data collected from Vijana construction site in Dar es Salaam, Tanzania. The results focused on the process of health and safety risk assessment and communication at the Vijana construction site, and how legal factors, organisation factors, individual factors and the work environment influence the process. Since there are a number of health and safety risks on construction sites, the results focused on only two hazards, working at height and manual handling, as these were established by the pilot study as the dominant hazards. The case study findings will be discussed in relation to each case, specifically focusing on the following sub-headings:

- Brief description of the project
- Key project actors and site organisation
- Legal system for health and safety risk assessment, communication and control
- Organizational factors concerning health and safety risk assessment, communication and control
- Individuals' role in risk assessment, communication and control at the sites
- Work environment factors concerning risk assessment, communication and control

Site observation and documentary sources on health and safety risk assessment and communication are reported alongside each other. Narration has been used to analyse the data, supported by photographs and charts.

7.1 Description of the Project

The Vijana project comprised the construction of a new house in a residential and commercial complex in Dar es Salaam city centre. The Vijana site is located along Morogoro road at the junction of Lumumba road, plot numbers 1081/1, 1081/2, 1082. The scope of the work is the design and construction of a 26 storey building comprising three wings, which will accommodate residential apartments, a hotel and restaurant, a swimming pool and car park, built on approximately 12000 square metres. Design and build was used as the procurement method. It is financed by a public-private partnership of a private and parastatal organisation. The principal contractor is a local class one contractor, namely Estim Construction Company.

The project had employed 600 workers, but at the time of data collection two wings were at the finishing stage and the third wing was under construction. Therefore, at this time there were 332 employees, 154 of whom were semi-skilled and 168 were unskilled. The project started in September 2008 and is expected to be finished in June 2012. The contract period of the project was 54 months. The contract sum was Tosh 6,000,000,000, equivalent to US$ 3,750,000.

The main components of the building are concrete columns, slabs and beams, which were all cast in situ. Cement and sand block walls were used to cover the buildings and partition off the rooms. The site has all the necessary facilities such as water and electricity, as there is an existing building at the front of the structure which has been used as offices.

Figure 7. 1 Vijana construction sites (two wings)


Figure 7. 2 Wing three, Vijana construction sites

Figure 7.3 indicates the site layout of the Vijana construction site, showing the different facilities at the site, such as transportation routes, office area, meeting area, toilets, canteen, and concrete-mixing area. The site has enough space so that all the activities took place there.

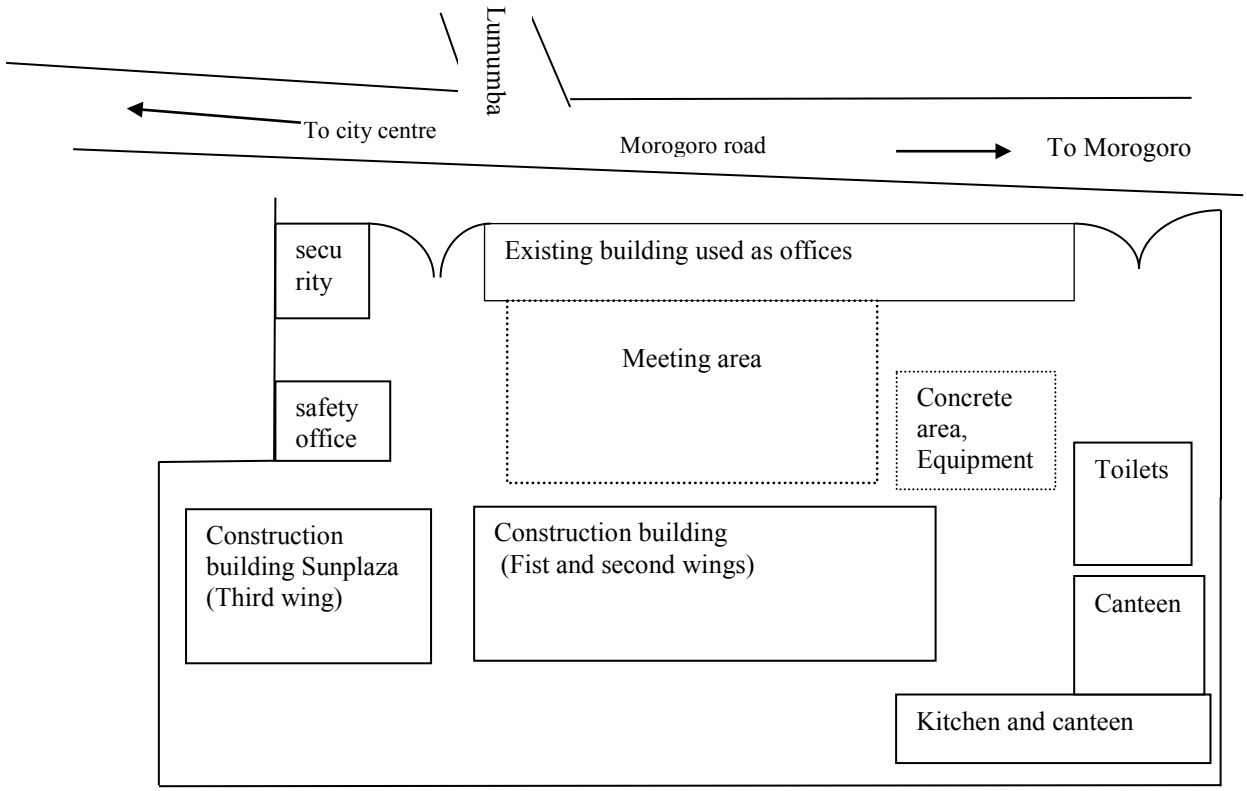

Figure 7.3: Site layout of the Vijana construction site

7.2 Actors involved in the construction project level and site organisation

The project has different actors, who include the client, architect, structural engineer, Quantity surveyor, contractor and sub-contractors (plumbing, electrical, Air conditioning and lift). All sub-contractors had a contract with the contractor and the contractual relationship is shown in figure 7.4.

Figure 7. 4: Project actors in on the signed board

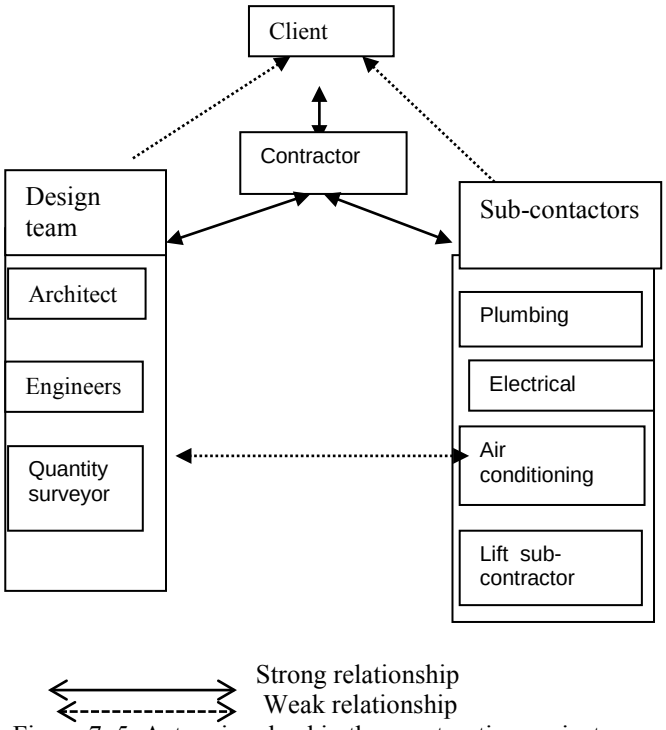

Figure 7. 5: Actors involved in the construction project.

Figure 7.4 shows the sign board indicating the actors at the project site. This is a legal requirement for construction sites to have sign boards indicating all the main project actors at a particular site. Furthermore Figure 7.5 indicates the communication relationship of the project actors. Figure 7.5 indicates that the project level was held by the client who employs the contractor to offer design and construction services to the client (as the mode of procurement was design and build), the contactor employed an architect to offer a design, a quantity surveyor to offer cost estimate services and structural engineers to offer structural services.

Although design teams were employed by the contactor they have a working relationship with the client as they have to work according to the client's requirements. Furthermore, the contractor had to employ sub-contractors (plumbing, electrical, lift and air conditioning), which had to be approved by the client. These actors in one way another influence the execution process at the site. Meanwhile the contractor had a number of workers at the construction site as indicated in Figure 7.6.

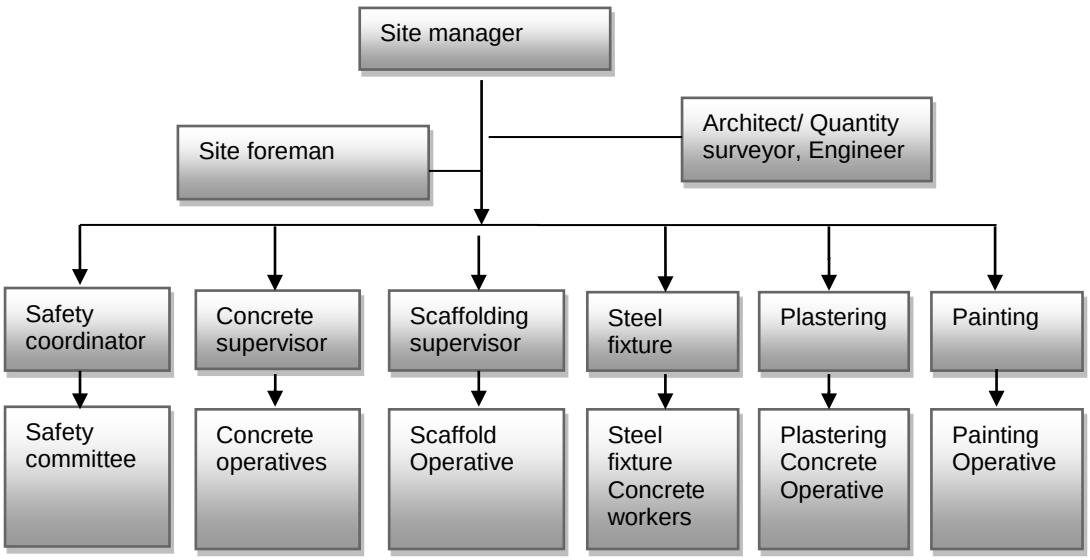

Figure 7.6: Vijana site organisational structure

Figure 7.6 shows that site management is made up of the site manager, gang supervisors and the site foreman. The nature of the site's organisation seems to be a vertical hierarchy and the site manager is responsible for economic and work environment issues. Communication of the site manager with workers is through gang supervisors and the safety committee.

7.3 Legal System for Health and Safety Risk Management at Vijana construction site

7.3.1 Health and safety Regulations and Provisions

There are many legal institutions regulating the construction industry in Tanzania, some of which have a more direct working relationship at the constitutional level. The first institution is the Occupational Health and Safety Authority (OSHA) under the Ministry of Labour and Employment Relations and the second is the Contractors Registration Board (CRB) under the Ministry of Infrastructure. OSHA is the custodian of all health and safety management matter in all workplaces under OSHA Act 2003, and CRB oversees all activities performed by contractors in Tanzania under CRB Act 1997 then act 2010. Key informants from these two institutions were interviewed with a view to obtaining their opinions on health and safety risk assessment and communication at construction sites. These key informers are inspectors who inspect construction sites. The semi-structured interview was used and supplemented by some questions during explanation. The interviews were tape recorded and later transcribed. Furthermore, OSHA Act 2003 and CRB Act 1997 were reviewed to arrive at a good understanding of their provisions. These two acts were used by the researcher to guide the interview. The main issues discussed under legal factors include the existing regulations, the

roles and responsibilities of institutions and their challenges concerning health and safety risk management.

7.3.2 The Roles and Responsibilities of Institutions concerning Health and Safety at Construction sites

The interview revealed that the main tasks of the two institutions are to make sure that regulations are complied with at workplaces, including construction sites. They monitor compliance through regular inspections of the sites and they proactively promote workplace health and safety through workshops and seminars. They also provide occupational health and safety information, as well as registering workplaces, examining the occupational health of workers, offering advice on ergonomics and scrutinizing workplace drawings. The institutions also issue guidelines, regulations and standards on occupational health and safety to enhance implementation.

Concerning the inspection process, it was revealed that before they conduct site inspections, the site must be registered with them (organisation). In the registration process, contractors have to provide information, such as the type and scope of projects, location, number of employees and the other project actors such as design teams and sub-contractors. The site is expected to be inspected before work starts. However one of the challenges facing inspectors in the inspection process is that contractors can start construction without being inspected. Thus sometimes contractors have started work without meeting all the health and safety requirements. As to whether the current case (site) had fulfilled the requirement of registration, it was revealed that the Vijana site was registered by both OSHA and CRB, as one of the inspectors commented;

"Vijana site is registered under CRB and the site has been inspected three times a year. There is no formal guide on how frequently inspection should be done; however it is very important to inspect a site before starting construction work[3]*.*

Regarding how inspection is done, it was also revealed that site inspection is carried out randomly and in most cases without prior notification. Compliance certificates are issued to the site which complied with the regulations and shortfall notices and fines are issued to those not complying, as one of the inspectors stated:

[3] Discuss with one of inspector Mr M. from Contractors Registration Board on *24th May 2011*.

"During inspection we establish whether the contractors carrying out the works are registered by CRB and whether they are complying with health and safety measures, such as the provision of welfare facilities and appropriate person protective equipment (PPE). In the case of shortfalls, a show cause notice is issued or one is fined on the spot or both, depending on the magnitude of the shortfalls or offences" …..pause

"When we inspect a site we want to see if the contractor has fulfilled all the regulations. We also provide an accident register book in which the contractor has to enter all accidents and incidents, and during inspection we audit the book. We have inspected this site three times and one time during our inspection we found some workers not wearing PPE, such as hard hat and safety shoes. The contractor was fined 600,000 Tosh[4]

Another inspector remarked;

"The Act states that it is necessary for an employer to conduct risk assessment and put in place control measures. There are no standard documents on how risk assessment should be carried out but we know about basic hazards on construction sites, such as falling from a height, chemical materials, manual handling and so far (in our organisation) we have employed various professionals, for example, on construction sites the person doing the inspection must also have been involved in accident and incident investigation"[5].

7.3.3 Influence on Health and safety risk assessment and communication process

It was noted that the OSHA and CRB Acts have identified some health and safety hazards and control measures at construction sites. Working at a height is the one of the major hazard and some control measures have been provided by the regulations, such as wearing full PPE, scaffolding being erected by a competent person, and edges, holes, lift shafts and wall edges should be barricaded to prevent falls. Furthermore, the regulations emphasise the importance of the contractor having a competent person familiar with health and safety issues who can foresee all risk, implement control measures and communicate with employees on health and safety risks and control measures. The regulation (OSHA act 2003) requires all employers to have in place an effective Health and Safety policy, to appoint health and safety officers and health and safety representatives at workplaces with more than 20 employees and to establish health and safety committees where there are more than 50 employees.

[4] Discuss with Mr J, inspector from Constractor Registration Board 24 May 2011.
[5]Discuss with Mr S, Inspector from OSHA 26th May 2011.

7.3.4 Inspectors' views on why accidents happen and what was the cause

Regarding why accidents happen on construction sites regardless of the control measures, this question was asked in line with the investigation report on the four accidents that happened at Vijana construction site. The interview revealed that the accidents were falls from a height, being injured by equipment and fire. However, falling from a height was the leading accident, accounting for two out of the four. The accidents were the fault of both the site management and individual workers. Regarding the cause of the four accidents on the construction site the inspector remarked that;

"The investigation of the first accident at the construction site revealed that the worker fell from a height (17th floor to 3rd floor). The worker was doing plastering work and was under a sub-contractor (the company had sub-contracted activities such as plastering and steel reinforcement). The worker was given all the necessary PPE (hard hat, safety boots and safety harness). He was in a rush and he wanted to do something quickly a few minutes before lunch, and did not use his safety harness. He missed the platform and fell. He died on the spot. Procedures for compensation are being followed".

"The second case was also falling from a height, from 7th floor to 3rdfloor.The person was working with the steel reinforcement group. The person was deaf but the site management did not notice. He had spent only three weeks on the site. The person was given all the necessary PPE but again he did not use his safety harness. He stepped off the platform and fell. The person was hospitalised for three months and recovered, though he has a small problem with his arm (partial disability).

The third accident was a person injured using equipment. The person was washing a concrete mixture, during which the operator switched on the machine without realising that the person was still in the machine. The machine belt chopped all five fingers off his left hand and he stayed away from work for three weeks. He is now partially disabled, without fingers on one of his hands. The fourth accident was a fire. The worker was a security guard and he was pouring water from the well and the water pump exploded and burned almost his whole body. The person was hospitalised and is still recovering.

Based on the four accidents, both site management and operative attitudes are seen as the cause of them. Management was the cause, for example, in case two, as the person was deaf and they did not notice that. That means that management does not have a mechanism for checking the health of employees pre-employment. What he was doing was really risky and if they had known about his situation they could have given him another task which was less risky. The first and second accidents were the fault of the individuals as they were given PPE but did not wear it"[6].

Regarding whether any cases of ill-health are reported to them, such as masculatory disorder or back or muscle pain, it was revealed that they were not reported at all, although a few minor injuries are reported. It was noted that even during inspection, both OSHA and CRB have no set criteria for assessing ill-health problems caused by manual handling. Explaining the accident reporting, one inspector said;

[6]Discuss with Mr M, inspector from OSHA, interviewed on , 26th May 2011

"Often, at construction sites we provide an accident register book in which they have to register all accidents and incidents that happen each day, but that has not been done and we only receive information if a fatal accident happens". You know we are dealing with all workplaces and we are still understaffed and so cannot follow up on all matters"[7].

7.3.5 The way to improve health and risk assessment and communication on construction sites

To improve the situation of health and safety risks on construction sites, inspectors stated that a campaign is needed as most contractors, workers and consultants are ignorant of health and safety regulations. Accordingly, some campaign programmes are in place now, jointly established by CRB and OSHA, assisted by the Institute of Engineers Tanzania. OSHA and CRB also have several programmes aimed at educating contractors, workers, clients and the general public through workshops, short courses, TV and radio programmes and newspapers on safety observation, to prevent the occurrence of diseases and accidents, and to make sure all people on construction sites, visitors and passers-by are protected.

7.4 Organisational System for Health and Safety Risk Assessment, Communication and Control

Interviews were conducted with Esteem Construction Company with the purpose of stressing the issue of leadership and organisational culture with regard to health and safety risk assessment and communication. The interview held with the Chief Executive Officer took half an hour, was tape recorded and later transcribed. It was semi–structured, supplemented by further questions during explanation. The main topic discussed was the culture of the organisation in terms of company policy, resource allocation and support given to the site management regarding risk assessment and communication.

7.4.1 Company policy and responsibility for health and safety on construction site

From the interview it was revealed that the Estim construction company has a health and safety policy which states that

"We are committed to protect the health and safety of each employee as the overriding priority of this company. There will be no compromise of an individual's well-being in anything we do. The implementation of actions to help our employees realize a healthy, injury-free environment is the responsibility of everyone.[8]

[7] Discuss with Mr S, inspector from CRB on *24th May 2011.*

[8] Discuss with Mr. O chief executive officer of Estim Construction Company, interview on 6th June 2011

The policy statement shows that Estim Company is committed to health and safety risk management. On further discussion on how they fulfil this commitment, it was revealed that the company has two safety coordinators who are permanently employed by the organisation. These coordinators work with safety committee members at each construction site. OSHA Act 2003 section (11) requires each construction site with more than fifty workers to have a safety committee. The company has to clearly obey this regulation and allow site managers to employ five workers to work on the health and safety issues only on the construction site. These safety workers work as the safety committee. The company (head office) provides all the necessary support for the site, such as making sure the site is boarded, supplying all welfare facilities such as safe drinking water and the required PPE and providing resting places and clothing areas. The company also supplies a free lunch for all workers working on the site. The food is checked by the safety committee.

7.4.2 Company System for Risk Assessment and Communication

Concerning whether the company has a specific method or software for risk assessment and communication on construction sites, it was revealed that it does not. However, responsibility for health and safety risk assessment and communication is given to the site manager, who is assisted by the safety coordinator and safety committee. It was noted that consideration of the health and safety aspect had been given at the time of the employment of the site manager. Thus site managers must have good construction experience and educational background as well as health and safety knowledge. Furthermore, in addition to construction experience safety committee members were required to have attended a health and safety training course. Sometimes the company sends some of the experienced workers for health and safety training, after which they become safety committee member on the sites.

Regarding communication between head office and site offices it was revealed that they have regular meetings with site managers and do site visits and receive feedback each day through phone calls or face-to-face meetings. They work very closely with site managers.

7.4.3 Challenges Facing Company in Implementing Health and Safety

It was revealed that lack of funds and complexity of design are the main challenges faced by the company in implementing health and safety risk assessment, communication and control. Clarifying how the issue of funds was a challenge in implementing health and safety management, the Chief executive officer stressed that they face stiff competition, whereby the

lowest evaluated tender is awarded the contract. Meanwhile the provisional sum for the health and safety section on preliminaries, which does not show details, is what contractors have to consider when pricing the health and safety section, as he stated:

"Sometimes we have to spend beyond what we have provided for health and safety due to the stiff competition and lowest bid tendered, and so we provide very little or nothing at all for the health and safety item ….pause….. until the area of competition excludes health and safety and provisional sums provided in the contract to cater for it, health and safety will always be poor on most sites because of the lack of investment in preventive and control measures"[9].

From these findings this study therefore argues the importance of considering health and safety issues in both phases of construction projects i.e. design and construction phases. The procurement system, where the issue of the lowest tender and stiff competition market has caused the provision of health and safety to be ignored, has been a challenge for contractor to invest in health and safety. Figure 7.7 summarises the factors and challenges influencing health and safety risk assessment, communication and control at the company level.

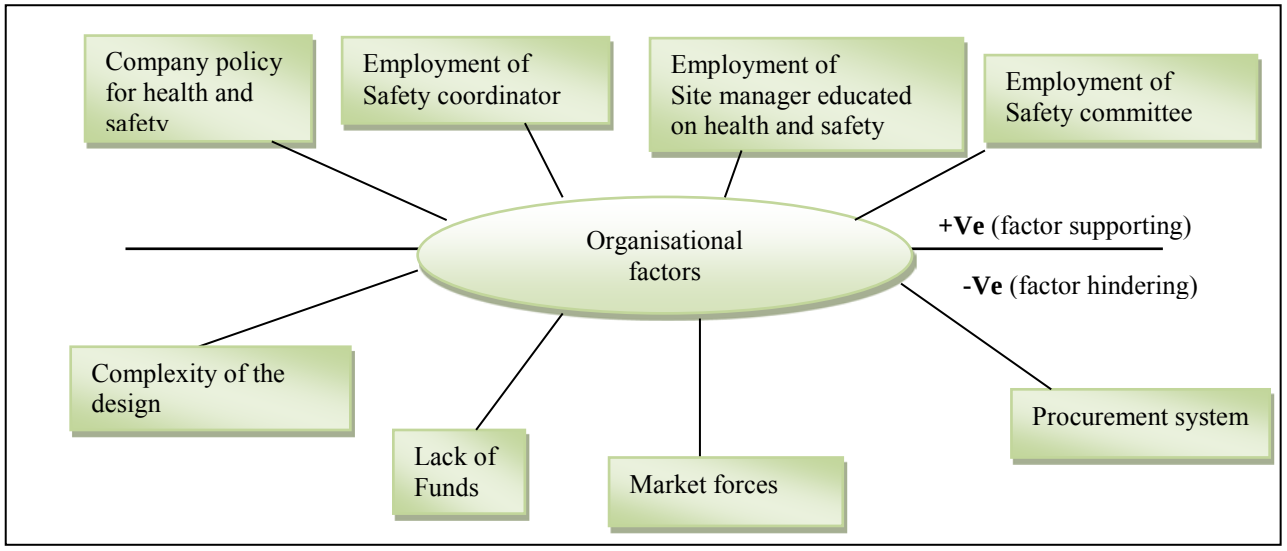

Figure 7.7: Factors and challenges on risk assessment, communication and control at organisation level.

Figure 7.7 indicates that the positive sides as factors facilitating the management of health and safety risk assessment communication and control include company policy, employment of safety coordinator, employment of site manager and employment of safety committee. It also indicates that the negative factors hindering the risk management process include lack of funds, market forces and the procurement system and design complexity which does not consider health and safety requirement.

[9] Discuss with Mr., chief executive officer from Estim on 6th June 2011

7.5 Interviews with Individuals at Vijana Construction Site.

An interview was conducted with four groups of individuals at the construction site as indicated in Table 7.1. For this part, questions put to the respondents focused on how risks are identified, evaluated, communicated and controlled at the sites. To open up the minds of the respondents, the questions were frequently reformulated during the interviews. Instead of only asking about risks, questions regarding 'what is your background education, experience and duties as a site manager and or as a supervisor or as a safety team or as a worker, and some questions related to how they are carrying out their health and safety responsibilities and what are the challenges they are facing.

Table 7.1: Individuals that participated in the interviews at Vijana construction site

S/N	Individuals	Number	Methods
1	Site management team (site manager and gang supervisors)	1 site manager + 3 supervisors	interview
2	Safety committee/ safety team	5 safety team members	Interview
3	Workers	5 scaffold +7 steel reinforcement +10 concrete workers	Interview
4	Design team	Architect+ Quantity surveyor+ Engineers	Interview

7.5.1: Site Managers and Gang Supervisors at Vijana Site

i) Background and Responsibility of the Site Management Team

The interview revealed that the site manager has a civil engineering background with a Master's degree in project management and has experience of 20 years on construction sites. He has worked as a site manager on different building projects for 10 years in Kenya and Tanzania, in charge of all activities on the site such as planning and scheduling the activities and coordinating different actors in the project, assisted by supervisors, as he said;

"As the site manager (boss of the site), my work is very much to do with planning, scheduling work and time and coordinating different actors in this project. As the project is design and build, I have to coordinate the architect, quantity surveyor, engineer and sub-contractors. I have also to ensure that all the work is done in a safe manner. To assist me I have a number of supervisors as well as health and safety committee working with me. We have given different responsibilities to each group and my duty is to follow up and make sure they are fulfilling them[10].

Regarding gang supervisors, it was revealed that they all the gang supervisors were from India, where they received their technical education. Their experience on construction sites

[10] Discuss with Mr. H, a site manager at Vijana site, interview on 13th June 2011

varied between one and four years. Their responsibility was to manage the site where they supervise workers in their respective sections.

ii) *The Knowledge and Perception of Site Management Team of Health and Safety Risk Management.*

The interview revealed that the site manager is very knowledgeable on health and safety risk management. With his experience as site manager on different construction sites he has been involved in safety management. Also with his educational background, especially his master's degree in project management, he learned how to do risk assessment and communication in construction projects. As a site manager he has witnessed a number of accidents. He commented that there had been four major accidents at Vijana site, when one worker lost his life, two are now partially disabled and one worker is now doing well. Two of the accidents were falling from a height and one was injury by equipment (washing the concrete mixture) and the other was injury by fire from the water pump. The site manager blamed the workers and sub-contractors for the accidents, as he said,

I know that this work (construction sites) is very dangerous but we are trying to keep as safe as possible by following regulations. The company's mission is to minimise accidents on its sites. However, we are facing some challenges as some workers do not want to follow what we are telling them, especially wearing PPE, and sub-contractors don't want to follow regulations. On this site so far we have had four major accidents when one worker died, two were partially disabled and one was hospitalised for a month. Two accidents were falling from a height and were the sub-contractor's fault. We were also fined TSH 600,000 (US$ 400) by the Contractors Registration Board because some workers had not put on PPE. You know the regulation say that if they find a worker who has not put on PPE the fine is Tosh 20,000 (equivalent to US$ 12)[11].

Regarding the gang supervisors, their perception of health and safety risks was low, as some of them were still learning. They had never attended a formal health and safety management course, but had acquired some health and safety information from the sites through toolbox meetings. They admitted that they had witnessed accidents on the construction sites. However they were not confident of identifying and assessing the majority of hazards on construction sites.

iii) *Regarding How Health and Safety Risks are Assessed, Communicated and Controlled*

It was revealed that health and safety management was coordinated by the site manager through the health and safety committee, comprising five members, which is coordinated by

[11] Discuss with Mr. H, a site manager at Vijana site on knowledge and his perception of health and safety risk, interview on 13th June 2011

the safety coordinator from head office (who comes to the site and spend a few hours with the health and safety committee and resolves any pressing issues). The health and safety committee works every day at the site to manage health and safety risks, especially to assess and communicate them to the workers. The site manager works closely with the safety team and provides all that is needed for managing health and safety risks. The role of gang supervisors in managing health and safety risks was not reflected in their responsibility, as there was a clear division of responsibilities. While supervisors had the role of supervising the work and the related quality and productivity, the health and safety team works with workers to make sure they are adhering to health and safety regulations. Figure.7.8 represents the safety organisation of the site.

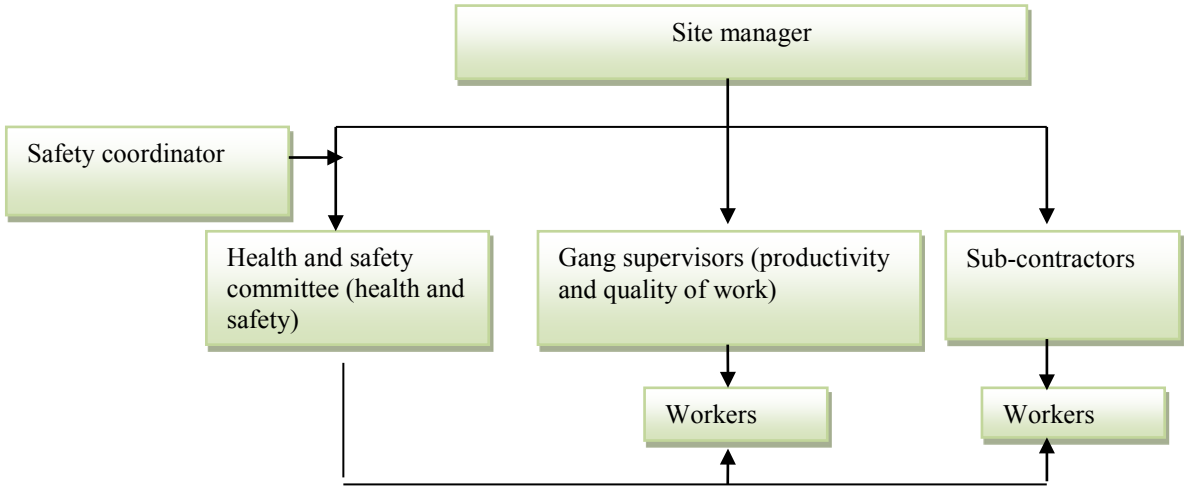

Figure 7.8: Health and safety organisation at Vijana site

iv) Risk Assessment and Communication

The site manager indicated that he carried out some form of hazard identification. The most common practice was the identification of hazards from everyday activities (tasks), especially from work schedule. Furthermore, before closing site each day he has meeting with the gang supervisors to discuss the progress of the work and to plan next day's activities. From the task, he identified some risks of falling from a height and manual handling associated with major operations on site. His experience, educational background and what has been provided in the regulations has helped him to identify health and safety risks and to provide control measures. He communicates those hazards to the safety team who have to communicate those hazards and control measures to the workers. The site manager explained how he managed the health and safety risks of projects.

"The actual assessment is based on experience and very much in my head" and is an everyday activity as each task has its own risks. From my schedule of the work, I identify a hazard and if you know there is one then automatically there is a risk. I assessed the risk of falling of workers in the site and noted measures to control it. I also communicated this information verbally to the safety coordinator or safety committee. Some of the other aspects of safety management are done by the health and safety coordinator and his committee[12]".

Regarding the relationship between the organisation management and site management it was revealed that there was strong collaboration between the site management and organisation management. Interviews also indicated that there exists an information flow between site management and sub-contractors through coordination meetings.

7.5.2 Interviews with Health and Safety Committee at Vijana Site

i) Background education and responsibility

The educational background of the safety team revealed that all of them have secondary education and experience ranging from two to seven years on construction sites. They have attended health and safety courses offered by OSHA on health and safety management, in which risk assessment and communication was one of the areas covered. They are employed by the firm to manage health and safety risks at the site. Some of them had already been working with the firm for three years as semi-skilled labourers and others as storekeepers. The safety coordinator has a university degree and seven years' experience with the firm and has worked as site foreman at different sites. He has also attended some health and safety courses offered by OSHA in conjunction with the Institute of Engineers and Contractor registration Board.

The safety committee has various responsibilities concerning health and safety risks on the site, as follows.

(i) To identify potential hazards at the sites
(ii) To communicate with workers about health and safety risks in their tasks and control measures.
(iii) In collaboration with the employer, to examine the causes of incidents,
(iv) To investigate workers' complaints with respect to health and safety,
(v) To make representations to the employer or where such representations are unsuccessful, to an inspector,
(vi) To inspect any document which the employer is required to keep with respect to health and safety,
(vii) To accompany any inspector on any investigation,

[12] Discussion with Mr. H, a site manager at Vijana site on how he assess, communicate and control risk interview on 13th June 2011

(viii) To participate in any internal health or safety audit,

(ix) To report accidents, near misses, injuries, illnesses, deaths, and non-compliance to the inspector.

(x) To provide first-aid to workers for minor injuries and to make the necessary arrangements for major injuries to be treated in hospital.

(xi) To distribute PPE to workers, according to the task performed by them. For example, all workers are given hard hats, safety shoes and overalls. However workers working at a height are provided with a safety harness and those working in dusty areas are provided with masks.

(xii) To inspect some of the health issues such as the cleanness and quality of the welfare facilities, such as drinking water, food (lunch) and toilets. Figures 7.9 and 7.10 provide some of the responsibilities of the safety committee.

Figure 7. 9: safety officer provides first-aid to one of the workers who was cut by a sharp nail in his foot

Figure 7. 10: the safety officer inspects the food as all workers on the site were given a free lunch

ii) Hazards Identification, Risk Estimation and Risk evaluation at Vijana site

Concerning how they identify hazards at the site, it was revealed that the safety team goes around the site every time to see if there are potential hazards that could cause accidents of falling and to put in place control measures. Those hazards include open holes and edges, and any obstacle on the routes. After a hazard has been identified, they have to barricade it as the control measure. The knowledge they got from the health and safety training helps them do this. Figures 7.11 and 7.12 show some hazards which can cause accidents and the control measure implemented

Figure 7. 11: falling hazard which has been barricaded

Figure 7. 12: Falling hazard on the stair edges which has been barricaded

iii) *Risk Communication at Vijana Site*

Concerning communicating risks to workers, it was revealed that the main health and safety communication method is the toolbox meeting. Workers normally have a toolbox meeting every day to deal with logistics issues before they start work in the morning, but health and safety matters are discussed three days a week. The safety meeting starts at 7.15 and ends at 7.30 in the morning on every Monday, Wednesday and Saturday, as reported by one of the health and safety officers.

Workers come early in the morning and they have to register at the gate (security). Every day they have to register stating at 7.00 am in the morning. At 7:15 they assemble at the meeting place. On Monday, Wednesday and Saturday we talk with them on health and safety issues. The main issue we discuss at the meeting is reminding them that the there are a lot of hazards on the site, the importance of them wearing person protective equipment (PPE) all the time, keeping the sites tidy and reporting any incidents or accidents[13].

Figure 7. 13 A safety officer communicates health and safety issues to the workers.

Figure 7. 14: Workers listening at the toolbox meeting

[13] Discussion with Mr A, health and safety officer at Vijana site on how they communicate health and safety risk. Interview on 17th June 2011

Through listening to some of the health and safety issues discussed at the toolbox meeting, it was observed that workers were reminded about the health and safety risks on construction sites and the importance of them wearing the appropriate personal protective equipment (PPE) according to their task and to take care of the PPE. For example, scaffold workers, external plasterers and painters, in addition to wearing a hard hat, overalls and safety shoes, must wear a flexible safety harness. Those working in dusty areas should wear a mask and those doing manual handling must wear strong gloves. Also the importance of workers observing warning signs was discussed. Workers were encouraged to report incidents and accidents to the safety officers, and were also reminded of the penalty if they default, as the following citation of one safety officer illustrates;

"If any of you (workers) are injured through your own fault as you have been given PPE and if you did not wear it and then you have an accident, the company will not be held responsible. Again, if you are found not following health and safety regulations, you will be given a written warning, and if you have received three written warnings you will be dismissed from the site"[14].

Regarding communication at toolbox meeting, it was noticed that great emphasis was placed on wearing the appropriate PPE, focusing the possibility of an immediate accident. The long-term impact, especially ill- health problems such as back injury, muscular pain and emasculatory disorder was not emphasised. The researcher had the opportunity to communicate with workers at one of the toolbox meeting as she is also a trainer in health and safety for contractors, consultants and workers. The emphasis was on the areas not normally emphasised by safety officers. Figures 7.15 and Figure 7.16 show the researcher communicating with workers during a toolbox meeting.

Figure 7. 15 Researcher communicating with workers at the toolbox meeting

Figure 7. 16 Researcher communicating with workers at the toolbox meeting

[14] Mr L , one of the safety team communicates with workers at Vijana site 22nd June 2011

Apart from toolbox meetings, posters, signs and symbols were also used by the safety team to communicate health and safety issues at the site. It was observed that a lot of information and instructions have been posted on wallboards of routes and offices at the construction sites. Some examples of instructions were simple and practically written in easily readable letters and with eye-catching colours, urging the personnel to use PPE. During the observations on construction sites, the following elements were commonly observed in the site layout: building signs giving a description of on-going construction work as indicated in 7.17 to 7.22.

Figure 7. 17: Educating poster showing that construction work is dangerous, followed by safety rules

Figure 7. 18: Shows safety at the workplace, think safety all the time, work in a safe manner, finish your work in safety and go back home in safety.

Warning posters and signs and symbols were used as indicated in Figure 7.19 and Figure 7.20.

Figure 7.19: Warning poster showing there is a danger

Figure 7.20: Warning tape showing there an open hole

Figure 7.21: Poster showing direction

Figure 7. 22: Barricaded wall edges

Apart from communication with workers at the toolbox meetings, the safety committee team has monthly safety meetings with the site management where they discuss all health and safety issues, the challenges and how they can resolve them. The safety team is also required to keep all documents concerning health and safety risks and to present any required documents to the inspectors or employers. Some of the documents include the accidents register book, in which they register all accidents and incidents that happen on the sites. The registration is on daily basis which they have to submit to the regulatory boards monthly. In the case of accident they have to report it immediately to site manager and to OSHA.

iv) Risk Control Measure

Regarding the health and safety control process, emphasis is placed on workers wearing PPE and having edges barricaded. After communicating with workers in the toolbox meeting, the safety team goes around the sites to check for potential hazards, whether workers are wearing PPE and to make sure that tasks are done in a safe manner. As the safety team is aware that falling from a height has different causes, such as unprotected edges, scaffolding not well erected and non-use of the safety harness, it has to make sure all scaffolding is properly erected and well protected and it must be tested before any worker climbs on it. From the observation and interview, it was revealed that special attention has been given to the scaffolding workers as they are at great risk of falling. One of the safety team members is working full time with the scaffolding team. Furthermore the issue of employment of the scaffolding team members was also important. They make sure that workers in the scaffolding team are well physically fit and are of a specific age (between ages 25 to 35). They must have

a lot of experience of scaffolding work and if they are not sure of them, they will be tested in a less risky area (low height).

Regarding other gangs (concrete and steel fixtures); the safety team do regular checks in their working areas to make sure they are well protected in terms of wearing PPE. On further discussion it was revealed that sometimes they find some workers not wearing PPE. If they find them they have to stop them working until they go down to collect PPE. They also issue a warning letter to the workers if they refuse to follow what they are asked by the safety team.

v) Perception of Why Accidents Happen

A number of criticisms were made by the safety team regarding the fact that sub-contractors' workers do not want to attend toolbox meetings. Sub-contractors were seen as distancing themselves from responsibility, are often inadequately supervised and ignorant of and not committed to the common responsibilities where health and safety is concerned. It was revealed that the two accidents of falling from a height were of sub-contractors' workers. The interview revealed that the main contractors were responsible for the health and safety of sub-contractors' workers. However, the sub-contractors focus more on production and keep a distance from the responsibilities of health and safety.

Another reason mentioned by the safety team as to why accident happens was that gang supervisors seem to focus more on production and ignore health and safety issues. This was observed when workers are working without wearing important PPE and the supervisor allows this. Putting blame on the supervisors, one of the safety officers said

"Supervisors can be challenged and sometimes we can say are the cause of accidents. In our daily control and making sure workers are wearing PPE, you find some workers don't have PPE, principally they have to collect PPE from our office and then they come to their respective areas. So you find they come straight to the working area without any PPE. If you find such a worker he is required to go down to collect PPE and continue with his work as now they are working on 25th floor and going down and coming back it can take more than 10 minutes. For a supervisor ten minutes is like a loss. Sometimes a supervisor does not allow them to go down and collect PPE. There is a conflict between production and safety management where most of the workers listen more to their bosses than us. But we often report this to the site manager, and he had discussed the matter with them (supervisors) and now they slowly understand[15]".

Workers' attitudes and behaviour regarding health and safety issues was mentioned as another cause of accidents. The safety team stated that the individual characteristic of workers has

[15] Discussion with Mr K, one of the safety team at Vijana site on their perception of why accidents happen. Interview on 24th June 2011

been a major problem. When some workers are provided with safety gear they refuse to wear it. Some of them are in the habit of drinking alcohol and smoking cannabis.

The issue of low educational profile and poverty among workers was mentioned by the safety team as one of the reasons for accidents on the sites. It was revealed that with a low level of education it is has been difficult for them to grasp what the safety team has communicated to them. Again due to the low level of education, their job opportunities are narrow and sometimes they have suffered when looking for a job. Therefore once they get a job they are afraid of asking for their rights. Over confidence of the workers was another issue. Some workers have a lot of experience and believe that they know everything about how to work safely. No matter what they are told they refuse to listen. For them it seems that safety is not for their own benefit but for the company's benefit.

7.5.3 Interview with workers

An interview was conducted with workers from three groups at the Vijana site. These groups were selected because they were directly exposed to height and manual handling hazards. The three groups comprised those involved in scaffold erecting, concrete and reinforcement and seven workers were selected from each group through convenience sampling.

i) Description of the work of different groups

Scaffold erection gang

This gang consisted of 20 workers and one supervisor. This group was regarded as at most risk of falling. Most workers in this group were employed on a contract basis (during the tenure of the project). According to the interviews, scaffolding workers are required to have knowledge of health and safety regulations and to do simple calculations to check if the scaffolding will hold. The work of a scaffolding worker entails various tasks (connecting, bolting) that require the worker to climb up on steel columns to walk on beams. They are also required to assemble building hoists, to lift the steel columns, assemble them and disassemble them when they are no longer needed for production. Scaffolding workers stated that for their tasks they need to be physically fit to cope with what is demanded of them. It was observed that lifting cranes and other mechanical aids were used for those heavy work tasks; however there were a lot of activities that were carried out manually. Figures 23 to 26 show the different activities done by the scaffolding group.

Figure 7. 23: Scaffold worker in joint hoist

Figure 7. 24: Scaffold worker walking on a steel column

Figure 7. 25: Scaffold worker working on steel column

Figure 7. 26: Scaffold worker sitting on the wall edge

Concreting work

This group involved 20 or 30 workers depending on the activities on the site. They are involved in mixing concrete and transporting it to the required points such as walls, columns and slabs and compacting concrete. They are involved in various hazards such as pulling and pushing concrete using wheelbarrows, bending on compacting, carrying heavy loads manually such as cement bags. This group also revealed that the task is too demanding as it requires one to be physically fit. Figures 7.27 to 7.30 indicate the different activities carried out by the concrete group.

Figure 7. 27: Concrete team compacting and spreading the concrete

Figure 7. 28: Using the wheelbarrow to pour concrete

Figure 7. 29: Concrete workers using wheelbarrow to pour concrete

Figure 7.30: Crane used to pour concrete

It was observed that concrete workers' tasks have been mechanised to a large extent in comparison to other construction trades. At the site, heavy work has been made less strenuous by the use of a crane, concrete pumps and other machines. Concrete was transported to the upper floor using a pump and dumpers and the workers collected concrete from pipes and dumped it where it was required. Concrete workers pointed out that the mechanical equipment along with the cranes has been helpful in improving the construction workplace in regard to manual material handling. Figures 7.31 and 7.32 show the mechanical equipment used for concrete work.

Figure 7. 31: Concrete dumper transporting concrete

Figure 7. 32: Concrete mixture plant at Vijana site

Reinforcement Steel gang

The steel reinforcement gang consisting of 17 workers also depends on the extent of the work. They position and secure steel bars, rods, or mesh in concrete form (on the column, wall, beams and slabs). They use fasteners, rod-bending machines, blow torches and hand tools. They are also space and fasten together rods according to the blueprint, using wire and pliers, they cut rods to the required length, using metal shears, hacksaws, bar cutters, they cut and fit wire mesh or fabric, using hooked rods, and position fabric or mesh in concrete to reinforce it. Observing the steel reinforcement group, they spent a lot of time bending at height and manual handling as they work with sharp equipment. Figures 7.33 to 7.36 indicated the different activities of the steel fixing group.

Figure 7.33: Reinforcedt steel waiting to be cut and fixed

Figure 7. 34: Workers fixing reinforced steel

Figure 7. 35: Worker fixing reinforced steel

Figure 7. 36 Workers carrying reinforced steel

ii) Workers' background education, experience and perception of health and safety risks

From the interview it was revealed that all the three groups had primary school education and a few had vocational training education. They have more than five years' experience in construction. They had never received formal training in how to do their tasks such as scaffold erection, concrete casting and reinforcement work, but acquired their skills informally on the site (on-the-job training) where the majority started as an assistant until they became knowledgeable.

On their perception of health and safety risks associated with their task, the workers said that they had never received formal training in health and safety but had received it informally at the site toolbox meetings, and so knew some of the risks. The scaffolding team cited falling from a height as their main risk, the concrete team said chemicals, muscle pain and falling from a height and the steel reinforcement group mentioned back pain, sharp cuts and falling. They have witnessed a number of accidents as the one of the scaffold team narrated;

"We know this is one of the most dangerous jobs on construction sites as I witnessed my friend falling from a height and he died. We are very careful when we erect scaffolding, especially at a very high height (as now we are on the 24th floor) and if I were to fall here I am sure nobody would recognise me you would see only my bones. As a team we keep reminding ourselves and if we see one of us is not putting on his safety harness properly we help him or if he is not wearing a safety harness we remind him to wear it" [16]*(J).*

[16] Discussion with Mr J. one of the scaffolding workers, on 21st June 2011

iii) Communication and cooperation between safety team and workers

On how they perceive the communication and cooperation of the safety team and supervisors, the scaffolding workers said that they received good cooperation from their supervisor and the safety team. It was observed that one of the safety officers works full time with the scaffolding team, which helped them to be more careful. They further explained that, before they start to erect scaffolding, the safety officer would ask them if they had slept well or if they had any problems or family issues and if they had eaten breakfast. This helped them to be close to the safety officer and supervisor, and if they have any problems including family problems they were free to tell their supervisor.

Regarding the concrete and steel reinforcement groups, they are well informed by the safety officer concerning health and safety issues, but they claimed that their supervisor was demanding a lot. Sometimes they are afraid to talk to their supervisor if they have a family problem or any other problem which could disturb their performance. They are not free to talk about their family or any other problems to their supervisor or coordinator. Sometimes an accident happens due to the situation of the workers on that day. Maybe he had had a bad day, or emotional or family problems. It is important that the supervisor and safety teams know about workers' daily situation, accompanied by workers trusting them so that they can explain their family situation.

iv) Why Workers don't want to wear PPE even if it is provided

The scaffolding group acknowledges that they have all the necessary PPE such as hard hats, safety shoes, overalls and safety harness. Accordingly, PPE is available all the time it is required. Observation showed that all scaffolding workers were wearing a full set of PPE. The concrete workers have a different view. Some of them have a complete set of PPE such as hard hat, safety shoes and overalls; some have only a hard hat and safety shoes while others have only a hard hat. Sometimes when they require PPE, they are told there is none. For the steel reinforcement workers the situation was the same as for the concrete workers. They are required to have safety shoes, safety harness, overalls, hard hat and strong gloves. However, it was observed that they were either wearing only a hard hat, or overalls and safety shoes. They claimed that there was not enough PPE on the site. Figure 7.37 show workers working without proper PPE.

Figure 7.37: Workers working without wearing a complete set of PPE

Through observation, it was revealed that some workers were provided with some PPE but were not wearing it. On asking them why they are not wearing their PPE, they said that it sometimes make them feel uncomfortable while working on their tasks. Sometimes it was hard for them to find exactly their size in safety shoes and overalls, which forces them to wear outsized ones, making them uncomfortable. The steel reinforcement group mentioned that wearing gloves causes them to work slowly and sometimes there is a lot of pressure coming from the supervisor. On the issue of whether they are involved in selecting PPE they responded that safety team ask what size of shoes they wear, but in most cases their size is not available and so the safety officer looks for the nearest size, which is usually bigger. Another reason mentioned by the workers for not wearing PPE was the weather. Dar es Salaam is a very hot area with high humidity. Wearing PPE such as overalls, hard hats, gloves and boots by concrete workers affected their work. They also said that most of the time they work on top floors or roofs where they are greatly exposed to direct sun.

7.5.4 Interviews with design team. (Architect, Quantity surveyor and Engineer)

The design team interview was conducted with the Architect, Quantity surveyor and Engineer of the Vijana project. Their responses came generally from their experience and not

specifically from this site, although some of the issues were applicable. The team was asked whether they had been formally or informally involved with health and safety risk assessment, communication and control. They said that they are somewhat responsible. As the Architect who designs the building and has the role of supervision, he has to make sure that the contractor is working according to the contract. In the contract there is a health and safety section which contractor has to follow. Furthermore, it was revealed that there was no risk assessment, communication and control during the design phase. However, they communicate with site managers most of the time and officially during the monthly site meeting. Sometimes if they find the work is too dangerous they can issue instructions to stop the contractor from working until he fulfils the safety requirements. The engineer has no responsibility for health and safety other than making sure his drawings are on the safe side. However if the engineer is the team leader, he has the same responsibility as an architect.

The quantity surveyor revealed that one of his responsibilities is to prepare a bill of quantities and organise the contract document, which consists of the legal conditions and technical specifications concerning the work environment which are incorporated in the tender document. Regarding the technical specifications, there is a section on health and safety provision which the contractor has to price during tendering. The quantity surveyor said that in Tanzania normally contracts are awarded through competitive bidding with the successful bidder being the one with the lowest evaluated tender figure. The main reason for the adoption and continuing use of this type of procurement is that the client must be able to get a good contractor who is also economical. But this has been misconceived by contractors as they sometimes do not price the section on health and safety so that they can be the lowest. During implementation they cannot afford to invest in health and safety and sometimes are not prepared to look for alternatives. On further discussion, it was revealed that procurement regulations do not put enough emphasis on contractors being responsible for health and safety in the initial stages, as pointed out by the quantity surveyor:

I have been involved in the tender evaluation and most of the time I find contractors either not pricing at all or providing very little on the health and safety section in the preliminaries. These contractors' tenders become the lowest. At this point I have to recommend the principal contractor to my client on the basis of lowest evaluated tender figure. But I don't have enough grounds for not recommending such because the regulations do not put emphasis on this[17]

[17] Discussion with Mr. M. A quantity surveyor at Vijana site, interview on 8th July 2011

7.6 Physical Work Environment

An observation was made by researcher regarding the physical site, work team, work procedures and space, methods for risk assessment and communication, and some photos were taken to support the findings.

i) Description of the physical workplace

Observing the site layout revealed that it was well organised with clear access and having enough work space that would help reduce the number of injuries while working in nearly finished buildings. The location and site size was good enough and most of the activities took place during the day. Construction workers had access to a room in which to eat meals or take breaks; they also had access to toilets, washing facilities, drinking water and they had lunch. Employers provided workers with reasonable access to appropriate and adequate first-aid equipment. There were also implemented and maintained safe housekeeping practices, including appropriate, safe and clear access to and from the workplace, adequate storage of materials and an adequate number of safety signs which enhance communication.

ii) Work team

Observing the management organisation chart of Vijana site revealed that the site manager is the head of the site and he has a good team working with him. He has gang supervisors who were good on technical matters and he has safety teams who were good on risk assessment and communication. The interview revealed that there was good cooperation between the work teams. If there is a conflict between the safety team and gang supervisors, the site manager intervenes**.**

iii) Methods and tools

The methods and tools used for risk assessment and communication were based on the experience and educational background of the individuals. The individuals' attitudes and perception of risk are much more important than what is available in the literature. Thus the educational background and their experience on construction of site managers and safety teams was an important in consideration regards their employment.

The means of communication with the workers was the toolbox meetings (verbal communication). However sometimes the workers were too many and the voice of the speaker was too weak. However some posters and signs were used to supplement oral communication.

Regarding the work situation some mechanical aids and other work tools are used for a wide variety of purposes on construction sites. Some mechanical aids were specific for certain construction workers, whereas others were used by everyone. Most of the mechanical aids observed being used by construction workers allowed less manual material handling and the performance of work tasks in the correct posture.

7.7 Chapter Summary

The chapter discussed the current practice of health and safety risk assessment, communication and control at Vijana construction sites. The results indicate that the location and site size of vijana site was good enough and most of the activities took place during the day. Meanwhile risk was assessed based on experiences, educational background and existing regulations. Health and safety committee were main player of communication risk to the workers assisted by site managers. The main risk control were on using PPE and engineering control such as isolation of the hazards. Through observation it was revealed that workers were subjected less on manual handling with many mechanical aids were used.

CHAPTER EIGHT

FINDINGS FROM KALUTA CONSTRUCTION SITE

This chapter presents the results of the data collected from Kaluta construction site in Dar es Salaam, Tanzania. The results focused on the process of health and safety risk assessment and communication at the Kaluta construction site, and how legal factors, organisation factors, individual factors and the work environment influence the process. The results will be presented as discussed in the introduction party of the previous chapter, (chapter seven).

8.1 Description of the Project

The project site case study comprised the construction of a new house for a residential and commercial complex in Dar es Salaam city centre. The project is located along Morogoro road and Kaluta Street, plot number 60/ 61 and 62. The scope of work is construction of an eleven storey building comprising shops and offices on the ground floor and apartments on the upper floors which can accommodate 10 families. The client is private, and Design Bid Construct building procurement was used whereby the client employs a design team for the design, after which a contractor is allowed to tender for the work based on the design. The principal contractor is a local class three contractor, named Nordic Construction Company.

The project employed 200 hundred workers whereby 150 were unskilled and 50 were skilled. The project started in January 2011 and is expected to be finished by June 2012.The contract period is 16 months. The contract sum is Tosh 2, 000,000,000, equivalent to US$ 1,750,000. The main components of the buildings are concrete columns, slabs and beams, all cast in situ. At the time of collecting data, the building was at the frame stage, when the main activities were concrete columns, slabs and beams. The site is very confined, and so the building covers 97% of the plot, and there is no space for other facilities. Materials are placed outside the plot along the roads. The site is located at the junction of two busy streets. Figure 8.1indicates the Kaluta construction site.

Figure 8.1: Kuluta construction site

8.2 Actors involved in the Kaluta construction project.

The project has different actors, including the client, architect, structural engineer, quantity surveyor, contractor and sub-contractors (plumbing and electrical). All sub-contractors have a contract with the contractor and the contractual relationship is shown in Figures 8.2and 8.3.

Figure 8.2: Project actors in on the signed board

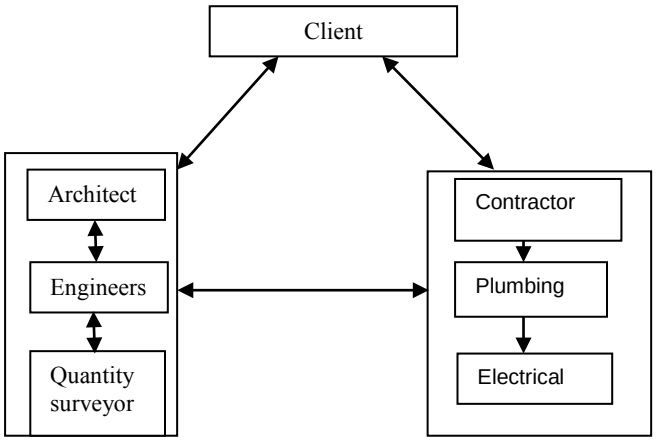

Figure 8.3; Actors involved in the construction project.

Figure 8.2 shows the sign board which indicates the actors of the Kaluta project site. Figure 8.3 indicates that the project level was held by the client, who employs the design team involving an Architect, Structural Engineer and Quantity Surveyor. Then client employs a contractor to offer construction services (as the mode of procurement was design, bid and build). Similarly the contractor has to employ sub-contractors (plumbing and electrical,) who have been approved by client.

On the contractor's sites, the site management organisational chart shows that the site is headed by the site manager assisted by the site foreman. Figure 8.4 indicates the site management on the construction site.

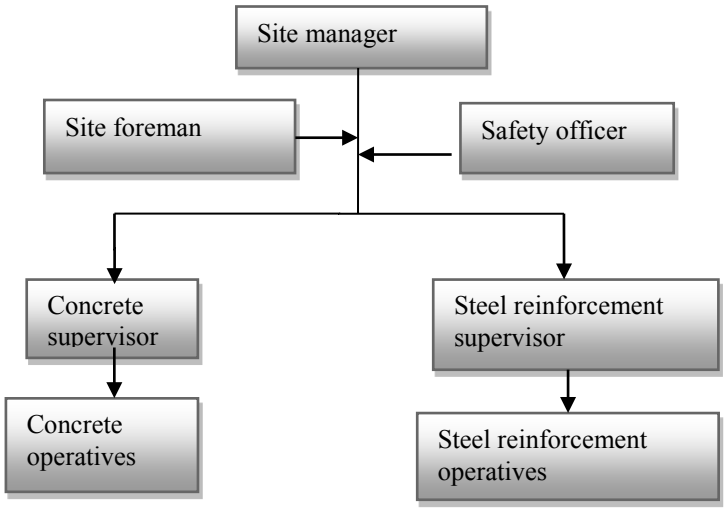

Figure 8.4: Organisational chart at Kaluta construction site

Figure 8.4 revealed that the site manager is the head of the site, assisted by the gang supervisor who works with the operatives. It was observed that the site organisation is not permanent as it changes according to the activities on the site. Gang supervisors were temporarily employed according to their task and only the site manager and foreman are employed permanently by the company.

8.3 Legal aspect of risk management at Kaluta site

It was observed that the site was registered by the CRB. Some inspection has been done by both CRB and OSHA. So far no fatal accidents on this site have been reported to the regulatory institutions. However the duties and responsibilities of the legal institution such as OSHA and CRB are discussed in section 7.3.

8.4 Organisational System of Risk Management at Kaluta Site

An interview was conducted with Nordic Construction Company to learn about its safety culture in terms of company policy, resource allocation and support given to the site management regarding risk assessment and communication. A semi-structured interview held with the Chief executive Officer took half an hour, was tape recorded and later transcribed. It was supplemented by some questions during explanation. The main topics discussed were as follows:

8.4.1 Company Policy and Responsibility for Health and Safety at Construction Site

The interviewer asked whether the company has a health and safety policy and found that it have informal policy. However, the company has a health safety officer/coordinator who is permanently employed and works with site managers on the sites to foresee any health and safety issues. At the company level it was revealed that all necessary health and safety welfare facilities and PPE are provided by head office.

8.4.2 Risk Assessment and Communication Process

Concerning whether the company has a risk assessment and communication system at its construction sites, it was revealed that there was no specific method or software used for risk assessment and communication, but responsibility for it is given to the site manager assisted by the safety officer. Employment of the site manager needed to take into consideration health and safety issues. Thus employment of the site manager and foremen takes into account their experience and educational background. Regarding communication with the site management, it was revealed that the site management and office communicate by phone in the case of any issue, and feedback is given at meetings.

Regarding the challenges faced by firms in implementing health and safety risk management, it was revealed that the site configuration was the main challenge. It was observed that the site is located at the junction of two busy streets, as he pointed out;

"*The nature of the site is a challenge. The site is so confined, located at the junction of intersecting roads where there is a lot of traffic. The site almost covers 97% of the plot. There is no place where you can put facilities such as toilets, resting rooms, meeting rooms and safety store. When you finish the ground floor, then you provide space for those facilities. Some of the activities such as concreting are done during the night, as you can't pour concrete during the day because of the heavy traffic along these streets*"[18]*.(B,3rd July 2011)*

Other challenges mentioned by the contractor were the stiff competition, funds and project variation during construction. He stressed that additional work during construction does not cover health and safety aspects as these are provided in the preliminaries. Some variation of the project requires extra investment in health and safety.

From the findings it is argued that, at the organization level, positive factors enhance health and safety risk assessment, communication and control on construction sites, such as employment of the site manager and safety officer. Meanwhile factors hindering the process of risk assessment and communication include site location, site configuration, funds,

[18] Discussion with Mr B, Director of the Nordic construction company on the challenges facing the firm in implementing health and safety risk management

procurement process, market forces and project variation. Figure 8.5 indicates the factors that enhance and hinder risk assessment, communication and control on construction sites.

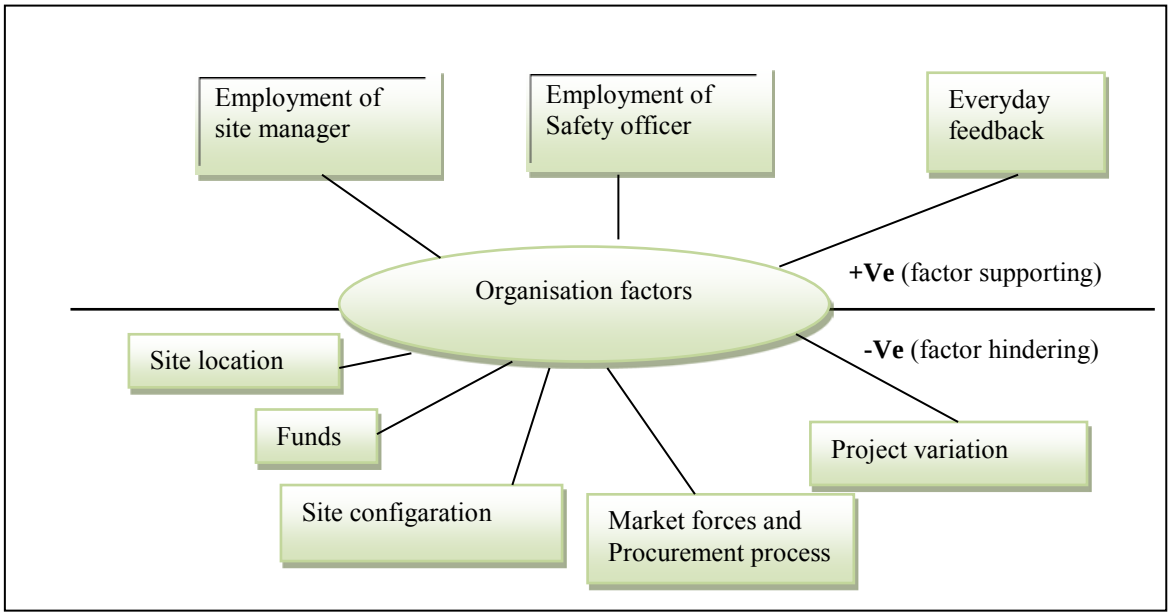

Figure 8.5: Factors which impact health and safety management on construction sites.

8.4.3 Interviews with Individuals on the Kaluta Construction Site

An Interview was conducted with individuals on the construction site, categorized into two groups as indicated in Table.8.1. For this part, questions put to the respondents focused on what is being done regarding risk identification, evaluation, estimation and communication, how it is being done and by whom. To open up the minds of the respondents, the questions were frequently reformulated during the interviews. Instead of only asking about risks, questions regarding 'what is your background education, experience and duties as a site manager and/or as a supervisor or as a safety team or as a worker, and some question related to how they are being responsible for health and safety and what are the challenges they are facing.

Table 8.1 Individuals who participated in the interviews

S/N	Individuals	Number	Methods
1	Site management team (manager and gang supervisors and safety officer)	1 site manager + 2 supervisors and safety officer	interview
2	Workers	5 steel reinforcement +10 concrete workers	interview

8.4.3.1: Site managers, gang supervisors and safety officer

i) Background and responsibility of the site management team

The interview revealed that the site manager has a civil engineering background and has 5 years' experience on construction sites. The site manager is in charge of all the activities on the site such as planning and scheduling the activities and coordinating different actors in the project, and he is assisted by gang supervisors. On the gang supervisor side it was revealed that they have primary education and vocational training. Their experience on construction sites varied between three and five years. Their responsibility was for site management where they supervise workers in their respective sections. The Safety officer has full technical education with formal training in health and safety given by OSHA and CRB. His responsibility is to work with site managers and gang supervisors on health and safety issues. However it was observed that the safety officer works on various construction sites at a time.

ii) ***The perception of health and safety risk management,***

The interview revealed that the site manager is very knowledgeable about health and safety risk management because of his experience as a site manager at different construction sites where he has been involved in safety management. Health and safety management was the one of the courses in his undergraduate degree. Through his experience as a site manager he has witnessed a number of accidents happening to his workers. He pointed out that no major accidents have happened on the current site, although minor injuries are common. On the gang supervisors' side, their perception of health and safety risks was moderate, as they have acquired safety information informally from different sites where they were working before. They admitted that they had witnessed accidents on construction sites. One safety officer has had formal training in health and safety, which has raised his awareness.

iii) Regarding how health and safety risks are assessed and communicated.

Health and safety management is coordinated by the site manager assisted by the safety officer and gang supervisors. Health and safety is embedded in the gang supervisors as they are required to communicate with workers on health and safety issues while they are issuing tasks and supervising them. As the safety officer is involved in various sites, he assists only when there is a pressing issue. Figure 8.6 represents the safety organisation at Kaluta site.

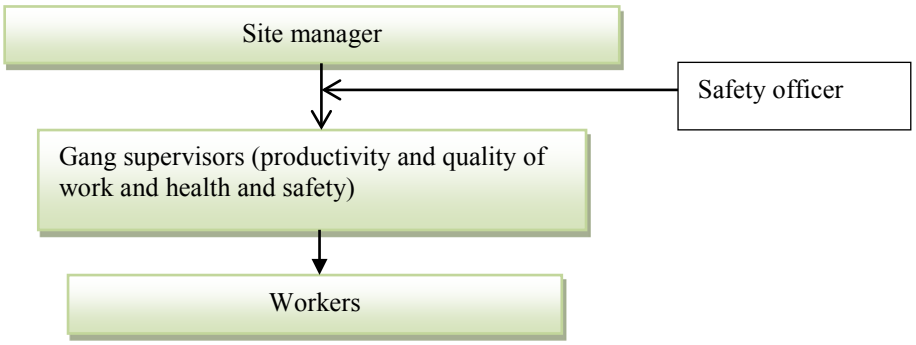

Figure 8.6: Health and safety organisation at Kaluta site

iv) Risk Assessment and Communication Process

Responses from the site manager revealed that he carried out hazard identification in his schedule work. He pointed out that before closing the site each day, the site manager and gang supervisors discuss the progress of the work and plan the following day's activities. In this discussion some potential hazards are identified and the control measure agreed on with gang supervisors. Identification is done through their experience and the provisions in the regulations.

A further discussion revealed that there was no formal communication on the health and safety of the workers, but it took place through individuals and gangs in face-to-face communication during the assignment of the tasks when the importance of wearing PPE was emphasised. This implies that communication was embedded in the production methods, which is an important aspect to consider. However, it was observed that there was very little communication on health and safety. The main focus was on work productivity and quality. Meanwhile, it was noted that the level of knowledge on health and safety of the gang supervisors was low as the majority had never undergone formal training, thus making interpretation of contract documents and health and safety law difficult. The result is a lack of understanding of many issues concerning the health and safety of workers.

Observing the communications much emphasis was placed on the wearing of PPE. The actual types of the health and safety risks on construction sites were missing in the communication. Manual handling hazards which were observed at the site were not communicated at all. Apart from individual meetings, there was no other form of communication such as posters and signs. This could be due to the site being so confined. However some red tape had been placed outside the plot to prevent pedestrians coming near the site. Furthermore, it was

observed that there was an accident and incident register book at the site, but no incident or accident had been documented. Figure 8.7 indicates the red tape outside the plot to protect pedestrians.

Figure 8.7: Red tape to protect pedestrians

v) Risk Control process

It was observed that there is no formal control mechanism other than that provided by the regulations. The wearing of PPE was depending on its availability. However gang supervisors were making sure that those provided with PPE were using it.

8.4.3.2 Interview with workers

The interview was conducted with workers from the concrete group and reinforcement group. These groups were selected because they were directly exposed to falling from a height and manual handling problems, the interview was conducted while they were working. Five workers from the steel reinforcement group and 10 workers from the concrete group were selected through convenience sampling.

i) Description of the work of different groups

Steel reinforcement group

The steel fixing gang consisting of 15 workers depends on the extent of the work. They position and secure steel bars, rods, or mesh in concrete form (on the columns, walls, beams and slabs). They use fasteners, rod-bending machines, blow torches and hand tools. They also space and fasten together rods according to the blueprint, using wire and pliers, they cut rods to the required length, using metal shears, hacksaws and bar cutters, they cut and fit wire

mesh or fabric, using hooked rods, and position fabric or mesh in concrete to reinforce it And they place blocks under rebar to lift the bars off the deck when reinforcing floors. Observing the Steel reinforcement group, they spent a lot of time bending at height and manually handling sharp equipment. Figures 8.8 and 8.9 represent the activities done by the steel reinforcement group.

Figure 8.8: Workers bending reinforced steel on the slab

Figure 8.9: Reinforced Steel waiting to be fixed.

Concreting work

This group involved 30 or 35 workers, depending on the activities on the site. They mix concrete, transporting it to the required walls, columns and slabs and compact the concrete. They are involved in carrying concrete and sand in buckets, bending when compacting, and carrying heavy loads manually such as cement bags. For this group it was observed that most of the tasks were done manually which require workers to be physically fit. Very few mechanical aids were used to assist the concreting process; hence workers were exposed to manual handling hazards. Figures 8.10 and 8.11 indicate the activities done by the concreting group. Furthermore, it was observed that concreting work is done during the night from 8.00pm to 3.00 a.m.

Figure 8.10: one of the workers pouring concrete at the column

Figure 8.11: one of the workers compacting concrete

ii) Workers' Background education, experience and perception of health and safety risks

From the interview it was revealed that all the workers had primary education and more than three years' experience on construction sites. Few of them they had received any formal training in how to do their job, such as concrete casting and reinforcement, but had acquired their skills informally on the site (on-the-job training). Regarding their perception of health and safety risks associated with their job, the workers said that they had never received formal training in health and safety but had received it informally at the sites from the safety officer, supervisors and co-workers. The steel reinforcement team cited falling, back pain and sharp cuts as their main risks, while the concrete group said chemicals, muscles pain and falling as their main risks. They have witnessed a number of accidents happening to their co-workers at different sites.

iii) Communication and corporation from gang supervisors

Regarding how they perceive the communication and cooperation of the gang and supervisors, the workers said that they received good cooperation from their supervisors regarding health and safety, especially the use of PPE. On further discussion they stated that they did not know all the hazards associated with their job and argued that they wanted to

know them all. However they explained that what was really communicated to them was the wearing of PPE.

iv) Why they do not want to wear PPE even if it is provided

It was observed that workers were not wearing a full set of PPE Some of them have only a hard hat and safety shoes, others have only a hard hat or safety shoes or did not wear any PPE at all. The reasons pointed out by workers were that PPE was not provided by the site management or that it was comfortable wearing PPE while working on their tasks. Figures 8.12 and 8.13 show the workers not wearing PPE.

Figure 8.12: concrete workers without PPE

Figure 8.13:Concrete workers without PPE

Giving the reason for not wearing PPE one of the workers from the concrete group said;

"*You know we can't work wearing a hard hat. We carry the concrete on our heads using a bucket. The hat is shaped in such a way that you can't put the bucket on it".....pause....*

"We are working tonight. All the offices are closed now (CRB and OSHA). Our boss does not provide PPE because no-one will inspect it. We have to work with this situation because we need money for our family"[19]

Another worker said;

"The activities are stressful. It requires a lot of energy and we sweat a lot. We work almost eight hours non-stop because we are required to finish this slab. We start at 8.00am and finish around 2.00.

[19] Discussion with Mr Y, explaining why workers do not want to wear PPE at Kaluta site on 6th July 2011

or 3.00pm.In this heat we need good respiration, and feeling energetic while we are working. That why some of as we are bare- chaste".[20]

8.5 Physical Work Environment

What was observed in the work environment was was the physical workplace, the teams, procedures, the space, and methods of risk assessment and communication.

8.5.1 Description of the physical workplace

Observation was made of the site layout which revealed that it was not well organised as there was no clear access or enough work space, which would contribute to workers being injured while doing their work. The site is so confined and most of the activities are done outside the boundary of the site. The site is located in a busy area, causing some activities to be done during the night. Most of the concrete work was done at night, which was observed to last from 8.00 pm to 2.00 am. The lighting is not good and no facilities could be seen on the site due to the confined space.

However, facilities such as sanitation were provided at another site. There was no place for a canteen, rest area or safe drinking water. Meanwhile there were no implemented and maintained safe housekeeping practices, such as safe and clear access to and from the site. It was observed that all construction materials such as sand and aggregate were stored outside the site, and there were an inadequate number of safety signs to enhance communication. Only a few tapes were used to prevent pedestrians from coming near the site.

8.5.2 Work team

As regards the site management organisation, it was observed that the site manager works with the site foreman and gang supervisors. The interview revealed that there was good cooperation among the working team.

8.5.3 Methods and tools

The methods and tools used for risk assessment and communication were based on experience and regulations. Educational background was not important as the majority of gang supervisors and workers had a low educational background. Observing the methods and tool for workers showed that only a few mechanical aids were provided. Workers in many situations were subjected to manual handling on concrete and reinforced steel.

[20] Discussion with Mr J a concrete worker explaining why they do not want to wear PPE, interviews on 6th July 2011

8.6 Chapter Summary

The chapter discussed the current practice of health and safety risk assessment, communication and control at Kaluta construction sites. The results indicate that kaluta site is located on a very busy street with the building covered 97% of the plot size. This situation causing some activities to be done during the night as the same time there was no clear access or enough work space, which would contribute to workers being injured while doing their work. Meanwhile risk was assessed based on experiences and existing regulations. Gang supervisors were main player of communication risk to the workers assisted by site managers. Thus risk communication was embedded on construction production process. The main risk control was only on using PPE. Through observation it was revealed that workers were subjected to more manual handling with very few mechanical aids.

CHAPTER NINE

GENERAL DISCUSSION OF THE FINDINGS

This section presents a general discussion of the findings. The chapter starts by providing a cross-case analysis of the Vijana and Kaluta sites. It systematically compares the two cases based on the research variables investigated in the two cases. The findings are then discussed according to the specific objectives.

9.1 Cross-Case Analysis

There are both similarities and differences between the Vijana site (case 1) and the Kaluta site (case 2). The essence of this section is to identify the main differences in order to substantiate the preposition that legal factors, organisational factors, individual factors and the work environment have impact on health and safety risk management on construction sites. The variations that exist between the two construction sites provide new insights into how health and safety risks are managed at different sites. Table 9.1 compares the research variables in the matrix format to make explanations more accessible.

Table 9.1: Cross case analysis of the Vijana and Kaluta construction site

	Variables	**Vijana site**	**Kaluta site**
1	Nature of the project	Commercial and residential building comprising of 26 storeys. Employs 600 workers	Commercial and residential building comprising eleven (11) storeys Employs 300 workers
2	Risk Assessment process	Done by Site manager through safety committee. Used Individual judgement based on experience, educational background, knowledge of health and safety risks, and regulations.	Done by Site manager through gang supervisors. Used Individual judgement based on experience, knowledge on health and safety and regulations.
3	Risk Communication	Verbally for all workers through toolbox meeting, written through posters and signs	Verbally, informally in individual groups (gangs)
4	Risk Control process	Use of PPE, Engineering control system.	The use of PPE
5	**Legal system**		
	Registration	registered with CRB and OSHA	Registered with CRB
	Control mechanism	Regular inspections, Fine and penalty Tsh.600,000 Five fatal accidents.	Inspections, No fines, no fatal accidents

6	**Organisation system**		
	Health and safety policy	Existence of formal health and safety policy. Health and safety coordinators were employed.	Existence of informal policy. Health and safety officer was employed.
	Management styles	Coordination through • Site managers, • Safety coordinators, • Safety committee	Coordination through • Site managers • Safety officer. • Gang supervisors
	Resource allocation	Provide all PPE and facilities including lunch	Provide few PPE and facilities
	Challenges on implementing Health and safety management	• Funds, • Procurement system, • Market forces, • Design complexity.	• Funds, • Site location and configuration, • Project variations, • Procurement system, • Market pressure.
7	**Individuals**	Site manager, foreman, gang supervisors, safety committee, subcontractors, operatives	Site manager, safety officer, gang supervisors and operatives
	Education background	High level of education of site management (e.g. site manager), Medium level of education e.g. gang supervisors, safety committee team), Low level of education for operatives	High level of education of site manager, Low level of education (e.g. foremen, gang supervisors and operatives)
	Experience	Much experience	Much experience
8	**Work environment**		
	Site organisation	Well organised with all welfare facilities provided	Confined site with no provision of welfare facilities
	Working methods	Few mechanical tools were used for transporting concrete	Concreting and reinforcement activities were done manually, Concrete was transported with bucket on head
	Work team	Site manager, safety committee and gang supervisors	Site manager and gang supervisors
	Physical space	Enough working space	Very confined, no area for meeting, posters, storage of materials.

Having analysed the two case studies, some salient points emerge. It is apparent that companies surveyed are trying to manage health and safety risk using their own methodology. While case one used safety committee team, case two used gang supervisors in

communicating health and safety risks. However, individual judgement based on experience and regulation on risk assessment was found common to the two sites. Meanwhile the nature of the two sites is different in terms of size, location and site configuration, number of employees and stage of the project. Some of the issues pointed out at the Table 9.1 are discussed in a following section, section 9.2

9.2 Discussion of the Findings

The discussions of the findings are presented according to the specific objectives.

9.2.1 The nature of health and safety risk on Tanzanian construction sites

The finding from the pilot study presents the most common health and safety hazards, its consequences and their cause at construction sites. The hazards include working at a height, falling objects, poor housekeeping, manual handling, chemicals, dust, noise, bullying and stress. Based on the perception of site managers, gang supervisors and workers of those hazards consequence, it was revealed that falling from a height and back pain, arm and muscle pain due to manual handling are among the most noted critical hazards. The findings are in line with the argument (Chan *et a*l 2008, Yung, 2009) that falling from a height kills more workers on construction sites than other accidents. Furthermore, manual handling, which causes muscular disorder, back injury and muscle pains due to manual handling, has been ranked high in various literatures (Rwanamana, 2007, Smallwood, 2008). Regarding the cause of accidents, it was observed that ignorance, attitudes and carelessness are the main causes of accidents and ill- health problems on Tanzanian construction sites.

9.2.2 Methods and techniques used for health and safety risk assessment, risk communication and risk control on Tanzania construction sites.

Risk Assessment

The findings in this study revealed that risk assessment on construction sites is coordinated by site managers through the safety committee or gang supervisors. Hazards are established either from the programme (work schedule) or the daily physical environment (work done on the sites). Furthermore, it was observed that brainstorming based on experience and educational background is used to judge the level of risk. This implies that risks are assessed through individual judgement guided by regulations, without any help from numerical judgement or any other tool or technique. Meanwhile, there is no clear demarcation between

risk estimation and risk evaluation. The findings are in line with Simu, (2007) on risk management in construction projects. She found out that theoretical risk assessment is not done in practice. Individual judgement based on experience was used for risk management. However, this study argues that both individual judgement based on experience and guided by regulations are critical for risk management.

The findings also revealed that risk assessment and communication are carried out only during the construction phase. All responsibility on risk management is with the contractor, and thus no risk assessment is done during the design or procurement stages. The finding is contrary to Mohamed (2004) who argued that the principle on which safety management is based, is that all project participants (clients, designers, sub-contractors, contractors) are included in considering safety systematically, stage-by-stage at the outset of the project. From the system thinking perspective on the construction project, it is argued that each phase of construction projects contribute to health and safety hazards. Meanwhile design and procurement have been argued to be the root cause of accidents in construction sites (Behn, 2005; Smallwood 2008; Well, 2007).

In line with this argument, the chief executive officer of the companies of the two case studies (Vijana and Kaluta) claims that complexity of the design, site configuration and the competitive procurement market are the challenges facing them with regard to managing health and safety. This finding revealed that the procurement system, whereby the lowest tender and stiff competition has led to health and safety provision being ignored, has been a challenge for contractors to invest in health and safety. Furthermore, the finding show that the health and safety section in the preliminaries in the tender documents has provided a sum, which does not show details of the issues contractors have to consider in pricing health and safety. At the same time in the tender evaluation process, health and safety provision was not considered as a criterion for awarding contracts, which have provided room for contractors not to be serious about the provision of health and safety during tendering.

This study therefore argues that it is important to consider health and safety risk management in the design, procurement and construction phases of construction projects. Some authors have stressed the importance of incorporating risk management in both the design (Behn, 2005; Mroszczyk, 2006, Smallwood 2008) and procurement phases (Well, 2007). They argued that addressing construction safety in the design and procurement phases could

therefore have a substantial impact on reducing injuries and the costs associated with safety-related delays in projects.

Meanwhile, the experience of the construction industry in different countries has shown the importance of including risk assessment in both phases, whereby they have specific regulations which require that risk assessment is done in the design and construction phases (Construction Design and Management Regulations, 1994 to CDM 2007) and South Africa construction regulation of 2003 (Deeks, 2005**),** Swedish construction industry with (BASS U and BASS P) (Work environment act 2010)

Risk Communication Methods

The finding from the two sites implies that verbal formal communication such as toolbox meetings and formal discussions, informal communication such as informal discussions, written communication such as posters, images and letters were used for communication of health and safety risks in construction industry in Tanzania. Toolbox meetings, posters and images/signs were used at Vijana site while informal discussions were used at Kaluta site. Furthermore, safety committee team mode of communication was effectively practised at Vijana site while at Kaluta it was through gang supervisors. Based on the methods of health and safety risk communication, it is argued that although various methods were used, toolbox meetings were observed to cover a wide range of workers and to establish a common understanding. Discussing with workers, toolbox meetings were greatly appreciated at the Vijana site, while at the Kaluta site informal verbal communication was not appreciated. At the Kaluta site, gang supervisors communicated informally with their workers in the respective areas.

Furthermore, there was little appreciation by the workers of images and posters as a method of communication, as some workers claimed that they did not know how to read while others claimed that they did not understand the meaning of the images/signs. This was revealed when the safety committee members complained about workers removing some of the red tape from respective areas. At the Kaluta site there were no posters or signs specifically directed at the workers. The finding was contrary to Bust et al, (2008), who suggested that images evoke deeper elements of human consciousness than words do. However, Johnson et al (1988) studied the effectiveness of qualitative (verbal) versus quantitative (both verbal and numerical) formats. They concluded that no single format was found to be unequivocally the

best, and the preferred format appears to vary depending on whether the purpose of the risk communication effort is to educate, to affect risk perceptions, or to motivate people to take appropriate action. The present study shows that both formal and informal verbal methods, posters and images were used to communicate health and safety risks in the construction industry in Tanzania.

The study also revealed that communication was embedded in the production methods at the Kaluta site while at the Vijana site it was not. At the Vijana site there was a clear separation of responsibilities between gang supervisors and the safety committee for communicating with workers. While the safety team communicated health and safety issues to the workers, gang supervisors have to communicate quality and productivity to the workers. This separation sometimes creates conflicts as supervisors seem to focus more on production and ignore health and safety aspects. In some cases, supervisors allow workers to work without any PPE. Power relations were observed as workers followed to what the supervisor told them rather than what the safety committee. Power relations and conflict were observed to bring challenges to managing health and safety risks in this study.

The issue of conflicts and power relations have been pointed out by different authors on risk communication (Morrow, 2009; Heath, 2010). Moreover, trust was observed to be an important aspect regarding risk communication. An environment of trust and close relations was observed on different groups at the Vijana site. The scaffolding team were free to explain their daily situation to the safety team and supervisors. Thus trust was observed to provide room for workers to participate in health and safety risk communication. The finding is in the same argument by Doboi (2009) that the active participation of site workers in health and safety induction meetings depends on the working relations that exist between the owner/manager and his employee.

Meanwhile, the finding reveals that safety committees and gang supervisors play a major role in educating workers in health and safety issues. The majority of workers have had no formal education and so they have learnt about health and safety from their safety committee, safety officer and gang supervisors. The finding is contrary to Michael et al (2006) that safety-related communication between supervisors and subordinates had insignificant direct effect on workers' safety-related events. However, this study argues that the quality of safety committee members and gang supervisors is important in terms of knowing about health and

safety risks and having communication skills. This study observed that the safety committee members at Vijana site had only secondary education with formal health and safety training, while at the Kaluta site; gang supervisors had primary education with informal training. The communication theory provides that the characteristics of the communicator (sender) are a major factor in conveying a message to the audience (worker).

Risk Control Methods

The findings reveal that at the Vijana site, the consequences of falling from a height was controlled by wearing personal protective equipment (PPE) such as a safety harness, hard hat, and safety boots. Futhermore, hazards were isolated, such as holes and edges of walls were barricaded with hand rails or safety mesh. Meanwhile formal communication through toolbox meetings was used to change workers' behaviour/attitudes to the correct safety system. Some penalties such as a warning letter and dismissed from sites were issued to workers to make sure they adhered to the safety rules. Manual handling was controlled by using mechanical aids such as a wheelbarrow, pipe to transport concrete, compacting machine and lifts. Falling from a height at Kaluga was controlled by workers wearing PPE such as a safety harness, hard cap and safety shoes. Very little isolation of the hazards and engineering control was observed. On the aspect of manual handling, little was observed as most of the activities were done manually. Concrete was transported on the head using a bucket.

Observing the two sites, they clearly portray differences in the control mechanisms of risks practice, possibly due to the different nature of the two sites in terms of size, location, site configuration and stage of the project. Kaluga site was not so complex; it had 11 storeys, was confined with no space for meetings and material storage. The building was at the second floor stage during data collection and so the height was not as great as at the Vijana site, which had twenty six floors, was complex, had enough space, and employed approximately 600 workers.

The findings from the study show that although different methods were used to control risk, PPE was mainly used method. Following the hierarchy of risk control, PPE was the first to be considered. This could be due to the fact that risk is assessed during construction, when the design and specification of materials has been done. Although PPE is the main risk control measure some challenges were observed in using them. While several workers were provided with incomplete sets of PPE others were not provided at all. Another surprising finding was

that several of those who were provided with sets of PPE were not wearing them, the reasons being discomfort, weather and work pressure as mentioned by the interviewees.

In the researcher's view, PPE should be provided to suit the climatic conditions of certain contexts. Meanwhile, the pressure of the work and pressure from supervisors seems to have an effect on compliance with health and safety risk regulations.

9.2.3 Factors influencing risk assessment, communication and control in construction projects

i) Institutional legal administrations.

In this study it was observed that regulations are the basis of risk assessment, communication and control at construction sites. Working at height has been pointed out by the regulations and the mechanism to control them such as scaffolding should be properly erected, all edges and holes should be barricaded and a safety harness should be provided for workers working at a height. Furthermore, the two Acts, OSHA act 2003 and CRB act 2010, have set the provisions which the industry has to follow as well as the normative. The importance of each site being boarded, the necessity of employers providing PPE and the importance of employers communicating health and safety risks to workers are well established by the regulations. Some authors have provided similar findings, as risks are managed by following regulations and contracts (Rawlinson 2008; Khan, 2007).

Meanwhile regular inspection, penalties and compliance certificates issued by legal institutions were observed to be critical in enforcing compliance with the regulations. The findings are in agreement with Rowlison and Lingard, (2005) that strong regulations, strict implementation of inspections and fines high enough to deter potential abusers of health and safety law are vital. The current study provides evidence to support this that fines and other punitive measures for breaking health and safety laws compel employers through site managers to proactively manage health and safety for fear of being penalised or exposed. As observed by this study, there was no adherence to regulations when there were no inspections, especially when pouring concrete during the night.

The lack of sufficient funds and personnel to effectively carry out their functions was claimed as a challenge facing legal institutions managing health and safety risks. It was observed that

the inspection process overlapped as both OSHA and CRB did their inspections separately while observing the same thing. This process sometimes brings confusion to the construction sites. It is argued by this study that there could be a joint effort for legal institutions to manage health and safety risk management.

Furthermore, since regulations were the basis for risk assessment and communication, it was observed that some of the hazards were not well provided for. For example, manual handling hazards are less provided for in the regulations, especially regarding assessment and communication. Discussing with inspectors whether they inspect manual handling it was revealed that manual handling hazards were not clearly inspected. Meanwhile in the accident and incident registration book there are no issues related to health. The focus seems to be on dealing with the immediate impact (acute accident), leaving those which have a slow impact not regulated. The majority workers complained about back injury and muscle pain (the survey from chapter six), ranked as the second risk, but the regulations are silent about the control measure. Even though the act makes it necessary for the employer to conduct pre-placement and periodic and exit medical examinations, there was no evidence that these had been conducted. There is need for regulations to put greater stress on slow acute accidents and health issues.

ii) Organizational factors for risk management

In this study it was observed that the two firms (Estim and Nordic Construction Company) have a health and safety policy, which shows some commitment to managing health and safety risks at their construction sites. The firms have either two safety coordinators or safety officers who were permanently employed by them and they work with site managers. It was observed that all welfare facilities, such as safe drinking water, canteen and clothing areas and all required PPE were provided by the organisation (head office). Vijana site provides free lunch for all workers as the motivation to be more productive and conscientious. Meanwhile, the management of health and safety risk was considered when employing site managers, as the organizational policy states that a site manager needs to have had a good education (degree relating to construction), a lot of experience and a knowledge of health and safety issues. At the same time the employment of the safety committee and safety officer was considered important for managing health and safety risks. Thus the safety committee members in addition to construction experience needed to have received formal training in

health and safety. As the company they have daily feedback from the sites and they attend monthly site meetings with clients and other stakeholders.

The results concurred with Reason (1997) that an organisation handles safety in different ways depending on its organisational culture. Organisations that have a commitment culture, such as a health and safety policy, can provide enough resources and good communication, hence having the potential to manage health and safety risks.

iii) Characteristics of Individuals Working on the Construction Sites

Educational Background of individuals

The educational background of individuals on construction sites varied from no academic qualification to master's degree. Site managers were observed to have the highest education level (university degree) while gang supervisors and safety officers had technical education, secondary education and primary education. Most workers had primary education with informal on-the-job training. As pointed out by many workers, they had not received any formal education in their specialised task, and so they had acquired their skills informally on the sites. Informal training is a common form of training within construction sites. However, many trainees do not complete their apprenticeships before becoming tradesmen on the site. This curtailment of the length required for trainees to become fully competent has negative consequences for health and safety on construction sites. From this finding it could asked to what extent informal/ on-the-job training covers the aspect of health and safety on construction sites.

Different researchers have pointed out the impact of education level on health and safety risk management. Khan (2007) observed that employers with a low level of education found it difficult to interpret contract documents and health and safety laws. This therefore leads to a poor understanding of many issues concerning the health and safety of workers. Phoya *et al* (2011) on the study on the perception of risk of site managers and workers at construction sites in Tanzania observed that those with higher education are more aware of health and safety risks than those with a low level of education. Meanwhile, the levels of education have been argued to have an impact on poverty and hence health and safety risk management. Thus with a low level of education, there is a very narrow opportunity of getting a job, and so a greater chance of being poor. High poverty levels compel workers to accept work in

unacceptably high risky situations without complaining or demanding that their employers put in place health and safety measures (Khan, 2007).

Furthermore, communication and training in health and safety was related to the level of education. In this study it was noted that workers with a minimum education level found it difficult to grasp what was being communicated. The same argument was supported by Koehn et al. (2000) who stressed that a key barrier to health and safety management was the difficulty in training illiterate workers. As observed in this study, the majority of workers had never received formal training in health and safety. Toolbox meetings have enriched their understanding of health and safety risks on construction sites**.** From this perspective, the toolbox meeting was the main educational tool for health and safety for workers and gang supervisors. As most workers had a low education level, how to design effect toolbox meetings and posters to accommodate all the health and safety hazards and the literacy level could be investigated further.

Individual's experiences.

The findings from this study show that experience was the basis for risk assessment, communication and control. For site managers, gang supervisors, safety committee and workers, experience was critical for identifying risks, judging the level of risk and making decisions on control measures. Experience has been pointed out as making a major contribution to the perception of risk (Phoya et al 2011). However, there are opposing arguments on experience in the literature. Some authors argue that with more experience, the chance of being exposed to different risks is higher, and so there is more consciousness and awareness (Phoya et al, 2011), while others argue that when workers have more experience they tend be over-confident and neglect the health and safety issues (Irizary, 2006 ; Che Hassan et al, 2007).

The findings are in line with Phoya et al (2011), who revealed that respondents with more experience were more conscious of risk than those with little experience. Meanwhile, Ali (2006) found that a perception of higher risk was associated with labouring experience. However, the finding from this study is contrary to the study done by Che Hassan et al, (2007), where respondents with more experience rated risk *low* due to the fact that they had developed confidence, having worked for a long time in risky situations. In the same lines, Maytorena et al. (2007) found that experienced project managers' approach to risk scenarios

was less questioning and more reliant on procedures than that of novice managers in the same situation. Furthermore, Brehmer (1980) commented that trusting experience for the purpose of judgement and decision was not well founded when it comes to the ability to make better judgements and decisions. Brehmer suggested that, in order to obtain value from experience, one has to be able to learn from experience.

This finding about experience and the apparently contradictory reliance on it in construction gives a greater understanding about the essence of experience and its relationship to judgements, communication and control of health and safety risks and how one can learn from experience.

Individuals' perception of health and safety risks and general Views on why accidents happen on the site

The perception of falling from a height and manual handling by individuals at construction sites was high, especially falling from a height. Most groups acknowledged that they knew the risk of height as they have witnessed some co-workers falling from a height, some of whom died on the spot, and others were permanently disabled. The experience of accidents has raised workers' awareness of the risks of their tasks. On manual handling, perception was not high among workers although they complained about back injury and muscle pain. This was also observed during the toolbox meeting as how workers can work in a safe manner, or handle loads in a safe manner was not emphasised at all. The perception of supervisors and site managers was that the level of manual handling was high. Where differences exist in the perception of risk, it is suggested that there should be more communication to bridge such a gap between supervisors and workers. The argument pointed out by this study is that workers who misjudge risk could have a higher probability of injury from accidents.

Regarding why accidents happen on construction sites, the blame culture was clearly seen among the groups. The site manager blames workers and sub-contractors who do not want to adhere to the health and safety rules; the safety team blames workers and gang supervisors as the cause of accidents on construction sites. Workers put the blame on their supervisors who put a lot of pressure on them, thus wearing PPE limits their speed of working. Workers blame the site management as they do not have enough PPE as in some sections workers have only one piece of PPE, mostly a safety hat. The blame culture has been stressed by different authors (HSE, 2008). No-one wants to be accountable for being the cause of accidents and ill-health problems.

i) Work environment

Work team

Regarding the site management organisation, it was observed that the site manager works with the site foreman and gang supervisors. From the interview it was revealed that there was good cooperation between the working teams.

Methods and tools

The methods and tools used for risk assessment and communication were based on experience and regulations. Educational background was not important as the majority of gang supervisors and workers had a low level of education. Observing the methods and tool for workers revealed that only a few mechanical aids were provided. Workers in many situations were subjected to manual handling on concrete and reinforced steel.

Nature of the project

Big and complex projects involved a lot of expertise and hence greater risk management.

Nature of the risk

Risks with immediate impact are managed better than slow/long-term impact risks.

9.3 Findings Summary (closing the loop)

Figure 9.1 present the summary of findings, which show that risk management is based on risk assessment, risk communication and risk control at construction sites. The results from the different research questions are combined and show the real picture of risk management on Tanzanian construction sites. The summary shows that many of the practitioners on construction sites, such as site manager, gang supervisors and safety committee members, use a checklist and brainstorming to assess risk. They also use different methods to communicate risk, which include formal verbal communication such as toolbox meetings and site meetings, informal verbal communication, posters and signs/images. To control risk, they use PPE and isolate hazards. However, the conclusion of this thesis is the importance of individuals in managing health and safety risks. It is the individual judgments that determine the results of the risk management system, based on experience, the regulatory system and educational background. The responsibility of individual in the projects as more workers, no link of design and construction,

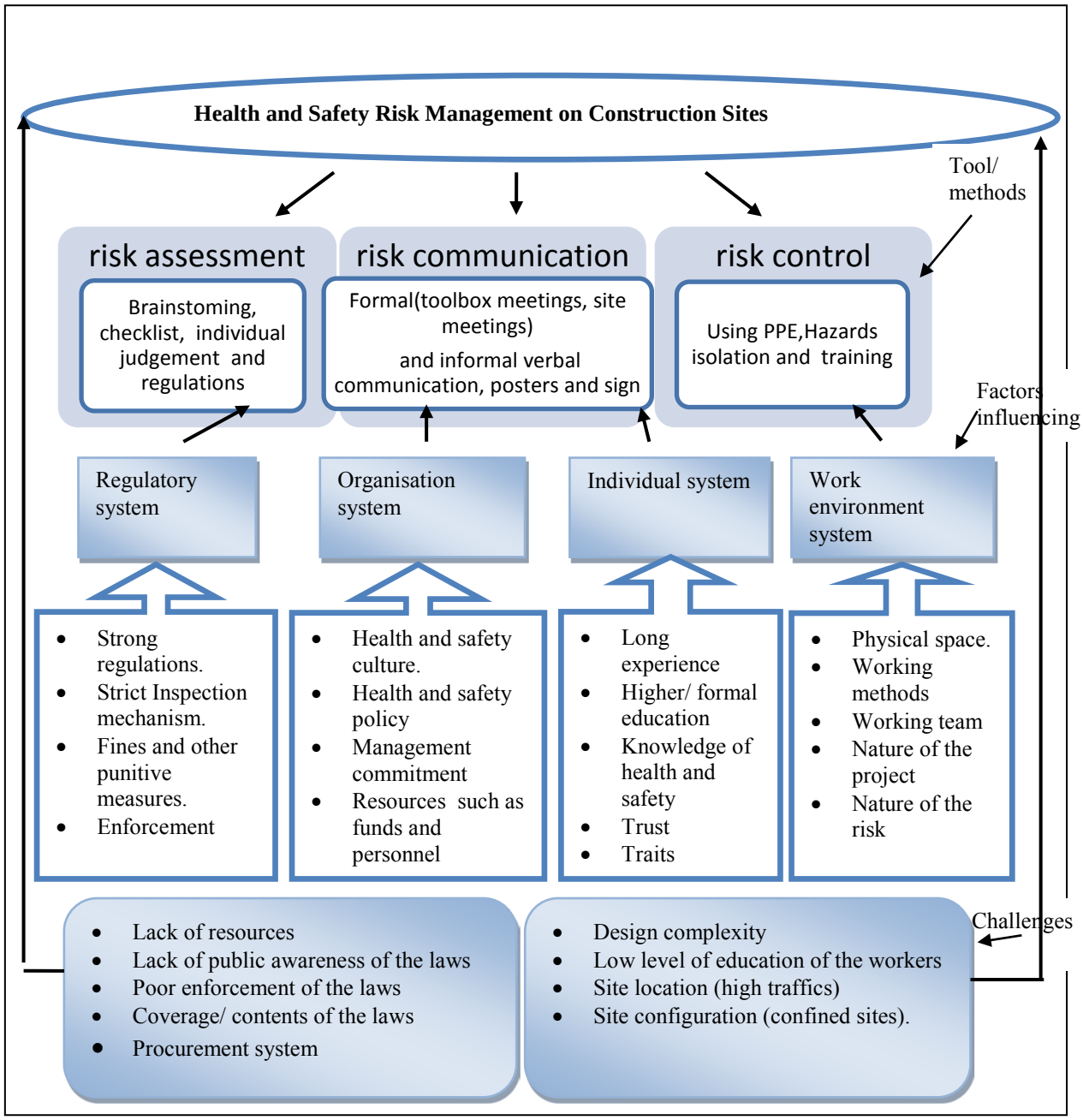

Figure 9.1:Health and safety risk management at Tanzania construction sites (Source; Authors's view)

9.4 Chapter Summary

Cross-case analysis and the general findings have been discussed in this chapter. On comparing the findings from the two cases, this study found that health and safety risk assessment was based more on individual judgement, experience and regulations. However, the study found that there were variations in terms of risk communication and risk control. It was observed that there was more formal risk communication and risk control in case one than in case two. The next Chapter provides general Conclusions, Recommendations and areas for further studies.

CHAPTER TEN

CONCLUSIONS AND RECOMMENDATIONS

This Chapter presents general conclusions and recommendations of this study, along with an implication of its major findings. The area for further research is also highlighted at the end of this Chapter.

10.1 Conclusions

This study aimed to ascertain the current practice of health and safety risk management on Tanzanian construction sites, focusing on risk assessment, risk communication and risk control. In pursuing this objective, the case study strategy was adopted, with a holistic view of health and safety risk assessment, risk communication and risk control on construction sites.

The study revealed that the responsibility for construction site health and safety lies with the main contractor, resulting in many designers, consultants and clients absolving themselves from responsibility if accidents occur on the site. The active participation of clients and design teams in the built environment in health and safety matters in Tanzania is yet to be realised. Meanwhile an appropriate procurement practice that promotes the adoption of good health and safety risk management is an issue.

The study also revealed that no systematic methods were used, but risk was assessed by brainstorming, checklists and health and safety regulations. Judgement of risk was based on individual judgement assisted by experience, educational background and knowledge of health and safety regulations. Working at height and manual handling observed to be most critical hazards in Tanzania construction sites.

Based on methods used to communicate risk at construction sites, it was revealed that toolbox meetings, site meetings, posters and informal verbal communication are used to communicate risk. It was also revealed that safety committees and gang supervisors play a major role in communicating health and safety risks. However the issue of power relations and conflicts was observed when there is a clear separation between health and safety communication and quality and productivity. The study also reveals that PPE is the main item used for risk control. However, there was not enough PPE on the sites and, comfort, the weather and work pressure were mentioned by workers as reasons for not wearing PPE.

Based on factors influencing risk management, the study reveals that legal system plays a major role in risk assessment, communication and control. The regulations provide for some hazards such as falling from a height and control mechanisms. They also require that health and safety risk to be communicated to workers and that PPE be provided for workers. Regular inspections, penalties and compliance certificates issued by regulatory institutions influence risk management more.

Furthermore, the organisational culture of safety is another factor influencing risk management. It is observed that construction firms with a safety culture considered health and safety when employing the site manager, the safety coordinator and safety officer. Knowledge of health and safety is a criterion for employment. Meanwhile firms with a safety culture provide resources for site workers, such as PPE and training.

Additionally, individual characteristics such as experience of those working on construction sites, their educational background and knowledge of health and safety matters also influence health and safety risk management. It was observed that risks were assessed based on experience and educational background. Furthermore, the study revealed that the work environment such as site layout and location, the nature and the size of the project, working methods and working team influence health and safety risk management.

The study also provides factors hindering health and safety risk management in construction sites. The factors include the low level of public awareness of regulations, lack of resources such as personnel and funds, coverage of the regulations, complexity of design, the procurement system, the low level of education, site configuration, and location. An important contribution from this study is that one cannot rely and be dependent on risk management systems as applied in construction sites in Tanzania. There is a need for a systematic approach and a wider perspective that includes individual's judgement, while at the same time an holistic approach which consider all project phases such as design, procurement and construction.

10.2 Recommendations

10.2.1 Implication for Policy, Regulatory System and Industry

The findings of this study show that regulations and laws have been the basis for risk assessment, risk communication and risk control. Thus the regulations guide the risk management process. Based on existing regulations, it was observed that only a few safety

hazards such as height, chemicals and fire have been provided for; little attention has been given to health hazards which have a slow impact, such as manual handling and ergonomic hazards. The study therefore recommends the inclusion of provisions in the regulations on manual handling and other slow/long-term impact hazards. Some codes of practice on manual handling could therefore be included in the health and safety policy.

Furthermore the study revealed that the responsibility for construction site health and safety lies with the main contractor, resulting in many designers, consultants and clients absolving themselves from responsibility if accidents occur on the site. The active participation of clients and design teams in the built environment in health and safety matters in the country is yet to be realised. Meanwhile an appropriate procurement practice that promotes the adoption of good health and safety risk management is an issue. Presently, competitive tendering and the practice of awarding contracts to the lowest bidder act as a disincentive to proactive health and safety management by construction firms. Some of the challenges mentioned hindering risk management are design complexity, site configuration and location, the procurement system and lack of funds and personnel these challenges could be addressed by incorporating the designer, consultant, client and contractor in the design, procurement and construction stages. It is therefore recommended that OSHA's policy and procurement regulations should incorporate this recommendation.

Furthermore the study found that there is an overlapping of health and safety risk management at the regulatory institutions of OSHA and CRB, which sometimes creates confusion for practitioners on construction sites concerning which regulations they have to follow. The study recommends finding a way to harmonize risk management and the regulatory system and increase the enforcement.

10.2.2 Implication for the Organisations

The findings of this study revealed that an organisation and individuals within it have the potential to influence risk assessment, communication and control. It is the individual who has experience, knowledge of health and safety matters and knowledge of the existing health and safety regulations. Companies that wish to use and benefit from risk management should first start to educate their staff in risk management. They should also include more in the educational package, and develop experiences to the workers through training, regular toolbox meetings. They should talk to individuals using the existing way to manage and control

projects, and develop those methods. Suggesting an improvement in the traditional way of controlling projects emphasizes the importance of a systematic approach.

10.2.3 Implication for the Professionals concerned with Project Management

Professionals such as Architects, Engineers and Quantity Surveyors are involved in construction project management as indicated in Figure 2.1. They offer a consultation services to construction projects in term of design, contract administration and supervisions. These consultants need to demonstrate commitment by resolving health and safety issues affecting projects. Well-designed projects incorporating health and safety aspects and effective supervision should be the cornerstone of the ethics of project consultants.

Since risk management is part of construction project management, consultants need to conduct risks analysis and method statements for all projects at the design phase. The use of extremely hazardous materials and construction methods that pose uncontrollable and unacceptably high risks to workers and other persons has no room in the future of the construction industry of Tanzania. The awarding of contracts needs to take account of the performance of contractors in terms of quality of the work executed, quality of management and health and safety; only in this way will there be a positive change in the attitudes of many non-performing Tanzanian construction firms. As the findings of this study revealed that there is no systematic method for health and safety risk management in Tanzania but rather it is based on individual judgement, experience, educational background and existing regulations, it is important for consultants to acquire health and safety knowledge in their professional development. It is important that training institution review their curriculum to incorporate more issues that affect health and safety in developing professionals in construction industry.

10.3 Recommendations for Future Research.

- The findings from this study provide that the responsibility for construction site health and safety lies with the main contractor, resulting in the situation that many designers, consultants and clients absolv themselves from responsibility if accidents occur on the site. The active participation of clients and design teams in the built environment in health and safety matters in the country is yet to be realised. Meanwhile an appropriate procurement practice that promotes the adoption of good health and safety risk management is an issue. While some of the challenges mention by site managers on

risk management such as design complex, site configuration, site location and procurement system cannot be addressed only by a contractor, the need for a corporation of those who are involved in the project in design and procurement is necessary. A study on how design, procurement and construction teams could be incorporated to manage health and safety risks could be important area for further research.

- The findings showed that risk management is dependent on individual judgement based on experience, educational background and regulations. The study on developing a systematic approach including individual judgement could be appropriate.

REFERENCES

Ali, H.T., (2006). Influence of National Culture on Construction Safety Climate in Pakistan. *Doctorial Thesis,* Griffith University.

Aneziris, O.N., Papazoglou, I.A. and Kallianiotis, D. (2010). Occupational Risk of Tunnelling Construction. *Journal of Safety Science* 48, 964–972.

Aneziris, O.N., Papazoglou, I.A., Baksteen, H., Mud, M., Ale, B.J.,Bellamy, L.J., Hale, A.R., Bloemhoff, A., Post, J.,and Oh, J., (2009). Quantified Risk Assessment for fall from Height. *Journal of Safety Science* 46 (2), 198–220.

Andersson, R. (1999). Injury Causation, Injury Prevention and Safety Promotion – Definitions and Related Analytical Frameworks. In: *Safety Promotion Research, Laflamme, L., Svanström, L. and Schelp, L*. (Eds.) 15-42. Karolinska Institutet, Stockholm.

Argent, P and Forman, J. (2002). *The Power of Corporate Communication: Crafting the Voice and Image of Your Business*, McGraw-Hill, New York.

Ayyub, B. M. (2003). *Risk analysis in Engineering and Economics*. Chapman & Hall/CRC.

Badenhorst, C.T. (2004). Occupational Health Risk Assessment: Central to the Management of Occupational Health. *International Platinum Conference 'Platinum Adding Value*. The South African Institute of Mining and Metallurgy, 2004.

Baradan, S. and Usmen, M.A. (2006). Comparative Injury and Fatality Risk Analysis of Building Trades. *Journal of Construction Engineering and Management* 132(5): 533-539.

Barnard, F. J. (2005). An integrated health, safety and environmental risk assessment model for the South African global systems mobile telecommunications industry; *Doctorial Thesis*. University of South Africa.

Behm, M. (2005). Linking Construction Fatalities to the Design for Construction Safety Concept. *Journal of Safety Science*. 43 (8): 589-611.

Bentley, T. A., Hide, S., Tappin, D., Moore, D., Legg, S., Ashby, L. & Parker, R. (2006). Investigating risk factors for slips, trips and falls in New Zealand residential construction using incident-centred and incident-independent methods. *Journal of Ergonomics*, 49, 62-77.

Bohrmann, B. (2000). A Socio-Psychological Model for Analyzing Risk Communication Process; *The Australian Journal of Disaster and Trauma studies*; 2000.

Breakwell, G.M. (2007). *The Psychology of Risk*, Cambridge University Press, Cambridge, UK

Bremer, B. (1980). In one word: not from experience, *Journal of Acta Psycologica,* 45, 223-241.

Bryman, A. (2006). *Integrating Qualitative and Quantitative research: how is it done?*, *Qualitative Research* : SAGE Publications.

Caccia L.E. (2009). Risk communication in the Workplaces: An analysis of the Communication Toolkits as Rhetorical Practice. *Doctorial Thesis*. Kent State.

Charles, M., Pillay , J. and Ryan R. (2007). Guide to Best Practice for Safer Construction: Literature review 'From concept to completion, *Cooperative Research Centre for Construction Innovation,* for Icon.Net Pty Ltd.

Chapman, C., and Ward, S. (2003). *Project Risk Management: Processes, Techniques and Insights* (2nd edition.). Chichester: Wiley.

Carter G and Smith S.D. (2006). Safety Hazard Identification on Construction Project. *Journal of Construction Engineer Management* 132- 200 (197-212).

Chan, A. P. C., Wong, F. K. W., Chan, D. W. M., Yam, M. C. H., Kwok, A. W. K., Lam, E. W. M. and Cheung, E. (2008). Work at Height Fatalities in the Repair, Maintenance, Alteration, and Addition Works. *Journal of Construction Engineering and Management-Asce*, 134, 527-535.

Checkland, P. (1990). *Systems Thinking, Systems Practice*, JohnWiley & Sons, Chichester.

Che Hasann, C., Basha, J., and Hanafi, W. (2007). Perception of Building Construction Workers Towards Safery, *Journal of Structural Engineers*. 2 (3). 271 – 279.

Cheng, E.L., Li, H., Fang, D.P.and Xie, F. (2004). Construction Safety Management: An Exploratory study from China. *Journal of Construction Innovation: Information, Process, Management* 4 (4), 229–241.

Cheng, C., Leu, S., Lin, C. and Fan, C. (2010). Characteristic Analysis of Occupational Accidents at Small Construction Enterprises. *Journal of Safety Science* 48 (6), 698–707.

Chi, C. F. and Wu, M. L. (1997). Fatal Occupational Injuries in Taiwan - Relationship between Fatality Rate and Age. *Journal of Safety Science*, 27, 1-17.

Chi, C., T. Chang and H. Ting. 2005. Accident Patterns and Prevention Measures for Fatal Occupational Falls in the Construction Industry. *Journal of Applied Ergonomics*. 36 (4): 391-400.

Contractors Registration Board (CRB), (2008). *Proceedings of CRB Annual Consultative Meetings 2008 "Corporate Governance*: A Key to Successful Contracting Business" 17th – 18th July

Creswell, J. W. (2003). *Research Design. Qualitative, Quantitative and Mixed Methods Approach* (2nd edition). University of Nebraska, Omaha: SAGE Publications.

Creswell, J. W. and Clark, V. L. P. (2007). *Designing and Conducting Mixed Methods Research*. Sage Publications, Thousand Oaks.

Davies V.J. and Tomasin K. (1996). *Construction Safety Handbook*, (2nd Edition). Thomas Telford Publishing, London.

Doloi, H. (2009). Relational Partnerships: The Importance of Communication, Trust and Confidence and Joint Risk Management in Achieving Project Success; *Journal of Construction Management and Economics* 27(11), 1099-1109.

Douglas M.S. and Wildavsky A. (1982). *Risk and Culture*; University of California: Press Berkeley

Dejus T. (2007). Accidents on Construction Sites and their Reasons. (online) www.vgtu.lt/leidiniai/leidykla/MBM_2007/2pdf/Dejus.pdf.

Business dictionary (online) -*www.**businessdictionary**.com/definition/**safety**.html.* Accessed 20 August 2011.)

Faber, M.H. and Stewart, M.G. (2003). Risk Assessment for Civil Engineering Facilities: Critical Overview and Discussion, *Journal of Reliability Engineering and System Safety*, 80(2) 173-184.

Fellows, R. and Liu, A. (2003). *Research Methods for Construction* (2nd Edition.). Cornwall: Blackwell Science Ltd.

Fera, M. (2009). Proposal of a Quali-Quantitative Assessment Model for the SMEs Health and Safety. *Journal of Safety and Security Engineering* 3, 117–126.

Fischhoff, B, Bostrom, A. and Quadrel M.J. (1997). *Risk Perception and Communication*. In R.Detes, J McEwen & G. Omenn (Eds), Oxford textbook of Public health (987-1002)

Fleming, M., Flin, R., Mearns, K., Gordon, R. (1998). Ofshore Workers' Perceptions of Risk: Comparisons with Quantitative Data. *Journal of Risk Analysis* 18, 103-110.

Flyvbjerg, B. (2001). *Making Social Science Matter; Why social inquiry fails and how it can succeed again* . Cambridge : Cambridge University Press

Fung, I.W, Tam, V.W, Lo, T. and Lu, L. (2010). Developing a Risk Assessment Model for construction safety; *International Journal of Project Management* 28; 593-600

Gambatese, J., Behm, M., and Hinze, J. (2005). Viability of Designing for Construction Worker Safety. *Journal of Construction Engineering and Management*. 1029-1036.

Giang D.T, Low Sui Pheng, S.L. (2010). Role of Construction in Economic Development: Review of key Concepts in the Past 40 Years; *Habitat International* (35) 118-125

Gillett, J.W. (1998), Issues in Risk Assessment of Compost from Municipal Solid waste: Occupational Health and Safety, Public Health, and Environmental Concerns",Journal of Biomass Bio energy (3):145-162

Gurcanli, G.E., Mungen, U.(2009). An occupational safety risk analysis method at construction sites using fuzzy sets. *International Journal of Industrial Ergonomics* 39, 371–387.

Gunningham N. (1984). *Safeguarding the Worker*, Sydney: Law Book Company,

Hämäläinen,P. Takala, J and Saarela, K. (2007). Global Estimates of Fatal Work-Related diseases. *Journal of industrial Medicine*.50(1) 28-41

Hale, A. R and Glendon, A. I. (1987). *Individual Behaviour in the Control of Danger*. Amsterdam, Elseveir

Haimes, (2009). *Risk Modeling, Assessment, and Management*, (3rd Edition) John Wiley and Sons, Ney Jersel Canada.

Hallowell, M.R.(2008). A Formal Model for Construction Safety and Health Risk Management. *Doctorial Thesis*; Oregon State University, Oregon,

Hallowell M.R and Gambatese, A.J. (2010). Construction Safety Risk Mitigation, *Journal of Construction Engineering and Management*, 136 (9).

Hampel, J (2006). Different Concept of Risk- A Challenge for Risk Communication; International *Journal of Medical Microbiology* 296; SI 5-10

Health and Safety Executive. 1998. *Managing Health and Safety: Five Steps to Success*. London: Health and Safety Executive.

Health and Safety Executive. 2001. *A Guide to Measuring Health and Safety Performance*. London: Health and Safety Executive

Health and Safety Executive (HSE). (2003). *Causal Factors in Construction Accident: Research Report 156*. London: Health and Safety Executive.

Health and Safety Executive (HSE). (2004). *Improving Health and Safety in the Construction Industry*. London: The Stationery Office.

Health and Safety Executive. (2009). "Managing Health Risks in Construction", *www.hse.gov.uk/construction/designers/index.htm* accessed 20 September 2010

Health and Safety Executive.(2010). Improving Health and Safety: An analysis of HSE's risk Communication in the 21st century; *Research Report* London.

Hinze, J. (2005). A Paradigm Shift: Leading to Safety; *Conference Proceeding CIB W99 on Rethinking and Revitalisation of Construction Safety, Health Environment and Quality*; Port Elizabeth South Africa 17-20 May 2005

Heinrich, H. W. (1931). *Industrial Accident Prevention*. New York: McGraw Hill.

Holt A.S (2001). *Principles of Construction Safety*, Blackwell Science, Oxford

Holmes, N., Gifford, S.M., Triggs 'T.J. (1998). Meaning of Risk Control in Occupational Health and safety among employers and employees. *Journal of Safety Science* 28,(3), 14 I – 154.

Hughes, P.and Ferrett E. (2011). *Introduction to Health and Safety in Construction: The Handbook for NEBOSH Construction Certificates*. (4th Edition) Routledge, Taylor and Francis Group; New York.

International Labour Office (ILO) (2001). The Construction Industry in the Twenty First Century: Its Image, Employment Prospects and Skill Requirements, *Tripartite Meeting on the Construction Industry.* Geneva

International Labour Office (ILO). (2005). Baseline Study on Labour Practice on Large Construction Sites in the United Republic of Tanzania, *Working paper 225*, Geneva

International Labour Office (ILO). (2005). *Global estimates of fatal work related diseases and occupational accidents,* World Bank Regions. International Labour Organisation, Geneva.

International Labour Office. (2006). *Promotional Framework for Occupational Safety and Health: Fourth Item on the Agenda.* Geneva: International Labour Office.

International Labour Office. (2007). The Decent Work Agenda in Africa: 2007-2015. In: *Eleventh African Regional Meeting in Addis Ababa*., ILO, Geneva.

Irizarry, J. and Abraham, D. (2006); Risk Perception of Ironworkers; *Journal of Construction Research.* 7(2), 111-132

Jason, A. (2008). Organizing Informal Workers in the Urban Economy, The Case of the Construction Industry in Dare s salaam, Tanzania. *Habitat International* (32) 292-202.

Johnson R, Fisher A, Smith K, and Desvouges W.H. (1988). Informed Choice or regulated risk? Lessons from a Study in Radon Risk Communication. *Journal Environment*; 30(4):12-15, 30-35

Jung, Y., Kang, S., Kim, Y.S., Park, C. (2008). Assessment of safety performance information systems for general contractors. *Journal Safety Science* 46 (4), 661–674.

Kaplan, S. And Garrick, J. (1981). On the Qualitative Definition of Risk. *Journal of Risk analysis* 1(1).

Kikwasi G. (2010). Client Involvement in Construction Safety and Health; *Journal for Building and Land development,* Ardhi University

Kines, P. Andersen P, Spangenberg, S., Mikkelsen K.L., Dyreborg, J. D. And Zohar, D. (2010). Improving construction site safety through leader-based verbal safety Communication. *Journal of Safety Research* (2010).

Kirchsteiger, C. (2005). A new Approach to Quantitative Assessment of Reliability of Passive Systems. *Journal of Safety Science*, 43(10), 771-777

Kitumbo H.I. and Kirenga, A. P. (2001). Construction Industry in Tanzania, *African Newsletter on Occupational Health and Safety,* 11(1) 8-9.

Kheni A. (2008). Impact of Health and Safety Management on Safety Performance of Small and Medium-sized Construction Businesses in Ghana, *Doctorial Thesis*, Loughborough University, UK

Koehn, D, Hilgers C, Bons P.D, Passchies, C, W (2000). Numerical Simulation of Fibre Growth in Antitaxial Strain Fringes. *Journal of Structural Geology*. 22, 1311-1324.

Kuyper, H. and Vlek, C. (1984). Contrasting Risk Judgements among Interest Groups. *Acta Psychology.* 56, 205-218.

Lawrence, R, Gil P.M, Fluckiger, Y. Lambert, C and Werma, E. (2008). Promoting Decent Work in the Construction Sector: The role of Local Authorities, *Habitat International* (32) 160-170.

Liao, C.W., Perng, Y.H., (2008). Data mining for occupational injuries in the Taiwan construction industry. *Safety Science* 46 (7), 1091–1102

Lingard, H and Rowlinson, S M. (2005). *Occupational Health and Safety in construction project management*; UK Taylor & Francis.

Lingard, H. and Holmes, N. (2001). 'Understandings of Occupational Health and Safety Risk Control in Small Business Construction firms: Barriers to Implementing Technological Controls', *Journal of Construction Management and Economics*, 19: 2, 217 — 226

Ling, F.Y.Y., Liu, M., Woo, Y.C., (2009). Construction Fatalities in Singapore. *International Journal of Project Management* 27 (7), 717–72

Lipscomb, H. J., Dale, A. M., Kaskutas, V., Sherman-Voellinger, R. and Evanoff, B. (2008). Challenges in residential fall prevention: Insight from apprentice carpenters. *American Journal of Industrial Medicine,* 51, 60-68.

Lindell. M.K. and Earle, T.C. (1983). How Close is Close Enough: Public Perceptions of the Risks of Industrial Facilities. *Journal of Risk Analysis*. 3 (41), 245-253.

Liu, J. and Low, P. (2009). Developing an organizational learning-based model for risk management in Chinese construction firms. *Journal of Disaster Prevention and Management* 18, 170-186.

Loushine, T.W., Hoonakker P.L.T., Carayon P., Smith M.J. (2006). Quality and Safety Management in Construction, *Journal of Total Quality Management* 17(9), 1171-1212.

Lubega, H., Kiggundu, B.M and Tindiwensi D. (2001). An Investigation into the Causes of Accident in the Construction Industry in Uganda. *http://buildnet.csir.co.za/cdcproc/dpcs/2nd/lubegah.pdf* Accessed on October 2011

Maytorena, E., Winch, G. M., Freeman, J. and Kiely, T. (2007). The Influence of Experience and Information Search Styles on Project Risk Identification Performance. *IEEE Transactions on Engineering Management*, 54(2), 315-326.

Marhavilas, P. K., and Koulouriotis, D. E. (2008). A risk estimation methodological framework using quantitative assessment techniques and real accidents' data: application in an aluminum extrusion industry. *Journal of Loss Prevention in the Process Industries*, 21(6), 596e603.

Marhavilas P.K, Koulouriotis, D. Gemeni, V. (2011). Risk Analysis and Assessment Methodologies in the Work Sites: On a Review, Classification and Comparative study of the Scientific Literature of the period 2000-2009; *Journal of Loss Prevention in the Process Industries* 24 (2011) 477-523

Mathews, J. (1993). *Health and Safety at Work,* (2nd edition). Pluto Press, Sydney.

Michael, J. H., Guo, Z. G., Wiedenback, J. K., & Ray, C. D. (2006). Production supervisor impacts on subordinates' safety outcomes: An investigation of leader-member exchange and safety communication. *Journal of Safety Research*, 37, 469−477.

Morgan, D. L. (2006). Practical Strategies for Combining Quantitative and Quantitative Methods: Applications to Health Research. In: *Emergent Methods in Social Research*. Sage Publications Inc., London, 165-182.

Mombeki, F. (2005). Occupational Health and Safety Challenges In Construction Sites in Tanzania. *Conference proceeding CIB W99 on Rethinking and Revitalisation of construction safety, health Environment and Quality*; Port Elizabeth South Africa 17-20 may 2005

Mombeki, F. (2006). Roles of Stakeholders, Partnering in Enhancing Health and Safety in Construction Sites. Tanzania Experience and Way Foward, *Conference proceeding CIB W99, Global unity for safety and health in construction* 28-30 June 2006, Beijing.

Moshi, E. (2011). Urban Tranformation: Changing Building Type in Kariakoo, Dar es salaam, Tanzania. *Doctorial Thesis*, School of Architecture, Oslo

Morrow, B. (2009). Risk behaviour and risk communication: Synthesis and expert interviews. *Final report for the NOAA coastal services centre SocResearch Miami*

Mohamed, S. (2004). *Safety Culture, Climate and Performance Measurement, Construction Safety Management System* Ed. Rowlison,S Taylor and Francis, New York.

Mohamed, S., Tam, W.Y.V., (2009). National culture and safe work behaviour of construction workers in Pakistan.*Journal of Safety Science* 47 (1), 29–35.

Mondarres, M., Kaminky, M., Krivtsov, V., (1999). *Releability Engineering and Risk Analysis Quality and Reliability*. A series edited by Schelling E.G \marcen Inc. New York.

Mbuya, E and Lema, N M (2002) Towards Development of Framework for Integration of Safety and Quality Management Techniques in Construction Project Delivery Process. *Proceedings of the 1st International Conference of CIB W107: Creating a Sustainable Construction Industry in Developing Countries*. 11th- 13th November.

Mroszczyk, J. (2006). Designing for Construction Worker Safety." *ASSE Blueprints.* 5(3):1, 3-4, 11.

Murie F. (2007). Building Safety – An international Perspective, *International journal of Occupational Safety, Environmental Health* 13(1) 5-11

Nachmias, D and Nachmias, C (1993); Research Methods in social science, st Martins, New York.

Nilsen & Aven (2003), Models and Model Uncertainty in the Context of Risk Analysis, *Journal of Reliability Engineering and System Safety* 79.309-317

Niza, C., Silva, S., Lima, M.L., (2008). Occupational Accident experience. association with workers' accident explanation and definition. *Journal of Safety Science* 46 (4), 959–971.

Ntiyakunze S. (2011). Conflicts in Building Projects in Tanzania: Analysis of Causes and Management Approaches; *Doctorial Thesis*; Royal Institute of Technology (KTH)

Olsson M.O and Sjostedt, G. (2004). *System Approaches and their Application; Example from Sweden*; Kluwer Academic; The Netherlands.

Oppenheim, A.N. (2004): *Questionnaire Design, Interviewing and Attitude Measurement* New Ed., Continuum, 11 York Road, London.

Patton, M. (2002). *Qualitative Research and Evaluation Methods*. Thousand Oaks: Sage.

Palencher, M.L., Heath, R. L., Hocke , T. (2010). Corporate (social) responsibility, risk management and communication *Handbook of Communication and Corporate Social Responsibility*. Ed. O. Ihlen, J. Bartlett, & S. May. Wiley Blackwell.

Petts, J. (2001). Evaluating the Effectiveness of Deliberative Processes: Waste Management case studies*. Journal of Environmental Planning and Management*, 44(2), 207-226

Pidgeon, N. (1997). The Limits to Safety? Culture, Politics, Learning and Man-made disasters.*Journal of Contingencies and Crisis Management* 5 (1), 1-14.

Phoya, S., Eliufoo H., Pietrzyk, K. and Nyström, M. (2011). Assessment of Health and Safety Risk Perception of Site Managers, Supervisors and Workers in Tanzania Urban Construction Sites; *Conference Proceeding; Prevention: Means to the End of Safety and Health Incidents and Illnesses;* Washington, DC 24th -26th August 2011.

Rahim A., Hamid, A., Zaimi M., Majid,A. and Singh, B (2008) Causes of Accidents at Construction Sites*. Malaysian Journal of Civil Engineering,* 20 (2). 242-259.

Rejda, G. (1992).*Principles of Risk Management and Insurance*, 4th Edition Harper Collins

Rwamamara, A.R .(2007). Planning the Healthy Construction Workplace through Risk Assessment and Design Methods, *Doctorial thesis* Luleå University of Technology, Department of Civil, Mining and Environmental Engineering

Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Ashgate Publishing, Aldershot, England.

Rozenfeld, O., Sacks, R., Rosenfeld, Y. And Baum, H., (2010). Construction Job Safety Analysis. *Journal of Safety Science* 48 (4), 491–498.

Rowlinson, S. (2005). The Rate of Accidents per 1000 workers. Steven Rolinson ARCOM Keynots 2005. London,

Rowe, W.D. (1982). *Corporate Risk Assessment, Strategies and Technologies: How to Limit the Risk in Industry.* New York: Dekker

Rayner, S. (1992). Cultural Theory and Risk Analysis in: *Kmmsky, S. and Golding (Eds) Social Theories of Risk*,. 83-115 (Westport, Praeger).

Smallwood, J.J. (2008). The Role and Influence of Clients and Designers in Construction Health and Safety. *First European Conference on Construction Health and Safety Coordination in the Construction Industry*, Barcelona,21-22 February.

Smallwood, J. Haupt, T and Shakantu .(2008). Construction Health and Safety in South Africa: Status and Recommendation, *CIDB report*

Stephenson J. (1991). *Systems Safety*. New York: Van Nostrand Reinhold

Stake, R.E. (2000). Case Studies. In: *Handbook of Qualitative Research, Denzin, N.K.and Lincoln, Y.S. (eds)*. Sage Publications, Inc., London

Stake, R. (1995). *The Art of Case Study Research*. Thousand Oaks: Sage.

Stake, R. (2006). *Multiple Case Study Analysis*. New York: The Guilford Press.

Simu, K. (2006). Risk management in Small Construction Projects. *Licentiate Thesis,* Luleå University of Technology; Lulea.

Smith, N. Merna, T. and Jobling, P. (2006). *Managing Risk in Construction Projects*; Blackwell, UK.

Slovic, P. (1987). Perception of risk. *Journal of Science*. 236, 280-285.

Slovic, P. (2000). *The perception of risk*. London: Earthscan.

Skitmore, R. M., Stradling, S. G. and Tuohy, A. P. (1989). Project Management under uncertainty. *Journal of Construction Management and Economics* (7), 103-113.

Stave, C. (2005). Safety as Process: From Risk Perception to Safety Activity, *Doctorial Thesis* Chalmers University of Technology, Gorthenburg

Stoecker, R. (1991). 'Evaluating and Rethinking the Case Study. *Journal of The Sociological Review* 31, (1) 88-112

Summerton, J. and Berner, B. (2003). *Constructing Risk and Safety in Technological Practice*. Routledge

Tam, C.M., Zeng, S.X., Deng, Z.M.,(2004). Identifying elements of poor construction safety management in China. *Journal of Safety Science* 42, 569–586.

Taylor, D. H. (1981). The Hermeneutics of Accidents and Safety. *Journal of Ergonomics*, 24(6), 487−495.

Taylor, G., Easter, K. and Hegney, R. (2004). *Enhancing Occupational Safety and Health*.Elsevier Butterworth-Heinemann, Oxford.

Trimpop, R and Zimolong B. (2006).International Labour Organisation: Risk Perception*. [Online]. Available: ilo.org/encyclopedia* (Accessed 23 September 2011.)

UN-HABITAT. (2008). *The State of African Cities 2008, A Framework for Addressing Urban Challenges in Africa.* Nairobi: UN-HABITAT.

UN-Habitat. (2010). *Citywide Action Plan for Upgrading Unplanned and Un-serviced Settlements in Dar es Salaam.* Nairobi.

The United Republic of Tanzania; *The Architects and Quantity Surveyors Registration Act No.16 of 1997/ Act no 4 of 2011*;Govenment printer, Dar es Salaam

The United Republic of Tanzania; *the Contractors Registration Act No.17 of 1997 and Act no 4 of 201*0, Govenment printer, Dar es Salaam

The United Republic of Tanzania; *the Public Procurement Act, 2004*. Govenment printer, Dar es Salaam

The United Republic of Tanzania; *Occupational Health and Safety Act 2003*. Govenment printer, Dar es salaam

The United Republic of Tanzania; *Employment and Labour Relation Act 2004*. Govenment printer, Dar es salaam

The United Republic of Tanzania; *National Budget 2011/2012,* Ministry of finance. Govenment printer, Dar es Salaam

Walters, D. (2009). The role of worker representation and Consultation in managing health and safety in the construction industry,*Cardiff Work Environment Research* Centre Cardiff University

Valsamakis, A.C., Vivian, R.W. and Du Toit, G.S. (2004). *Risk management.Managing Enterprise Risks* (3rd edition.). Sandton: Heinemann

Weterings, R., and Van Eijndhoven, J. (1989). Informing the public about uncertain risks. *Journal of Risk Analysis*, 9(4), 473–482.

Wells, J and Hawkins, J .(2007). Promoting Construction Health and Safety through Procurement: *A Briefing note for Developing Countries,* ILO Geneva

World Health Organization (1989).*The First World Conference on Accident and Injury Prevention*. Stockholm, 17-20 September 1989

World Health Organization. (2006). *Constitution of the World Health Organization - Basic Documents*, (4-5 edition), Supplement, October 2006.

Wu, W., Gibb, A.F. and Li, Q., (2010). Accident Precursors and Near Misses on Construction Sites: an Investigative Tool to Derive Information from Accident Databases. Journal of Safety Science 48 (7), 845–858.

Yin, R.K. (1994). *Case Study Research: Design and Methods;* (2nd Edition), Sages Publications. Thousands, Inc., Oaks.

Yin, R. (2003). *Case Study Research, Design and Methods* (3rd Edition, Vol. 5). Thousand Oaks: Sage.

Yin, R.K (2009). *Case Study Research, Design and Methods*; Los Angeles; Sage

Yung, P. (2009). Institutional Arrangements and Construction Safety in China : An empirical examination. Journal of Construction Management and Economics, 27, 439-450

APPENDICES

Appendix 1 Questionnaire survey

QUESTIONNAIRE FOR RISK PERCEPTION

Section A: Demography

Personal details Project Ref. No ……

1) Are you Male ☐ Female? ☐
2) Your age
20-35 ☐ 36-45 ☐ 46-55 above 55 ☐
3) Are you employed on the basis of
Part Time ☐ Full Time ☐ Temporary (daily?) ☐
4) Type of employer
Main Cont. ☐ Sub-Contractor Other (specify)_____
5) Job title (trade/description) Masonry (block layers) concrete ☐ others (specify)…….
6) Experience on construction: (6.1) with employer ---------- (6.2) on site ……
7) Education background; Primary education ☐Primary education with vocation skills ☐
Secondary education ☐ College ☐ university ☐ other (specify).....

Section B: Knowledge on health and safety risk

8) Do you have any information about health and safety in the workplaces?
Yes No ☐ Don't Know ☐
9) If yes where did you get information?
From study ☐ from organization ☐ Short training ☐ My co- workers ☐ My supervisor ☐

Section C: Risk Perception

11) How safe are you feeling when you are working with your task (1=very safe, 2 =safe, 3=moderate safe 4 =not safe, 5= not safe at all)

	Type of hazard	**1**	**2**	**3**	**4**	**5**
1	Waking at height					
2	Manual handling					
3	Overcrowded site					
4	Handling heavy load					
5	Manual handling (carrying cement bags or bricks/blocks)					
6	Noise (using block/brick cutting machine)					
7	Dust (mortal/ cement)					
8	Bending, twisting while laying blocks/ bricks					

12) In your experience how probable do you think you the following risk will occur in the task performing

	Type of hazard	**1**	**2**	**3**	**4**	**5**
	Falling from height (Serious injury of fatal injury)					
	Falling object (blocks, bricks, debris) heating head body including feet					
	Manual handling (carrying cement bags or bricks/blocks) Neck, back or arm injury					
	Workers crushed or stucked by moving vehicles, focal lift					
	Noise (using block/brick cutting machine) which cause hearing loss					
	Handling heavy load					
	Inhalation of dust from cement-cancer, respiratory system					
	muscular skeleton disorder, back pain due to Bending, twisting while laying blocks/ bricks					

Appendix 2 Interview Guides

Interview Guide for Institutional legal system

1. What is your role in ensuring health and safety are managed in construction sites
2. How do you doing inspection
3. What are challenges you are facing
4. How can you improve situation

Interview Guide for Organisation system

1. Does your firm has a health and safety policy, how does it state
2. How does your firm manage health and safety risk in the sites
3. What are the challenges you are facing on managing health and safety management
4. What your comments on improving health and safety risk management

Interview Guide for Individual system

1. What your education background
2. What is your experience in construction industry?
3. How did you learn to perform your construction activities
4. Do you have any training of health and safety risk in construction sites
5. How do you involved on risk assessment, what methods/ tool used for risk assessment
6. How do you involved in risk communication, what methods used for communication, what message are communicated
7. How do you involved in risk control, what methods used for risk control.
8. What are the challenges on managing health and safety risks?