UNIVERSITY OF NAIROBI

AN INVESTIGATION INTO THE QUALITY OF WORKMANSHIP ON CONSTRUCTION SITES.

A CASE STUDY OF CONSTRUCTION SITES IN NAIROBI.

BY

NDOKA GICHUKI RAPHAEL

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DECLARATION

I, NDOKA GICHUKI RAPHAEL, hereby declare that this project is my original work and has not been presented for a degree in any other University.

Signed:..... Date: 21/06/07.

NDOKA G.R

DECLARATION OF THE SUPERVISOR

This research has been submitted for examination with my approval as a university supervisor.

Signed:..... Date: 26/06/2007

ASIENGA EBOLE.

B.Arch (Hons), M.A (Const Mngnt) NRB; MAAK(A)

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DEDICATION

This work is dedicated to my parents, PATRICK and MARY and my siblings; whose dedication and commitment have inspired me throughout my life.

Am indebted to love you.

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ABBREVIATIONS

BS- British Standards

AAK- Architectural Association of Kenya

BORAQS- Board of Registration for Architects and Quantity Surveyors

JBC- Joint Building Council

DEFINATION OF TERMS

1. **Workmanship**- this is the quality as seen in something made or persons skill in doing something.
2. **Quality management factors**- are the desired and essential site management factors to be observed in order to achieve the right quality end product.
3. **Level/extent**- this refers to magnitude or measure.
4. **Variables**- they are measurable characteristic that assume different values amongst subjects.
5. **Contractor**- this refers to the builder and the construction expert who does construction work for payment and who enters into a contract with an owner for this purpose.
6. **Owner/ Client/ Employer**- this refers to the initiator of the construction who is also known as the developer. He may be an individual person, a company or public body.
7. **Contractual arrangements**- are all those arrangements in the contract documents showing the obligations, rights, liabilities and the distribution of risks between the contract parties.

ABSTRACT

The aim of the study was to address the problem of low level of workmanship in Kenyan construction sector, which manifests itself in defects on the final products. The role of the sector in the economy cannot be over emphasised, and it is a forgone conclusion that the sector is here to stay.

The study hypothesized that quality management factors influence the quality of workmanship on construction sites.

Construction management determinants are the essential and desired site management factors to be observed in order to achieve the right quality end product. These are; supervision, training, experience, workers motivation, communication on site, clarity in specifications, subcontracting and provision of proper tools and equipments.

In order to achieve the objectives, the study carried out a survey of concreting works on accessible ongoing construction sites in Nairobi. Questionnaires were administered to contractors, workers and architects while a checklist was used to observe the level of workmanship as well as the level of construction management determinants. Data from the sites was statistically analyzed. Regression analysis between the two major variables; level of workmanship and construction management determinants was carried out.

The study concluded that inadequate construction management has resulted to low level of workmanship. It recommends close observation of construction management factors like supervision, training and ensuring good communication on site in order to minimize the costs and effects associated with poor workmanship

CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.0 INTRODUCTION

Construction industry is one of the world's major industries and infact the economy of a country can be gauged by the performance of the country's construction industry. It is responsible for the production of the built environment. As such it designs, manufactures, maintains and demolishes all the manmade buildings, bridges, roads tunnels, dams that we utilize every day of our lives (Achieng, 2001)

Despite mechanization construction remains a major employer of labour and quite often employs between 9 percent and 12 percent of the country's working population and sometimes as much as 20 percent (Nyakiongora 2001).

The continuous growth of the industry however comes with a price. People have compromised on the quality of workmanship leading to collapse of building , defective construction products and even subjecting building occupants to a high risk.

In view of the important role of the construction industry to the economy it is vital for producers to ensure the fitness of construction products so as to improve their performance. (Muinde, 2003). This can effectively be achieved if the required standards of workmanship are met.

Quality is almost exclusively dependant on the workmanship on site.

Workmanship is the quality as seen in something made or persons skill in doing something.(Advanced Learners Dictionary,2nd Edition)

Clause 23.1 of the Joint Building Council's agreement and conditions of contract for building works states that all materials, goods and workmanship shall so far as procurable be of the respective kinds and standards described in the contract bills, the drawings and the specifications. (The Joint Building Council of Kenya, 1999). It further gives the architect authority and grounds to reject materials and works at the expense of the contractor.

The purpose of construction industry is to provide the basic facilities and infrastructure within stipulated time, budget and specification overlooking of these conditions can have disastrous effects (Wachira, 2003).

The fragmented nature of the construction industry is widely cited as a significant obstacle to progress in quality achievement (Muinde 2003). The separation of design and productions phases creates a problem in achieving the desired quality.

The heterogeneity of operations in the construction work, mobility of labour and environmental influence make a project more vulnerable to poor quality attainment. Muinde also noted that poor quality is triggered by the complexity in controlling the efficiency and effectiveness of the production.

In the construction process, the contract documents prepared by the design team determine the standard and scope of the project. However, execution of the work is left to the production team whereby many are the times where the standard and specifications set are not met.

The Kenyan construction industry has occasionally been blamed for general quality and there is absolutely lack of general quality assurance in the industry (Dindi 2004) and quality of workmanship is an important component of the general construction quality.

In every construction project, there is the quality control which the supervisors must be knowledgeable about in order to achieve the required standards of the final products.

One can have elaborate designs, which meet minimum safety requirements, but it is in translating the designs into actual structure or execution of the work where serious quality control is required.

A building should be constructed in such a way that it provides conditions appropriate to the activities to be carried there in. The safety and comfort of the occupants are the most important factors in the construction of any building (Munderu, 1990). Poor quality of workmanship will no doubt lead to

poor standards of safety and comfort thus the need to ensure that the highest possible quality of workmanship is met in the construction process.
Many of the construction products are made of concrete, hence the research will be based on this trade. In concrete structures the structural; members are more often than not made in-stitu and the quality will depend on workmanship of concrete making and placing.

1.1 PROBLEM STATEMENT

In the construction process, poor workmanship will result into several problems which include; financial problems, lack of safety, inconvenience of demolition and rebuilding, legal issues of non- compliance to quality requirements as well as short life span of the finished product.
Poor quality of workmanship often manifests as water infiltration through some portion of the building structure such as cracks in some building relevant and mechanical problems or lack of appropriate sound insulation or fire resistance construction (Otieno 2006).
In Kenya, there have been incidences of poor quality of workmanship despite all the effort to induce quality. Construction process has in recent past been criticized for sub-standards work.
Evidence includes the collapsing of buildings and other defects experienced in the finished construction product.

In a recent case, the Architectural Association of Kenya (AAK) chairman said that investigation of a collapse of a building was due to poor workmanship and use of inferior structural equipments. (Daily Nation 18th Nov, 2006)
In another case of a collapse of building in Kilimani in Nairobi, it was observed that workers were trying to re-fill the cracks on the building before the tragedy occurred (Daily Nation 21st Nov, 2006).
The above cases indicate that much is lacking in terms of workmanship on site.

The issue of maintaining the highest possible standards of workmanships has thus been a concern to various authorities, but despite this no much effort has been made to achieve the required quality of workmanship.

The main question will be:

Is good quality of workmanship achieved on sites and if no, why is this so?

1.2 RESERCH HYPOTHESIS

It is the hypothesis of this study that lack of observance of quality management factors is the cause of poor workmanship on construction sites.

1.3 OBJECTIVES

a) Establish the level of workmanship on construction sites.

b) Establish the causes of poor workmanship on construction projects.

c) Establish the relationship between quality management factors and the level of workmanship.

d) Identify the measures taken by the responsible authorities in ensuring proper quality of workmanship.

1.4 SCOPE OF THE STUDY

For practical purposes, the concept of workmanship in this study has been limited to concreting and on sites. This is the most common trade in the construction industry. This will enable the researcher to dig deep into details of workmanship content in concreting within the short period allowed for the study.

Concreting work is the most convenient to the study, concrete being an end product of several materials mixed together under defined standards or specifications.

By geographical coverage, the study is limited to Nairobi due to financial and time constraints.

1.5 JUSTIFICATION OF THE STUDY

Achieving client satisfaction is main focus of any construction project process. If the cause of low level workmanship can be established and a solution identified, then the problem of poor workmanship can be eliminated or greatly minimized thereby increasing client satisfaction. This will enable provision of quality housing to the public, as well as upholding the good reputation of the construction industry as a whole.

The outcome of this study will assist in reducing the effects of poor to low level workmanship, such as costs associated with rework and repairs. Safety risks to users of the facilities will also reduce.

1.6 ORGANISATION OF THE STUDY

The study is organized in five parts. Chapter one gives a general introduction, which includes introduction, problem background and statement, study hypothesis, study objectives, study limitations, justification of the study and organization of the study.

Chapter two forms the theoretical basis of the study. In this part, reviewed literature related to quality in construction as noted from textbooks and other publications. This forms the basis for evaluation of the primary data to make the research conclusion.

Chapter three outlines the study methodology. This chapter explains the type of research design adopted for the study, the type of sampling used, data collection method and sampling tools, and data presentation and analysis techniques.

Chapter four contains the actual data from the survey. It gives findings and analysis related to thee problem of the study. This chapter evaluates facts from, the survey and their import noted.

Chapter five is the final part and contains conclusions and recommendations. The reference section follows immediately

1.7 STUDY LIMITATIONS

The study offers several important findings, yet there were some limitations to the study as well. These include:

- Inadequate time and finance for the project.
- Lack of response to some questionnaires reducing the researcher's accessible sample.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

BS 8000 defines workmanship as the aspects of craftsmanship, supervision and management that combine to affect the level of quality achieved on site.

Poor workmanship is one of the construction deficiencies which affect quality (American society of civil engineers, 2003).

In recent past increasing concern has been expressed at the standards of performance and quality achieved in Kenya building work . The need for structured and formal systems of construction management to address the aspects of workmanship performance and quality has risen as a direct result of deficiencies and problems in construction, design, materials and components. (Griffth, 1990).

Many of the problems experienced in building appear as a range of inadequacies from minor technical and aesthetic to major building defects. Irrespective of their degree of severity such problems are known to cost the industry hundreds of millions of shillings annually yet many difficulties might be alleviated through greater care and attention to standards of performance and quality at the briefing design and construction stages of building process.

Poor workmanship on building sites leads to many building failures and defects which occasion large economic loss and human inconvenience.

2.2 EFFECTS OF WORKMANSHIP

The focus of blame for inadequate building performance and inferior quality is frequently appropriated to the architect . It is not uncommon for the architect to be severely criticized for:

- Lack of awareness for the building process on site.
- Failing to understand new technology and the performance of innovative materials.

- Reluctance to delegate authority to project based supervisors.
- Simply not spending more time on site.

Whilst some of these criticisms may indeed be justified it is not always appropriate and not just the architect who may be at fault (Griffth, 1990).

Building clients may be found lacking in specifying clearly their desires and requirements for a building and frequently they have difficulty in deciding quite what they want in terms of building performance and standards of quality. Building contractors could spend more time structuring a planned approach and organization towards meeting the requirements of quality rather than progress chasing. They could also give greater attention to leading and motivating the workforce towards achieving better workmanship.

Forms of buildings procurement and contractual systems are sometimes pin pointed as being responsible for inadequate standards of project performance and building quality.

A BRE survey achieving quality on building sites (1985) sought to examine how site staff handled problems of quality and also reviewed their roles and responsibilities under different types of contractual arrangement to see if this noticeably affected quality.

It revealed that both designers and site based managers have little difficulty in identifying problems of quality occurring within their projects but have considerable difficultly in implementing a suitable solution. Site based staff have too little authority to invoke remedial action when required and refer problems to head office staff who are, in essence, too far removed from site to make any effective challenge to the problem (Griffth 1990).

On projects where a quality control or management supervisors was appointed benefits were seen in the quality levels achieved. The quality management role even today is bestowed upon the clerk of works, the designers or another representative of the client. When quality problems a rise for the clerk of works, there is little back up from the architect.

Quality management by clerk of works depends to a greater extent upon the relationship between clerk of works and the contractors site manager and the level of mutual support in managing quality through informal means.

2.3 HOW TO IMPROVE QUALITY ON THE CONSTRUCTION SITE.

Munderu (1990) observes that the quality of construction is generally falling. He makes clear that reasons for post performance of the industry could be found at all stages of construction. He gives some of the reasons as:

- Inadequacies in the materials or component specified and the way they are incorporated into the design.
- The level of competence and care in site operations.

Munderu also notes that quality on site is relatively less of a technical problem than in products and design, and more of a question of training and motivation.

A symposium organized by the Building Research Establishment (BRE) at Garston in 1989 to discuss ways of achieving on site acceptable standards of quality in construction made a number of observations with respect to quality of construction which can be summarized as follows:

1) Written specifications were unclear as to quality requirements. There was clearly a lack of precision in defining the quality required and a resultant tendency to over specify.

The designer must ensure that the specification reflects the clients requirements for a project and must be stated in unambiguous terms.

2) Use of samples could be beneficial in establishing standards.

3) The client needs guidance on how to define his requirements for quality more explicitly and the need to know the relevant merits of different ways of processing buildings.

4) The design team had to learn more about how buildings were really constructed on site, so that they could reflect site realities in more buildable designs and provide details that were functional and workable with the type of expertise available on site today.

5) Site management clearly needs improvement shortcomings in productions phase include deterioration in craftsmanship and lack of financial awareness.

6) The role of clerk of works in establishing quality standards is much broader that his formal terms of reference and largely complementary to that of site management.

7) That the industry has been de-skilled to a considerable extent.

8) The prime responsibility for inspection of works lay with the contractor.

2.4 QUALITY MANAGEMENT FACTORS

These are the desired and essential site management factors to be observed in order to achieve the right quality end product. These factors have been identified as independent variables that affect the level of workmanship. They include the following;

- Supervision
- Nature of training
- Experience of workers
- Tools and equipment
- Clarity in specifications
- Communication on site
- Motivation on workers
- Subcontracting
- Care in concreting

2.4.1 Supervision

Contract manager must ensure that the tradesmen carrying out the work clearly understand and have been properly instructed as to what standard of workmanship is required for each element of work. Any productivity schemes in operation must fully reflect the workmanship expectation of each project.

Supervisors on a construction site should know the specifications and posses both technical and administrative skills and appreciate the quality required. For a supervisor to carry out his work with competence and efficiency, he needs to have a wide range of basic craft skills and details of materials and workmanship or be in a position to readily give a hand on the information required.

Although the acceptable span of control is between 5 and 8, every operative should have only one boss from whom he receives instruction and forwards his queries through so that supervision can be effective.

Monitoring of work during building process is essential to ensure that work conforms to standards and also reveal areas in which improvements can be made. The supervisors on a construction site include the site agent, general foremen, trades foremen and clerk of works. Supervision on construction site is done to ensure, for instance in the preparation of concrete, the application of correct proportions, cleanliness of the aggregates and adequate mixing. It helps to control and develop good workmanship particularly where techniques are required.

2.4.2 Training

Training refers to proficiency in specific skills. Training is crucial if clients are to receive products as per their expectations. It is focused in developing person's level of understanding about a task.

Training plays an integral part in the achievement of quality in a product. Continuance training creates an atmosphere that encourages the discovery of new ideas and methods. Training enhances the productivity of workers by

improving their skills. This ensures that the products produced meet standards based on client requirements.

Suitable training is necessary in the building industry and can be acquired through;

- Technical training- this can be through some form of study at polytechnics or colleges of technology.
- Practical training- this is where a trainee acquires knowledge through apprenticeship. He works under supervision of qualified and trained personnel who have gained experience in the type of work the trainee wishes to pursue.

In the Kenyan building industry, training also takes place in seminars, workshops, symposiums and exhibitions. It is of necessity that participants in the building industry participate in most forums so as to advance in technology and get informed of the latest happenings in the field. There is need for a contractor to establish a training program for his/her workers. This advances their skills in construction thus resulting in to better production. The training should also emphasize on the issue of good workmanship. The upcoming complexities of design require the production team to be well versed with modern technology to enhance the implementation.

2.4.3 Experience

Experience refers to the frequency of utilising an acquired skill for its rightful purpose. It is important in improving the efficiency of skilled operation. With experience, improvements are achieved in observation, concentration and thought, and sequence of movement of body parts. The skill reaches optimum when the operation becomes automatic without the benefit of conscious control.

Although a person may attain a higher level of experience in a shorter time than one who has been long with the skills, it is generally believed that a competent person especially concrete worker should have been in the trade for over three years.

Contractors and site agents should therefore consider the experience of the workers on site when allocating duties and responsibilities the most critical work being allocated to experienced ones.

2.4.4 Tools and equipments

Mechanization is increasingly replacing manpower on construction sites. Construction plant refers to the machinery, tools and other equipment used in the execution of works on site like hoisting and mixing concrete. The lack of proper selection, operation and maintenance of the mechanical plant may deter good site workmanship which is a vital ingredient for a quality building.

It is expected that concrete mixed by hand will not have good consistency as that done by machine, hence there is need for mechanization of concrete work on site.

The site management must ensure that all the necessary tools and equipments are available to allow workers perform their duties well. The contractor should instil the norm of 'right equipment every time for the right work.' Any time he buys a technically operated plant, he should ensure that he gets the operation manual because this directs him on how to handle such a plant. The plant operator should be qualified to operate such a plant, according to the manufacturer's instruction provided.

2.4.5 Clarity in specifications

Specification can be described as a concise and complete description of workmanship and materials to be incorporated in new construction alterations or repairs (Smith, 1982).

Atkinson (1995) notes that the proper recording of changes in specifications during the process of construction is a key element in any quality management system

BRS Investigators (1940) found that inmost cases studied, the architects specification had never been followed in their entirely, that copies of variations

orders had in no instance been preserved, and that changes of intention could be interfaced only from visual evidence in the building, seldom do accurate records appear to have been kept of alterations made in the course of the contractor or subsequently, whether to the plan, the constructional details or the services.

In most specifications records, there is lack of technical information due to the inclusion of prime cost items for work to be undertaken bus sub contractors, whose records of the job are no longer available.

In addition, the production team should be well conversant with the specifications so that when they are provided them they are able to meet the standards required. The only way that workmanship can be enhanced is through meeting the specifications.

2.4.6 Communication on site

This is the transfer of information and understanding from one person to another. Emphasis should be put on ensuring effective communication between parties in the construction team, that is, the design team, production team and the client. Effective and amicable communication should serve to motivate the management and labour towards quality production. The various communication channels used in construction site include:

a) Verbal communication- this takes place orally. It enhances face to face exchange of information and encourages suggestions, questions for clarifications of the message or elaboration. On site verbal instructions are the most popular between management and workers. Oral communication provides room for discussions thus end up with the best decision possible. Instruction issued by the design team ought to be clear and well understood by the contractor and other supervisors.

b) Written communication- this is characterised by documentation of events. In the Kenyan building industry, written communication on sites mainly occurs when the design team is giving instructions to the contractor through working drawings, specifications, bill of quantities, site comments book and so on.

c) Illustrations- this is type of communication where the information is transferred to the recipient by the use of a practical example and use of samples.

The contractor while on site should always check that the documents used in the execution of works conform. For instance, the drawings should reflect what is indicated in the bill of quantities otherwise, a barrier to communication may arise due to misunderstandings by the contractor.

2.4.7 Motivation on workers

Motivation is influenced by levels of wages, working conditions, growth and development. In most cases, contractors claim that construction needs are costly and do not make construction any good business sense (Mwangi, 2000).

Mwangi also noted that contractors in building industry do not give concern or any priority to motivation requirements of workers. This is evidenced by low levels of wages, unconducive working conditions, poor job security, poor possibility of growth and advancement among others.

Good working conditions are very important factors which enable a worker to have a sense of satisfaction. Worker should be provided with conducive environment to enable them to carry out their duties. Good working conditions boost workers morale and motivate them to work harder.

Most workers on site are not provided with gumboots, goggles, hand gloves. Workers hence work with bare hand even in dangerous tasks that required safe handling of materials such as reinforcement fixing.

Contractors ought to motivate the worker through providing the mentioned factors so that they keep yearning for more hence inducing them to work properly and even much harder for quality achievement.

2.4.8 Subcontracting

A subcontract is an agreement between the main contractor and the subcontractor under which the later agrees to perform a certain portion of works for a fee paid by the former.

Subcontracting has been identified as a major cause of substandard performance. Damage by subcontractors and poor workmanship has also been identified as a major cause of defects at completion.

Uncertainties in connection with nominated subcontractors, technical qualification, timeliness, reliability and financial stability may bring performance problems in terms of budget, project schedule and quality.

To achieve the right quality of workmanship there should be proper management of subcontract work.

2.4.9 Care in concreting

Munderu (1990) notes that proper workmanship is not met on site due to carelessness by the workers. However, this can be overcome if the workers are well motivated and well supervision.

2.5 QUALITY IN BUILDINGS

BS 4778 defines quality as the totality of features and characteristics of a products or service that bear upon its ability to satisfy a given need.

Quality in buildings depends to a large extent upon:

a) Quality of workmanship on site during constructions.
b) Quality of initial design
c) Quality of component parts and materials specified
d) Occupiers use of the dwelling.

Poor performance and inadequate quality in housing can result from a building 'fault' in design material or construction which manifests during the life of the building given certain precursors as a "defect" (Griffth 1990).

The BRE defines building faults and defects in context of quality as follows:

Building fault: A departure from good practice as defined by criteria in Building Regulations, British standards and codes, the published

recommendations of recognized authoritative bodies, and a departure from design requirements where these were not themselves at fault.

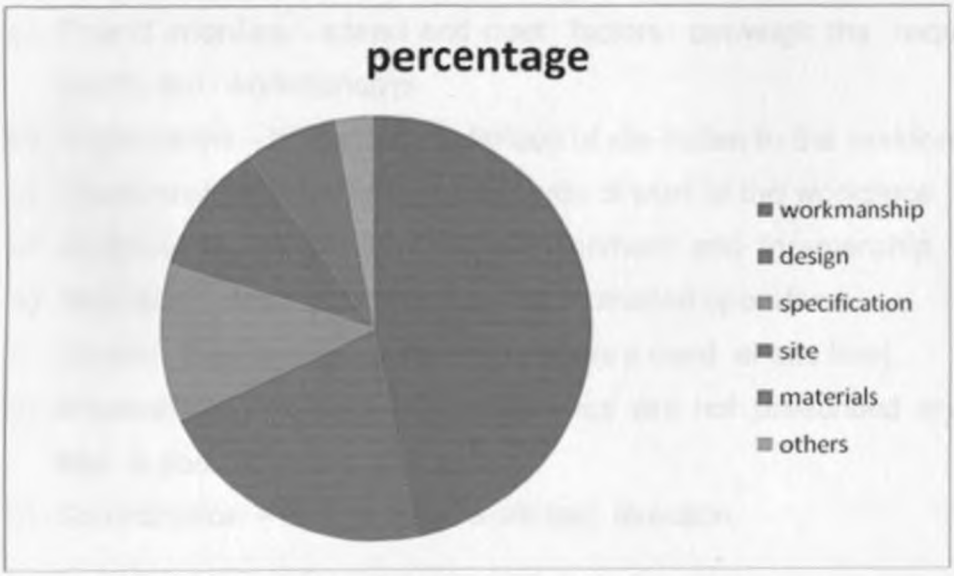
Building defect: A shortfall in performance as a result of a building fault.

The BRE study 'Quality in Traditional Housing' (BRE 1982) presents a clear indication of performance and quality in masonry construction through investigation of building faults.

A survey of 1725 dwellings in both public and private sectors housing in England identified over 900 individual types of building faults classified into over 100 different groups of faults.

Nearly one half (48%) of the se faults types were judged to have originated due to poor workmanship. One quarter originated in design process and one quarter attributed to deficiencies in building materials and components.

Chart 2.1: Origin of types of building faults



Source; Quality in traditional housing BRE (1982).

The largest category of problems these resulting from poor workmanship were said to result from the general lack of care during execution of the work on

site with inadequate supervision and independent inspection being a significant influence.

2.5.1 Problems of achieving quality

These problems pervade due to:

- Historic separation of design from construction.
- Poor communication of design requirements
- Design is difficult to build
- Complex contract documentation
- Poor labour skills and supervision
- Unrealistic time and cost assessment.

Specific problems surrounding the achievements of quality can be broadly categorized into two areas:

Construction

a) Project priorities - speed and cost factors outweigh the requirements for quality and workmanship.
b) Organization – Inadequate definition of site duties to the workforce.
c) Workmanship – inadequate standards of work at the workplace.
d) Supervision - inadequate site management and foremanship
e) Motivation – Inadequate skilled and motivated operatives.
f) Control - Few quality control procedure s used at site level.
g) Information- yardsticks of performance are not prescribed and information flow is poor.
h) Co-ordination – lack of teamwork and direction.

Design

a) Detailing – Inaccurate or inadequate detail of design concepts.
b) Specification – incorrectly specified or misused materials and components.

c) Legislation- Inadequate knowledge or disregarded for compulsory legislation or advisory documentation
d) Co-ordination – Inadequate co-ordination between client/designer and contractor.
e) Communication - poor interaction between client and designer and designer and contractor.
f) Supervision – inadequate supervision of construction by client and designer.
g) Build ability – Lack of design empathy for construction.

2.5.2 Organization for quality

1) Client

Clients in the construction industry range from individual to corporate bodies. They may be either in private or public sector.

A client or a developer is in charge of the whole process and were it not for his financing there would be no project. He is concerned with giving the brief and also appointing the consultants. In most cases he approves the tender list and this has a major influence on the choice of contractors. He therefore, influences the kind and quality of services offered. It is important that clients should appoint consultants of known repute and integrity.

2) Design team

They are the design consultants comprising consultants of architects, engineers and quality surveyors who play a crucial role in ensuring that a building is constructed properly and also protecting the interests of the client.

a. Architect

He directs quality achievements by way of identifying specifications suitable for the client's requirements, which are communicated to the contractor by the quantity surveyor in the bill of quantities.

The architect visits the site appropriately to monitor the progress of work. He has substantial power under the main contract to enable him enforce quality standards.

The Joint Building Council (JBC), 1999 Edition, Agreement and conditions of Building contracts clause 23 gives the architect the powers to reject material and workmanship by the contractor which are not in accordance with the contract. All these powers would appear to imply a clear duty on the part of the architect to ensure that the finished building product complies in every respect with the specifications.

To ensure quality enforcement, he may involve a clerk of works who is to be present on site to continually check on the construction methods and record the happenings on site.

b. Engineer

The responsibilities an engineer owes to his client are extensive and matched by greater powers to control work on site. To ensure the necessary integration of the functions of design and construction, the engineer has powers for controlling the site. He can call for details of the contractors proposed constructions methods and if he has a good reason not to be satisfied with them, he may reject them. Generally his duties during the constructions stage include:

- Inspecting and testing during installation of electric and mechanical material, machinery and plant for inspiration in works.
- Make visits to the site as the consulting engineer in order to satisfy himself as to the performance of any staff appointed as technical staff. He also checks whether works are executed as per the contract and whether in accordance with good engineering practice.

c. The Quatity Surveyor

The Quantity surveyor engage in a construction project knowing very well that the clients objectives are to maximize value for money and get the project completed to the required quality and in time. He controls and advises on costs and thus influences the quality of work. The JBC (1999) Agreement and conditions of building Contracts, clause 8.3 provides that the quality and quantity of work included in the contract price is that set out in the contract bills. Therefore the quantity of work included in the contract price is that set out in the contract bills. Therefore, the quantity surveyor in his preparation of bill of quantities should take a keen note on the client's requirements.

Broadly, the design team has the responsibility to ascertain that construction is per the design. Hence they are quality enforcers.

3) Contractors

Ashford (1989) indicates that the contractors main objectives of being in the project is to maximize on profits, therefore a paper system of control of construction activities is the most significant precursor to achieving quality on the site. Being the producer of the building the contractor is charged with the responsibility of constructing as per the design and to the specification set out. The engagement of appropriate personnel on site is a step towards quality production .

On construction site the following people are responsible (Rougher, 1984):

i) Site Manager /Agent

This is the person responsible for the basic task of controlling and directing construction work process on site. Being the contractors' representative on site he should be able to handle workers and obtain the maximum efficiency from them and be in a position to select suitable men to occupy the key position under

him. He is required to fully understand the design and ensure proper implementation.

On large projects the site agent should be engaged on full time basis, his duties on site include:

a) Co-coordinating work of the main contractor and subcontractors to ensure that the contract is accomplished on time and it complies with the specifications.
b) Issuing instruction to the general labourers through foremen.
c) Working in conjunction with the clerk of works to ensure that progress and quality of work are maintained.
d) Receiving instructions from the architect or head office and actualizing them on site.
e) Checking that the quality standards administered on site are reasonable.
f) Organizing for tests and inspections to be carried out.
g) Ensuring economical utilization of the resources to the best possible advantage.

ii) General foreman

As a labour controller in the management team, he is in the best position to judge the suitability or otherwise of the labour employed. His knowledge of building work and technical experience is required for him to be able to recruit and handle workers he should be familiar with the plans and specifications of all trades.

He is the person directly involved in the field where construction is taking place entailing him to handle tasks such as:

- Ensuring that there is smooth work progress throughout the day as had been planned by the site agent, by issuing detailed instructions to foremen.
- Compiling the daily labour and materials requirement on site.
- Contributing in translation of the drawings into the finished structure.

and mainly employed on casual basis. They therefore require close supervision.

For them to perform well, the contractor needs to motivate them through monetary forms (wage rise bonuses) or non monetary forms (promotion, recognition) and creation of a conducive working environment. This boosts the operatives' morale to work to their best.

2.6 SPECIFICATIONS

The importance of good, workmanship on building sites is self evident and the need to specify this important aspect adequately cannot be over emphasized, but adequate specification has in the past never proved easy to achieve (Willis, 1997).

Specification can be described as a concise and complete description of workmanship and materials to be incorporated in new construction alterations or repairs (Smith, 1982).

Watson (1978) further defines specifications as a statement containing a minute description or enumeration of particulars as of the terms of a contract or the details of construction not shown on architect's drawings.

Consequently, specifications a statement must contain all the contractor needs to know as to: -

i) Standards of workmanship
ii) Scope of workmanship
iii) Material quality and quantities
iv) Condition of contract

These will enable the contractor to prepare a bonafide bid and give guidance as to work execution during construction.

2.6.1 Purpose and use of a specification

All building contracts require a written specification to instruct or direct for the following purposes (Bowyer, 1981).

a) To be issued as an architect's instruction to the clerk of works and builders site management staff to enable them, in conjunction with the drawings, to interpret the architects precise intentions in respect of materials to be used and standard or workmanship to be employed.
b) For the use of a builders estimator, in conjunction with the drawings, to enable him to prepare an estimate of the cost of the work prior to submitting a tender.
c) For the use of the Quantity surveyor, in conjunction with the drawings to ascertain precisely the architects intentions regarding workmanship and materials, so that he can prepare Bill of Quantities, which enable competitive tenders to be obtained for the work.
d) Specifications segregate the work shown on the drawings into trade sections and into units of work so that a general contractor can sublet the work to various sub contractors.
e) Specifications establish inspection and testing procedures to be followed during the construction operations.

2.6.2 Contents of specifications

The specification is drafted to convey to the reader all the information about a proposed building which the architect cannot easily show on the drawing (Willis, 1997)

The writing of specification, requires great power of concentration and a full and detailed knowledge of building materials, methods of working and craftsmanship. Too many specifications are badly written, slipshod and in precise and can open the way to claims for extension.

2.6.3 Essentials of a specification writer

A specification writer must be:

a) Clear as to exactly what the architect has in mind when he prepared or issued the detail drawings for the project.

b) Able to express the architect's requirements in clear, technical and precise written form free from any ambiguity (Bowyer, 1981).

2.6.4 Objectives of the specifications

The main objective of specifications is to make it quite clear to the context how far his responsibilities go and exactly what is required of him (Macey, 1955)

This is so that: -

i) Mistakes and misunderstandings when construction is in progress can be avoided

ii) The architect will avoid unforeseen claims at the final account stage.

iii) To provide a legal basis for an architect to ensure that work are carried out according to his intentions.

2.6.5 Types of specification

In general there are two approaches to the writing of specifications (Willis, 1997)

a) Method system

b) Results system

2.6.5.1 Method system

When this system is used the specifer describes in detail: -

i) Materials

ii) The workmanship

iii) Installation and erection preceding.

There was to be used by the contractor in the conduct of work operation in order to achieve the expected results.

2.6.5.2 Results system

When this method is used the responsibility is placed on the contractors for securing the desired results whatever method he chooses.

The method system is popularly referred to as descriptive specification where as results system is referred to as performer specifications.

a. Descriptive specification

A descriptive specification can be defined as one that describes in detail the materials to be used and the workmanship required in fabricating, erecting and installing the materials. This method relies heavily on the availability of information and experience of the specifier.

b. Performance specification

Here the contractor is required to obtain results consistent with an existing situation. Since the end is the most significant goal, a performance specification can be defined as specifying the final product by formulating the standards for its accomplishment. The standards for materials are established on the basis of physical properties of the end product.

c. Reference specification

The reference specification is the one that makes referenced to a standard that has been established for either a material, a test method or an installation procedure.

The term reference specification can similarly be applied to workmanship standards. Various trade associations normally prepare standard workmanship specifications that can be incorporated to project specifications. In this case one can use a material or component by simply inserting the clause "fixed or applied in accordance to manufacturers specifications".

Since some standard specifications cover several types of grades its important that the specifier familiarizes themselves with various grades and types of existing for the material in question.

d. Proprietary specifications

A proprietary specification is one in which the specifier states outright the actual make, model, catalogue number and so on of a product or installation of manufacturer.

2.7 BUILDING DEFECTS

A building defect may be defined as an imperfection, deficiency or fault in a building element or component, which adversely affects its functional performance or appearance (Lee, 1993).

Some defects are the natural consequence of ageing and normal use but many premature failures can be traced to a lack of proper skill and care.

A BRE study (1976) concluded that over 90% of building defects could be explained partly or wholly as the result of readily identifiable faults in design or construction which could have been foreseen and hence prevented.

2.7.1 Causes of defects

a. Construction methods

The conditions under which construction takes place are often far from ideal and, coupled with an emphasis on speedy completion, can result to poor workmanship.

Some manufactures have little awareness of the figures of a building site or the standards of accuracy achievable under such conditions. Thus, whilst the materials may be perfect on leaving the factory they can quite easily be damaged in transit, loading and unloading, unsuitable conditions of storage on site and hoisting and placing in position (Lee, 1993).

Many such defects could be avoided by: -

a. Ensuring greater care at all stages in the process
b. Proper training of operators

c. Closer supervision

To tackle this problem there is need to introduce the quality assurance techniques in construction industry developed in other industries such as Quality Assurance (QA) groups and circles (QC)

Essentially these techniques consist of setting down appropriate inspection procedure and specifying level of acceptance and rejection together with methods of sampling and testing the performance characteristics.

b. Inadequate brief

Lee (1993) notes that it is often said that defects start on the drawing board but in some cases they can originate at even earlier stage, for example, the brief may lay down totally unrealistic cost limits or fail to give vital information on the functional requirements of the buildings.

c. Faulty design decisions

The most common faults may be grouped as follows: -

a) Failure to follow well established design criteria in the choice of structural system and selection of materials.
b) Ignorance of the basic physical properties of materials.
c) Use of innovative forms of construction or new materials, which have not been properly tested in use.
d) Poor communications between different members of the design and construction team.
e) Complex details, which have a low probability of successful execution or an open building site.
f) Misjudgement of user and climatic conditions under which the material will have to perform.

d. User activities

Defects may be caused by unintentional misuse through a lack of information on the correct mode of use or by deliberate acts of vandalism.

The solution is to provide the designer with more information on the degree of severity of use so that a better match can be made between the robustness of the fittings and finishing and the conditions of use.

e. Maintenance

Incorrect identification of the true cause of a defect, and inappropriate remedial work, will not only do nothing to rectify the original defect but may substantially worsen the condition of the building.

Lack of care in carrying out repairs and inspections may be the cause of defects in previously satisfactory elements (Lee, 1993).

2.7.2 Defects in concrete that are attributed to poor workmanship

Lee (1993) established the following defects and causes: -

1. Cracking and disintegration of concrete.

Causes

a) Weak concrete due to improper mix design, unsuitable aggregates or cement, wrong water.
b) Insufficient cover to reinforcement
c) Use of calcium chloride as an additive to accelerate setting of concrete
d) Over stressing caused by compressive, tensile or shearing forces.

2. Pattern straining and efflorescence on fair faced concrete

Causes

a) Formwork – use of different quality boards or mixture of old and new boards causing uneven attachment of concrete and irregular curing.
b) Excess water from freshly placed concrete running over surface of concrete underneath

3. Sagging and cracking

Causes

a) In adequate workmanship and / or design

b) Overloading

4. Brown stains

Cause

a) Rusting of reinforcement through penetration of water where cover of weak porous concrete is of inadequate thickness.

5. Deflection

Cause

a) Use of shrinkable aggregates in concrete mix

6. Detachment of plaster from background

Cause

a) Inadequate key to background material such as smooth concrete with perhaps oil films from formwork

7. Powdering of plaster

Cause

a) Improper setting and hardening of plaster attributable to unsound or stale material or unsuitable mix.

2.8 CONCRETE IN CONSTRUCTION

Chudley (1987) defines concrete as a mixture of cement, fine aggregate, coarse aggregate and water.

The most commonly used concrete in the Kenyan construction industry is the concrete formed with the common binding agent of Portland cement, and a loose mass consisting of sand consisting of sand and gravel. This is what most people mean when they use the term concrete for various forms of construction.(Ebole 2005)

Structural concrete is the most widely used type of concrete. It is classified into plain concrete, reinforced concrete and pre-stressed concrete. This type of concrete is widely used in the construction of buildings, dams, tanks, and host of other structures (Ireri 1998).

The structural members of concrete are more often than not made insitu and their quality is almost exclusively dependent on the workmanship of concrete making and placing (Neville, 2000).

Winter (1979) states that for concrete to achieve its best qualities there is need for good workmanship in mixing, transporting , compacting, finishing and curing of concrete in addition to careful selection of ingredients, correct grading of ingredients and accurate water measurement in the construction works.

The production process of concrete involves different parties, many independent operations and different categories of construction materials. The quality of concrete produced will depend on commitment, competence and experience of the involved parties, quality of each individual operation and the quality of each category of construction materials. Concrete has to be satisfactory in its hardened state, and also in its fresh state while being transported from the mixer and placed in the formwork (Neville, 2000).

2.8.1 Constituents of concrete

i) Cement

Cement is a fine powder manufactured from clay and limestone. It sets and hardens when mixed with water, although it is of structural use only when mixed with aggregate. It is possible to buy cement with additives. Additives are non-cementing materials such as blast furnace slag which change the properties of the cement. Some additives cause the cement to set quickly and are used when rapid construction is required. Cement manufacturers provide details of the additives when the cement is bought.

Cement should be kept dry during transportation and storage. Bags should be stored on pallets or another form of support which will allow ventilation and prevent ground moisture entering the bags. Bags should not be piled more than six bags high, although if space is limited and the bags will not be stored for long, they may be piled up to ten bags high.

ii) Filler

Filler is a very fine material and is used to fill the voids between the fine aggregate particles. It is often omitted if the fine aggregate used is sufficiently fine initially.

iii) Fine aggregate

Sand is nearly always used as the fine aggregate in concrete. It is a material with particle size ranging from 2 to 0.3mm. Up to 10% by volume of oversized particles (5 to 2mm) is normally acceptable, although if more than 10% it should be screened out by sieving. It is important to know the particle size and the mineral composition of the sand when concrete structures. Some fine aggregate minerals are very weak. If particles can be pulverized by squeezing in the hand, the sand is not suitable for use.

iv) Coarse aggregate

Coarse aggregate contributes most of the concrete's compressive strength through its high particle strength and close particle interlock. Coarse aggregate particles should be between 50 and 7mm, although a reduced maximum size maybe specified if the structure is to be reinforced. Coarse aggregate can be produced by quarrying and crushing rock or excavated from a gravel quarry. Coarse aggregate can also be crushed and selected manually. The aggregate should always be sieved to remove undersized particles.

v) Water

The water used in concrete should be clean and free of organic material and salts, including chlorides, although for low cost structures the salt content and some suspended solids can be ignored. Most surface water is good enough for concreting work, but care should be taken when using ground water. A shortage of water must not disrupt the concreting operation, so water should be either readily available nearby or stored in sufficient quantity on site.

2.8.2 Materials and workmanship

Failure to observe design detail and poor quality control, incorrect placement of the concrete, inconsistent mixes, inadequate compaction or vibration, cement/water ratio not being adhered to, poor curing of the concrete, inadequate cover to steel reinforcement, allowing corrosion promoting chemicals to be included during mixing and placement are all factors which affect the durability of concrete.

Materials and workmanship in the construction of concrete buildings are potential sources of problems. For example, aggregates used in concrete, such as certain crushed brick, absorb water and produce a weak and porous concrete. Alkali-

aggregate reactions within the concrete can result in cracking and white surface staining. Aggregates are not always properly graded by size to ensure an even distribution of elements from small to large. The use of aggregates with similarly sized particles normally produces a poorly consolidated and therefore weaker concrete.

In addition, concrete is not vibrated well when poured into forms as it should be. More often it is tamped or rodded to consolidate it. These practices tend to leave voids (areas of no concrete) at congested areas, such as at reinforcing bars at column heads and other critical structural locations. Areas of connecting voids seen when concrete forms are removed are known as "honeycombs" and can reduce the protective cover over the reinforcing bars.

Other problems caused by poor workmanship known today are; if the first layer of concrete is allowed to harden before the next one is poured next to or on top of it, joints can form at the interface of the layers. In some cases, these "cold joints" visibly detract from the architecture, but are otherwise harmless. In other cases, "cold joints" can permit water to infiltrate, and subsequent freeze-thaw action can cause the joints to move. Dirt packed in the joints allows weeds to grow, further opening paths for water to enter. Inadequate curing can also lead to problems. If moisture leaves newly poured concrete too rapidly because of low humidity, excessive exposure to sun or wind, or use of too porous a substrate, the concrete will develop shrinkage cracks and will not reach its full potential strength.

Structural Design Defects in historic concrete structures can be an important cause of deterioration. For example, the amount of protective concrete cover around reinforcing bars was often insufficient. Another design problem in early concrete buildings is related to the absence of standards for expansion-contraction joints to prevent stresses caused by thermal movements, which may result in cracking.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 RESEARCH DESIGN

For the researcher to achieve the objectives of the study, the researcher has adopted survey research. Survey research seeks to obtain information that describes phenomena by asking people about their perceptions, behaviours and opinions (Mugenda, 1999). For the survey, the problem has a social dimension with a vast population to be observed directly.

Data was collected from on-going construction projects where relevant information was gathered through interviews and direct observations. Questionnaires were administered to architects, contractors and workers on construction sites.

Given the constraints in time and resources, a sample size of 40 sites has been considered for data collection. Simple random sampling has been used to get a true, representative sample from the accessible population. All the construction sites in Nairobi had an equal chance of being considered for data collection.

3.1 SAMPLING METHOD AND PROCEDURE

3.1.1 Population

The accessible population in this study consists of;

- Ongoing construction sites within Nairobi City.
- Architectural firms.

The level of workmanship was observed from work already done on sites while other data such as the causes of poor workmanship was collected by interviewing the various professionals and workers involved.

Nairobi has many construction sites within any given moment due to its rapid growth. Most of the work is within Central Business District and the suburbs. The

sites that form the population are sites in 20 zone of Nairobi obtained from the Department of City planning in Nairobi City council.

For each of the site only the main contractor and one of the workers were interviewed.

The second category of target population was the architectural firms whereby the accessible population was made up of the firms based in Nairobi. The number of architectural firms was obtained from BORAQS. This number of registered consulting firms was however assumed to be actively participating in construction as of now. BORAQS gave a number of 182 registered architectural firms.

3.1.2 Sampling methods

The accessible population in this research is composed of all ongoing construction sites in 20 Nairobi zones. Since the number of site is too large, the researcher randomly selected two zones for the study;

- Zone one which includes Central Business District and Upper Hill area.
- Zone four which include Spring Valley, Riverside, Kileleshwa, Kilimani, Thompson and Woodley.

The researcher did reconnaissance study and established a number of 40 ongoing construction sites in the two zones.

For the architectural firms, the researcher sampled out of the population of 182 firms into a conservative size that would be a true representative of the larger population.

The sample size will be composed of 52 architectural firms and 42 construction sites. The researcher did not get the sample of the architects from the sites identified due to limitation of time and money. Since the problem studied is common to all sites, the sample was obtained from the practicing architects in Nairobi.

3.1.3 Determination of the sample size

A list of all practicing and registered architectural firms had 182 firms. In sampling out the researcher assumed a confidence level of 95% which then results to positive or negative error.

The sample size was then calculated as follows:-

$$n = \frac{z^2.p.q.N}{e^2.(N-1)+z^2.p.q}$$

(Source: Chava F and Nachmias D, 1969)

Where;

N= size of the population

n= sample size

p= sample proportion

q=1-p

e= acceptable error (e= 0.05) that is estimates to be within 5% of the true value.

Z= value of the standard variant at a confidence level (area under normal curve in the distribution table)

Therefore;

For the architectural firms the following was obtained:

$$n = \frac{(1.96^2).(0.95).(1-0.95).(182)}{(0.05)^2.(181)+(1.96)^2.(0.95).(1-0.95)}$$

$$= \mathbf{52}$$

3.2 DATA COLLECTION PROCEDURES

Observation and interview were the methods of data collection used for this study. The data on level of workmanship at each sample site which is the dependent variable was collected through observation with aid of checklist while the independent variables which are the quality management factors will be collected through questionnaires administered to the parties involved in construction as well as a through observation with an aid of checklist.

Questionnaires and checklists were the instruments of data collection used. Questionnaires were administered to architects, contractors and workers on site while the checklist was used by the researcher to observe the level of workmanship on sites.

For ease of administering the questionnaires and analyzing of data the researcher used structured (closed ended) questionnaire developed from the objectives of the research which were intended to give information on independent variables that relate to experience, knowledge, motivation of workers as well as tools and equipments they use.

The dependent variable, workmanship, was measured through a checklist. The operational definition of workmanship has been taken as the amount of defects on work done and, therefore, the checklist comprised of possible and easily identifiable defects on concrete work which are due to workmanship. These include; cracks disintegration of concrete and detachment of plaster.

The researcher went to the sites and made observation on the level of workmanship in the checklist by giving a zero (0) mark where a defect was observed and one (1) mark where a defect was missing

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3.3 MEASUREMENT OF VARIABLES

A variable is a measurable characteristic that assumes different values among the subjects. It is therefore a logical way of expressing a particular characteristic in a subject. (Mugenda and Mugenda, 1999).

There are different classifications of variables;

3.3.1 Independent variables

An independent variable is variable that a researcher manipulates in order to determine its effect or influence on another. Independent variables are selected because they are seen to be causative or very important to the particular logical purpose of the research project.

In this study the quality management factors were viewed as the independent variables. These include; level of training for workers, experience, supervision, lack of care, availability of proper tools and equipments, clarity in specifications, subcontracting, workers motivation and communication on sites.

The measurement of the components of this variable was in an ordinal scale as can be derived from the descriptive nature of the study.

An ordinal scale groups subjects into categories and ranks them into some order with numerals reflecting increasing amount of the characteristics but not at intervals. The numerals are used to represent relative position or order among the values of the variables. However, the order indicated in an ordinal scale does not imply quantitive diction (Mugenda and Mugenda, 1999).

Based on the responses from the questionnaires and also through observation, each site was given a score of either zero (o) or one (1) for each of the components of the independent variables to indicate its performance in that aspect. For example, a site that was deemed to have excelled well in supervision would score one (1) for supervision while a site that has not excelled would score zero (o). This was done for all the components of the independent variable for every site studied.

The cumulative score for every site was assumed to form an interval scale and thus a measurement of quality management factors. Therefore a site that has excelled and scored one (1) in each of the components of the independent variable would have a cumulative total of nine (9). A site that scores zero (o) in every component of the variable would have a cumulative total of zero (o) and its score of independent variable will therefore be taken as zero (o).

In an interval scale, the numerals reflect increasing amount of the characteristic with equal interval (Mugenda and Mugenda, 1999).

Table 3.1: Scoring for quality management factors.

Determinant	Maximum score
Training	1
Supervision	1
Lack of care	1
Experience	1
Availability of tools and equipments	1
Clarity in specifications	1
Subcontracting	1
Motivation on workers	1
Communication on site	1
Total	**9**

3.3.2 Dependent variables

For the dependent variables, their results are presumed to depend upon differences in the independent variables. A dependent variable therefore varies as a function of the independent variable.

In this study, the level of workmanship on construction sites was viewed as the dependent variable because it should vary in some relationship to independent variable. It was measured in interval scale. Six observable defects have been identified for determining the level of workmanship achieved on site.

The marks (o) or (1) on the level of workmanship have been transformed into points such that a site without defects scores 6 points while a site with all the defects observed gets no point. This means that a site loses a point for the presence of each of the six defects.

Table 3.2: Scoring for level of workmanship

Defect	maximum score
Cracking	1
Disintegration	1
Deflection	1
Detachment of plaster	1
Inadequate reinforcement cover	1
Brown stains	1
Total	**6**

3.4 DATA ANALYSIS TECHNIQUES

Since this is a qualitative research, data presentation and analysis is mainly in the non-empirical forms. Thus, the study has adopted descriptive analysis with simple percentages to represent the proportions of various outcomes. However, inferential statistics has been applied to assist in testing hypothesis.

CHAPTER FOUR

DATA COLLECTION, PRESENTATION AND ANALYSIS

4.0 INTRODUCTION

The data collected includes that from questionnaires administered to contractors, architects, and workers on construction sites as well as data collected with use of a checklist. Architects interviewed were not necessarily the ones being involved in the identified sites since the questions were general.

In the construction sites identified, the contractor and one of the workers dealing with concreting were interviewed. A checklist was used to observe the level of workmanship and the level of quality management factors.

Out of a sample of 42 sites, 35 sites provided full response, presenting 83% which is reasonable and sufficient for proceeding with the analysis.

For the architects, out of a sample of 52 architects, 32 architects provided a full response.
This represent 62% response rate which is sufficient for the analysis.

4.1 FINDINGS AND ANALYSIS

Descriptive analysis has been used with some of the data being presented in form of tables showing broad percentages and ratios and by way of describing the responses to various questionnaires. The results obtained are then analyzed to give a basis for drawing up conclusions.

4.3 RESPONSE FROM THE CONTRACTORS

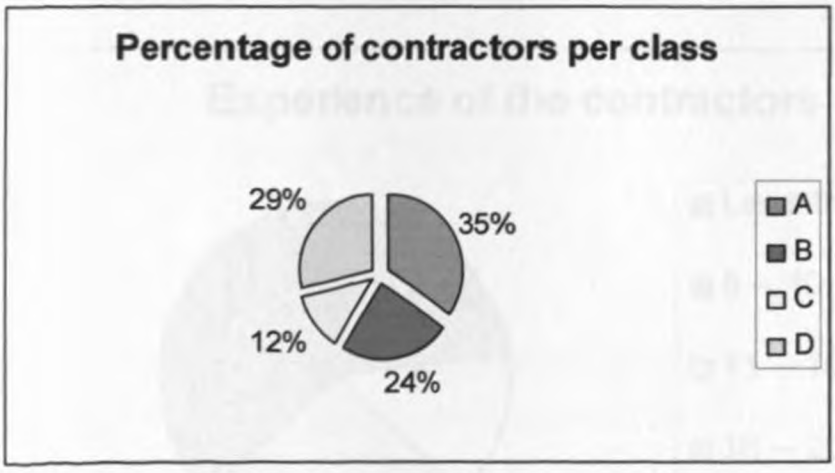
Out of the sites identified, the breakdown as per grade of the contracts is as shown in table 4.1

Table 4.1: categories of contractor

Grade of contractor	Number of sites	Percentage (%)
A	12	35
B	8	24
C	5	12
D	10	29
Total	35	100

Source: field survey, April 2007.

Chart 4.1: Breakdown of contractors as per grade



Source: field survey, April 2007.

No site with contractor below grade D was studied. It was not the intention of this study to stratify the contractors as that could complicate the study further. However, it is hoped that the findings of this study would be applicable to contractors of all grades.

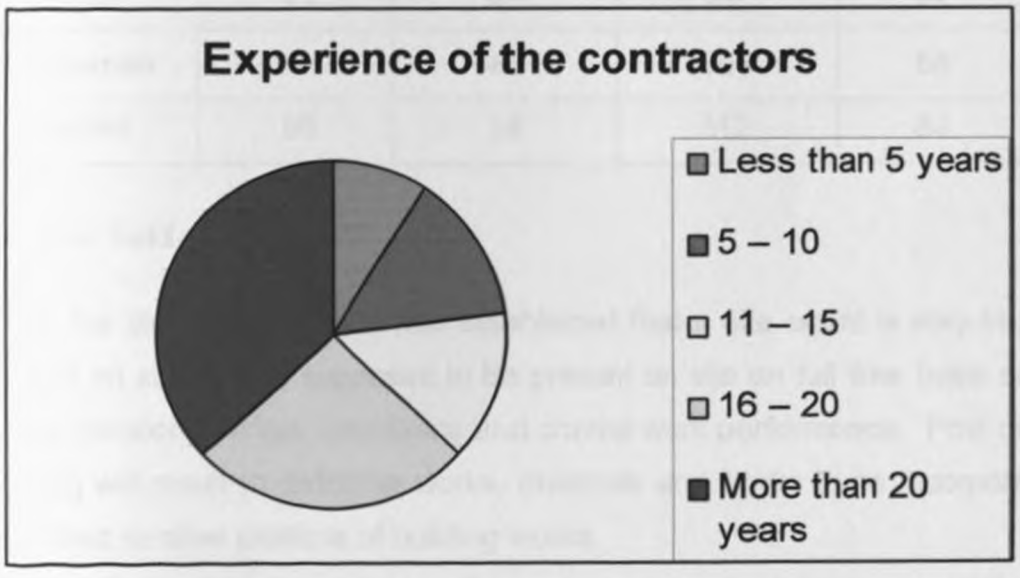
All the contractors in the studied sites were general building contractors.

Table 4.2 Working experience for the contractors in the building industry

Experience (years)	No. of respondents	Percentage (%)
Less than 5 years	3	9
5 – 10	5	14
11 – 15	5	14
16 – 20	9	26
More than 20 years	13	37
Total	**35**	**100**

Source: Field survey, April 2007

Chart 4.2: Working experience of the contractors



Source: Field survey, 2007

40% of the respondents had been in operation for more than 20 years. This implies that the information given in the study is by contractors who have had enough experience in the construction industry over the years.

The difference in years of experience also depicts the different experiences, opinions and views that will be highlighted by the respondent

Table 4.3: persons engaged on site

Person	**Mode of engagement and numbers of people on site studied**			
	Permanent	Percentage %	**Temporary**	Percentage %
Site agent	29	**83**	6	**17**
Foreman	36	**64**	20	**36**
Tradesmen	114	**45**	140	**55**
Operative	96	**16**	512	**84**

Source: field survey, 2007

From the literature review it was established that a site agent is very important person on site. He is supposed to be present on site on full time basis so as to make decisions, direct, coordinate and control work performance. Post decision making will result to defective works, materials and works to be incorporated or extended to other portions of building works.

Most of the tradesmen and operatives were engaged on temporary basis. This gives rise to mobility of labour in construction industry which eventually has a negative impact on quality performance because it becomes hard to motivate temporary labour.

Moreover, for most of them their main motive is not quality performance but just earn their deal for the day.

Table 4.4: preference criteria for labour

Factors	Rating							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Mean**
Job Experience	21	12	2	0	0	0	0	**1.46**
Technical Experience	8	19	5	3	0	0	0	**2.09**
Academic qualification	1	2	17	10	3	2	0	**3.51**
First come first served	0	2	9	23	1	0	0	**3.66**
Familiarity to management	1	0	1	1	3	17	12	**5.97**
Age	1	0	0	0	4	8	23	**6.57**
Renumeration	3	0	0	6	18	8	0	**4.7**

Source: field survey, 2007

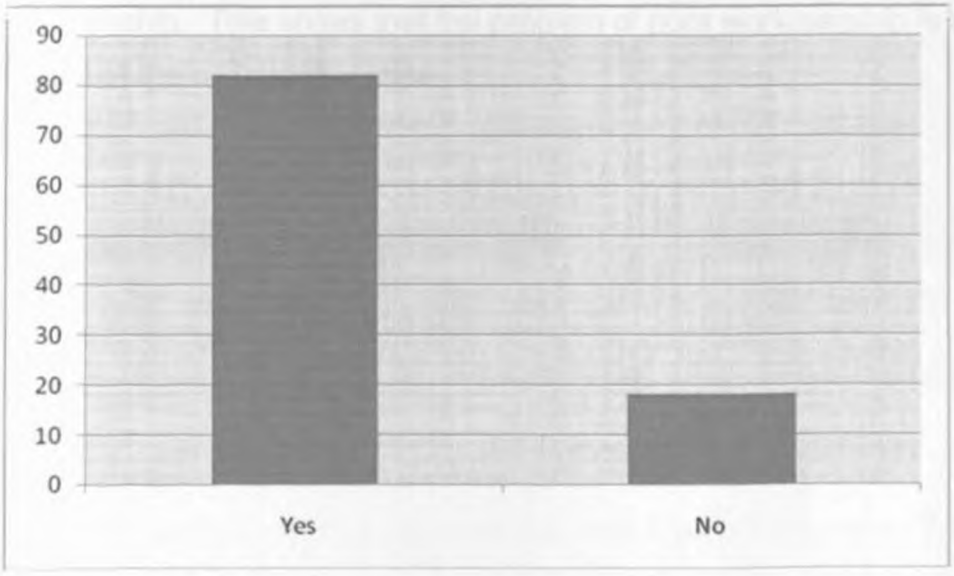
The researcher computed the significance factor for each of the criteria selected by the respondents and this was used in arranging them in order of preference. The factor with the lowest mean shows the most preferred factor while the one with the highest mean shows the least preferred factor.

From the above table, the preference criteria is as follows (starting with the most preferred).

a) Job experience
b) Technical qualification
c) Academic qualification
d) First come first served
e) Remuneration or salary
f) Familiarity to management
g) Age

Most respondents gave job experience and technical qualification the first priority in recruitment of labour. This could be for the reason that much of the construction work requires post experience in order to be in a position of tackling the job well. Technical qualification is a critical factor for consideration because construction requires technical skills to enable one understand the technical part of construction for better execution of work. Most contractors cited 'age' as the last criterion to consider in labour recruitment saying that almost all of the people who come seeking for jobs were adults.

Chart 4.3: Whether contractors carried out job analysis



Source: field survey,2007

Job description increases the chances of getting the right person to match a certain job as most of the tasks are technical. This will enhance on efficiency and improve on the quality of workmanship on site. 18 per cent of the contractors were against the system of undertaking job analysis and description arguing that one will learn from experience on site and that job analysis and description discourages flexibility as they required someone who would be flexible to tackle job arising on site.

This clearly shows that such contractors do not care much about the labour handling a particular job whether the person is competent to do it up to the required standards or not.

4.3.1 Poor workmanship

In response to the question as to whether the contractors experienced a problem of poor workmanship, 29 contractors (83%) said that they experienced the problem. Out of this, 31% cited that they often experience it but 52% cited that they experience it rarely.

Only 17% contractors said that they do not experience the problem of poor workmanship. This shows that the problem of poor workmanship is experienced in most of the construction sites.

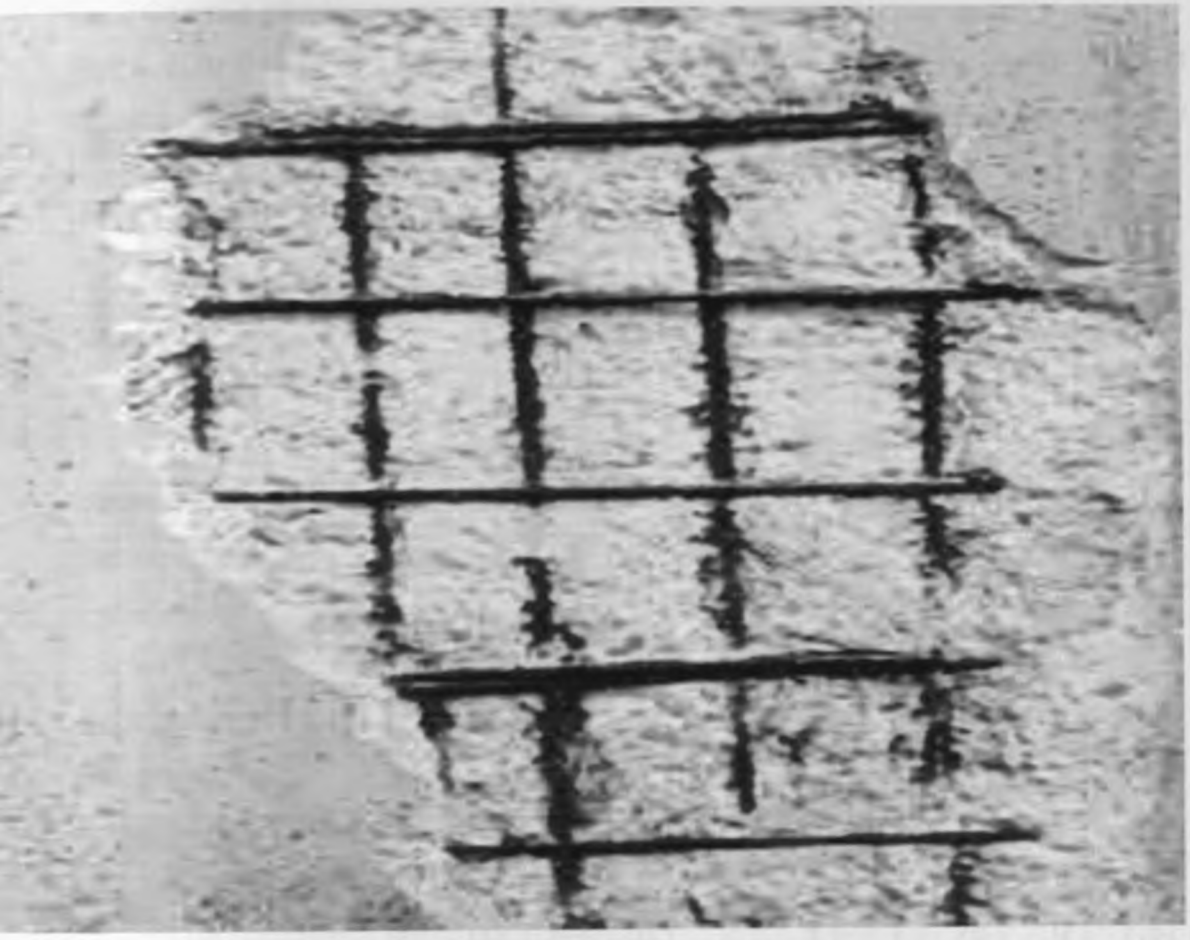


Plate 01: Inadequate concrete cover over the steel reinforcement has caused the steel to corrode. As it expands it causes the concrete to crack and spall.

4.3.2 Causes of poor workmanship

Respondents were asked to rank the causes of poor workmanship in order of importance starting with 1 as the most important. The researcher calculated the significance factors for each cause in order to rank them.

Table 4.5: Causes of poor workmanship

Cause	Rating									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Mean**
Training	4	2	3	10	14	1	1	0	0	**4**
Supervision	28	3	2	1	1	0	0	0	0	**1.4**
Carelessness	1	3	2	21	2	5	1	0	0	**4.1**
Experience	2	17	11	1	3	1	0	0	0	**2.7**
Tools &equipment	0	0	1	2	9	18	5	0	0	**5.68**
Specifications clarity	0	8	16	0	4	2	4	1	0	**3.77**
Subcontracting	0	0	0	0	0	6	14	5	10	**7.54**
Motivation	0	0	0	0	2	1	7	25	0	**7.57**
Communication	0	2	0	0	0	1	3	4	25	**8.23**

Source: field survey, 2007

The researcher computed the mean for each of the causes depending on the responses. The cause with the lowest mean indicates the most important cause while the one with the largest mean indicates the least important factor.

From the given table, the causes can be ranked as follows:

1. Lack of close supervision
2. Lack of experience at work
3. Lack of clarity in specification

4. Lack of training for workers
5. Lack of care when concreting
6. Lack of proper tools and equipments
7. Subcontracting
8. Lack of motivation on workers
9. Poor communication on site.

Table 4.6: Response on factors considered the most important in improving quality of workmanship

Factors	Very important	Important	Less important
Improve training and learning	83%	17%	-
Improve on inspection	100%	-	-
Workers selection criteria	18%	82%	-
Reducing subcontracting	-	40%	60%
Motivation of workers	29%	54%	17%
Availing proper tools and equipment	33%	67%	-
Improving communication on site	20%	80%	-

Source: field survey, 2007

The information shows that the most important factor in improving quality of workmanship is enhancing on inspection with 100% of the respondents affirming this. Improving on training and learning of workers was also a very important factor to consider with 83%.

Workers selection criteria and improving communication on site and equipments were considered as just important with 82% and 80% respectively. Reducing subcontracting was cited as less important with 60% of the respondents indicating this.

Contractors were also asked whether it is possible to achieve zero defects in construction 100% of the contractors said No citing the some of the reason as:

a) Workers are apt to making errors.
b) Counterfeit materials are common in the construction industry.
c) Nature of construction projects is unpredictable.

The above question was asked to see if contractors believe that it is actually possible to work towards defects prevention rather than rectification and in the end achieve continuous improvement.

The construction industry is an assembly industry and this means that quality depends on very many parties not just on the contractor alone and other external factors as well. Unless all these conditions work together unto the good, poor workmanship will always be there.

4.3.3 Improving quality

One of the questions sought to examine as to what is being done to motivate workers to work right the first time. 85 per cent of the respondents cited increase of workers wages as the major consideration. Giving workers longer work contracts was also seen as a major factor in improving quality with 62% of respondents supporting it.

Only 14% of the contractors were on the opinion that employing a supervisor who knows the workers would help in improving quality.

Asked whether employing workers on a permanent basis would help to improve on quality, 100% of the respondents said Yes giving some of the reasons as:

i) Workers will feel being part of the construction company and thus will do their best to improve on quality.

ii) Workers will gain wider experience.

Table 4.7: Existence of quality assurance department

Response	No. of respondents	Percentage (%)
Yes	26	74
No	9	26
Total	**35**	**100**

Source: Field survey, 2007

The above table shows that most of the construction companies (74%) have a Quality Assurance department established in most of them since inception of the companies. The contractors stated that the main aim of its establishment was due to pressure out of competitiveness and the need to ensure the quality of work. As observed in the literature review, for a contractor to remain competitive in today's global market, he must integrate quality assurance system in his areas of organization. This could be through the establishment of such a department to deal with quality management.

For the 26% firm without a quality assurance department, 80% were willing to establish one so that there can be a department that specializes with quality affairs of workmanship, labour and materials. They further explained that this would mean to cutting down the expenses incurred due to lack of quality and would also promote the firm's image.

4.3.4 Work inspection

Most of the firms indicated that statutory bodies inspected works occasionally although this was seen to depend more on the location of the site. 65% of the respondents noted that the architects carried out work inspection on ongoing construction sites very often while 35% noted that architects did inspection rarely. Inspection of works gives way to ensuring that quality work is in place.

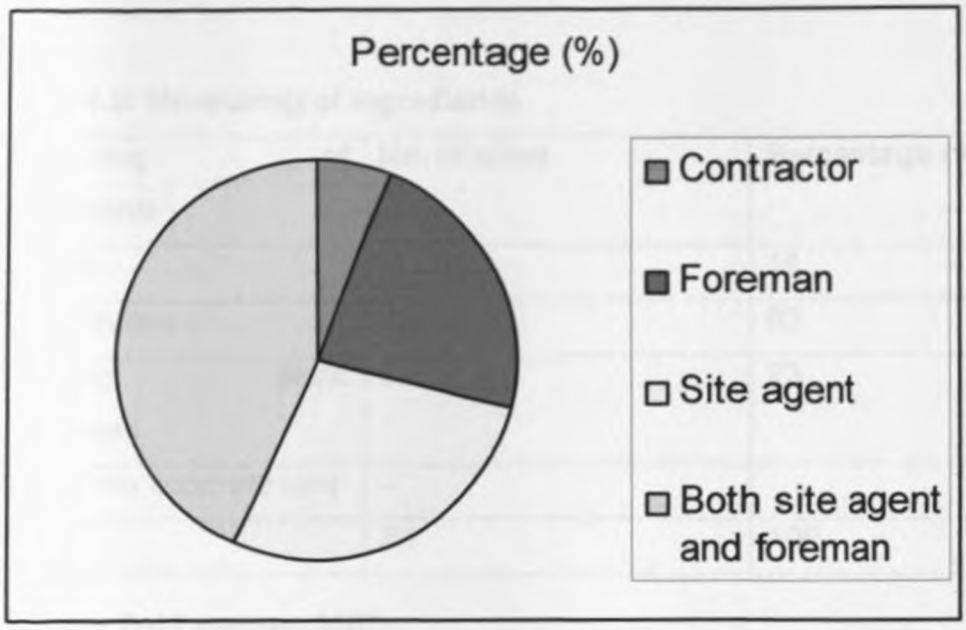
All respondents perceived a role of the central government in ensuring quality on construction site by making sure that the regulations set are adhered to and also by approving work being executed.

Table 4.8: Person responsible for supervising construction work on site

Person	No. of respondents	Percentage (%)
Contractor	2	6
Foreman	8	23
Site agent	10	28
Both site agent and foreman	15	43
Total	**35**	**100**

Source: field survey, 2007

Chart 4.4: Persons responsible for supervising work on site



Source: field survey, 2007

The above table shows that in most of the sites, both the site agent and foreman are the ones responsible for work supervision on site with 43% of the respondents supporting that. Contractors rarely supervise work on site simply because they are rarely on site.

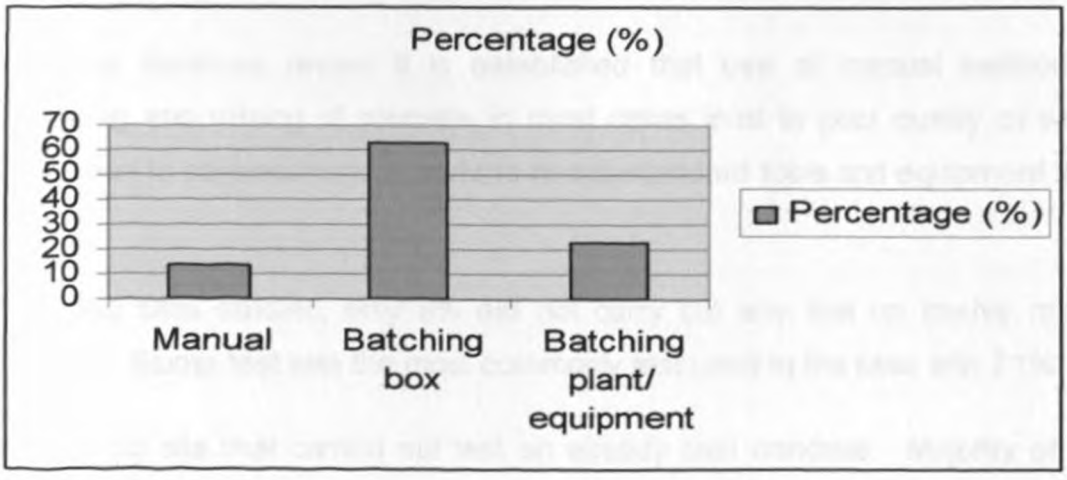
4.3.5 Measuring and mixing of concrete

Table 4.9: Measuring of ingredients

Measuring of ingredients	No. of sites	Percentage (%)
Manual	5	14
Batching box	22	63
Batching plant/ equipment	8	23
Ready mix concrete user	-	-
Total	35	100

Source: field survey, 2007

Chart 4.5: Methods of measuring concrete ingredients



Source: Field survey, 2007

Table 4.10: mixing of concrete

Mixing of concrete	No. of sites	Percentage (%)
Hand mixed	3	9
Concrete mixers	32	71
Ready mix concrete used	-	-
Total	35	100

Source: Field survey, 2007

Use of batching boxes for measuring of concrete ingredients was the most common with 63% of the respondent using it. However 23% of the sites used batching plant or equipment while only 14% of the sites used manual method of measuring the ingredients.

Mixing of concrete was mostly by use of concrete mixers with 91% while only 9% used hand mixing up concrete. This could be attributed to the readily availability of concrete mixers for hire and the labour intensiveness that concrete requires.

From the literature review it is established that use of manual method of measuring and mixing of concrete in most cases lead to poor quality of work. This id due to carelessness of workers or sub-standard tools and equipment they use.

Of all the sites studied, only 9% did not carry out any test on freshly mixed concrete. Slump test was the most commonly test used in the sites with 71%.

There is no site that carried out test on already cast concrete. Majority of the sites (63%) delivered their concrete into position by use of hoists and cranes while only 37% delivered it manually.

The respondents were finally requested to give some recommendations to be implemented in the building industry in order to achieve quality workmanship on

sites most of the respondents gave different opinions hence the researcher analysed them as follows:

(a) Regular inspections

Proper inspections on site should be regularly done by the statutory bodies. This should be done at every stage of construction in order to ensure quality workmanship on sites. Location of the construction site should not determine the number of inspections to be carried out by the statutory bodies.

(b) Training of workers

Workers should be well trained on technical issues of construction before they are allowed to work on sites. The respondents proposed the introduction of more training institutes in order to handle the large number of workers in the building industry.

(c) Proper supervision

Most of the respondents noted that supervision on construction sites should be intensified. The number of experienced supervisors should be increased on site to monitor execution of any work.

(d) Improvement of working conditions

Being in a good working environment is a motivator for many employees on site as indicated in the literature review. Therefore, the respondents advocated for a favourable working atmosphere to be created on site and maintenance of better health standards and safety measures. This motivates workers to work to their best the enhancing on quality of workmanship on sites.

4.4 RESPONSE FROM WORKERS ON SITE

The second category of questionnaires was administered to the workers on the identified sites. Only one worker involved in concreting per site was interviewed hence they formed a number of 35 workers.

The questionnaire was designed to establish their experience, education level, career development, tools and equipment they use as well as challenges they face and the way they perceive quality on site.

Education

Table 4.11: Education level of workers

Level of education	No. of masons	Percentage
Did not attend school	2	6
Obtained KCPE certificate	17	49
Obtained KCSE certificate	16	45
Obtained degree certificate	0	0
Total	35	100

Source: Field survey, 2007

Majority of the respondents at 49% have obtained a KCPE certificate while none of them has obtained a degree certificate. Those with KCPE and KCSE certificates compose 94%. This is the level of requirement for entry to formal training centres hence majority has attained the required level of education for the training.

The workers under study were over 26 years, and none of them was over 40 years of age. This means that all the workers met the minimum required age of employment and were within the youthful working age where their productivity is expected to be high for manual work.

4.4.1 Work experience

Table 4.12: Work experience of workers on site

Period worked (in years)	No. of masons	Percentage
Less than 6 months	0	0
6 – 12 months	0	0
1 – 2 years	2	6
2 – 3 years	4	11
3 – 4 years	7	20
Over 4 years	22	63
Total	**35**	**100**

Source: Field survey, 2007

From the above table, 63% of the workers had over four years work experience while none had less than a year of work experience.
This shows that the workers have gained enough experience and they can work under minimum supervision.

4.4.2 Quality of work on site

One of the questions sought to examine on how workers judge quality of workmanship on site, 64% of the respondents noted that it was 'average' while only 36% noted that it was 'good'. Majority of them 77% blame the contractor for the poor workmanship on sites. 19% of the respondents blame the workers while only 4% blame the architects.

All the respondents noted they rarely redo concrete work after it fails on quality.

Workers were also asked whether they report on any problem found when concreting or on completed concrete work. 97% of the respondents do report the problems of which 59% report to the site agent while 41% report to foremen.

To improve on the quality of workmanship, the respondents recommended the following to be done (in order of importance).

a) Contractors to enhance on supervision
b) Workers to be employed based on skills and experience
c) Workers welfare to be enhanced by increasing their pay.
d) Provision of proper tools and equipment.

4.4.3 Challenges faced by workers when working

58 per cent of the respondents noted one of the major challenges as being overworked, 55% felt that they are being underpaid.

These two factors determine motivation hence production. Quality of workmanship to be achieved on site will thus depend on these two factors.

Only 19% acknowledged that they lacked proper tools and equipment.

One question sought to examine the wish of the workers on their employment, 63% acknowledged that they would like to earn a regular income, 56% intended to gain wider experience and acquire more skills. None of them was for the idea of working under no supervision.

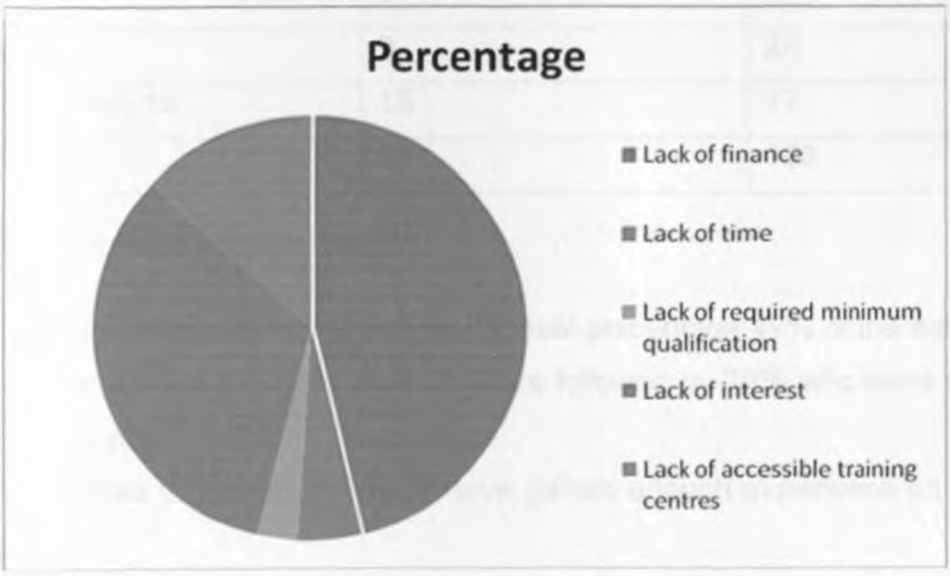
This shows that workers would not mind the level of supervision and also the need motivation which will both lead to quality improvement.

Table 4.13: Factors that hinder workers from seeking further training

Factors	Responses	Percentage
Lack of finance	29	83
Lack of time	3	9
Lack of required minimum qualification	2	6
Lack of interest	21	60
Lack of accessible training centres	8	23

Source: Field survey, 2007

Chart 4.6: Factors that hinder workers from seeking further training



Source: Field survey, 2007

From the table, the major hindrances in seeking further training are lack of finance and lack of interest with 83% and 60% respectively. Lack of required minimum qualification was considered as a least hindrance in seeking further training.

4.5 RESPONSE FROM THE ARCHITECTS

A sample of 52 architectural firms was chosen. In each firm selected only one of the architects was interviewed. 32 out of the 52 (62%) provided full response while 20 of the 52 (38%) had not been completed on time and could therefore not be used for analysis. The response rate of 62% gave an adequate basis for data analysis.

4.5.1 Data analysis and presentation

Table 4.14: Practicing period in field

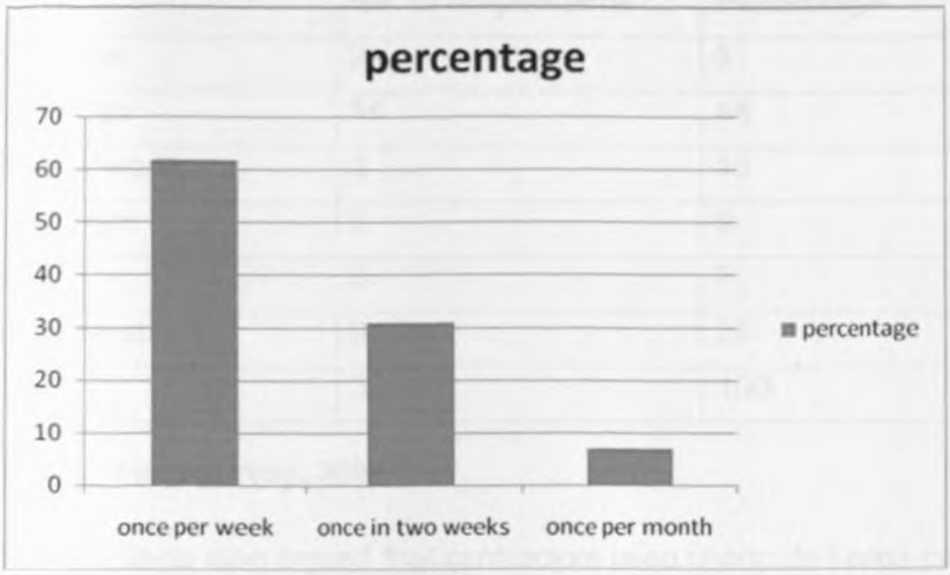
Period (years)	No. of respondents	Percentage
Less than 5 years	5	16
5 – 10	3	9
11 – 15	9	28
More than 15	15	47
Total	**32**	**100**

Source: Field survey, 2007

The above table indicates that the highest percentage 47% of the architects have been practicing for more than 15 years followed by 28% who have practiced for 11 – 15 years.

This shows that most architects have gained enough experience on construction matters.

Chart 4.7: Work inspection by the architects



Source; Field survey, 2007

The architects said that these inspections were more crucial during the execution of sensitive works, which deserve high quality control measures.

Regarding to how the architects judge the quality of workmanship on most of the construction site, 57% said it was average while the remaining 43% said it was good. This shows that the level of workmanship is not to the required standards in many construction sites.

Table 4.15: Responsible party for quality of workmanship on site

Party	No. of respondents	Percentage
Architects	2	6
Contractor	14	44
Clerk of works	4	13
Supervisor	3	9
Worker	0	0
All of the above	9	28
Total	32	100

Source: Field survey, 2007

The architects also argued that contractors used shortcuts hence compromising on quality of work on sites.

All the architects (100%) acknowledge that they cause work to be re-done on account of poor workmanship but this is very rare. They noted that workers should be supervised to ensure that execution of work is to the required standard and if this is well done there is no point at which work will be redone on account of poor workmanship.

Regarding to the kind of mistakes from the designer's side that can lead to quality problems, the architects noted the first one as the lack of sufficient details with 83% of the respondents indicating this. Insufficient supervision was the second one with 61% of the respondents indicating this while lack of proper communication was the third one with 35%. No respondent highlighted variation as a major cause of quality problems on site. Quality problems arose in many cases where the architects gave details like designs which could not be achieved practically.

One question sought to examine the reasons why construction products sometimes fail in terms of quality despite conforming to specification. Different reasons were given but the research summarized them as follows:

(a) Insufficient supervision

(b) Speedy construction through taking shortcuts

(c) Incompetent staff at work

PLATE 02: A crack on a recently completed car park.

In order to achieve an improvement in quality of workmanship on construction, the architects advised the contractors to do the following (in order of importance).

1. Train workers in quality issues
2. Work on how to motivate the workers
3. Provide proper tools and equipment
4. Cease dependence on inspection by the architects

4.5.2 Labour recruitment

The architects were requested to give factors which should be considered before recruiting labour for a particular task of which they gave out the following factors starting with the major ones;

(i) Technical experience

(ii) Job experience

(iii) Remuneration

Academic qualification and age were considered as least factors in recruiting labour and hence they are of no much significance.

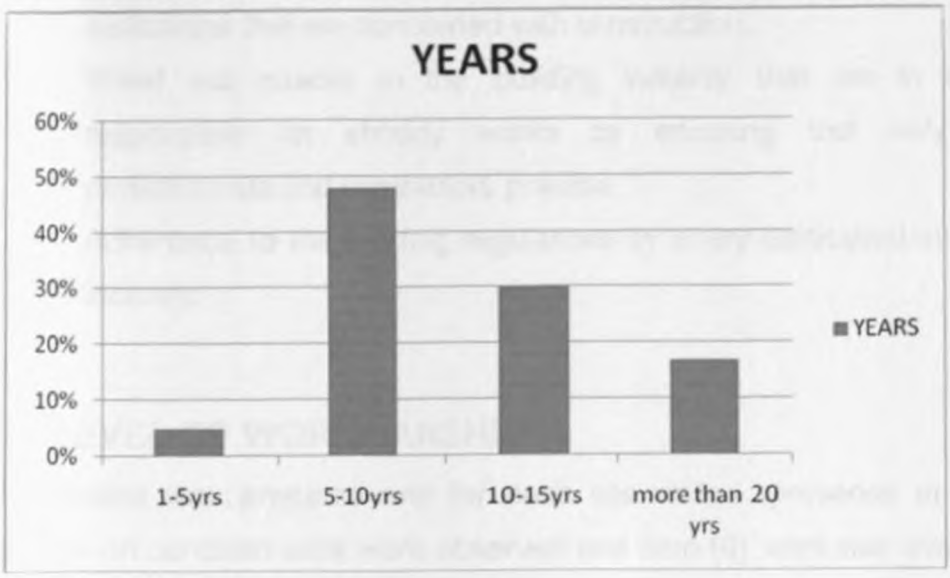
One question was requesting the architects to give the minimum number of years of experience that they would recommend for one to be a clerk of works or a site agent. They gave the following response.

Table 4.16: Recommended site agent or clerk of works experience

Experience	1-5yrs	5-10yrs	10-15yrs	more than 20 yrs	Total
YEARS	5%	48%	30%	17%	100%

Source: Field survey, 2007

Chart 4.8: Recommended site agent or clerk of works experience



Source: field survey, 2007

All the architects (100%) acknowledged that they perceive central government's role in achieving quality of workmanship on construction sites by:

a) Ensuring quality materials are used on sites
b) Enforcement of building regulations
c) Help in training of labour force

Regarding to measures taken by the architects against contractors for poor quality work, 89% of the respondents suggested that contractors should re-do the shoddy work at their own cost. 63 per cent of the respondents also said that they determine whether the contract persists and they seek damages if there is any delay.

The respondents finally gave the following recommendations to be implemented in the building industry in order to achieve good quality work on site.

i) Inspection by the local authorities as well as professionals should be intensified on sites.

ii) Creating awareness of the importance of technical training in all institutions that are concerned with construction.

iii) Weed out quacks in the building industry that are in most cases responsible for shoddy works by ensuring that only registered professionals and contractors practice.

iv) Adherence to the building regulations by every participant in the building industry.

4.6 LEVEL OF WORKMANSHIP

A checklist was prepared and for each site visited, presence or absence of defects on concrete work were observed and zero (0) work was awarded where a defect was observed while one (1) mark awarded where a defect was not observed. Since there were 6 indicators, a site without any defect on the variables scored a maximum of 6 points, while a site with defects on all the variables scored 0 marks, the lowest.

Table 4.18 shows the findings

Table 4.17: level of workmanship on sites

Score	No. of sites	Percentage
0	1	3
1	3	9
2	7	20
3	10	28
4	6	17
5	5	14
6	3	9
Total	**35**	**100**

Source: Field survey, 2007

A score of 6 is the highest mark showing no defect, that is, the required level of (high level) workmanship. Only 9% met this requirement showing that the level of workmanship is low. 97 percent of the sites have at least a defect on the variables. It is important to note that only 3% of all the sites visited scored zero. This indicates that majority of sites need improvement of workmanship.

Plate 03: Poor Workmanship allowed this spanner to be dropped into the shuttering before the concrete was poured. The spanner has rusted causing the surface to spall.

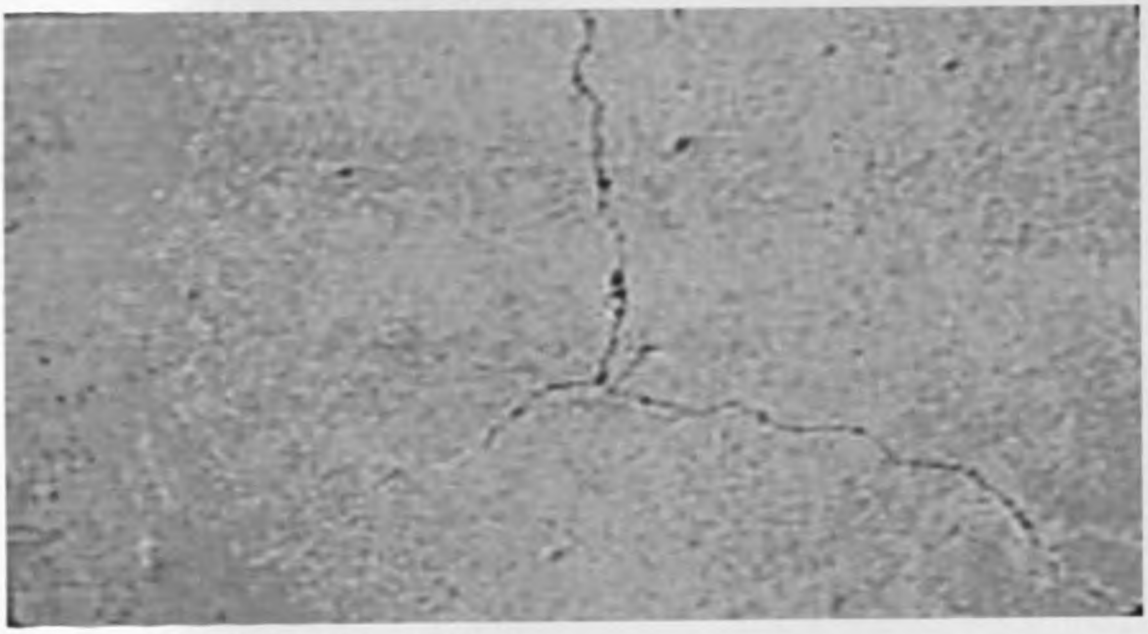


Plate 04: A crack a concrete wall.

4.7 REGRESSION ANALYSIS AND HYPOTHESIS TESTING

In order to establish a relationship between the two variables under study, as expressed in hypothesis, a simple regression between levels of quality management factors and levels of workmanship in their respective sites is hereby carried out.

Regression analysis is developed from properties of a straight line graph,

y = a + bx.

In this study, the dependent variable **y** is the level of workmanship while the independent variable **x** is the level of quality management factors (Level of training, supervision, experience, availability of tools and equipment, and others). **a** represents the rate of change or gradient.

The sample size **n** is 35. For each site, the corresponding levels of workmanship and levels of quality management factors have been registered and other useful parameters calculated to assist in the analysis as represented in table 4 that follows.

Table 4.18: Regression analysis parameters

Site No.	Levels of quality management factors (x)	Levels of workmanship (y)	xy	x^2	y^2	xy^2
1	9	5	45	81	25	225
2	5	2	10	25	4	20
3	6	3	18	36	9	54
4	5	3	15	25	9	45
5	8	6	48	64	36	288
6	7	4	28	49	16	112
7	8	5	40	64	25	200
8	4	1	4	16	1	4
9	2	2	4	9	4	8
10	3	2	6	4	4	12
11	8	5	40	64	25	200
12	3	1	3	9	1	3
13	6	3	18	36	9	54
14	7	3	21	49	9	63
15	3	0	0	9	0	0
16	4	2	8	16	4	16
17	7	5	35	49	25	175
18	7	4	28	49	16	112
19	5	3	15	25	9	45
20	6	4	24	36	16	96
21	3	3	9	9	9	27
22	4	2	8	16	4	16
23	9	6	54	81	36	324
24	7	4	28	49	16	112
25	4	3	12	16	9	36
26	2	1	2	4	1	2
27	3	2	6	9	4	12
28	4	4	16	16	16	64
29	5	3	15	25	9	45
30	9	5	45	81	25	225

31	3	2	6	9	4	12
32	7	4	28	49	16	112
33	8	6	48	64	36	288
34	7	3	21	49	9	63
35	6	3	18	36	9	54
	194 Σx	**114** Σy	**726** Σxy	**1228** Σx^2	**450** Σy^2	**3124** Σxy^2

Source: Field survey, 2007

The values of intercept, a, and gradient b, can be calculated as follows:

$$b = \frac{n\Sigma xy - \Sigma x\Sigma y}{N\Sigma x^2 - (\Sigma x)^2}$$

=0.62

$$a = \frac{\Sigma y - b\Sigma x}{n}$$

= -0.2

The equation for line of 'best fit' in this study is thus **y = -0.2 + 0.62**

Graphically represented it will look as follows;

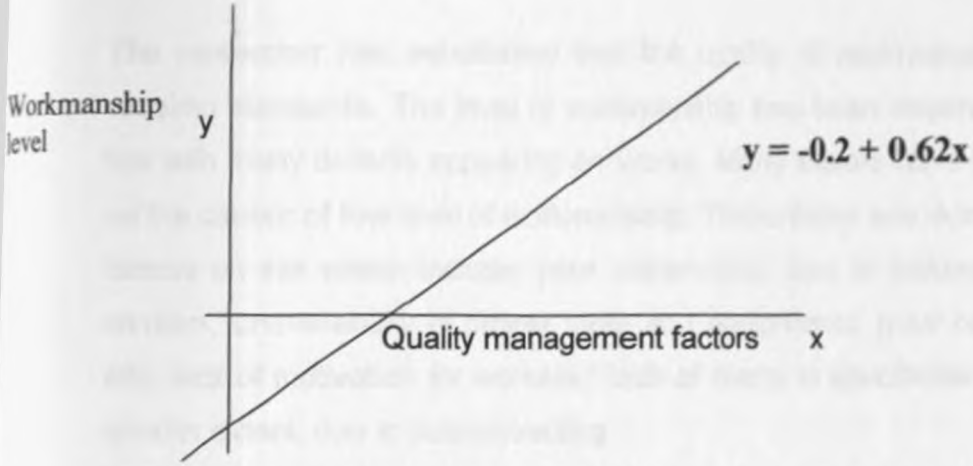


Fig.4.1: Graphical representation of relationship between samples levels of training and workmanship.

The line has a positive gradient, rising from left to right. This proves that there is positive relationship between quality management factors (supervision, training, experience, availability of tools and equipment and others) and level of workmanship. The level of workmanship will rise with the level of quality management factors.

Generally, the study confirms the hypothesis that quality management factors influence the level of workmanship on construction sites.

4.8 SUMMARY OF FINDINGS

The researcher has established that the quality of workmanship is not to the required standards. The level of workmanship has been observed to be equally low with many defects appearing on works. Many factors have been established as the causes of low level of workmanship. These factor are management related factors on site which include; poor supervision, lack of training, inexperienced workers, unavailability of proper tools and equipments, poor communication on site, lack of motivation for workers, lack of clarity in specifications and also to a smaller extent, due to subcontracting.

From Table 4.19, the level of workmanship has been found to be directly proportion to the level of quality management factors. However, lack of proper supervision on site has been noted as the major cause of poor workmanship in comparison to the other factors.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 CONCLUSION

The aim of this study is to improve the level of workmanship on construction sites and thus enhance on the general project performance.

Quality management factors (supervision, training, experience, availability of tools and equipments) were hypothesized as the cause of poor workmanship on construction sites. Objectives were also set out at the beginning along which the research was to be carried out. The related literature has been reviewed and data collected from the field and analyzed.

The findings have been compared against the set objectives and conclusions made.

However, it is worth noting that this research had several limitations as outlined in chapter one. The conclusions and recommendations should therefore be looked at in respect to limitations.

5.1 FINDINGS OF THE STUDY OBJECTIVES

The first objective of the study was to establish the level of workmanship on concreting sites. The findings show that only 3 percent of construction sites are free of the assessed defects and are thus to the desired level of workmanship. The remaining 97 percent of sites had at least one of the defects that included: disintegration of concrete, cracking, detachment of plaster and brown stains.

The findings are proof of low level of workmanship.

The second objective was to establish the main causes of poor workmanship on construction sites.

From the results obtained from the respondents the major causes of poor workmanship are:

(1) Lack of proper supervisions
(2) Lack of experience
(3) Lack of care when concreting
(4) Lack of training for workers.
(5) Lack of proper tools and equipment
(6) Lack of clarity in specifications.

Results further indicate that poor workmanship is also resulting from contractor's speedy construction as well as using shortcuts in construction. Subcontracting has been noted to have less impact on workmanship. However all respondent acknowledge lack of supervision as the major cause of poor workmanship.

The third objective was to establish the relationship between the quality management factors (supervision, training, experience, availability of proper tools and equipment among others) and the level of workmanship.

Field data on levels of quality management factors and workmanship on site were analyzed through simple regression analysis and a positive relationship was established. Higher level of workmanship was observed on sites with higher level of management and vice versa.

The fourth objective was to identify the measures taken by the responsible authorities in ensuring proper quality of workmanship. For this study, the responsible authorities have been taken as the architects, engineers and statutory bodies.

Regarding to measures taken by the architects against contractors for poor quality work, 89% of the architects noted that contractors are forced to re-do the work at their own cost. 63 percent of the respondents also noted that they determine whether the contract persists and they seek damages if there is any delay.

5.2 IMPLICATIONS OF THE FINDINGS

From the findings and analysis of this study, it can be concluded that the quality of workmanship on constructions sites is fairly poor.

The study has summarized all the causes of poor workmanship to one, that is, quality management factors. All these factors have a positive influence on the level of workmanship.

The implications of the findings is that low level of workmanship on the construction sites in Kenya will continue unless the quality management factors are enhanced (that is supervision, training, availability of proper tools and equipment among others). Therefore, to reverse the trend, all efforts should be aimed at provision and improvement of the content and context of these factors to enable the achievement of proper quality of work on sites.

5.3 RECOMMENDATIONS

The study has established that low level of workmanship prevails on construction sites. It therefore recommends the following:

(1) There is need to ensure strict supervision on construction projects. Supervision on sites can be enhanced by employing enough and competent clerk of works and site agent. The parties should always be on site and ensure that they supervise every work which is being executed. It is necessary to engage well trained and experienced supervisors on each project as this is indeed a prerequisite towards achieving quality in construction. 95 percent of the identified architects noted that both the clerk of works and the site agent should have a minimum of five years of experience in the construction work.

(2) Training of workers and other personnel should be enhanced. Workers should be well trained on technical issues of construction before they are allowed to work on sites. More training institutes should be introduced in order to handle

the large number of workers involved in the building industry. Training content and context for workers in both the technical education programmes and the industrial training schemes should be speedily be harmonized and geared towards meeting the needs of the building industry. Training of other personnel should be enhanced even through focused seminars in order to capture the arising issues in the construction work.

(3) Inspections should be done regularly on sites. There is need for professional bodies like Architectural Associations of Kenya to work hand-in-hand with the local authorities in doing the inspections. This will ensure that quality is not compromised through corruption in the building industry. This inspection will help in ensuring that speedy construction is avoided as well as use of shortcuts by the contractors who compromise on quality. The number of inspections carried out on site should not be based on the location of the site as the researcher has found out.

(4) Manual work on site should be reduced to minimum especially in concreting whereby workers are much involved in mixing instead of using concrete mixers. Lifting of concrete to the final position should be mechanized for example by use of cranes. This will help in reducing the disintegration of concrete which lowers the quality of concrete.

(5) Specification should be strictly adhered to. This will ensure that the final product is to the required standards. in concreting, proper selection of concrete ingredients in ensuring that they are of the right quality should be carried out. Aggregates should be of the required size and should have no foreign materials. Cement should be as specified, and water should be palatable quality. Any additives to be used and the method of mixing should be as specified.

(6) There is need to establish a quality assurance department in every construction company. This department will be responsible in ensuring that

quality achieved in construction is of the right standard. The department will hence ensure that there is good workmanship on site.

(7) There is also need to weed out quacks in the building industry that are in most cases responsible for the poor quality work. This can be achieved by ensuring that only registered professionals and contractors practice. Building regulations should also be adhered to by every participant in the building industry.

(8) In order to ensure and encourage the maintenance of quality production on construction sites, the labour should be motivated by offering rewards such as bonuses, allowances, promotions so as to stir up their morale. Their working conditions should generally be made much conducive.

5.4 AREAS OF FURTHER STUDY

1. The study was only limited to quality of workmanship in concreting, therefore, further study should be conducted to investigate the quality of workmanship on other trades in construction.

2. There is need to study on ways of motivating workers in achieving quality workmanship.

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APPENDIX A

University of Nairobi
Department of Real Estate and Construction Management
BBE 408: Research Project

AN INVESTIGATION INTO THE QUALITY OF WORK MANSHIP IN CONSTRUCTION SITES: A CASE STUDY OF CONCRETING AND FINISHES ON SITES IN NAIROBI.

Questionnaire to Contractors

DECLARATION: The information given under this study shall be treated with utmost confidentiality and used only for this research and not for any other purposes.

Please fill in the blank spaces. Where options are provided, tick in the box alongside the appropriate choice.

1. Under what category is your firm registered with the ministry of republic works?

   ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H

2. What is the nature of your business?

   ☐ General building contractor

   ☐ Specialist contractor

3. Fix how long have you worked in the building industry?

   ☐ Less than 5 years

   ☐ 5-10

☐ 11-15

☐ 16- 20

☐ More than 20 years

4. How many of the following categories of workers do you have on site and on what terms are they engaged?

Mode of engagement

Person	Permanent	Temporary
Site agent		
Foreman		
Tradesmen		
Operatives		

5. What criterion is considered before recruiting labour for a particular task? (Mark in order of the most important to least important starting with 1 for the most important)

☐ Job experience

☐ Technical qualification

☐ Academic qualification

☐ First come first served

☐ Familiarity to management

☐ Age

☐ Renumeration or salary

☐ Any other .....

6. i) Do you find it necessary to describe and analyze jobs before recruiting labour?

☐ Yes ☐ No

ii) Give reasons for your answer.....

iii) If yes, how do you do it?.....

7. In your construction sites do you experience a problem of poor workmanship?

☐ Yes ☐ No

If Yes, how often is this?

☐ Rarely

☐ Often

☐ Very often

8. Rank in order of merit the major causes of poor workmanship in construction projects?

☐ Lack of training for workers

☐ Lack of close supervision

☐ Lack of care when concreting

☐ Lack of experience at work

- ☐ Lack of proper tools and equipment
- ☐ Lack of clarity in specification
- ☐ Subcontracting
- ☐ Lack of motivation on workers
- ☐ Poor communication on site

9. Which of the following factors do you consider the most important in improving quality of workmanship (Number them in order of importance).

	Very important	Important	Less important
Improve training and learning	☐	☐	☐
Improving on inspection	☐	☐	☐
Workers selection criteria	☐	☐	☐
Reducing subcontracting	☐	☐	☐
Motivation of workers	☐	☐	☐
Availing proper tools and equipment	☐	☐	☐
Improving communication on site	☐	☐	☐

10. Is it possible to achieve zero defects in construction?

Yes ☐ No ☐

Give reasons for your answer .....

.....

11. What is being done to motivate workers to work right the first time?

- ☐ Increase their wages
- ☐ Employ a supervisor who knows them
- ☐ Give them longer work contracts
- ☐ None of the above
- ☐ Any other .....

12. Would employing workers on a permanent basis help improve quality?

Yes ☐ No ☐

Explain you answer .....

13. Who supervises the construction work on site?

- ☐ My self
- ☐ Foreman
- ☐ Site agent
- ☐ Others

14. How often do statutory bodies (e.g local authority) carry out work inspections on on-going site?.....

.....

15. How often does the architect or engineer carry out work inspection on on-going construction site?

- ☐ Rarely

☐ Often

☐ Very often

16. i) Do you have a quality assurance department?

☐ Yes ☐ No

ii) If no, do you intend to establish one?

Yes ☐ No☐

Give reasons for your answer .....

iii) If yes, when was the department established.....

iv) Why was the department established?

☐ To meet the tendering requirements

☐ To enhance the quality of workmanship, labour and materials

☐ Lost job previously.

☐ Pressure act of competitiveness

Any other.....

17. Do you perceive any role of the central government in ensuring quality on construction site?

☐ Yes No☐

If yes, what role do they play? .....

.....

18. How are the concrete ingredients measured out before mixing of concrete?

☐ Manual (wheelbarrows, spades, trays etc)

☐ Batching box

☐ Batching plant / equipment

☐ Ready mix concrete used

☐ Others

19. How is the concrete mixed?

☐ Hand mixed

☐ Concrete mixers

☐ Batching plant/ equipment

☐ Ready mix concrete used

Others .....

20. Is any testing for quality carried out on the

a) Freshly mixed concrete before pouring

Yes ☐ No ☐

If yes, which test is carried out .....

.....

b) Already cast concrete

Yes ☐ No ☐

If yes, which test is carried out .....

21. Which method is used to deliver the mixed concrete into final position formwork.....

.....

22. What can you recommend to be implemented in the building industry in Kenya to achieve quality workmanship in concreting on sites?.....

.....

.....

APPENDIX B

University of Nairobi
Department of Real Estate and Construction Management
BBE 408: Research Project

AN INVESTIGATION INTO THE QUALITY OF WORK MANSHIP IN CONSTRUCTION SITES: A CASE STUDY OF CONCRETING AND FINISHES ON SITES IN NAIROBI.

Questionnaire to workers on site

***DECLARATION*:** The information given under this study shall be treated with utmost confidentiality and used only for this research and not for any other purposes.

Please fill in the blank spaces. Where options are provided, tick in the box alongside the appropriate choice.

1. How old are you ? [Tick where appropriate]

   ☐ 15-20 years

   ☐ 21-25 years

   ☐ 26-30 years

   ☐ 31-35 years

   ☐ 36-40 years

   ☐ Over 40

2. What is your level of Education?

   ☐ Did not attend school

   ☐ Obtained K.C.P.E certificate

   ☐ Obtained K.C.S.E certificate

   ☐ Obtained a Diploma certificate

- ☐ Obtained a Degree certificate
- ☐ Others.....

3. For how long have you worked in construction?
   - ☐ Less than 6 months
   - ☐ 6-12 months
   - ☐ 1-2 years
   - ☐ 2-3 years
   - ☐ 3-4 years
   - ☐ Over 4 years
4. Do you feel that the work executed on site is of the right quality?

   ☐ Yes ☐ No
5. What challenges do you face when working?
   - ☐ Lack of proper tools and equipments
   - ☐ Low pay
   - ☐ Being overworked
   - ☐ Poor communication between workers and supervisors
   - ☐ Mistreatment
   - ☐ Any other (specify).....
6. What is your wish on your employment?
   - ☐ To earn more money
   - ☐ To work under no supervision

☐ To gain wider experience and acquire more skills

☐ To have a regular income

☐ Others .....

7. In concreting, are you supplied with the right tools and equipments?

☐ Yes ☐ No

8. After concreting, do you re-do the work after it fails on quality?

☐ Yes ☐ No

If Yes, how often is this?

☐ Rarely

☐ Often

☐ Very often

9. Do you usually report on any problem found when concreting or on completed concreting work?

☐ Yes ☐ No

If yes, who do you report to?

☐ Site agent

☐ Contractor

☐ Foreman

☐ Others.....

10. What do you think should be done to improve on the workmanship on site? [In order of importance]

☐ Contractors to enhance on supervision

- ☐ Increase pay for workers
- ☐ Employment based on skills and experience
- ☐ Provision of proper tools and equipment
- ☐ Others.....

APPENDIX C

University of Nairobi
Department of Real Estate and Construction Management
BBE 408: Research Project

AN INVESTIGATION INTO THE QUALITY OF WORKMANSHIP ON CONSTRUCTION SITES: A CASE STUDY OF CONCRETING ON SITES IN NAIROBI.

Questionnaire to Architects

***DECLARATION*:** The information given under this study shall be treated with utmost confidentiality and used only for this research and not for any other purposes.

Please fill in the blank spaces. Where options are provided, tick in the box alongside the appropriate choice.

1. For how long have you been practicing?
   - ☐ Less than 5 years A
   - ☐ 5-10 years
   - ☐ 11-15 years
   - ☐ More than 15 years
2. How often do you do inspection on construction sites?
   - ☐ Every day
   - ☐ Once a week
   - ☐ Once in every two weeks
   - ☐ Once a month

3. How do you judge the quality of workmanship on most of the construction sites?

   - ☐ Excellent
   - ☐ Good
   - ☐ Average
   - ☐ Below average
   - ☐ Poor

4. Who do you think should be responsible for quality on site?

   - ☐ Architect
   - ☐ Contractor
   - ☐ Clerk of works
   - ☐ Supervisor
   - ☐ Worker
   - ☐ All of the above

5. How frequent do you cause work to be re-done on account of poor workmanship?

   - ☐ Rarely
   - ☐ Often
   - ☐ Very often

6. What kind of mistakes from the designer's side can lead to quality problems?

- ☐ Lack of proper communication
- ☐ Insufficient details
- ☐ Many variations
- ☐ Insufficient supervision.
- ☐ Any other (specify).....

7. In your opinion why does a construction product sometimes fail in terms of quality despite conforming to specifications?.....

.....

8. In order to achieve improvement in quality of workmanship on contraction, what advice would you give to contractor? (In order of importance)
   - ☐ Train workers in quality issue
   - ☐ Cease dependence on inspection by the architect
   - ☐ Provide proper tools and equipments
   - ☐ Work on how to motivate the workers
   - ☐ Any other.....
9. What measures do you take against contractors for poor quality works?.....

.....

10. What can you recommend to be implemented in the building industry in Kenya to achieve good quality work on site?.....

.....

APPENDIX D

UNIVERSITY OF NAIROBI

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT

P.O. Box 30197, 00100 Nairobi, KENYA. ***Tel: No. +254-2-2724525/9 Fax: +254-2-2718548***
E-mail: ***building_econ@uonbi.ac.ke*** OR ***land_econ@uonbi.ac.ke***

April 10, 2007

TO WHOM IT MAY CONCERN

RE: NDOKA GICHUKI RAPHAEL – B03/0322/2003

The above named is a student of this Department pursuing a Bachelor of Arts Degree in Building Economics. He is currently in his final year of the course and is writing a project paper titled:- ***An investigation into the quality of workmanship on construction site. "A case study on concreting on sites in Nairobi"***

The purpose of this letter therefore is to request you kindly to allow him access into any kind of material he may require from your organization to enable him complete the project paper successfully. The information given will be used for research purposes only.

Yours faithfully,

CHAIRMAN
DEPARTMENT OF REAL ESTATE
AND CONSTRUCTION MANAGEMENT
UNIVERSITY OF NAIROBI

Dr. Hezekiah Gichunge
Chairman
Department of Real Estate and Construction Management

APPENDIX E

CHECKLIST OF CONCRETE WORK DEFECTS IN CONSTRUCTION SITES

A mark of zero [0] is awarded where a defect has been observed ,and a mark of [1] where defect has not been observed.

Site No.	Cracking	Disintegration	Deflection	Detachment of plaster	Inadequate reinforcement cover	Brown stains
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
12						
13						
14						
15						
16						
17						
18						
19						
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23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						

APPENDIX F

CHECKLIST OF QUALITY MANAGEMENT FACTORS ON CONSTRUCTION SITES

A mark of zero [1] is awarded where a site has excelled in the given factor,and
a mark of [0] where a site has not excelled in the given factor.

Site No.													
Training													
Supervision													
Care in concreting													
Experience													
Tools and equipments													
Clarity in specifications													
Subcontracting													
Motivation on workers													
Communication													