Cape Peninsula University of Technology

FRAMEWORK FOR EFFECTIVE MANAGEMENT OF THE CONSTRUCTION WORKFORCE TOWARDS ENHANCEMENT OF LABOUR EFFICIENCY DURING THE BUILDING PRODUCTION PROCESS IN SOUTH AFRICA

by

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DECLARATION

I, Adebowale Oluseyi Julius, declare that the contents of this thesis represent my own unaided work, and that the content has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

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ABSTRACT

The study investigates the predominant factors that adversely affect the efficiency of construction labour in the South African construction industry.

There is a significant number of studies on construction labour efficiency and productivity. Nonetheless, construction labour efficiency in developed and developing nations is widely reported to be inadequate, and thus adversely impacts the delivery of construction projects. Adequate utilisation of basic construction resources (construction materials and machinery) is significantly dependent on the efficiency of human assets in the construction industry. Hence, the utilisation of construction resources to achieve project objectives in the construction sector cannot be disconnected from the efficiency of construction employees. As a result, the study identified five objectives directed towards improving the efficiency of employees in the construction industry. The first objective identified construction-related factors affecting construction workers' efficiency; the second objective highlighted design-related factors reducing the efficiency of construction labour; the third identified the impact of construction resources on construction labour efficiency; and the fourth ascertained the external factors affecting the efficiency of human assets in the construction industry. Finally, the last objective is directed towards developing a framework for improving the efficiency of the South African construction workforce.

The research adopted a mixed methodological approach, utilising a quantitative questionnaire completed by construction professionals (architects, quantity surveyors, site engineers, project managers, contract managers and site manager). Due to the high level of awareness of site supervisors on labour performance in construction, the quantitative data obtained from construction professionals was subsequently validated using semi-structured interviews with site supervisors. The research questionnaire was designed to elicit the perceptions of construction professionals on various identified factors affecting construction workers' efficiency on Gauteng and Western Cape construction sites in South Africa.

With the aid of 35 unstructured questionnaire surveys, an exploratory study was undertaken within construction firms in Cape Town to ensure the validity of research instruments, where the inputs and comments of respondents were duly considered in formulating the questionnaire for the main study. In the main study, two hundred and sixty-five (265) questionnaires were administered via hand-delivered and electronic mail to construction professionals in the Western Cape and Gauteng provinces, South Africa. Sixty-two (62) questionnaires (23.39%) were duly completed, returned and analysed with Statistical Package for the Social Sciences (SPSS) version 22. Cronbach's alpha coefficient reliability test was subsequently conducted on scaled research questions to ensure reliability of the research questionnaire.

The findings revealed that the major factors contributing to the shortfall of construction workers' performance include; missing details in architectural working drawings, the communication ability of site managers, site managers' coordinating skills, the effect of strikes on construction operations, the planning ability of site managers, slow response of architects to drawing questions, slow response of structural engineers to drawing questions, construction skills of site supervisors and, finally, shortages of construction materials. Improved construction productivity is a product of construction labour efficiency and enables the achievement of construction project objectives. Therefore, an adequate implementation of the framework presented in this study will not only enhance construction labour efficiency and heighten construction productivity during building production process, but will also increase the satisfaction of construction stakeholder on Gauteng and Western Cape construction projects.

LIST OF PUBLICATIONS

Adebowale O.J. & Fapohunda J.A. 2014. Adverse impacts of design team on construction workforce productivity *In:* Laryea, S. and Ibem, E. (Eds) proceedings *8th Construction Industry Development Board (cidb) Postgraduate Conference,* 10-11 February 2014, University of Witwatersrand, Johannesburg, South Africa, 111-119.

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DEDICATION

I completely and without any reservations dedicate this thesis to God Almighty, whose grace ensured possibility of my admission, made adequate provisions for my sustenance and ultimately saw me through the hurdles of the programme.

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DEFINITION OF TERMS

- **Effective management:** Effective management is the discipline of planning, organising and managing organisational resources towards the achievement of project goals and objectives.
- **Framework:** The supporting structure or system formulated to constitute the reality of a phenomenon.
- **Human resource management:** Human resource management is defined as the utilisation of individuals to achieve organisational set objectives.
- **Manpower:** Skilled tradesmen and unskilled labour with technically qualified persons that supervise the execution of organisation operations.
- **Productivity:** Productivity is expressed as the degree of employee efficiency, performance and how much can be achieved with the available resources of an organisation.
- **Labour efficiency:** The quality of labour being effective to ensure accomplishment of construction tasks with minimum expenditure of time and capital resources.
- **Building production process:** The series of events enabling systematic integration of building construction operations by utilisation of various organisation resources to achieve an output.
- **Construction workforce:** Workers employed in the construction industry for construction operations.
- **Construction project team:** Participants from diverse organisations who work together to build up a short-term organisation with the purpose of achieving the same objectives towards project delivery.

LIST OF ABBREVIATIONS

ASCE:	American Society of Civil Engineers
BCAWU:	Building Construction and Allied Workers Union
CIDB:	Construction Industry Development Board
CMP:	Construction Management Programme
GDP:	Gross Domestic Product
ISO:	International Organisation for Standardization
3Ms:	Material, Machinery and Manpower
PMBOK:	Project Management Body of Knowledge
QIM:	Quality Inspection and Management
SABAWO:	South African Building and Allied Workers Organisation
SASQL:	South African Statistics Quarterly Labour force Survey
SPSS:	Statistical Package for Social Science
TQM:	Total Quality Management
WBS:	Work Breakdown Schedule

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The cost of employing construction workers on different construction projects varies widely: labour costs on large construction projects typically account for approximately 40% of direct capital cost (Kazaz, Manisali & Ulubeyli, 2008:95). Regardless of this significant percentage of labour cost, the construction industry is generally characterised by poor productivity of construction labour (Kakkaew & Koompai, 2012:1). However, "human resource of an organisation represents the most variable, uncontrollable, and important element of production" (Kazaz & Ulubeyli, 2007:2132). This is an indication that employees in an organisation merit a higher level of concern, most essentially in relation to labour-intensive sectors like the construction industry. Monese and Thawa (2009:199) note that employees are characterised as the most challenging resource for an organisation to manage. As a result, construction management is meant to be strategically used to improve the efficiency of construction employees and enhance overall construction performance during building production processes (Kakkaew & Koompai, 2012:3).

Management of workforce is extensively defined as a logical approach to the management of an organisation's expensive asset (employees), who individually and as a group work together towards achieving the set goals of an organisation (Kakkaew & Koompai, 2012:3). Significantly, construction workers are essential to the construction sector, just as construction activities are significant to the economies of nations (Durdyev, Ismail & Abu Bakar, 2012). Enshassi, Mohammed, Mustafa and Mayer (2007:245) stressed that the economy of every nation is significantly dependent on the activities of the construction sector, which has a momentous effect on national gross domestic profit and vice versa. Therefore, there exists a correlation between national economic growth and construction industry development (Kakkaew & Koompai, 2012:1). Loosemore and Lee (2001) further note that human assets in the construction industry are an important asset to the construction sector. Hence the performance of the construction industry impacts the economy of both developed and developing nations.

Considering the contribution of the construction sector to job creation, the construction industry, offers employment to a significant percentage of a nation's working population, with a large percentage of unskilled and menial workers (Loosemore & Lee, 2001: 517). Therefore, the construction sector is more labour-reliant than the manufacturing industry (Lill, 2008:864). Although, Kakkaew and Koompai (2012:1) point out that the construction sector still lags behind in the area of workers' efficiency, when compared with the manufacturing industry. The fragmented structure, itinerary nature, and challenging working environments of construction employees are arguably contributing factors to the comparative inefficiencies of the construction workforce. Nonetheless, considering the relevance of employees to organisational development, there is a need to devise an effective management system that can afford utilisation of the construction industry's human assets to improve performance on construction projects. Olomolaiye and Egbu (2004:536) support the notion that effective management of the construction workforce will enhance construction project performance. Therefore, construction workers' performance improvement, as an essential tool for improving construction project performance, requires industrial and academic interventions.

1.2 Construction workforce efficiency and labour productivity

Construction workforce efficiency and construction productivity are inseparable in the construction environment. Hanna, Russell, Nordheim, and Bruggink (1999:225) note the efficiency of construction workers as being comprised of the ratio of *actual* performance of an employee to the theoretical maximum or *expected* performance. Similarly, construction labour productivity can be defined as construction input (resources) divided by construction output (completed task) or vice versa, as explained later in this section. Therefore, there is a significant relationship between construction workers' efficiency and productivity. As such, the higher the efficiency of the construction workforce, the higher the productivity of an employee obtained.

In the construction industry in particular, construction productivity implies labour productivity (Shehata & El-Gohary, 2012:322). Although a significant amount of research has been undertaken on construction labour productivity, there is no consensus on general productivity standards in the construction environment (Park, Thomas & Tucker, 2005:773). The absence of construction industry overall benchmarking of labour productivity could be a result of the complexity, diversity and fragmentation inherent to the construction industry (Kakkaew & Koompai, 2012). Several productivity definitions have been provided by different researchers and scholars; for example, Enshassi*,* Mohamed, Mustafa and Mayne (2007:246) define construction productivity as the ratio of output to input (output / input). Conversely, Park *et al.* (2005:773) posit that construction productivity can be defined as the ratio of input to output. That is, labour productivity = the actual work hours/quantity installed. The latter definition expresses the number of actual hours required to perform the appropriate unit of work, as previously determined. Notably, this study focuses on the factors that affect the efficiency of construction workers, and does not measure the degree of construction workers' efficiency.

Research has revealed undue cost overruns, time overruns and loss of productivity as a predominant occurrence in delivery of most construction projects (Jergeas, 2009:3). Geneva

(2001:1) posits that construction labour constitutes a significant percentage of construction cost, and the quantity of labour hours in performing a task in construction is susceptible to labour influence by management through motivation, incentives, performance assessment, and recognition. These measures are rarely adopted. Thus, improving the efficiency and productivity of workforce in the construction industry becomes challenging, thereby resulting in an increased construction cost and extended duration of projects (Zakari, Olomolaiye, Holt & Harris, 1996:417).

The project-based nature of construction works and co-ordination of people from different locations to effectively work together in the same trade, and under a strictly-controlled budget, are noted as major challenges in the construction sector (Dainty, Grugulus & Langford, 2007:502). As a result, the construction industry's project-based nature contributes to the growth of self-employment in the construction industry and reduces the investment and commitment to training by construction contractors (Lill, 2008:864). Nonetheless, the construction workforce requires adequate training, both for individual development and to enhance the collective commitment of the workforce to achieve a high quality of production and, ultimately, to achieve organisational set goals (Drucker, white, Hegewisch & Mayne 2006: 406). The construction industry is one of the most complex and dynamic industrial environments (Raiden, Dainty & Neale, 2003:309). These attributes within the sector create a negative impression on people who are able to deliver a good job, make construction work undesirable and thereby increase the challenge of the acquisition of skilled workers in the construction sector (Agapiou, 2006:150). Previous studies reveal that there exists less effort geared towards proper utilisation of the construction workforce by construction firms, and this in turn adversely impacts the quality of construction work during production processes (Lill, 2008:866). Geneva (2001:2) supports this notion, by pointing out that one of the major reasons for low quality of construction output is inadequate skill of construction workers, due to a lack of opportunity for training.

Conversely, Lill (2008: 866) states that the client's desire for project execution at the lowest cost, while demanding the achievement of project objectives is a notable reason for the prevalence of challenges to productivity in the construction sector. Therefore, contractors tend to reduce the duration, or avoid altogether, training for the construction workforce and engage workers with lower levels of skill to execute construction operations. Construction workers have a significant level of control on construction materials and machinery. Therefore, the efforts of construction practitioners to effectively manage construction materials and machinery resources and to prevent construction wastage significantly depend on the effective and efficient utilisation of construction human capital. Thus, this study considers: (1) construction-related factors affecting construction workers' efficiency, (2) design-related factors reducing the efficiency of construction labour, (3) the impact of construction materials and machinery on construction labour efficiency, (4) external factors affecting the efficiency of the construction industry's human assets and (5) the possibility of subsequently developing a framework for improving the efficiency of the South African construction workforce.

1.3 Background to research problem

The nature and formation of construction projects presents the sector with diverse challenges. One of the most significant of these challenges is the low productivity of construction labour (Jarkas & Bitar, 2012:811). Kakkaew and Koompai (2012:1) point out that the construction industry lags behind in terms of construction productivity when compared to the manufacturing industry, as discussed earlier. Further, Long, Ogunlana, Quang and Lam (2004:553) note that construction project performance is determined by on-time completion of the project, completion within budgeted cost and conformity with specifications and stakeholders' satisfaction. Zakeri *et al.* (1996:421) cite poor transportation of construction materials as leading to wastage of transported materials and causing construction delays and an attendant increased cost of construction production. The efficiency of construction projects significantly depends on the right application of construction tools and equipment. Inadequate use of equipment may lead to damage of construction equipment (due to operative lack of agreement with the management policy or unsatisfied earnings) or as a result of lack of technical know-how (Zakeri *et al.* 1996:422).

Lill (2008:865) notes management as an issue of interest, whereby the interest of the workforce occasionally contradicts the interests of the employer and employer's interest, in turn, occasionally contradicts the interest of client. Mostly, the client is motivated towards high quality of construction work, timeous delivery and low cost. On the other hand, contractors are mostly interested in spending less to maximise profit, while construction workforce desire a good salary, good working conditions and a stable workload. The various contradictory interests of the parties involved in construction projects need to be balanced in order to achieve an improved efficiency within the construction workforce. Further, construction organisations are faced with the uncertainty of winning contracts, which are gained via a competitive tender process. Therefore, Fabi and Petterson (1992:81) argue that there may be little or no time to consolidate a good workforce that could suit a new project. Drucker *et al.* (1996:411) posit that construction line managers are prone to fail in management of construction human capital in the absence of good working relationships with the workforce.

However, construction's open working environment is particularly vulnerable to weather, such as heavy rainfall and direct sunlight, which can affect the progress of construction works (Mohammed & Shrinavin 2005:351).

Due to the significant impact of construction labour on successful project delivery, this study aims at exploring diverse factors affecting construction labour efficiency in South African construction industry, and subsequently presents a framework towards improved efficiency of construction workforce. The conceptual framework for the study is presented in figure 1.1. The figure presents construction participants (constructors and designers) and external factors considered in the research objectives in relation to Management Principles and Practice geared towards increasing the efficiency of construction workforces for a successful project delivery. The figure outlines the concept and approach adopted for the purpose of this study, in line with study objectives.

1.4 Problem statement

Labour productivity/efficiency in the construction sector has long been identified to be unduly low (Jarkas & Bitar, 2012: 811). This produces negative long-term effects on construction project delivery time and construction cost (Jergeas, 2009:3). A significant number of observations have been made such as; project based practices obtainable in the construction sector and non-conducive working environments on construction sites as some of the underlying causes of the challenge to productivity within the construction industry (Dainty *et al.,* 2007:502; Raiden *et al.,* 2003:309). Nonetheless, productivity within the construction sector requires academic and industrial interventions which consider the need for stakeholder satisfaction and the significant contribution of the construction sector to the economy of developed and developing nations. The study undertaken by Jeselskis and Talukhaba (1998:186), affirmed that the rate of construction labour productivity in developing nations is low, compared to the productivity level in developed countries. Largely, the construction industry is a labour-reliant sector (Olomolaiye & Egbu, 2004:536) and more commonly, construction productivity often implied labour productivity (Shehata & El-Gohary, 2012:322). This makes human resources an important input to construction project delivery. However, Fapohunda (2009:23) note that construction employees represent the channel through which construction resources are being wasted, while Soham and Rajiv (2013:583) identify construction workers as the only productive resource in the construction sector. Hence, construction operations are a product of human efforts and performance. South Africa is recognised as one of the developing nations confronted with low construction productivity. Therefore, there is a need to augment construction labour efficiency in South Africa. It can be construed that construction workforce efficiency and productivity has become an essential focus and a frequently researched area to improve construction project performance (Jarkas & Bitar, 2012: 811). This study is concerned with the enhancement of construction labour efficiency, since effective utilisation of other construction resources (construction materials and machinery) cannot be disconnected from worker efficiency.

The research project's conceptual approach is presented in Figure 1.1. This figure encapsulates participant groups in the construction industry, resources and external factors affecting the efficiency of human assets in the construction industry during construction operations. The adverse contribution of construction professionals and non-professionals (construction and design) leading to the shortfall of construction workers' performance on construction sites are attributed to design and construction-related factors. The 3Ms (Manpower, Machinery and Material resources) and external conditions affecting construction workers performance are also identified as variables to be explored towards improved efficiency of construction labour in South Africa.

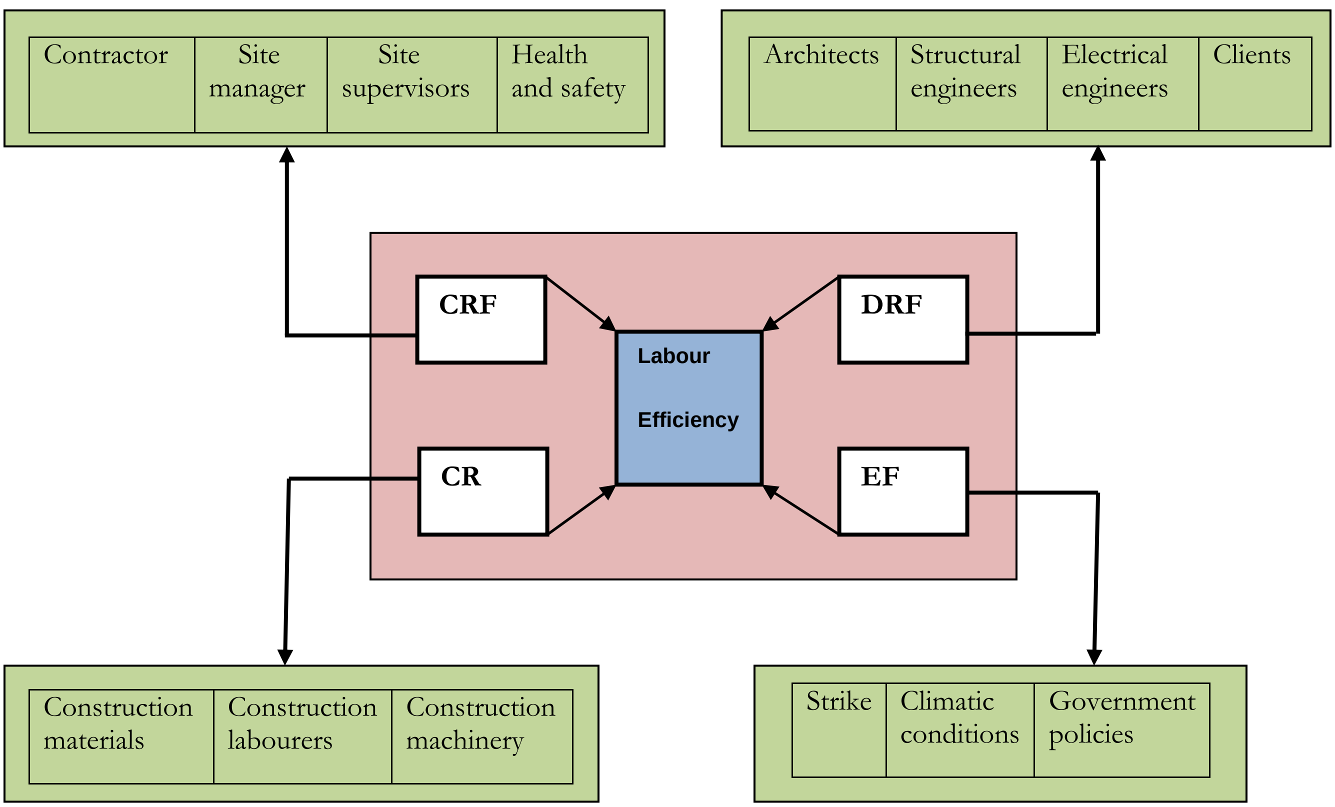

Figure 1.1: Conceptual framework

Key:

CRF: Construction-related factors

DRF: Design-related factors

CR: Construction resources

EF: External factors

1.5 Aim and Objectives

1.5.1 Aim

- The aim of this study is to develop a framework to improve construction workers' efficiency during the building production process in the South African construction industry.

1.5.2 Objectives

1. To identify construction-related factors affecting construction workers efficiency
2. To ascertain design-related factors reducing the efficiency of construction labour
3. To identify the impact of construction resources on construction labour efficiency
4. To ascertain the external factors affecting the efficiency of human assets in the construction industry.
5. To develop a framework for improving the efficiency of the South African construction workforce

This study will achieve its aim by providing answers to the research question and investigating sub-questions in line with its objectives.

1.6 Research question

- What strategies can be adopted by construction organisations to improve the efficiency of construction workers for successful project delivery?

1.6.1 Research investigative sub-questions

1. What are the construction-related factors affecting the efficiency of construction workers?

2. What are the design-related factors that interfere with the efficiency of construction workers?
3. What is the impact of construction resources on construction labour efficiency?
4. What are the required site management efforts that could reduce the adverse effects of critical external conditions on construction project performance?

Table 1.1 shows the relationship between the research objectives, the research questions, and the research method to be adopted.

Table 1.1: Relationship between research objectives, research questions and method

RESEARCH OBJECTIVES	RESEARCH QUESTIONS	RESEARCH METHOD
To identify construction-related factors affecting construction workers' efficiency	What are the construction-related factors affecting the efficiency of construction workers?	Review of relevant literature, questionnaire administration and semi-structured interviews.
To ascertain design-related factors reducing the efficiency of construction labour	What are the design-related factors that interfere with the efficiency of construction workers?	Review of relevant literature, Questionnaire administration and semi-structured interviews.
To identify the impact of construction resources on construction labour efficiency	What is the impact of construction resources on construction labour efficiency?	Review of relevant literature, questionnaire administration and semi-structured interviews.
To ascertain the external factors affecting the efficiency of human assets in the construction industry	What are the required site management efforts that could reduce the adverse effects of critical external conditions on construction project performance?	Review of relevant literature, questionnaire administration and semi-structured interviews.
To develop a framework for improving the efficiency of the South African construction workforce	What strategies can be adopted by construction organisations to improve the efficiency of the construction process for successful project delivery?	Analysis of retrieved structured questionnaires and semi-structured interview conducted.

1.7 Significance of the study

Considering the contribution of the construction industry to the Gross Domestic Product of South Africa, enhancement of construction workforce efficiency for improved productivity is essential (Durdyev, Ismail & Abu Bakar, 2012:1). Pattanayak (2005:7) states that, the "human resource of an organisation represents the largest investment of an organisation". Therefore, inadequate utilisation of human assets in the construction industry does not only constitute waste to construction organisations, but also to individual clients, governmental organisations, construction workforce and ultimately affects the construction industry's project delivery record. In addition, efficiency is attained through effective utilisation of all construction resources to achieve the set organisational objectives (Durdyev *et al.* 2012:1). The basic objectives of construction organisations are: on time project delivery, project delivery within budgeted cost and delivery at quality expected. These factors constitute the benchmark for construction success and are significantly dependent on the adequate management of the construction workforce (Minks & Johnston, 2011:204; Kasim, 2012:775). Moselhi and Khan (2010:289) point out that labour productivity improvement in construction is essential, due to the workers' impact on timely completion of projects and delivery within proposed cost. Hence, since both adequate utilisation of construction resources and project performance are subject to the efficiency of construction labour, the improvement of construction workforce performance is essential to ensure efficiency in the building production process (Lill, 2008: 865; Fapohunda, 2009).

1.8 Research methodology

The reliability of research data is significantly dependent on the methods adopted to gather data and eventually determines the success of any research work (Leedy, 1993). This research project adopted an exploratory study using quantitative questionnaires to obtain the input of construction professionals. The questionnaire survey for the exploratory study was supported with qualitative interviews to allow broader expression on the subject of construction workforce productivity challenges. The exploratory study was undertaken for the purpose of identifying the predominant worker efficiency challenges within the South African construction industry and ultimately for improving on the questionnaire for the main study. For the purpose of exploratory study, construction firms within the Western Cape Province were selected, and questionnaires were administered to construction professionals, who were also subsequently interviewed. However, the main study adopts a mixed method approach, involving a quantitative research approach with construction professionals and validated using qualitative interviews with construction site supervisors.

The research adopts primary and secondary systems of data collection. The primary data collection involves the administration of a research questionnaire to the research population with qualitative interviews. The questionnaire for the main study is designed in a structured form, in conformity with study objectives. Semi-structured interviews were conducted with site supervisors to validate quantitative findings and ensure validity of results. The secondary system of data collection for the project involved an extensive review of relevant literature on previous research work, which includes a review of published conference papers, textbooks, published academic journals and articles. Quantitative data was analysed with descriptive statistics using Statistical Package for Social Science version 22 (SPSS). Data gathered from qualitative interviews was analysed using content analysis. The responses obtained from qualitative interview conducted with site supervisors was transcribed verbatim with an electronic device and subsequently summarised and documented.

1.9 Research population

The population of this research comprises professionals and site supervisors in the South African construction industry.

1.10 Scope

The study is restricted to data collected from construction organisations in the Gauteng and Western Cape Provinces due to massive construction operations in the two Provinces.

1.11 Key assumptions

The research assumptions were as follows;

- Construction firms that will be sampled are confronted with construction labour efficiency challenges.
- Selected construction firms will allow access to their various construction sites.
- The research population will provide relevant information that will answer the study objectives and research questions.

The research process from inception to completion is presented in the Figure 1.2

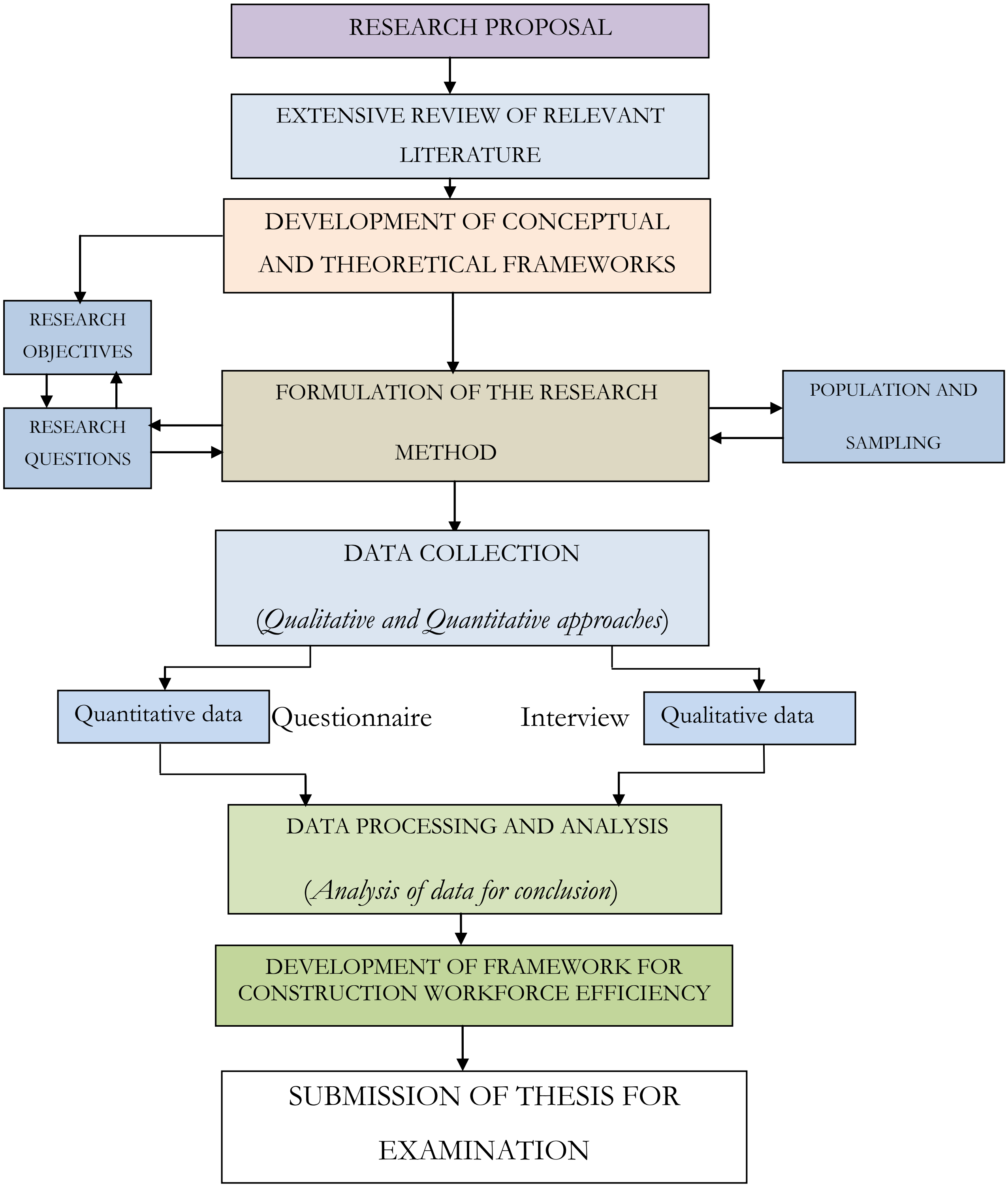

Figure 1.2: Process of research

1.12 Ethical considerations

In order to comply with internationally accepted ethical standards, the names of participant organisations and individuals will not be recorded on research documents. No compensation will be paid to any respondent or participant in the study, and quality will be assured with respect to the following:

- General conduct and competence of interviewers
- Quality of data
- Accuracy in calculations and
- Correctness and completeness of questionnaires, especially in the case of open-ended questions

1.13 Thesis structure

Chapter one - Introduction:

The introductory chapter comprises the background of the research, statement of the problem, the background to problem statement, the significance of the research, the research aim and objectives, research question and sub-questions, the scope of the study, key assumptions of the study, and ethical considerations of the study.

Chapter Two - **Literature review:** Chapter two involves an extensive literature review of previous research on the efficiency and productivity of the construction workforce. The parties and factors contributing to the challenges of construction workforce efficiency are comprehensively reviewed in this chapter.

Chapter Three - **Methodology:** Chapter three comprise both the research methodology and method employed during this study in order to achieve the research aim and objectives. This chapter examines the research population, instruments used for research data collection, processes involved in administering the research instruments, the general research approach, research philosophies and finally, the validity and reliability of the study.

Chapter Four - **Data analysis and discussion of findings:**

This chapter presents an analysis of quantitative and qualitative data as well as findings and discussion of the results obtained in the study. The chapter involves graphical and tabular representations of analysed data.

Chapter five – Conclusions, limitation, recommendations for further research:

This chapter revisits the aim of the study, the study objectives, conclusions drawn from research findings, limitations of the study, and recommendations for further research to improve the efficiency of construction workers.

1.14 Chapter summary

Construction workers' efficiency is identified to be concurrently affected by several factors within and outside the construction sector. Improved construction productivity is reported to be a product of effective integration of basic construction resources. However, the construction workforce is identified as the only productive construction resource with significant impact on construction materials and machinery. This chapter reveals that the activities of workers lead to wastage of other construction resources and increase construction cost and duration. The basic standard for determining the success of every construction project are; project delivery within expected quality, on time and within budgeted cost is significantly dependent on adequate planning for the effectiveness of construction workforce. The consulted literature reveals that construction operations projects are affected by the productivity of the workforce at every stage of the construction project. Improved construction labour productivity is a product of improved construction labour efficiency and enables the achievement of construction project objectives. The next chapter explores the objectives of the study with reference to relevant literature in order to identify various factors affecting the efficiency of human assets in the construction industry with the goal of improving construction performance.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The construction industry is characterised by its complexity, its traditional method of operation, its project based nature and its unfavourable working conditions, with relatively high rates of accidents and deaths of employees (Kazaz, Manisali & Ulubeyli, 2008:95; Enshassi, Mohamed & Abushaban, 2009:269; Gambatese, Behm & Rajendran, 2008:684; Dainty, Grugulus & Langford, 2007:502). These attributes of construction, combined with the fact that the workforce is made up of professionals and casual workers from diverse construction backgrounds and levels of education, all working towards achieving the same goal, would create challenges in any industrial environment. Soham and Rajiv (2013:583) posit that human capital is an important resource in the construction sector and problematic to control. However, Durdyev *et al.* (2012:1) note that construction workforce efficiency could be improved through effective management and integration of construction resources to achieve construction project goals. The effort to improve the efficiency of construction workers requires an adequate awareness of the basic factors impinging on the performance of human capital in the industry, as discussed later in this chapter.

2.2 The construction industry

The Construction Industry Development Board (Cidb, 2004:Online) reported that the construction industry globally accounts for over 10% of the world's economy. The industry is recognised as the second largest production industry in the United States, while the construction sector provides employment for over 6.4 million workers (Knutson, Schexnayder, Fiori & Mayo, 2009:29). South African Statistics Quarterly Labour Force Survey (SASQLS) affirmed that the overall income of the South African construction industry (Building and civil sector) in 2011 was two hundred and sixty-eight thousand, one hundred million rand (R268,100 million). This represents an increase of 12% over the reported total income of 2007 (Statistics, 2012:2). The report reveals a vast extension of construction activities in the South African construction industry over a period of four years. Arguably, the extension in construction activities in the South African construction industry has significantly contributed to the recent consistent economic growth of South Africa.

Notably, it was ascertained that the highest capital expenditure on assets in the South African construction sector in 2011 was construction machinery, plant and equipment, which represented 54% of the total capital expenditure (Statistics, 2012:2).The effective utilisation of construction machinery, plant and equipment is a notable determinant of construction workforce efficiency. Further, the report presented by (SASQLS) confirms the turnover of thirty one thousand construction workers between the second quarter of 2011 and the second quarter of 2012. This is an indication of the dissatisfaction of construction workers in terms of work environment and/or payment, or lack of workers' motivation. In the United Kingdom for example, the construction industry's annual output is approximately 114 billion pounds, which contributes almost 9% of the GDP (Cooke & Williams, 2009:4). On the other hand, South African construction industry contributes approximately 8.6% GDP to South Africa economy (SA report: Online). Therefore, it can be construed that the construction sector is a driver of economy growth (Khan, 2008:282).

The construction sector is characterised by high labour turnover, where rigid systems of working for long hours and rigid schedules of work are predominant. Lingard, Brown, Bradley, Bailey, & Townsend (2007:807) opined that these rigid systems and long hours affect the problem of attracting and retaining skilled workers in the construction sector. The combination of the construction industry's systems of operation, managerial approaches and external factors has resulted in the reduction in the South African Construction industry workforce which have declined by 2.9% in 2009, when compared with 2007 (Statistics, 2012:2). The workforce is the central input resource that represents the connecting link in every facet of the construction process to achieve client's satisfaction (Kazaz & Ulubeyli, 2007:2132). Due to the substantial loss of performance capacity encountered by the South African construction sector, ten critical factors responsible for construction inefficiencies in Construction Management Programmes (CMP) were explored by Ofori, Hindle and Hugo (1996:211) where labour productivity was among the top critical factors.

The construction sector is labour intensive and thus enhances high community participation in the construction production processes. This participation can create a challenge to the construction industry. Thus, clients, project managers, design professionals, contractors and construction managers are required to demonstrate sound managerial skills on construction projects (Ofori *et al.,* 1996:216). The environmental impact such as the sound of equipments and heavy operations on large construction projects can be extreme to the community and constitute unnecessary interference. This necessitate adequate community liaison in the planning phase of every construction project.

The outcome of construction projects is a product of processes and stages from conception to final delivery of projects. The effectiveness of strategies and approaches employed in the construction developmental process will positively affect construction workers' efficiency. Hence, Figure 2.1 presents the construction project developmental process from inception stage and highlights the basic tasks of project managers, from commencement of a construction project to the satisfaction of clients' requirements.

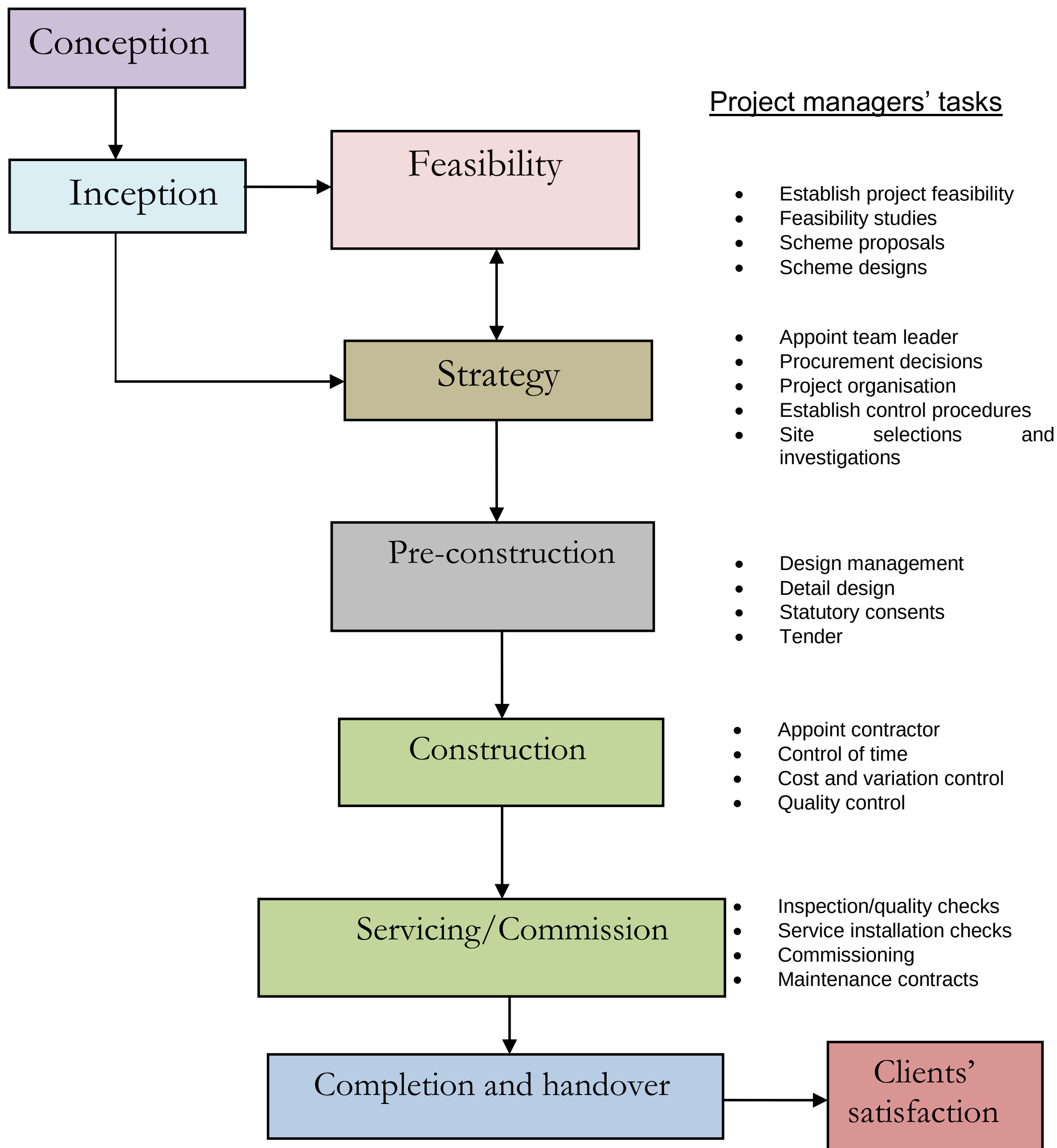

Figure 2.1: Project development process

(Adapted from Cooke and Williams, 2004:38)

2.3 The construction workforce

The relevance of the construction workforce has become a subject of academic concern (Drucker *et al.* 2006:406). Kazaz, Manisali, and Ulubeyli (2008:95) indicate that the workforce of the construction industry, especially in developing nations, is not considered an important asset by construction organisations. Nonetheless, construction labour represents an important construction variable and attracts a significant percentage of construction cost. Soham and Rajiv (2013:583) affirmed that the construction workforce is the most essential asset of construction firms, rather than merely a source of costs. Hence, effective management of construction workforces could afford improved and efficient performance of workforces on construction projects (Hanna, Taylor & Sullivan, 2005:734).

The increasing challenges of training skilled workers in the South African construction industry is recognised by Frank (2013:Online) as a notable basis of inadequate performance of the South African construction workforce. S.A Construction (2013:15) argues that the lack of expertise in the South African construction industry poses significant challenges for the industrial sector. Skill shortage in the sector is not only restricted to casual workers, but also prevalent at management level and is detrimental to the production process of construction projects (Frank, 2013:Online). Construction management entails the combination of better understanding of the construction workforce, the construction industry itself, changes in market and clients' orientation (Bozai & Ahmed, 2011:752). Chen, Liaw and Lee (2003:299) identify human resources as the twenty-first century's most valuable asset. The underlying reason is that construction workers are the only productive resource in the construction industry whose effectiveness demands contributions from all stakeholders in the construction sector. Therefore, successful organisations consider the construction industry's human resource function as the main focus when planning for organisations' business strategies (Olomolaiye & Egbu 2004:537). Due to the significant contribution of the construction workforce to the successful production of construction projects, Kazaz and Ulubeyli (2007:2132) opined that effective utilisation of human capital in the industry will enhance efficiency of other construction production units (materials and equipment) and render the organisations' set objectives more achievable.

The three typical resources associated with construction include; material, machinery and manpower (3Ms). Manpower is the source of more risks than construction materials and machinery (Hanna *et al.,* 2005:734). However, Jarkas (2010:143) expresses labour productivity as a degree of output (work done) obtained by a combination of various inputs (resources). Hence, it can be concluded that the combination of various inputs in the construction sector has not yet produced optimal results, and significantly affects the quality of construction output. The present state of workforce performance in the construction sector necessitates the improvement of the efficiency of the construction workforce. Kazaz *et al*., (2008:95) asserts that labour-intensive construction involves much more insight and diligence than equipment–intensive construction, and thereby makes effective human resource management in the industry a subject of concern.

2.3.1 Human resource management in the construction industry

The current practices in the construction environment are dynamic, complex and under-developed in respect to human resource management (Mustapha & Rashid, 2012:8). Consequently, most academics opinions concerning the approach of the construction industry with regard to human resource management are disjointed from the realities of construction activities (Dainty & Loosemore, 2012:9). A major challenge of human resource management in construction is identified as the difficulty in balancing the needs of the construction project, the organisational requirements and the needs of the construction workforce (Mustapha & Rashid, 2012:7). Notably, a typical distinguishing factor of the construction industry is the uniqueness involved in every construction project, which highlights the necessity of exhibiting a clear understanding of the construction industry in order to understand the human capital involved (Dainty & Loosemore, 2012:9).

A significant number of studies have identified human resources as the greatest resource of any organisation, and human resource management in construction is not an exception (Yankov & Kleiner, 2001:101). Kilby and McCabe (2008:106) state that a majority of the firms in the construction sector have yet to acknowledge human capital as the greatest asset of the construction industry, and consequently treat human assets as less important. It could be argued that when the stated objectives of an organisation are given primacy; the objectives are unlikely to be achieved without significant consideration of human resources. Kilby and McCabe (2008:106) further opined that, construction workforce efficiency can be enhanced for better performance of workers like their counterparts in manufacturing industries. Hence, Mustapha and Rashid (2012:7) identify good communication management as a major instrument for enhancing the management of human resources in construction.

2.3.2 Factors affecting construction workforce efficiency

In order to improve construction workforce efficiency, a study of factors affecting productivity is necessary (Enshassi *et al.,* 2007:246) to explore the critical productivity factors (Soham & Rajiv, 2013:583). As has been shown by previous research undertaken on labour productivity in the construction sector, there are diverse findings and opinions on the factors that affect the performance of the construction workforce. In an effort to explore the present state of productivity in the construction sector, Levy (2007:5) reports that workforce productivity in construction remains the same and has even drastically declined in some areas of construction.

Nonetheless, the output of construction workers is widely researched and the factors affecting workforce efficiency and effectiveness are for the most part established.

Many studies have been undertaken to explore the factors affecting construction labour efficiency. Among the most significant factors impinging on the output and efficiency of the construction workforce is unavailability and shortage of construction materials (Olomolaiye, Wahab & Price, 1987:321; Zakeri *et al.,* 1996:424; Kaming, Olomolaiye, Holt & Harris 1997:26; Makulsawatudom, Emsley & Sinthawanarong, 2004:3; Enshassi *et al.,* 2007:252; Dai, Goodrum and Maloney, 2009:221; Ameh & Osegbo 2011:620; Rivas, Borcherding, Gonzalez & Alarcon, 2011:316). Further, general construction performance is reported to be adversely affected by lack of, or breakdown of construction tools and equipment during construction production processes (Dai *et al*., 2009:222; Rivas *et al.,* 2011:316; Ameh & Osegbo, 2011:62; Makulsawatudom *et al*., 2004:4). Construction challenges derived from rework is noted by Olomolaiye *et al.* (1987:320); Kaming *et al*. (1997:26); Alinaitwe, Mwakali & Hansson (2007:174); Rivas *et al.* (2011:317), and Durdyev *et al.* (2012:7) as the critical factor affecting the efficiency of construction organisations. Construction rework could occur as a result of insufficient experience of construction workers or supervision inefficiencies. Hence, Olomolaiye *et al*. (1987:321); Kaming *et al.* (1997:25), Jarkas and Bitar (2012:817) report supervision delays to significantly contribute to current construction productivity challenges.

The difficulty in recruitment of skilled construction supervisors contributes to shortage of experienced site supervisors, which ultimately affects the efficiency of construction operations (Lim & Alum, 1995:57; Enshassi *et al*., 2009:275). Notably, construction projects involve work planning and scheduling with an eye towards practical completion to achieve the client's completion date. However, absenteeism of supervisors and construction workers is noted by Lim and Alum (1995:55); Kaming *et al.* (1997:24); and Makulsawatudom *et al.* (2004:4) as major factors affecting the progress of construction projects and eventually contributing to construction project extension. Olasipo, Ayodeji and James (2011:256); Makulsawatudom *et al.* (2004:5) identify poor communication as a barrier to good performance of construction workers.

It follows that most of the factors affecting construction productivity can be controlled with managerial efforts. However, there are factors that impinge on the effectiveness of construction productivity that are beyond the control of management. Previous studies identify these as *"external factors"* affecting construction productivity. Enshassi *et al.* (2009:274) identify increases in the price of construction materials as external conditions contributing to construction productivity challenges. Similarly, Soham and Rajiv (2013:585) identify high and low temperature, rain and high wind as falling under this category. Olabosipo *et al.* (2011:256), too, posit weather and site conditions as external factors affecting construction workers performance.

Factors affecting construction productivity vary across construction participants (professionals and non-professionals). Several studies acknowledged the adverse impact of clients or design professionals on construction productivity. The study undertaken by Zakeri *et al*. (1996:422); Makulsawatudom *et al*. (2004:3); Enshassi *et al.* (2007:250); Dai *et al.* (2009:223); Ameh and Osegbo (2011:62); Jarkas and Bitar (2012:818); Soham and Rajiv (2013:585) highlighted the late response of design professionals to drawing questions and production information inadequacies (Clarity, complexity and drawing errors) as a design challenge. In addition, late payment of construction workers is noted by Soham and Rajiv (2013:454) as another factor affecting construction productivity. Olabosipo *et al.* (2011:255) argue that the performance of the construction workforce is significantly dependent on training and worker motivation.

Insufficient worker training in the construction sector may contribute to the construction skills shortage. Thus, deficiency of skills of construction labour forces could result in construction rework, lower pace of work and negatively affect general construction performance (Ameh & Osegbo 2011:62; Soham & Rajiv 2013:455; Durdyev *et al.* 2012:5). Further, Moselhi and Khan (2012:292) posit that the type and height above ground of construction work considerably affects construction performance. Durdyev *et al.* (2012:5) further identify the adoption of an overtime system as a detrimental factor in construction workforce performance.

According to Dai *et al*. (2009:397), the factors affecting construction productivity are enormous and are mostly interdependent. Enshassi *et al*. (2007:246) added that the factors that impinge on construction workers efficiency are not usually the same, and these factors may vary from one country to another, one project to another and sometimes within the same project, depending on the circumstances involved. Productivity factors such as lack of availability of construction materials and equipment can be controlled and managed, while factors such as shortage of skilled labour and inclement weather are difficult to control, but their impact on construction productivity can be reduced through the application of various methods (Dai *et al.,* 2009:397). Figure 2.2 presents a model for continuous improvement in construction productivity to enhance timely delivery of construction projects, at budgeted costs and expected quality standards.

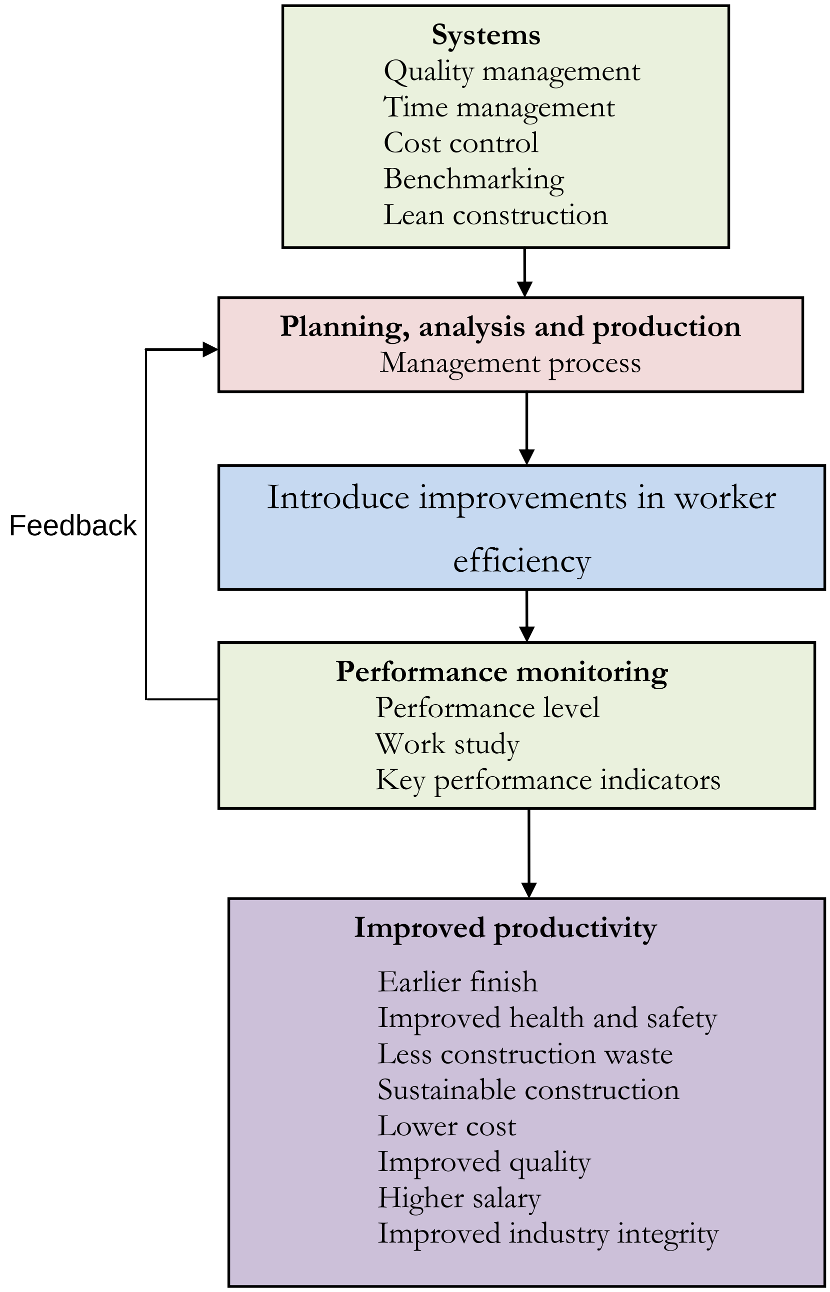

Figure 2.2: Model for continuous improvement of construction productivity

(Adapted from Harris & McCaffer, 2013:47)

2.3.3 Construction labour unions

In the construction industry, previous research revealed that labour relations are not historically positive (Kilby & McCabe, 2008:104). Labour unions and employers of labour sometimes disagree. Occasionally, labour unions express dissatisfaction in employer's actions through different strategies such as embarking on demonstrations or strikes. The South African construction industry is experiencing a nationwide strike as of October, 2014 resulting in tremendous loss of construction output, as stated by construction professionals. The South

African labour department reported in 2007, that a vast percentage of construction employers failed to comply with occupational health and safety regulations. As a result, the Building Construction and Allied Workers Union (BCAWU), in collaboration with South African Building and Allied Workers Organisation (SABAWO), both affiliated to the Building Workers International (BWI), formed an alliance and set an objective to facilitate a better future for the union in the construction sector (Schurman & Eaton, 2012:20). The purpose of the alliance is to ensure that the general contractor on a particular project is responsible for construction workers' benefits, working conditions, wages, health and safety and standards of employment, irrespective of whether workers are employed by either the main contractor or the sub-contractor. Conversely, due to the unsafe nature of employment and the informality of the construction sector, there is a disconnect between the union members, since construction workers' employment is terminated at the end of a project and other members could not afford union dues as a result of inconsistent income (Schurman & Eaton, 2012:20).

Broadly, at the time of this study, the United States construction labour union movement was initiated about 150 years ago with the objective of creating better lives for the members of the unions (Knutson *et al.,* 2009:46). Right from the initiation of the labour union movement, the construction workforce and the employers engage in construction-related disputes which affects the activities of the construction industry. The disorganisation of the construction sector and the long standing reluctance of employers to gainfully engage the workforce have limited the advancement of trade union membership and standard industrial relation processes (Walters, 2009:4). Also, in the United Kingdom, the long-standing problems between construction workers and employers led to a national strike in 1972, called by the major union representing construction workers, to set the minimum wage of labour and total weekly working hours (Kilby & McCabe, 2008:105). The section nine of the South African Labour Legislation stated that employers of labour should regularly assess whether the work environment are adequate for the health, safety and physical comfort of employees (Clarke, 2003:190).

Broadly, due to the unsatisfactory actions of employers with regard to construction labour, the trade union itself represents the contract negotiating body for the members of the union of construction trade. Contractors that employ union workers must abide by the terms and conditions set by the union (Knutson *et al.,* 2009:46). The structural and organisational distinguishing features of the construction industry require more inventive approaches to construction workers' representation and consultation. It must be taken into account, however, that the predominance of unskilled, semi-skilled, and migrant labour contributes to participative challenge and negatively affects effectiveness of construction labour unions (Walters, 2009:5).

2.4 Construction workforce and resources

The construction sector performance is majorly dependent on manpower, materials, machinery and cash (Donyavi & Flanagan, 2009:12). The resources majorly attributed to the construction sector are manpower, materials and machinery (3Ms), as discussed earlier. Nevertheless, the construction workforce activates materials and machinery resources, and substantially determines construction project efficiency and delivery cost. In other words, the performance of construction materials and machinery resources is a product of effectiveness and efficiency of human assets in the construction industry. Therefore, this necessitates the need for improvement of construction manpower for increased efficiency of construction resources.

2.4.1 Material resources

In construction projects, the cost of materials and plant components represents approximately 70% of the project sum in civil engineering projects, while materials cost represents 45% - 50% in housing and commercial building projects (Donyavi & Flanagan, 2009:12). Construction materials require significant considerations to reduce construction waste, or the loss of construction materials that could ultimately affect all aspects of construction projects (Kasim, Anumba & Dainty, 2005:795). Hence, the availability of construction materials at the right place and at the right time is essential to construction project success (Donyavi & Flanagan, 2009:11). However, non-availability of construction materials is identified by Zakeri *et al.* (1996:420), as the primary factor affecting the efficiency of construction operations. Zakeri *et al.* (1996:421) further note the factors causing non-availability of construction materials to include, waste due to negligence/sabotage, difficulties in transportation of materials on site, improper handling of materials on site, inadequate usage of materials to specification, lack of effective plan of work to be carried out, improper delivery of construction materials to site, and materials requisitions are subject to excessive paperwork.

Kasim, Anumba and Dainty (2005:796) identify improper construction materials handling as a factor affecting the general performance of construction projects in respect to construction time, quality, cost and overall construction productivity. Furthermore, Donyavi and Flanagan (2009:12) contend that materials management entails adequate planning and control to ensure that the right materials (in quality and quantity) are procured in time. A shortage of construction materials increases the chances exhausting the available materials and thereby slowing down the pace of work in anticipation of materials delivery, leading to idle time and ultimately construction cost overruns (Kazaz *et al.,* 2008:102). According to Rivas *et al.* (2011:316), late delivery of construction materials, unavailability of materials before commencement of construction work, the long distance of materials from the work location and excessive paperwork are the principal causes of materials-related problems on construction sites. Additionally Kazaz *et al.* (2008:102) found poor planning for construction materials and difficulties associated with site transportation as factors leading to a lack of construction materials on sites. According to Kasim *et al.* (2005:796), materials delivered to construction sites require an adequate organisation of stock control to prevent materials shortage. Kazaz *et al.* (2008:102) reports the factors to be prevented in order to ensure the correct materials management as: running out of construction material, poor sorting and marking of materials for proper recognition, incorrect materials or damage of materials beyond specification tolerance, and poor flow of materials.

Dai, Goodrum and Maloney (2009:225) recognised the waiting for transportation of materials and equipment on site as the most significant factor impinging on the productivity of construction workers. Similarly, Mincks and Johnston (2011:335) state that poor location of construction materials is an underlying material factor distorting construction output. As a result, construction workers would occasionally be challenged with unavailability of resources needed to perform allocated tasks. This may affect workers' motivation and distorts construction output efficiency (Dai *et al.,* 2007:1140). Cooke and William (2009: 401) acknowledge the necessity of establishing good communication practices between the supplier of construction materials and the construction site manager, expressly to ensure that materials delivery does not alter the schedule of construction activities. Immediately construction contracts are signed, deadlines on appropriate material ordering time should be established (Sears, Sears & Clough 2008:192). Mincks and Johnston (2011:141) suggested that the lowest-paid workers - such as apprentices or labourers should be relegated the responsibility of materials movement, while craftsmen with higher earnings, such as masons and carpenters, should be engaged with a more specific type of job.

2.4.2 Machinery resources

The complexity involved in contemporary building construction projects creates difficulties when assessing alternatives to existing construction equipment (Peurifoy *et al.,* 2006 cited in Goldenberg & Saphira, 2007:72). The study undertaken by Dai *et al.* (2009:401) reports construction equipment as being the most significant factor in the construction industry that affects construction workers productivity. A study undertaken by Goodrum and Haas (2004:132) on the long term impact of equipment technology on construction labour productivity at the level of worker activity posited that advances in equipment technologies have led to an improvement in productivity of the majority of production activities. The authors emphasised the importance of adequate implementation of equipment technology as a means of enhancing productivity of the construction workforce. Gransberg, Popescu and Ryan (2006:252) identify several factors responsible for loss of construction workers productivity: excessive time spent on identifying equipment parts, waiting for replacement parts for construction tools and equipment and the use of obsolete or incorrect tools for specific construction tasks. In addition to this, the complexity of construction operations, age of equipment, type of equipment, equipment quality and degree of usage are reported by Nepal and Park (2004:200) as significant factors that considerably affect construction productivity.

In the United Kingdom's construction sector, the acceptable standard for the acceptance of equipment operatives is certification through satisfactory fulfilment of an accredited scheme, and the construction equipment operator is awarded a certification card, which is necessary before the worker is allowed to operate the construction equipment in question (Edward & Holt, 2009:193). This point was supported by Bernold (2007:889), who states that the present day construction equipment operators require different competencies and skills than was the case in the past, because, while construction equipment in the last century often required the use of physical power, modern-day equipment requires primarily mental skills. Therefore, Nepal and Park (2004:200) maintain that the operative's skill is a paramount factor to be considered to ensure efficiency of equipment and prevent equipment downtime. Additionally, Cabahug and Edward (2002:22) claim that the efficiency of construction machinery is significantly dependent on the operator to perform daily maintenance on site, and that this maintains mechanical equilibrium which, in turn, enhances construction productivity. Competence, skill and the ability of equipment operators significantly contribute to efficient functioning of construction equipment and influence the progress of construction activities. Furthermore, Cabahug and Edward (2002:22) note that inadequate or inappropriate utilisation of construction machinery leads to the breakdown of construction equipment and consequently results in a decline in productivity, irrespective of the level of in-house maintenance. Hence, training, motivation and adequate supervision of equipment operators will help to improve the productivity of equipment technology, since equipment productivity significantly depends on operators. A fundamental reason for denying construction equipment operators the required training can be attributed to a lack of basic knowledge of construction by managers (Cabahug & Edward, 2002:28). This exacerbates under-utilisation of construction equipment, idleness of construction workers and delay of construction activities (Nepal & Park, 2004:200). Therefore, training should not be restricted to construction equipment operators alone, but also to construction managers so that they can take appropriate management actions to enhance construction productivity. It is therefore obvious that skilled operators are more likely to maintain the equipment they use, and put it to its proper use, resulting in less downtime, better task completion and lower maintenance and replacement costs.

Mincks and Johnston (2011:335) identify cost of equipment, availability of equipment, capacity of equipment, safety of usage, quantity of materials to be transported and access to the point of use as factors to be considered before selecting construction equipment for construction operations.

2.5 Project scope and objectives

Kasimu (2012:775) identifies the basic objectives of construction organisations as; on time project delivery, delivery within budgeted cost, and delivery at expected quality. A construction project work is a temporary operation of identified magnitude, expected to be delivered under the constraints of time and cost. Song and AbouRizk (2005:360) state that the definition of the construction project's scope has become the point of reference for developing construction estimates and schedules. Although design professionals seek to design construction facilities that are cost-effective and meet the client's deadline, there is nevertheless an outrageous percentage of time and cost overrun within the construction sector (Ameh & Osegbo, 2011:57).

2.5.1 Project scope

Knutson *et al.* (2009:59) claim that the first activity that must be settled in the planning phase of a construction project is the definition of the project's scope, which is the primary responsibility of the client. Adequate scope definition helps the designers to be aware of the project objectives and design in accordance with the defined scope. Fisk and Reynolds (2006:27) maintain that lack of clear definition of construction scope often results in claims and disputes between architects/engineers and construction clients. Unclear project scope may lead to the assumption on the part of the client that the designer will provide services that may not be in the plan of the designer. This may arguably lead to poor service delivery from the designer, which will affect the productivity of construction workers due to design-related problems. Hence, proper definition of project scope is essential to the successful implementation of engineering projects. Song and AbouRizk, (2005:360) agree that clear definition of project scope plays a significant role in the management of the construction design process. The author emphasised that poor scope can affect the pace of activities, lead to increased cost, increased project duration and, importantly, affect the morale and productivity of the construction workforce.

"In a construction project, the scope is defined by the quantities of construction items within each labour discipline that can be easily measured, such as volume of earth hauled, concrete poured or the length of pipe installed" (Song & AbouRizk, 2005:362). Besides these factors, project scope definition is also defined as the process of developing a comprehensive description of the project and product (PMBOK, 2008:49). The Work Breakdown Schedule (WBS) has been a frequently adopted method for definition of project scope, as it can be used to split the project into measurable units (Song & AbouRizk, 2005:362). The Project Management Institute defines

the Work Breakdown Schedule (WBS) as the system of sub-dividing construction project deliverables and project activities into smaller and more manageable components (PMBOK, 2008:49). Therefore, Mincks and Johnston (2011:315) agree that in any construction project, each activity in the construction schedule must be identifiable. The basic information underlying all project management functions concerns the subject of engineering productivity, where lack of a quantitative and reliable method of defining the project scope has been a major obstacle for engineering productivity (Song & AbouRizk, 2005). The scope of a construction project may exceed the budget of the client, especially when that owner does not have extensive construction experience. Knutson, *et al.* (2009:61) further stress the importance of construction clients without construction experience relying on professionals to define the scope within the owner-budgeted cost. It can therefore be seen that precise project scope definition is in the best interest of the client and therefore should be defined early, clearly and accurately.

2.5.2 Construction cost

The principal objective of the construction project manager is achieving the completion of the construction project within the predefined time, budgeted cost and expected quality constraints (Lambropoulos, 2005:452). These three factors are significantly important in any construction projects. Nonetheless, the order of importance of cost, quality and time is dependent on the requirements of clients (Lambropoulos, 2005:452). Basically, construction cost is divided into direct and indirect costs. Direct costs are the costs attributed to the construction workforce performing a task with the use of specific materials and equipment, Sub-contractor costs to the prime contractor in estimate also fall under direct construction costs. The costs attributed to construction overhead are identified as indirect costs (Knutson *et al*., 2009:146). These are the costs that are not included in direct labour, material or expenses that are not billed directly into a project. In the construction sector, cost is recognised as being among the key factors in the life cycle of construction projects and has a significant impact on the success of any construction project (Abdul Rahman, Memon, Azis & Abdullah, 2013:1964). As a result, one of the major challenges confronting the construction sector is the problem of construction cost overrun.

Moreover**,** Kasimu (2012:775) argues that the construction cost overrun problem is more common than construction time overrun. Research has revealed that there are higher numbers of building construction projects affected by cost overruns than those completed within budgeted cost. According to Lambropoulos (2005:452) private clients consider cost as the least important of the project objectives, while public clients accord more importance to construction cost. In the light of problems associated with construction costs, Olabosipo *et al.* (2011:255) note that the ability of construction supervisors to make adequate plans of construction work effectively communicate with workers and efficiently direct activities of subordinates, as major factors that determine cost-effectiveness of construction projects. However, Kasimu (2012:775) argues that, the factors which constitute construction overrun may vary from project to project, due to different conditions of under which projects in the construction industry may operate. Changes in the price of construction materials, additional work or changes of work specifications by clients, and delays brought about by contractors are identified by Baloyi and Bekker (2011:55) as the major causes of construction cost overruns. Further, Kasimu (2012:779) notes the most significant factors that result in cost overrun in building construction as; condition of market, experience of contractor, time constraints, fluctuation in price of construction materials and political situation.

The universal settings consist of a series of external factors that affect the progress and cost of construction work, including external factors such as rainfall and temperatures, are noted by Baloyi and Bekker (2011:58) as essential for consideration when determining the causes of cost overrun in any construction project. Hence, Kasimu (2012:776) posits the critical factors that lead to construction cost overrun as follows:

1. Changes made to a client's brief;
2. Incomplete design during tendering;
3. Site and poor soil condition;
4. Lack of monitoring and cost planning during pre-contract and post-contract phases;
5. Additional work by the client;
6. Adjustment of prime cost and provisional cost;
7. Logistics due to site conditions; and
8. Lack of reportage on cost during construction stage.

2.5.3 Construction time

Chan and Chan (2004:211) define construction time as the complete time calculated as the number of days, weeks, months or year from the beginning of construction activities on site to practical completion of a construction project. Time in construction is one of the determinant factors of the success of the construction project and an important subject in the construction environment. Love, Tse, and Edward (2005:193) maintain that the nature and complexity of a construction project considerably affect construction delivery time. Further, Choudhury and Rajan (2003:1) argue that the size of construction crew, method of construction and equipment adopted to execute a construction project, significantly determine the duration of a construction project. The study undertaken by Ameh and Osegbo (2011:61) identifies the major factors leading to extension of construction activities as follows:

- Inadequate funds for the construction project;
- Poor project planning prior to commencement of construction;
- Inadequate construction equipment and tools;
- Late materials delivery; and
- Changes in construction design during project execution.

The study undertaken by Baloyi and Bekker (2011:57) on the causes of time delay in construction projects identifies shortage of construction materials, changes made to designs and drawings at client request, poor management of construction sites by contractors and slow decision-making by clients as the major factors affecting on-time delivery of construction projects. Ameh and Osegbo (2011:65) claim that the relationship between time overrun and construction labour productivity is inversely proportional. In other words, a decrease in labour productivity inevitably increases time overruns and vice versa. Love *et al.* (2005:193), however, claims that cost is not a good predictor of project time, since the exact project cost is unknown before the practical completion of a construction project. According to Choudhury and Rajan (2003:4), an increase in construction project duration will result in an increase in construction cost. Hence, Sears *et al.* (2008:173) argues that completion of a construction project on budget and within specified time depends on the effective co-ordination, planning and allocation of construction resources.

Due to the uncertainties involved in the construction sector, construction practitioners occasionally adopt the practise of overtime to meet the proposed deadlines for practical completion of the construction project. Construction overtime leads to injury, creates general safety problems and causes workers to adopt a slower pace of work in order to reduce physical and mental fatigue. It is thus apparent that overtime is actually a source of expense to construction firms, causing additional workforce payment and negatively impacting workers' productivity (Mincks & Johnston, 2011:204). Thomas, Maloney, Horner, Smith, Handa and Sanders (1990:709) suggest that construction managers can enhance construction productivity by developing models for the most efficient ways to perform each construction activity, as well as optimal timing for such activities, i.e. work method. Mincks and Johnston (2011:313) state the conditions for implementing construction overtime measures by the construction superintendent to include; inclement weather foreseen to affect the duration of an activity while the cost to stop and begin the activity again is too expensive, the case of construction-critical activities, tasks with shortage of construction labour.

2.5.4 Construction quality

Construction quality and productivity are closely related. Knutson *et al.* (2009:505) define quality as "meeting *or exceeding the needs of the customer"*. Notably, the Japanese manufacturing industry was the first to develop Total Quality Management (TQM), with the objectives of improving reliability of product, reducing the cost of product and ultimately increasing productivity (Arditi & Gunaydin, 1997:235). Due to this awareness of the essence of quality, the concept of TQM extends beyond the manufacturing industry and permeates into every sector. Furthermore, it renders production quality a strategic objective of many organisations. Within the construction context, Wang (2007:1) stresses the significance of Quality Inspection and Management (QIM) in construction production process. In other words, periodic inspection of the quality of construction operations is essential to ensure construction product conformity with the predetermined specifications. It must be said, however, that the pursuit of acceptable standards of quality has been going on for a long time and is not of recent origin (Arditi & Gunaydin, 1997:235).

Rumane (2011:8) argues that construction quality does not only imply the quality of product and equipment used in construction works, but also encompasses the complete management approach employed to complete a construction project. Arditi and Gunaydin (1997:236) argue that organisations can ensure the quality of materials, equipment and technology required for a construction project (product quality) and may yet fail to ensure the quality of organisation, management, planning, design and construction phase (process quality). Inadequate co-ordination and poor planning of a construction project's human capital can contribute significantly to poor process quality in construction projects. Moreover, Mincks and Johnston (2011:290) define the quality of construction work as consisting of the output of productivity development, improved innovation, and improvement in quality through the involvement of a competent construction workforce. Hence, the availability of a capable workforce becomes a subject of concern for the production of a quality building construction product. The inability of the management staff of construction organisations to commit the entire workforce of the organisation to quality production is one of the major challenges to the quality of the construction product itself (Mincks & Johnston, 2011:292).

In order to maintain a standard quality of production in industries, the International Organisation for Standardization (ISO) was founded in 1947 in Switzerland. This body crafted the certified management standard known as ISO 9000 (Terlaak & King, 2006:580). The ISO 9000 is important in quality production because it affords a system which is internationally accepted; which further combines implementation of policies, attitude, procedure, technology, record keeping and resource management to achieve an acceptable minimum quality of production

(Knutson *et al.,* 2009:506). Nonetheless, in spite of the significance and prevalence of this quality management standard, Terlaak and King (2005:580) argue that the standard of construction quality management remains relatively understudied. Therefore, Knutson *et al.* (2009:506) summarise several principles advocated by ISO 9000, to provide the following framework for practice:

1. Construction organisations should focus on customers.
2. Construction organisations should provide reliable leaders.
3. Construction workers at all levels should be involved.
4. Construction organisations should use a process approach to manage activities.
5. Construction organisations should adopt a systems approach by identifying interrelated issues and treating them as a system.
6. There should be encouragement of continuous improvement.
7. Construction organisations should assemble the relevant facts before decisions are made.
8. There should be a good working relationship between construction organisations and their suppliers.

2.6 Impact of construction-related factors on construction workforce efficiency

Construction generally is concerned with the actions of a group of individuals, each involved in different capacities, who engage in the construction production process with the primary aim of building a facility. However, Pheng and Chuan (2006:31) opine that the ability of construction team to effectively communicate and maintain a good working environment is termed the "team relationship".

2.6.1 Impact of contractors on construction workforce performance

The term "contractor" implies from a legal agreement or contract negotiated and executed between the client and the builder (Knutson *et al.,* 2009:28). Contractors have significant roles to play in construction worker management aimed at enhancing overall construction productivity. Delay and loss of construction productivity may occur as a result of a contractor's inability to effectively utilise construction human capital (Haseeb, Lu, Bibi, Dyian & Rabbani, 2011:42). Unarguably, construction contractors are generally involved in most successful construction projects. Contractor organisations are generally one of the major parties in the construction production process that is majorly involved in planning stage. According to Harris and McCaffer (2001:74), a well-planned, effectively monitored and controlled project results in successful delivery of any contract and determines the contractor's profit. Therefore, the selection of construction contractors constitutes a major decision for clients and the professionals engaged by them (Palaneeswaran & Kumaraswamy, 2001:73). Considering only the construction cost can negatively affect the quality of construction during the production process. Wong (2004:69) suggested that contractor selection efforts should weed out incapable contractors at an early stage to prevent poor project performance.

In the construction environment, contractors are responsible for developing strategies for successful construction projects, including planning for a sufficient and capable construction workforce, materials, machinery and sub-contractors (Mincks & Johnston, 2011:18). According to Baloyi and Bekker (2011:58), contractor-specific factors responsible for cost and time overruns are; shortage of skill workers, poor resources and time planning, actions of sub-contractors, site management and poor labour productivity. Assaf and Al-Hejji (2006:351) further opine that lack of effective planning and scheduling, shortage of a capable and sufficiently large construction workforce and difficulties in financing by contractors are the common causes of delay in construction projects.

Under a single system of contract, construction clients award the execution of the entire project to a single prime or general contractor. General contractors bring together different elements and inputs under a single and coordinated system for project execution, in compliance with contract documents. In this system of contract, the contractor is completely responsible to the client. However, in a separate system of contract, several independent contractors work on the project without recourse to a single coordinated system. Each prime contractor is responsible for the allocated section of work, and directly responsible to the client (Sears *et al.,* 2008:5). During construction project execution, the contractor plans and directs the workforce and other construction resources required for the project. Therefore, the contractor is directly responsible for monitoring progress and proactively planning for the present and future of construction operations (Harris & McCaffer, 2001:75).

General contractors employ speciality contractors or sub-contractors to accomplish specific sections of each construction phase, such as: plumbing, electrical work, earthmoving etc. Knutson *et al.* (2009:45) state that speciality contractors on a project can number more than twenty and consequently represent the largest portion of workers on construction projects. A speciality contractor employed by the client to carry out a project may employ a general contractor who executes some portions of the project. The specialty contractor becomes the general contractor while the general contractor becomes the sub-contractor on the particular project (Nunnally, 2011:1). Hence, in this contractual system, the speciality contractor is responsible to the client for project completion within the specified time, budgeted cost and expected quality. Considering the impact of sub-contracted work on construction workforce productivity, Egbu, Ellis and Gorse, (2004:149) stress that contractors only have a direct influence over labour directly employed by each contractor, and indirectly control the workforce employed by sub-contractors. The construction contractor can make a substantial effort to afford favourable working conditions for the sub-contractor. However, the contractor's effort may not improve construction productivity unless the sub-contractor's own management themselves makes supportive efforts (Egbu *et al.,* 2004:149).

2.6.2 Impact of site managers on construction workers efficiency

Building and civil engineering projects are complex, both in design and production processes (Shohet & Frydman, 2003:571). Therefore, the effectiveness of construction organisations is determined by the ability of site managers to manage this complexity and effectively control the construction work team (Egbu *et al.,* 2004:17). Turner and Muller (2004:335) note that communication contributes to trust building on a construction project, and ineffective communication can result in a breakdown of trust. Unarguably, the construction site manager plays an important role in successful delivery of construction projects. Styhre and Josephson (2006:521) note that the success of a construction project significantly depends on the site manager, and the responsibility of the construction site manager extends beyond technical and production-oriented matters. Therefore, the site manager is required to be versatile in to afford attainment of project objectives. Fraser (2000:35) suggested that construction organisations should consider training and professional development of site managers for performance improvement. Consequently, due to the wide range of responsibilities of the construction site manager, production responsibility on site is becoming largely delegated to site supervisors, while construction site managers become more dedicated to construction planning, co-ordination, procurement activities, documentation and reporting (Styhle, 2006:275). Similarly, Egbu *et al.* (2004:19) maintain that planning, co-ordination and procurement ensures co-ordination of labour inputs, control of construction resources (materials, and plants) and ensures general efficiency of construction operations.

Traditionally, the successful delivery of a construction project hinges on the performance of the project manager, who must consider delivery time, budgeted cost and expected quality (Pheng & Chuan, 2005:25). Further, Walker (2007:7) claims that the title "project manager" contains a reserved implication, as, in construction, being a project manager implies managing the entire construction process. Considering the relevance of project managers in the construction process, they require good construction skills and capabilities in order to effectively fulfil their function. However, project manager with such abilities are rare (Zavadskas, Turskis, Tamosaitiene & Marina, 2008:463).

A significant challenge confronting construction site managers is the difficulty of ascertaining the needs of construction project stakeholders, comparing those needs with the project objectives and deciding on the best strategy to fulfil those needs and objectives (Olander, 2007:277). Although the construction project manager's principal responsibility is to achieve project objectives in a particular contract, the objectives of construction projects are rarely accomplished as expected. Consequently, Pheng and Chuan (2005:36) argue that the causes of underperformance of a construction project manager is not restricted to inadequate skill on their part alone, but that a poor working environment can negatively impact the efficiency of a contractor's project manager. The actions of the construction client can also influence the performance of the client's project manager.

Soham and Rajiv (2013:583) point out that the construction industry faces labour productivity challenges. The opinion is advanced by Levy (2008:7) that the efficiency of the construction workforce is a product of the scarcity of skilled workers and inadequate technical know-how on the part of construction managers. With the exception of design errors, most of the significant factors affecting construction workforce efficiency can be controlled by the day-to-day actions of the project manager and site supervisors (Dai *et al.*, 2009:225). Hence, project managers are responsible for construction success and project quality, completion within specified cost and completion with the specified time (Sears *et al.,* 2008:14). Pheng and Chuan (2006:29) opine that successful delivery of construction projects greatly depends on the project team members' ability to efficiently work together, since effective construction planning significantly reduces construction progress interruption (Ameh & Osegbo, 2011:61).

Project managers of construction firms are not only required to concentrate on building technologies and management of material resources, but also must pay significant attention to the construction workforce itself, an entity whose behaviour cannot be easily predicted (Lill 2008:864). With regard to the achievement of improved worker efficiency, Kazaz *et al.* (2008:101) opined that the qualifications held by construction managers, as well as the experience of site supervisors , are important elements that determine the level of construction labour efficiency. Lill (2008:865) further argues for the necessity of creating a balance between construction project requirements and the needs of workers in the construction industry. Fapohunda and Stephenson (2010:363) note the need for training and personal development of construction managers, especially on new technologies that could improve effective and efficient utilisation of construction resources. Jarkas and Bitar (2012:819) suggest that a high level of technical skill and extensive knowledge of contractual arrangement on behalf of the construction manager are important factors if the construction manager is to anticipate future hazards and avoid missing important construction details. Therefore, successful delivery of construction projects is significantly dependent on the competence of project manager's skills and ability (Zavadskas, *et al.,* 2008:463).

2.6.3 Site supervisors' impact on construction workers productivity

In the construction context, the terms "site supervisors" and "foremen" are used interchangeably. Usage depends on the individual construction firm (Dingsdag, Biggs and Sheahan, 2008:628). The site supervisor represents the link between management and construction labour (Serpell & Ferrada, 2007:592; Uwakweh, 2005:1322). In other words, construction site supervisors are directly responsible for directing the activities of labours on the construction site. This makes the supervisors' impact on workers' productivity significant (Uwakweh, 2005:1320). Similarly, Serpell and Ferrada (2007:591) report that *"Construction site supervisors direct the execution of basic construction work operations, as well as communicating project objectives and goals to workers"*. Therefore, the construction site supervisor becomes the most active leader on site and is generally perceived by workers as *"the most visible people on site"* (Dingsdag *et al.,* 2008:630). However, from the standpoint of communication, Serpell and Ferrada (2007:588) posit that communication management on building construction sites is relatively poor. However, Kines, Andersen, Spangenberg, Mikkelsen, Dyreborg and Zohar (2010:404) contend that there is regular communication between supervisors and workers, although there is a need to improve on the effectiveness of the message.

Achievement of construction project objectives and general performance of construction crafts is the responsibility of the construction site supervisor, which is termed "*labour critical function*" (Serpell & Ferrada, 2007:588). Hence, the site supervisor's adoption of an appropriate channel of communication is a significant tool for effective labour performance. Kines *et al.* (2010:400) note that the attitude of site supervisors to construction safety significantly influences the safety behaviour of junior construction workers. Serpell and Ferrada, (2007:593) summarise the primary site supervisor-related challenges confronting construction performance as follows:

- Lack of formal training to ensure site supervisors' efficiency in supervisory responsibilities.
- Deficiency in site supervisor training results in increase in cost of construction, due to poor work planning and inefficiency in communication with subordinates.
- Insufficient formal training programmes that could afford the construction industry the required number of qualified site supervisors.

- Inappropriate selection processes adopt by supervisory personnel.

2.7 Impact of construction organisations on efficiency of construction workers

The construction organisations make decisions and formulate strategies that either positively or adversely influence the performance of the construction sector. However, Henderson and Ruikar (2010:314) stress the necessity for continual construction improvement by formulating appropriate strategies for new initiatives, rather than continual implementation of past strategies on the rationale that they have previously produced satisfactory results. The basic decissions made by construction organisations have an impact on the efficiency of the organisation employee. Some of these critical decissions include issues that are related to occupational health and safety, employment related, motivational system, training and communication system.

2.7.1 Construction occupational health and safety

Generally, a construction site is one of the most dangerous working environments, being generally unsafe and complex, which makes construction sites prone to accidents (Teo, Ling & Chong, 2005:329; Toole & Gambatese, 2008:226). According to Abudayyeh, Fredericks, Butt and Shaar (2006:167), the percentage of worker fatality in the construction industry is only exceeded by worker fatality in agricultural and mining sectors. Therefore, safety knowledge based on training and education becomes a fundamental requirement for both safety officers and participants in a construction project generally (Dingsdag *et al.,* 2008:628). Kazaz *et al.* (2008:101) note that a well-motivated and skilled construction workforce operating under poor working conditions is prone to produce low quality construction work. Fung, Tam, Tung and Man (2005:510) report that a construction workforce tends to focus more on monetary rewards for the job done and ignore the importance of safety on construction sites. With an effort to ensure construction site safety, "The South African Construction Regulation (SACR) state that *"the designer shall modify the design or make use of substitute materials where the design necessitates the use of dangerous structural or other procedure or materials hazardous to health and safety, and the designer shall inform principal contractors of any known or anticipated dangers or hazard or special measure required for the safe execution of work"* (Gambatese, Behm & Hinze, 2005:1030). The SACR identifies the importance of employees' safety by ensuring a safe working condition which will arguably affect construction workers performance.
Abudayyeh, Fredricks, Butt, and Shaar (2006:168) affirm that the success of any construction safety programme significantly relies on the involvement of construction health and safety officers, construction managers, and labourers. Fang, Chen and Wong (2006:581) argue that less educated construction workers fail with regard to construction safety significantly more often

than their learned counterparts. This statement is reinforced by Fung *et al.* (2005:510) that the management group and construction supervisory staff with higher education have a better construction safety culture.

Abudayyeh *et al.* (2006:167) claim that the prevalence of fatal and non-fatal injuries recorded in the construction industry is outrageous and had not declined from 1996-2006. This is an indication of inadequate safety practices in the construction sector, which ultimately impact construction workforce output. Thus, Toole and Gambatese (2008:226) further opine that every professional involved in the process of construction (Owner, contractor and designer) should strive to minimise injury on construction sites. Fung *et al*. (2005:509) note that peer group pressure of construction workers influence safety culture. The authors further emphasise the need for a higher number of construction workers to be safety-minded, and that the behaviour deriving from such a mind-set will influence other construction workers. Kines *et al.* (2010:400) maintain that the efforts to change the attitude of construction manpower towards improved safety are a significant challenge in the construction sector. Better site supervisor's attitude to safety can be helpful in proffering good safety behaviours on site, since site supervisors are important element with direct working relationship with construction labours.

The study undertaken by Fang *et al.* (2006:581) evaluated individual safety behaviour and found older construction workers and workers with family responsibilities exhibit better safety culture than younger workers with less responsibility. Abudayyeh *et al.* (2006:173) opine that construction safety culture can only be improved through the change of behaviour and perceptions of safety, which could be achieved through education, continuous training, receiving feedback and ultimately evaluating the results. Similarly, Aksorn and Hadikusumo (2008:719) note that construction workers' motivation toward safety can be improved by ensuring the participation of craft workers in organisation-level safety activities such as worker involvement in safety committees, monitoring, reporting, and correcting hazards in their trades. Serpell and Ferrada (2007:591) do point out, however, that craft workers' participation in decision making is limited, due to the strong hierarchical structure of the construction sector. Abudayyeh *et al.* (2006:168) contend that the success of any construction safety programme significantly depends on the involvement and collaboration of both managers and construction workers at various levels in making policies and devising a system of feedback to enhance consistent improvement. Figure 2.1 presents the safety triangle for as it applies to construction sites. Gellor identifies construction workers, working environment and behaviour or attitude on sites as three significant factors that may influence safety culture on construction sites and ultimately influence the performance of construction operations.

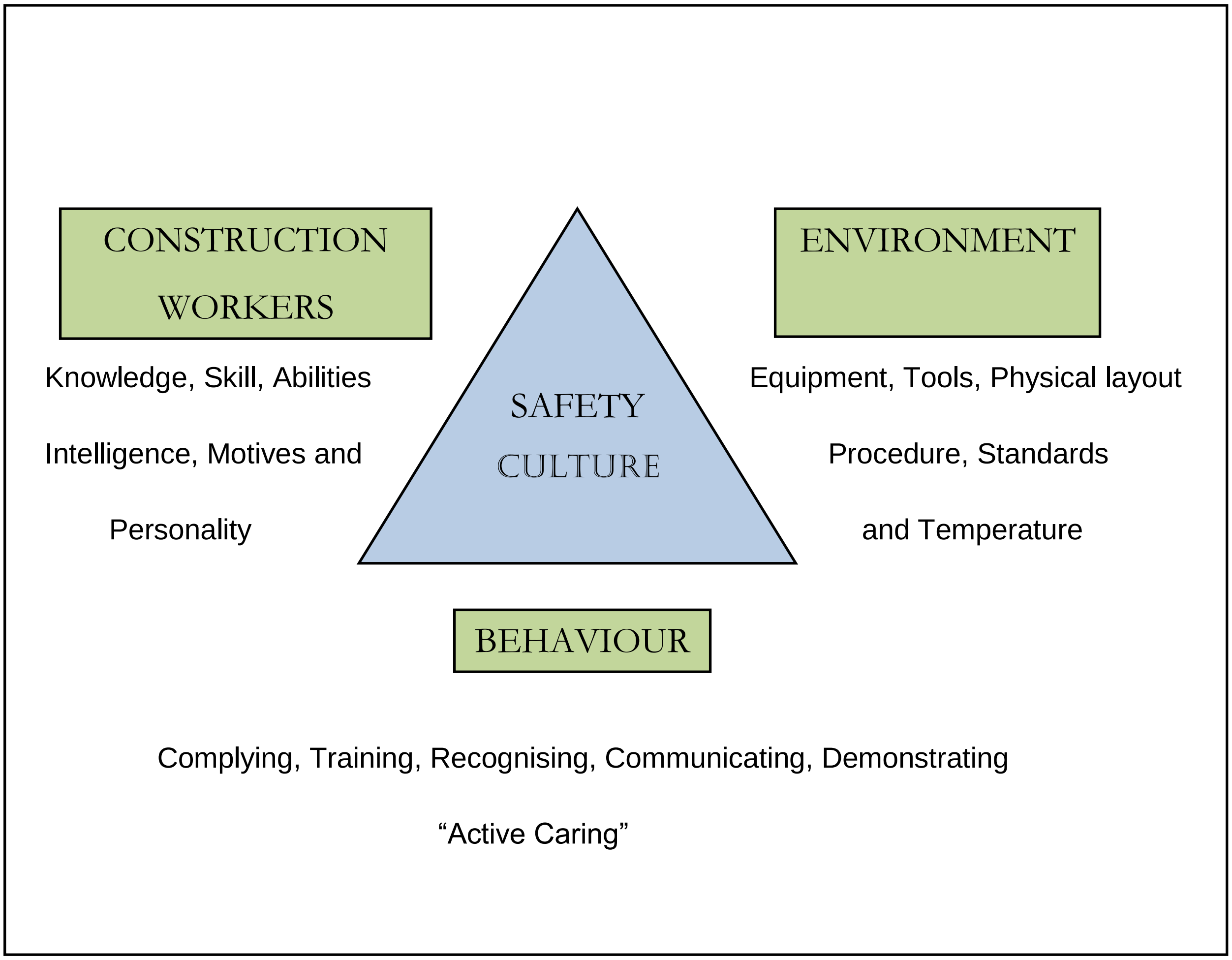

Figure 2.3: Safety triangle

(Adapted from Gellor, 2001)

2.7.2 Design for safety

Construction design for safety allows for the safety of the construction workforce as a permanent feature of a construction project (Gambatese *et al.,* 2005:1029). In a large construction project, the subject of safety is of great concern to construction clients, as lack of safety can negatively influence the end result of a construction project (Aksorn & Hadikusumo, 2008:720). The study undertaken by Gambatese *et al.* (2005:1032) with an eye towards improving construction safety investigated the viability of design for safety of construction workers. Comprehensive knowledge on the part of the designers and awareness of methods of implementation of the safety design concept were reported as two important fundamental factors to be considered in designing for construction safety. Larson and Torner (2008:410) identify the psychological climate of an organisation as having direct or indirect impacts on individual safety behaviour. The authors define psychological climate *"as the way individuals in an organisation perceive the psychosocial condition at work, measure and analyse at individual level*".

The impact of safety design in construction may influence any aspect of a construction project. Gambatese *et al.* (2005:1032) note an increased cost of construction and extension in schedule of activities as an impact of non-adherence to safety design. Although the construction sector is confronted with a wide range of challenges; nonetheless the occurrence of accidents on construction sites that impinge on the efficiency of construction operations is a notable part of the construction struggle (Aksorn & Hadikusumo, 2008:710). Considering the total number of workers in the construction industry and other industries, previous studies undertaken show that the construction industry accounted for 14% of the total number of deaths in 2003, while 24% of construction workers suffer permanent disability (Aksorn & Hadikusumo, 2008:711). Hence, Gambatese *et al.* (2005:1035) suggested consistent consideration of design for construction safety as a way to significantly reduce construction workers' injury and fatalities rates.

2.7.3 Construction worker recruitment

The growth of self-employment in the construction industry is identified as one of the most significant factors for the shortfall of construction skills, due to the influence of construction self-employment on training (Dainty, Ison & Briscoe, 2005:388). Disregarding actual physical strength, Dainty *et al.* (2005:392) pointed out that older construction workers generally outperform younger workers in term of dedication and commitment to work. The authors reported the problem confronting the construction industry as consisting of inadequate quality of workers, rather than a shortage.

The poor image of the construction sector is mostly attributed to the difficult, dirty, and delicate nature of construction works. Geneva (2001:1) notes that the basic reason for construction work's poor image is the recruitment procedure adopted within the construction sector. Cotton, Sohail and Scott (2005:618) state that construction firms rarely adopt a formal system of employment, due to the temporary nature of construction works. This encourages the casual system of employment in the construction industry and is one of the underlying reasons for poor performance of construction operations. Lim and Ling (2012:103) state that it is common practice for contractors to dismiss the workers immediately after the completion of a project. Lill (2008:867) argues that this gesture shows a lack of concern for the development of the construction industry workforce. Mondy (2010:424) supports this contention by arguing that the termination of employee appointment is an extreme penalty for workers, and construction management should carefully make this vital decision at the right time. The existing practice may discourage other workers and thereby affect the construction workforce's output. However, Mincks and Johnston (2011:204) contend that termination of employee appointments due to inability to deliver should not be seen as an unfair management action.

Fellow, Langford, Newcombe and Urry (2002: 135) claim that construction firms have many sites; some construction sites recruit their workforce based on the immediate needs of the site without considering the basic requirements of the central management. Agapiou *et al.* (2006:158) suggested a change in the current system of employment to improve efficiency of construction workers whereby management would be encouraged to develop a more understanding attitude towards industry workforce employment. Raiden, Dainty and Neale (2003:313) acknowledge a behavioural interview system as a good practice for attracting managers with good communication abilities, technical ability and reliable past experience, in order to foster organisational development. This may be helpful as a means to improve the prevalent "hiring and firing" system in the construction sector (Mincks & Johnston, 2011:204).

2.7.4 Workforce motivation

Tabassi and Abu Bakar (2009:474) define motivation as *"the characteristic of an individual willing to expend effort towards a particular set of behaviours"*. Construction worker motivation is a significant factor in the augmentation of construction productivity (Uwakweh, 2005:1326). According to Schermerhorn, Hunt, Osborn and Uhl-Bien (2011:110), the main theories of motivation include content and process theories. The authors define the content theory of motivation as being based upon individual needs resting on psychological needs that demand satisfaction. On the other hand, a process theory focuses on the thought that runs through the mind of individual workers and affects their performance. Kazaz *et al.* (2008:96) claim that productivity is related to workers motivations, and worker motivation is directly linked to construction productivity. Parkin, Tutesigensi and Buyukalp (2009:110) argue that construction workers can be made more productive by adopting the right system of motivation. Hence, Monese and Thawa (2009:208) suggest that improving worker motivation would have a significant effect on the development of the South African construction industry.

According to Parkin *et al.* (2009:110), construction managers' knowledge of workers' motivating factors can help construction management to develop approaches for improving construction workers motivation. The quality of human performance is significantly dependent on motivation, where an increased motivation brings increased productivity and vice-versa (Kazaz *et al.,* 2008:96). Therefore, managers should understand individual needs to create a better work environment for construction employees (Schermerhorn *et al.,* 2011:111).

Olabosipo *et al.* (2011:255) maintain that construction workers' motivation can be financial or non-financial. Although money is mostly recognised as a good motivational drive, Parkin (2009:109) also recognises the necessity to consider the financial strength of an organisation. Conversely, Tabassi and Abu Bakar (2009:474) argue that worker recognition by the employer is a significant non-financial motivation. Every individual within an organisation has different needs which could include; a sense of belonging to a team or workers' participation in collective effort. Effective employee motivation requires management to devise a means of identifying construction workers' needs and develop a strategy towards meeting those needs (Tabassi & Abu Bakar, 2009:474). Parkin *et al.* (2009:109) confirm that workers may have different levels of passion for growth and development.

Efficiency of construction workers requires employers to recognise the driving forces of their employees (financial and non-financial). Nonetheless, Parkin, *et al.* (2009:109) argue that as soon as a need has been satisfied, the same need ceases to play an effective role in motivating the particular worker. Hence, there is a necessity to consistently evaluate individual needs of employees by construction managers. Herzberg, Harris and McCaffer, (2013:119) identify employee motivational drives and demotivating factors that enhance job satisfaction and dissatisfaction as consisting of the following:

- Motivation drives

1. Achievement
2. Employer recognition
3. The work itself
4. Taking responsibility
5. The chance to advance

- Demotivating factors

1. Working conditions of employees
2. Poor Salary
3. Poor relations with superiors
4. Policy of organisations

In figure figure 2.4, Maslow's identifies human needs in hierarchical order which in turn affect and contribute to performance level of individual in any organisation. Considering Maslow's triangle of need, the principal need every individual desire are food, clothing and other basic needs of live. After the fundamental human needs are met, individual thereafter look forward to safety, shelter, recognition, respect, self-expression and ultimately self-fulfilment.

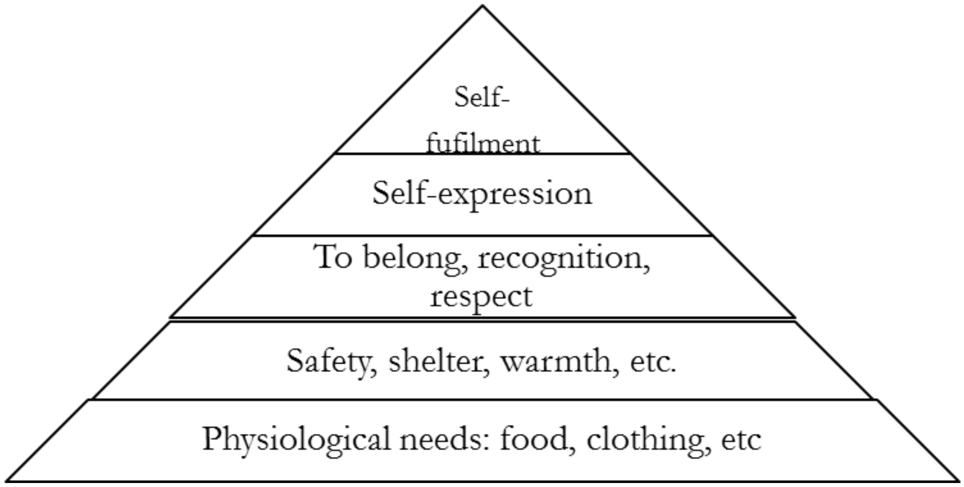

Figure 2.4: Maslow's hierarchy of needs

Source: Harris and McCaffer (2013:118)

2.7.5 Employee training

Considering the declining nature of construction productivity, construction employee training will have a positive effect on worker efficiency (Abdel Wahab, Dainty, Ison, Bowen & Hazlehurst, 2008:379). Tabassi and Abu bakar (2009:473) contend that one of the most significant factors in achieving human resource management in the construction sector is the need for effective training of the workforce. Lim and Ling (2012:103) maintain that the core objective of training and development is to improve workforce knowledge and skills. Nonetheless, Abdel Wahab *et al.* (2008:379) argue that not every training activity is geared towards improvement of construction productivity. Therefore the focus on training as a means of improving construction productivity may sometimes be unhelpful.

Olabosipo *et al.* (2011:256) note that the project-based nature of construction is a significant factor that affects training of construction labourers. Contractors feel unmotivated to invest in training workers that are not in long-term employment. Training begins with identifying the need for training through the analysis of jobs, analysis of organisations and assessment of workforce performance (Tabassi & Abu bakar, 2009:473). However Neitzel, Meischke, Daniell, Trabeau, Somer and Seixas (2007:121) posit that training facilities may be regarded as basic, but are not generally available and difficult to implement, due to high construction labour turnover. Arguably, training success may be achieved by construction organisations adopting a simpler training approach with minimum facilities.

Tabassi and Abu bakar (2009:473) further stated that, the two types of training that could be made available to construction workers are; (a) On-the-job training and (b) Off-the-job training.

The industry utilises a large number of skilled bricklayers, carpenters, welders or plumbers, skills which could be produced using apprenticeship training or "*on the job training*". Training could also be carried out through lectures or film shows to encourage the growth of skills in organisation employees, and example of an *"off the job system".* Such a dual solution is recommended by Glover and Bilginsoy (2005:338), who claim that both practical and theoretical knowledge, acquired through on-the-job training in addition to classroom knowledge are important attributes needed by construction workers. Abdel Wahab *et al.* (2008:379) suggest that the act of training too many new entrants (apprentice) can create a negative impact on construction productivity, since most of the experienced workers will be engaged in training the new entrants.

2.7.6 Communication management

Pheng and Chuan (2006:28) state that information considerably contributes to the achievement of construction project objectives. Cheng, Li, Love and Irani (2001:63) define communication *"as the transmission of resources (e.g. information and other means including ideas, knowledge, specific skills and technology) from one person to another through the use of shared symbol and media".* The subject of communication in the construction sector is a challenge, as workers in a team planning to achieve the same goal are brought together from different firms and backgrounds (Egbu *et al.,* 2004). Nevertheless, the effectiveness of construction workers significantly depends on the clarity of information on the job requiring execution (Olabosipo *et al.,* 2011:256). Cheng *et al.* (2001:62) identify effective communication as a fundamental factor for management to consider in order to achieve project success. Balout and Gauvreau, (2004:9) support this contention by identifying the importance of clarity of message to communicate project objectives and goals during the planning process.

Dai and Goodrum (2011:698) note the inability of construction supervisors to provide the craftsmen with adequate information to implement their jobs as a significant factor that interferes with construction labour output. Donyavi and Flanagan (2009:18) suggest good communication and co-ordination system among project participants as a way of achieving the set objectives of construction projects. The challenge of dealing with construction workers from diverse ethnic backgrounds is essential for construction site supervisors to overcome. This is to avoid the tendency of construction operatives handling problems independently, or even ignoring them, rather than consulting construction management (Loosemore & Lee, 2001:520).

Due to the fragmented nature of the construction sector, poor interpersonal communication leads to conflicts and disputes (Cheng *et al.,* 2001:69). However, as a result of multilingual practice on a construction site, Loosemore and Lee (2001:521) report a conflict between two trades on a construction site that led to wastage of 30% of formwork in a multi-storey building.

Moreover, the study revealed a lack of a shared language between construction managers and the construction workforce as constituting a source of frustration for, and ineffectiveness on the part of, construction managers. Further, Olabosipo *et al.* (2011:256) claim that on most construction sites, employees are not informed about the plan of work early enough, but are mostly informed close to the commencement of daily activities. This may be detrimental to construction workers' efficiency. Chen *et al.* (2001:62) maintain that a significant reason for lack of co-operation between construction professionals lies in a lack of effective communication.

2.8 Effective construction project management system

The application of knowledge, skills, techniques, and tools in project activities to meet project objectives is termed "project management" (PMBOK, 2008:37). Fundamentally, project management involves two major challenges; understanding the project and possessing sufficient knowledge of project management itself (Koskela & Howell, 2001:1). The processes involved in effective project management are broadly identified as: initiating, planning, executing, monitoring, controlling and closing (Zavadskas *et al.,* 2008: 464).

2.8.1 Initiation

Project initiation involves an act of determining project requirements to some degree of detail, setting out approaches to solutions and, ultimately, the assessment of feasibility of proceeding with a project (Greer & Conradi, 2009:357). Similarly, the process of project initiation could also imply arrangements to define a new project or a new section of an already-existing project by obtaining approval to commence a project or a particular section of a project (PMBOK, 2008:44). However, Sabotka and Czarnigowska (2005:79) pointed out that project initiation encompasses checking construction concepts from a logistics point of view, preparing logistics for site planning and formulating strategies for the management of construction projects. The initial scope of a project is defined, the initial resources are committed, project managers and stakeholders are appointed and then interact to influence project objectives (PMBOK, 2008:44). Kloppenborg, Tesch, Manolis and Heitkamp (2006:16) suggest that a significant percentage of changes necessary in a project's lifecycle are more appropriate at the early stage of construction projects. Hence Han, Kim and Kim (2007:425) identify the need to proactively forecast the effects of risks associated with a project early enough to establish risk management strategies to improve the contractor's profit.

2.8.2 Planning

Planning for construction projects is among the foremost challenging tasks that confronts the construction project team (Waly & Thabet, 2002:139). Construction project planning is considered to be a critical process in the early stage of construction and determines successful delivery of project within stated objectives (Huang, Hong, Baldwin & Li, 2006:576). However, Project Management Body of Knowledge states that planning involves the process of establishing the total possibility of effort, act of defining and redefining project objectives (PMBOK, 2008:46). This will ultimately consolidate the required effort to achieve project objectives. Since the construction industry is identified as a major contributor to the economic growth of every country (Enshassi *et al.,* 2007:245), effective planning for activities in the construction sector represents a growth engine for national economic development (Wong, Ng & Chan, 2010:256). Inevitably, construction operations mostly involve changes during the construction process. Planning in construction activities requires consideration of future changes to considerably reduce delay in activities. Balout and Gauvreau (2004:7) stress the need for adequate feasibility studies in the construction planning stage. Effective project planning is further stressed by PMBOK (2008:46) who recommend that project teams encourage participation from all appropriate project stakeholders by planning and developing project management documents. Koskela and Howell present the project management managerial process in Figure 2.5**.** According to the figure, the entire delivery process of a project involves planning process, controlling process and execution process. The construction project decisions and management approaches adopted during these three essential stages will arguably determine the performance of any construction project.

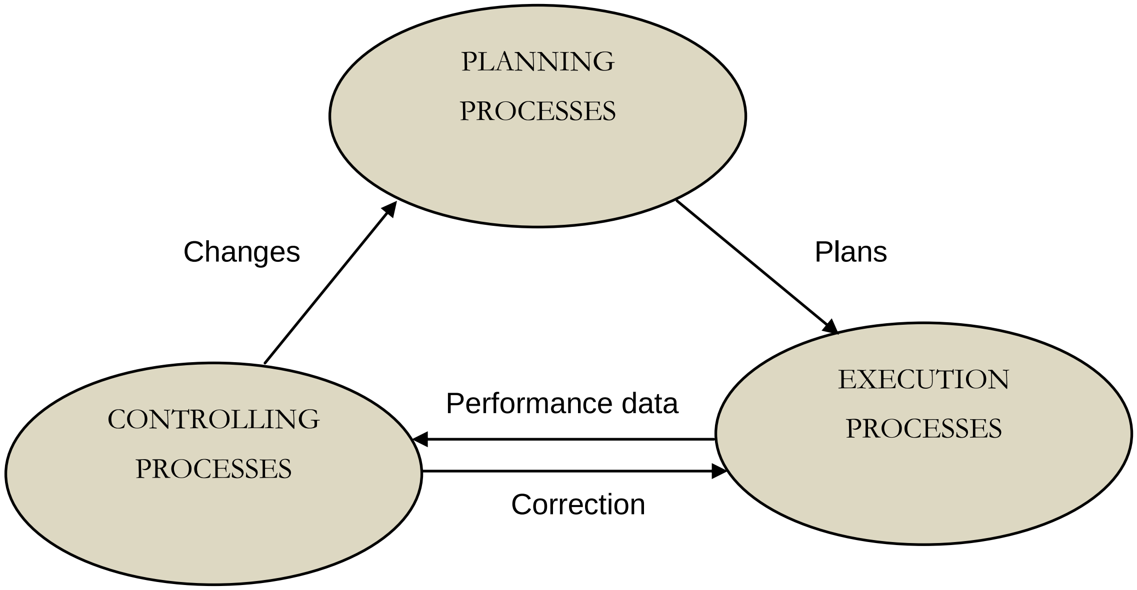

Figure 2.5: Project management managerial process

Source: Koskela and Howell (2001)

Fabi and Pettersen (1992: 81) note that planning for construction requires construction managers to forecast good quality and quantity of human resource (employee) needed for construction operations. Waly and Thabet (2002:139) maintain that decisions made during construction planning stage tremendously impact delivery result of construction projects. According to Sabotka and Czarnigowska (2005:79), planning for construction operations to ensure effectiveness and efficiency of construction labour involves the following:

1. Preparation of schedules, and chart of labour and equipment utilisation, sub-contractors work and material consumption;
2. Appointment of suppliers;
3. Planning and guideline for purchase or lease of equipment;
4. Planning for logistics concept of site management;
5. Design of site installation and disassembly;
6. Planning for flow of information;
7. Planning for method of control;
8. Planning for placing orders and schedule of deliveries; and
9. Planning for waste management.

2.8.3 Execution

The success of a construction project often relies on the right workforce, having access to materials and equipment, which is capable of delivering the construction project on time and at specified budgeted cost (Donyavi & Flanagan, 2009:11). Process execution process involves the implementation of defined activities contained in the management plan, specifically to accomplish project objectives and specifications. PMBOK (2008:55) indicated that the project execution phase involves co-ordination and integration of the project workforce and other available resources in conformance with management plans. This is supported by Koskela and Howell (2001:5), who claim that the execution of construction plans is only feasible if resources are available to implement the plans. Boazi and Ahmed (2011:752) further identify the need for construction management to possess technical and managerial skills coupled with a thorough understanding of the construction workforce itself. Chan, Scott and Chan (2004:155) further contend that the execution of the construction project is more successful with less complex projects, which possess a short duration and are funded by a client with construction experience.

2.8.4 Monitoring and controlling

Monitoring and controlling of project work is expressed as the procedure for reviewing and regulating project progress in order to meet performance objectives stated by an organisation (PMBOK, 2008:61). Nevertheless, project performance control systems within the construction sector are rarely used, when compared to the use of control systems in manufacturing industries (Navon, 2005:467).

Project monitoring encompasses the ability of an organisation to forecast, report and measure organisational progress (PMBOK, 2008:61). Bohn and Teizer (2010:632) note that monitoring and tracking the performance of construction projects is a contributing factor in the achievement of organisational objectives. Thus, Navon (2005:468) suggests control systems as a means to identify discrepancies involved in construction projects. The project manager explores the causes of deviation and accordingly decides on corrective measures to be adopted. The longer the project discrepancies take to be discovered, the greater the damage to construction process and increase in the cost of corrective measures (Navon, 2005:468). Figure 2.6 shows the traditional approach to strategic control. In achieving a better performance of employee on a project, definite approaches/strategies for employee control is required to be identified in relation to project type and demand of project. The identification of these controlling strategies should be taken further to implementation and ensure objective adherence by strategic control of the approaches.

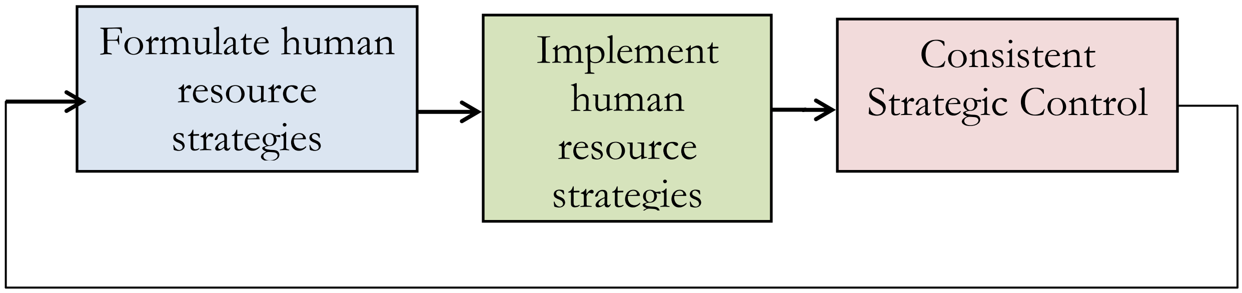

Figure 2.6: Traditional approach to strategic control

(Adapted from Dess, Lumpkin & Eisner, 2008:305)

2.8.5 Closing

A project is a temporary endeavour undertaken to create a unique product, service or result (PMBOK, 2008:1). Owing to the temporary nature of construction operations, the project scope is defined, and contractor then operates within the constraints of time and budgeted cost. However, the closing of construction operations is determined after the practical completion of the construction project and dismantling of site installations (Sabotka & Czarnigowska, 2005:80). According to Project Management Body of Knowledge, the process of closing a project includes all effort geared towards finalising every operation across Project Management process. This process is relevant to formal completion of a project and contractual obligations (PMBOK, 2008:64). Consequently, PMBOK (2008:64) identifies the necessary factors at the closing stage of a project as follows:

1. Acquire approval by customer or sponsor;
2. Conduct phase-end or post-project review;
3. Document of experiences and lessons learnt;
4. Record impacts of the adoption of any process;
5. Application of appropriate updates to assets of the organisation;
6. Archive the relevant document of the project in the Project Management Information System (PMIS) for history purposes; and
7. Close out procurement.

2.9 Impact of design related factors on construction workforce efficiency

Schermerhorn *et al.* (2011:157) *define a team "as a group of people holding themselves collectively accountable for using complimentary skills to achieve a common purpose"*. Jarkas and Bitar (2012:819) report that the cost of construction design ranges between 2 to 5% of the total project sum. Therefore, the role of construction designers cannot be underestimated in the construction production processes (Chan *et al.,* 2004:155). Clients are, of course, involved in the process of construction, but are not always experienced in the field of construction (Murray & Langford, 2004:18). As a result, professionals acting on behalf of the client become significant and transform the client's ideas to drawings and specification. They also provide the client with necessary professional inputs towards successful delivery of construction projects.

Osmani and Price (2007:1147) note that design factors significantly contribute to wastage of construction resources. Much can be done during the preparation of production information (specification, schedule and construction drawings) to reduce wastage of construction resources through effective drawings and specifications. Rivas *et al.* (2011:317) further note the causes of construction design-related problems as residing in poor construction drawings and specifications, lack of familiarity of engineers with field conditions and poor decision-making. Zakeri *et al.* however *(*1996:422) contend that the predominant design factors affecting construction workers efficiency are: error in construction design; poor constructability of design; contradiction in architectural, mechanical, electrical, and structural engineering drawings; and finally, discrepancies of contract documents with drawings, specification and variations.

2.9.1 Construction clients

The consent of construction clients forms the basis of design for most construction projects. Knutson *et al.* (2009:44) identify one of the responsibilities of facility owner as providing the designer with open access to construction sites. Notably, Knutson *et al.* (2009:61) claim that construction clients could be individuals, private or public organisations that provide a brief or guidance to professionals in terms of facility type, quality standards of proposed facility (workmanship and materials), and, perhaps most importantly, with financial capacity. However, inadequate client experience of the construction process may lead to poor briefing and increased variation. This may lead to rework and affect worker efficiency during the production process. Chan et al. (2004:155) note that successful execution of any construction project significantly depends on the client's funding, experience and competence in brief preparation and decision-making.

Gambatese *et al.* (2005:1032) report that industrial clients have significant experience of the construction process, along with a sizeable budget for construction projects, but considerable numbers of residential and commercial clients have less construction experience. Jarkas and

Bitar (2012:819) maintain that clients have essential responsibilities for ensuring the efficiency of construction labour in order to attract the best value for their capital investment. Donyavi and Flanagan (2009:15) argue that the type of contractor who undertakes a construction project has a direct impact on the performance of construction projects. Assaf and Al-Hejji (2006:351) report bad habit of some construction clients that award contracts to lowest bidders. Many lowest bidders are arguably contractors without adequate resources and required capabilities to effectively deliver construction jobs. Gambatese *et al*. (2005:1031) argue that client selection policies that award contracts to the lowest bid without considering contractor competence in terms of safety may interfere with the progress of the construction project. Assaf and Al-Hejji (2006:251) note that delays in payment and changes in orders constitute significant factors that may affect the output of construction workforces. Donyavi and Flanagan (2009:58) added delays in clients' approval, technical definitions and poor decision-making as factors to be considered when evaluating the efficiency of workers. The approach of clients' mounting pressure on members of the design team to reduce design fees and design duration is reported by Jarkas and Bitar (2012:819) as the basis for poor design details and concepts. This leads to lack of co-ordinated drawings and unclear specifications, and may affect construction project operations.

2.9.2 Architects

Among construction design professionals, the role of architect is significant in the construction project delivery process. Architects are involved in construction from the conception stage of the project to the final handing-over process (Oyedele & Tham, 2007:2090). However, the effort of an architect to design a conceived construction project is complex, and therefore an important responsibility of client is the ability to effectively communicate the design intention to an architect (Campbell, 2000:129). Gambatese, Behm and Rajendran (2008:676) report that construction safety professionals recognise the safety of construction workers to be best ensured during the design phase of construction projects. Consequently, the decisions made by an architect have a significant effect on the successful delivery of construction activities and impact the output of the construction workforce (Oyedele & Tham, 2006:2090). Gould and Joyce (2009:31) added that the architect is the primary representative of the client and significantly influences the choice of contractor and the efficiency of the construction project delivery.

The management function of an architect is directed towards achieving the client's objectives for project actualisation through effective implementation of production information. Conversely, construction projects are complex, filled with uncertainties and high levels of risk (Chan *et al.,* 2004:863). In building construction, the architect generally becomes the lead design professional, and sub-lets part of the work such as structural frame, mechanical and electrical systems, etc., to specialist engineers (Knutson *et al.*, 2009:45; Gould & Joyce, 2009:29).

Therefore, the architect sets out construction project objectives that must be accomplished for the successful delivery of the construction project (Murray & Langford, 2004:4). Notably, prior to the approval of the architect's design for physical development, numerous sets of drawings are generated, distributed for review, comments are made and the drawings are thoroughly revised (Campbell, 2000:130). Oyedele and Tham (2006:2091) maintain that the review of architectural design enhances the constructability of construction projects. Therefore, lack of adequate skills on the part of the architect or the avoidance of constructor's inputs in the design stage could affect constructability and adversely affects the output of the construction workforce. Lack of significant consideration for design constructability may constitute a delay in the construction process, building collapse during the construction process, cost overruns and extension of project duration (Oyedele & Tham 2006:2091).

2.9.3 Engineers

Basically, structural, mechanical, electrical and service engineers are the predominant building construction design engineers responsible for producing project production information to achieve a viable and functional construction product. As the architect leads the design team in commercial and residential building projects, so engineers lead construction designers in industrial and heavy engineering projects, and architects undertake the design of office space in the project (Gould & Joyce, 2009:29; Knutson *et al.,* (2009:45). Gao, Walters, Jeselskis and Terry (2006:1188) identify poor production quality of engineering drawings and ineffective specification as factors affecting construction cost, quality and schedule. Similarly, the delay caused by waiting for design interpretations and engineer information is identified by Rivas *et al.* (2011:316) as a factor influencing construction workforce efficiency. *Gao et al.* (2006:89) claim that engineering drawing information may be complex to interpret and therefore much valuable time is spent on drawings by users. Gao *et al.* (2011:1120) further recommends the adoption of colour drawings to facilitate drawing communication by design engineers.

Pektars and Pultar (2005:116) note that decisions made in the early stage of construction engineering design have an unforeseen impact on construction at a later stage. Wrong decisions become expensive to modify, since numerous parameters will be affected. According to Aibinu and Odeyinka (2006:673), poor structural design information, inadequate supervision of structural works, and late issuance of instructions impinge on construction productivity. Design engineers are required to design facilities that conform to the functional demands of construction clients at the expected quality, budgeted cost and specified deadline of the client (Toole & Gambatese, 2008:225). Recognising the relevance of construction design on construction workforce safety, the American Society of Civil engineers (ASCE) states that safety and constructability are essential factors to be considered by engineers during the preparation of construction plans and specifications (Gambatese *et al.,* 2006:1030).

2.9.4 Quantity Surveyors

The quantity surveying profession in South Africa is controlled by The Quantity Surveying Profession Act (49 of 2000). The requirements to become a member of the profession consist of a four years degree in quantity surveying, practical experience of three years and successful completion of an assessment for professional competence (Bowen & Cattel, 2008:261). Construction practitioners are well aware of the uncertainty and unforeseen circumstances affecting construction cost (Elhag, Bonssabaine & Ballal, 2005:538). Prior to the acquisition of a construction site to undertake a construction project, the construction client requires robust and accurate advice on construction cost estimates from a quantity surveyor to ascertain the cost implication and feasibility of construction projects (Lowe, Emsley & Harding, 2006:750). The quantity surveyor produces detailed descriptions, estimates of cost and quality of materials, and the standard of workmanship required for a construction project (Maritz & Sigle, 2012:27). Akintoye and Fitzerald (2000:171) state the major challenges in estimating the cost of construction projects. These factors include; insufficient time for preparation of cost estimate, poor documentation of tenders and wide variability in sub-contractor prices. Besides, Jarkas and Bitar (2012:819) identify clarity in technical specifications as the most significant factor affecting construction productivity, increased construction cost and duration of construction. Maritz and Sigle (2012:27) identify specification as a tool for communication between the members of the construction project team. Therefore, specification is required to be clear, simple and comprehensive enough to prevent delay of construction workers during the construction delivery process. Olabosipo *et al.* (2011:256) point out that the efficiency of construction workers significantly relies on clarity of instruction and understanding the details of the task required to be executed. Figure 2.8 presents the structure of the construction management team.

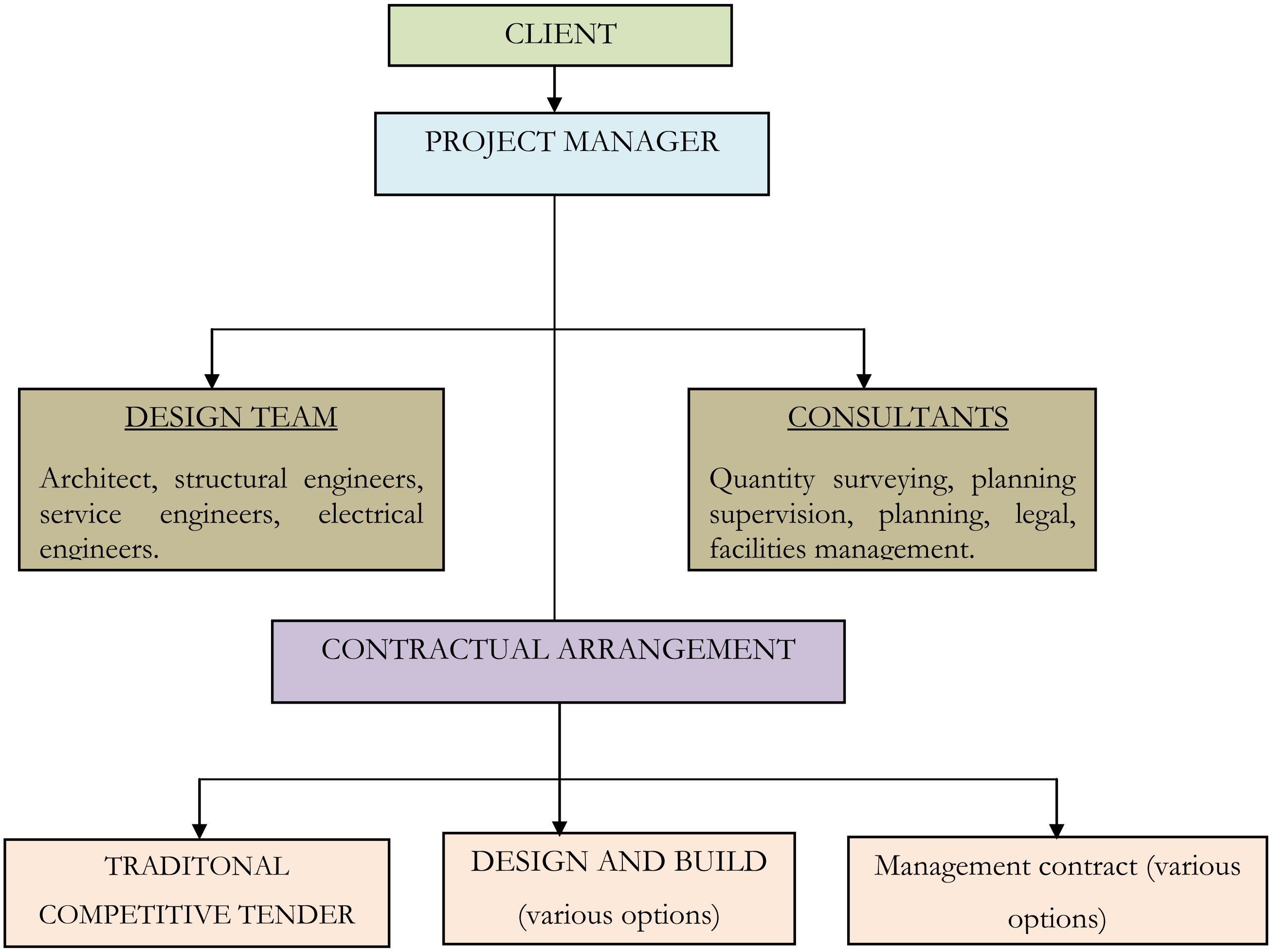

Figure 2.7: Project management team structure

Source: Cooke & Williams (2004:36)

2.10 Impact of external factors on construction workforce efficiency

Variations in the output of the construction workforce are attributed to several factors (Dai *et al.,* 2009:397). The efficiency and productivity of the construction workforce is influenced by air temperature, wind velocity, relative humidity, solar radiation, precipitation and light (Koehn and Brown, 1984:129). Further, Srinavin and Mohamed (2002:341) maintain that construction workforce performance and productivity is dependent on the thermal environment to a little extent. External factors that affect construction productivity are widely recognised as factors outside the control of construction organisations. These factors are mostly beyond management control. With reference to previous research on factors affecting construction workforce productivity, the impact of external factors on construction workers productivity is comparatively minimal.

Srinavin and Mohamed (2003:340) report that the quality of workmanship of construction workers declines at high and low temperature. Moreover, Baloyi and Bekker (2011:58) identify external factors affecting construction productivity as; delay of project finance by contractor, delay of statutory consent, inflation, escalation and the unpredictable nature of site conditions. Enshassi *et al.* (2007:251) report inclement weather such as winds and rain as factors that reduce the output of construction workforce; especially during execution of external works. Assaf and Al-Hejji (2005:354) note that changes in government regulations and laws as one of the lesser factors causing delay in large construction firms. In respect to the study undertaken by Haseeb *et al.* (2011:43), the external factors that affect construction productivity include; natural disasters, statutory undertakings, changes in government regulations and laws, weather conditions and the effect of subsurface conditions.

The theoretical background for the research is presented in Figure 2.9. Previous studies established that the productivity of construction employees is lower than worker productivity in the manufacturing industry. The working conditions and the project-based nature of the construction industry are identified as notable reasons for poor worker performance in the construction sector. The literature identifies a performance relationship between construction workers, construction materials and machinery. Significant factors affecting the efficiency of construction workers are identified in the literature. Improved training, good safety culture, adequate workers motivation and effective communication between project participants are noted as helpful inputs for effective delivery of construction projects.

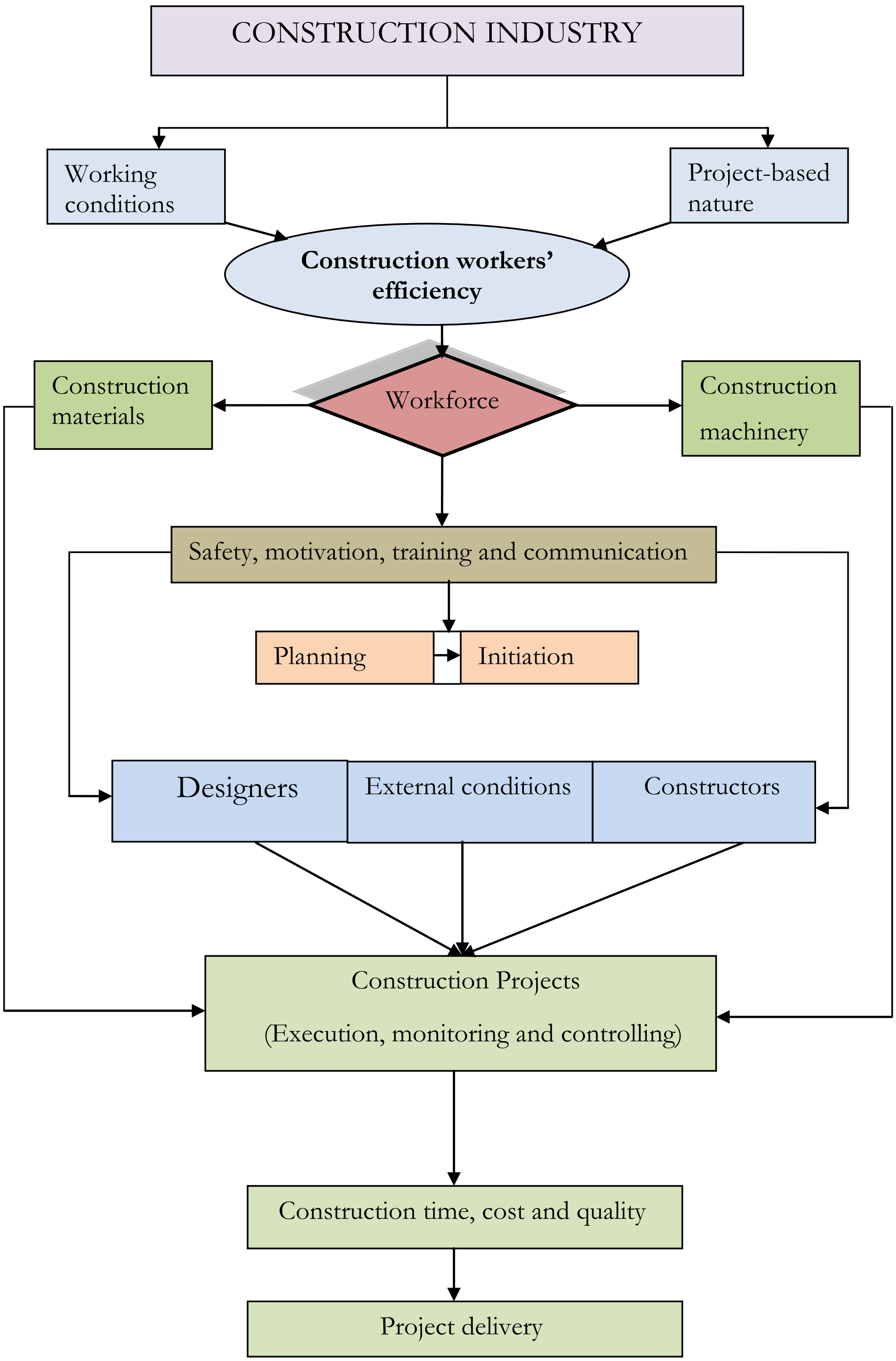

Figure 2.8: Theoretical framework

2.11 Chapter summary

This chapter presents the review of literature on subjects related to construction worker efficiency. The review of literature established prevalent productivity challenges that affect construction workers during the building production process. Factors impinging on construction workforce efficiency are, for the most part, found to be vary with the construction projects concerned. The factors vary significantly from country to country, project to project, and sometimes within the same project, depending on the circumstances involved. Some of the factors that affect construction workforce efficiency are identified by previous studies as; unavailability and shortage of construction materials, breakdown of construction tools and machinery, delays in supervision, problems in communication between superiors and subordinates, inadequacies in designer's production information, inadequate skill of workforce, client payment delays, and inadequate workforce motivation. Previous studies established that the factors affecting construction workforce efficiency spread across individual participants (skilled and unskilled) in the construction sector. Literature reveals that human assets in the construction industry represent the most significant construction variable that attracts a significant construction cost and is problematic to control. Therefore, construction organisations are required to identify and balance the needs of construction projects, organisation requirements and construction workforce needs. The practice of disregarding the relevance of construction craft worker inputs is identified by literature as being detrimental to construction productivity improvement. Considering the tremendous contribution of the construction industry to economic development in South Africa and most other nations of the world, the literature has identified the necessity of construction organisations considering human resource functions as a major focus in the planning process of organisational strategies.

CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

The previous chapter reviewed existing literature in accordance with the research objectives. Dahlberg and McCaig (2010:64) note the research methodology section as an extension of the aims and objectives of a research project that clearly states the details of the approach to undertaking a research project. The research instruments are designed to achieve research objectives by producing answers to research questions enumerated in Chapter One of the study. In this section, different types of research methodology are identified and the specific research design adopted for this study is subsequently presented. This chapter presents research methodology and research method separately. The chapter therefore describes the various research approaches, the research design, the sampling techniques, the procedures for data collection, the techniques adopted for data analysis and ultimately the testing of validity and the reliability of research instruments.

3.2 Research philosophies

3.2.1 Positivism

A significant research philosophy in social science research involves generation and testing of hypotheses by proving and disproving (Neuman, 2000:516). Neuman further describes positivism as a research paradigm or framework that involves a deductive approach with an accurate measurement of quantitative data that allows for discovery and confirmation of causal laws to permit the prediction of human behaviour. The approach is based on knowledge acquired through the scientific method or experimental testing. Kumar (2011:140) explains that the positivist research paradigm mostly involve quantitative approaches, rather than qualitative. However, Struwig and Stead, (2007) maintain that every feature of quantitative research should not be attributed to positivism. Therefore Henn, Weinstein and Foard (2006:13) state the logic of the positivist research philosophy as follows:

- Seeking to recognise processes of causes and effect of phenomena, and to test theories.
- Knowledge should be based on what can be tested by observation of tangible evidence.
- Researchers should use the scientific method, which emphasises control, objectivity and standardisation.

3.2.2 Interpretivism

The interpretivist paradigm of research is concerned with an unstructured qualitative approach that may include participant observation studies and in-depth interviews (Henn *et al.,* 2006:14). This research philosophy is directed towards allowing study participants to present information in their own words (Henn *et al.,* 2006:14). Interpretivists believe that the study of phenomena in the natural environment is paramount, and scientists cannot avoid affecting the phenomenon being studied. Interpretivism deals with a subjective interpretation and involvement in reality which allows the reality to be completely understood. The fundamental idea of the interpretivist research paradigm is to work with subjective meaning already in the social world by acknowledging its existence, reconstructing the meaning, avoiding distortion, understanding the meaning and incorporate these as building blocks for theorising (Goldkuhl, 2012:5). This research combines the positivist and Interpretivist approaches as reflected in the research method section of the study.

3.3 Research methodology

Research methodology is defined as all-encompassing macro frameworks that offer principles of reasoning associated with paradigmatic assumptions that validate various schools of research (O'leary, 2010:88). Research methodology offers both strategies and grounding for conducting a study. Hall and Hall (1996:29) state that the philosophy and the general principles for conducting research are termed "research methodology". The general principles of research methodology though not exhaustible is described in this section while the specific method adopted for this research is presented in the research method section of the study.

3.3.1 Quantitative research method

The quantitative methodological approach allows researchers to separate themselves from the object of study and promotes scientific objectivity (O'leary, 2010:105). The method of research allows for significant indicators of credibility such as validity, reliability, generalizability, and reproducibility. Quantitative research is usually considered as an objective positivist undertaking, with large scale but little depth (O'leary, 2010:105). The development process of the quantitative research method presents respondents with clear questions which provide answers in line with research objectives (Dahlberg & McCaig, 2010:159). In formulating questions in quantitative research, Flick (2011) notes the fundamental concerns as follows:

- Researcher should understand how to formulate the questions;
- Which kind of questions to be posed; and
- The purpose of asking the questions.

Similarly, Dahlberg and McCaig (2010:160) state the essential points to be noted by a quantitative researcher as follows:

- What do you ask?
- Why do you ask?
- Who do you ask?
- How do you ask?
- What is the answer?

The merits and demerits of quantitative research, as identified by Flick (2011:12) and Kumar (2011:104), include the following.

3.3.1.1 Advantages of quantitative research method

- The results have a high degree of generalisation.
- The quantitative approach allows the study of a large number of cases for certain aspects in a relatively short time.
- The design of quantitative research is specific, well-structured and can be clearly defined and recognised.
- The quantitative approach possesses clarity and distinction between design and method of data collection.

3.3.1.2 Disadvantages of quantitative research method

- The aspects of research studied are not necessarily the relevant aspects of the participants.
- The distance between the researcher and the study population is comparatively wide.
- Respondents may interpret questions differently from each other.

3.3.2 Qualitative research method

The qualitative research method is mostly characterised by small number and in-depth cases (O'leary, 2010:105). The qualitative tradition demands inductive and deductive logic, embraces subjectivity, accepts multiple perspectives realities and recognises the power of search on both participants and researchers. Qualitative researchers demonstrate a common belief that their approach provides a more in-depth understanding of phenomena than the quantitative methodological approach (Silverman, 2006:56). Similarly, O'leary (2010:114) posits that the purpose of undertaking qualitative research is to acquire an intimate understanding of people, environment, subject and culture through rigorous involvement in the reality of the study. The research methodology involves a critical examination of the perspective of the individual or group that is of interest to qualitative researchers. It adequately examines population attitudes, ideas, intentions and motives (Henn *et al.,* 2006).

The strengths and weaknesses of qualitative research as presented by Flick (2011:12) and Kumar (2011: 104) include the following.

3.3.2.1 Advantages of qualitative research method

- It allows for detailed and exact analysis of a few cases in which participants have much more freedom to determine issues that are relevant in the context.
- The main strength of qualitative research is the ability to study phenomena with much in-depth.

3.3.2.2 Disadvantages of the qualitative research method

- The analysis usually requires much time and results are not broadly generalizable.
- The design of qualitative research projects are less specific, and do not have a consistent structural depth.

3.3.3 Mixed method

Utilising a mixed method of research provides a premise for using both qualitative and quantitative approaches that together offer a better understanding of research problems than either of the two approaches alone (Creswell & Clark, 2007:5). A mixed research approach reduces the impact of personal bias and maximises validity in research (Henn *et al.,* 2006*:*3). Researchers adopt a mixed methodological approach in the interests of combining qualitative and quantitative research pragmatically, purposely to compensate the paradigmatic shortcomings in the two approaches (Flick, 2011:188). The method enhances collection of different types of data, and allows interpretation of results from a variety of different analytic techniques. The fundamental purposes of combining both quantitative and qualitative approach are enumerated by Silverman (2006) as;

1. Using qualitative research to explore a particular topic in order to set up a quantitative study.
2. Initiation of a study with a quantitative approach purposely to establish a sample of respondents. Qualitative research can later be used to explore the key issues in depth.
3. Engaging a qualitative study that uses quantitative data to locate the result in a broader perspective.

Similarly, O'leary (2013:128) identifies the strategies of a mixed method of research that are basically designed in three ways;

1. **Using a quantitative perspective with acceptance of qualitative data:** This method is used by researchers that accept more of the underlying assumptions of the quantitative approach, but also accept that some qualitative data might be helpful to validate the study.
2. **Using a qualitative perspective with acceptance of quantitative data:** This methodological approach is adopted by researchers that believe in quality rather than quantity, and subscribe more to the underlying assumptions of the qualitative traditions.
3. **Question- driven perspective:** The motivation for selecting this approach is neither for qualitative nor quantitative interest areas but rather because it favours the adoption of an examination of research questions and selects the method that can best answer the research question, irrespective of paradigm.

3.4 Research approach

3.4.1 Deductive approach

The deductive research approach involves the researcher using theory at the beginning of the study, generating hypotheses from the theory and then testing the hypotheses (Dahlberg & McCaig, 2010:20). This approach is described by Dahlberg & McCaig (2010:20) as a *"top-down"* research approach. The applicable theory is consulted purposely to give a guide to the formulation of research questions (Henn *et al.,* 2006:49). The information or factual contents in the conclusion of a deductive approach is significant to the theory (Mouton, 1996: 77). The deductive research approach is principally used in quantitative research (Bryman, 2004:20).

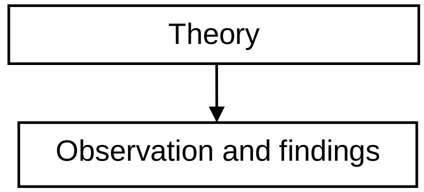

Figure 3.1: Deductive research approach

Source: Bryman (2004:10)

3.4.2 Inductive approach

The inductive research approach begins with the collection of flexible empirical data. This approach allows for the change of questions in order to introduce new questions at any point in the study (Dahlberg & McCaig, 2010:20). The approach is a "*bottom up*" research approach, which contributes to comprehension of reality first and ultimately produces a theory. The genuine evidence supporting the theory leads to a conclusion which is probable i.e. supporting statements gradually support the conclusion as the explored reality becomes clearer(Mouton, 1996:77). Bryman (2004:20) argues that the inductive research approach generates, rather than tests, a theory and is predominantly used in qualitative research. Henn *et al.* (2009) state that a researcher can begin the research process with an inductive exploratory stage and afterwards generate a theory that can be tested in a deductive explanatory stage.

3.5 Research strategies

3.5.1 Experimental designs

The research strategy entails a rigorous and controlled search for cause and effect. Experimental design requires researchers to purposely vary an independent variable (the key determinant in the study) to determine the impact on the dependent variable (the main object of study inquiry) (O'leary, 2010:107). The research strategy is often held up as a standard because it produces considerable confidence in the robustness and credibility of causal findings (Bryman, 2004:34). The design consists of goal-directed acts performed upon study groups for the purpose of analysing the impact of one on the other (Flick, 2011:66). Experimental design involves at least two experimental groups. Kumar (2011) enumerates a number of challenges inherent in the experimental design:

- Matching increase in difficulty when carried out on more than one variable.
- Variables that are hard to measure, such as opinion or attitude, pose a great challenge.
- Choosing a variable to serve as the basis of matching may sometimes be challenging.

3.5.2 Survey research

O'leary (2010:181) defines survey research *"as the process of data collection by asking a range of individuals the same questions related to their characteristics, attitude, ways of living or opinion through a questionnaire administration"*. This form of research is undertaken purposely to afford the researcher with statistical information, either on particular subjects/challenges that require improvement or to test the robustness of an existing theory (Hann *et al*., 2006:126). A survey researcher selects the kind of population that best suits an investigation of the research topic, formulates a research instrument and devises a means of administering the instrument (Bryman, 2004:84). Dahlberg and McCaig (2010:160) claim that response rate is an important factor to be considered for a survey to be statistically valid and to allow study conclusions to be generalizable to the research population. Babbie (2004:243) posits that survey research is perhaps the best available method for collecting data from a study population that is too large to observe directly.

3.5.2.1 Cross-sectional studies

Cross-sectional study involves an observation of a study sample, or cross section of a population or phenomenon that exists at a particular point in time (Babbie, 2007:102). Descriptive and exploratory studies are often cross-sectional in nature. This kind of research is undertaken for the purpose of obtaining variation in respect to people, organisation or events. Data are gathered more or less at the same time. Bryman (2004:41) states that cross-sectional study data may be validated by pre-testing the data, which allows for intervention and post-testing after days, weeks, months or years to derive the needed variation in the study. This research is cross-sectional in nature. The study is to derive the present challenges associated with the efficiency of construction workers on construction projects to recommend a helpful framework. The same group of respondents were used for the qualitative and quantitative parts of the study.

3.5.2.2 Longitudinal studies

Longitudinal studies are concerned with the observation of the same sample or phenomenon over an extended period of time (Babbie, 2007:102). A significant strength of longitudinal studies is that the observer is involved for a period of time, therefore changes and relationships between events can be observed (Bryman, 2004:341). These studies are suitable for collecting data to derive factual information on a continuous basis. The population of the study is visited at regular intervals, the timing of which may vary from study to study. The information gathered at regular intervals comes from the same population, but may not be from the same respondents (Kumar, 2011:110).

3.6 Case study

The case study research refers to units of investigation that are studied at different levels as individuals within a community, group of people, an organisation or phenomenon (Henn *et al.,* 2006:58). This type of research can involve the study of a single case, comparative studies (multiplicity of cases) or retrospective studies using historical sources, documentation and interviews (Flick, 2011:70). However, Barbour (2008:61) suggests that the adoption of a single case study is significantly advantageous because of the possibility to closely scrutinise the case under study. Arguably, qualitative research may be comparatively suitable for a case study, due to the ability of the qualitative research to provide an in-depth study. Nonetheless, Bryman (2004:49) contends that both qualitative and quantitative research approaches may be adopted for case study research.

3.7 Action research

Mcniff and Whitehead (2011:8) describe action research *as "a form of enquiry that enables practitioners in every job and work of life to investigate and evaluate their work".* As the name implies "*action* and *research",* is the kind of research directed by the desire to take an action either to improve a practice, resolve a problem or issue (Kumar, 2011:131). This system of research can be a powerfully liberating form of professional inquiry, because practitioners within a profession may investigate practices within the profession and devise ways of improving the existing practice. The fundamental purpose of action research is to enable changes and to learn from experience (Dahlberg & McCaig, 2010:102). However, the reality of changes by practitioners of a profession significantly depends on the ability of practitioners to interpret a problem, on their motivation to undertake research and their propensity to enquire into their own practice. Kumar (2011:131) states that most action research is directed towards improving quality of service by identifying areas of interest, developing, testing alternatives and experimenting with a new approach.

3.8 Research design for the study

The majority of studies undertaken to improve the efficiency of construction labour consider the perceptions of professionals on the factors affecting construction labour performance. However, Dai *et al.* (2007) and Dai *et al.* (2009) recognised the necessity of exploring the views and perceptions of construction labour in an effort to improve the performance of workers on construction projects. Dai *et al.* (2009:225) note that the input of construction craft workers on construction productivity has not been considered significant by researchers and construction site management teams. This research project adopts a mixed method research approach to explore the perceptions of construction professionals and site supervisors on the factors affecting the efficiency of construction labour. To achieve this, a structured questionnaire was designed and administered to construction professionals, while site supervisor's opinions were obtained through semi-structured interviews in order to validate quantitative data obtained from construction professionals.

Any given research topic can be studied in a number of ways and can adopt diverse approaches (Dahlberg & McCaig, 2010:64). Research design essentially implies the plan or strategy required for conducting a research work (Henn, Weinstein & Foard, 2006:3). The design of a research project entails explaining the processes to plan for data collection and analysis, and to select empirical material (situation, cases, individual) in order to provide answers to research questions in the available time with the available resources (Flick, 2011:68). However, Silverman (2006) contends that, rather than adopting the most attractive research design, research design should involve careful consideration of the appropriate research approach capable of providing answers to research questions in a valid, objective, accurate and economical method. Henn *et al.* (2006:3) identify three necessary qualities of research design as:

- The research design should be adequately structured.
- The method should be sufficiently reliable.
- The research design should aim to generate large scale, statistically-based studies.

Kumar (2011:94) maintains that competent research design provides adequate answers to the following questions:

- Who will constitute the study population?
- How will the study population be identified?
- Will a sample or the whole population be selected?
- If a sample is selected, how will it be contacted?
- How will consent be sought?
- What method of data collection will be used and why?
- In the case of questionnaires, where will the responses be returned?
- How should respondents contact the researcher in case of queries?
- In the case of interviews, where will they be conducted?
- How will ethical issues be taken care of?

The approach adopted for a research project is vital to the success or failure of any study. This research acknowledges the theory of construction workforce efficiency challenges. Essentially, the factors affecting construction labour efficiency were explored in the study to devise a measure for improving construction labour efficiency. However, there is diversity in the adoption of research approach in every study, as earlier stated. The selection of a particular approach significantly depends on the nature of the topic being studied, researcher experience, location of the study and the study participants (Kumar, 2011). Arguably, these factors contribute to the originality of research work.

Considering the significant knowledge of construction professionals and the site supervisors' supervisory experience in building production processes, the research employed a mixed method research approach. According to Flick (2011), a mixed research approach combines qualitative and quantitative approaches where the shortcoming of one paradigm is compensated for by the strengths of the second. Specifically, the mixed methodological design for this study adopts quantitative perspectives with the acceptance of qualitative data, as endorsed by O'leary (2011). Flick (2011) maintains that a higher degree of generalisation is obtained in quantitative research than is the case with the qualitative approach. The quantitative approach for the study is to allow for a degree of generalization. Research data for the study was gathered from construction professionals with the aid of a structured questionnaire survey, and complemented by semi-structured interviews conducted with site supervisors to ensure validity of the quantitative data.

3.8.1 Exploratory study

According to Dahlberg and McCaig (2010:181), an important part of questionnaire design is piloting. The questionnaire used for the exploratory study was piloted using both Master of Technology degree students in the Construction Management and Quantity Surveying Department, Cape Peninsula University of Technology as well as construction professionals to ensure the appropriateness of the chosen research instrument. Neuman (2000:166) notes that the use of pre-test or pilot study questionnaires can improve the reliability of research work. Subsequent to piloting the research questionnaire, an exploratory study was undertaken to elicit the perceptions of construction professionals on the relevance of the research subject to the South African construction industry. The inputs of construction professionals in the questionnaires administered and interviews conducted allowed for necessary adjustments in the formulation of the main questionnaire to achieve the purpose of the research. The process of questionnaire modification involves; rephrasing of research questions, removal of irrelevant questions, addition of relevant questions and overall re-structuring of the research questionnaire. The exploratory study undertaken aids in justifying the relevance of the research subject, the relevance of variables contained in the research questionnaire, and allowed the researcher to become acquainted with interview procedures. Adler and Clark (2008) argue that undertaking practice interviews enhances interviewer preparation for the actual experience of developing conversation generators. The retrieved questionnaires for the exploratory study were analysed using Statistical Package for Social Science (SPSS) package 21.

3.8.2 Population and sample size

The universe of units from which a sample is to be selected is termed population (Bryman, 2004:87). Population does not necessarily refer to people being sampled in a study, but largely depends on the nature of the researcher's study. O'leary (2010:161) defines population as the total membership of a defined class, objects or events. For the purpose of this research, the poor performance of the construction workforce is the identified issue that the research aims at addressing. Therefore, the population for this study consists of construction workers in the South African construction industry.

In the simplest sample design, the sample frame is a list of elements comprising the population of a study (Babbie, 2007:200). In addition, Flick (2011:71) posits that the sample of a study should be a minimised representation of the population in terms of heterogeneity of the elements and representativeness of the variables. Nonetheless, O'leary (2010:164) added that the larger the sample in a quantitative research project, the better it is represented and therefore the more generalizable the conclusions are. Thus, the sample frame for the research is an adequate representation of construction workers in South Africa. The majority of survey participants are construction professionals with extensive construction knowledge, skills and formal educational background, with the exception of site supervisors with minimum formal education but adequate construction backgrounds. Site managers, contract managers, project managers, site supervisors, architects, site engineers and quantity surveyors are the selected sample to represent the population for the purpose of this study. Construction workers that constitute the sample for the research, as previously highlighted, are tasked with site responsibilities on construction projects, and therefore are arguably a good representation of the South African construction workforce.

3.8.3 Study sampling technique

The process of selecting elements of a population to be included in research is referred to as sampling (O'leary, 2010:162). O'leary (2010) stressed that a significant number of research samples are representative sample distributions and possess characteristics that allow findings to be generalised to the entire population. Population samples enable the research process to be manageable. The research adopts convenient and purposive sampling techniques. Considering that the complex nature of construction operations leads to busy schedules of project participants, questionnaires were administered to construction professionals in Gauteng and Western Cape provinces base on accessibility to construction sites and availability of construction professionals on sites. Strung and Stead (2007:111) expressed convenient sampling as a sampling technique adopted on the basis of availability and accessibility of respondents. However, construction site supervisors interviewed were purposively selected on the basis of the direct working relationship between site supervisors and construction labour. Participant site supervisors interviewed were experienced in construction, with adequate years of supervisory responsibilities in the construction sector. The experience of the site supervisors is arguably a helpful instrument to assess the validity of data obtained from construction professionals. Richard and Morse (2007:195) note purposive sampling as a sampling technique that enables the researcher to select study participants with respect to their characteristics (participants with the right information). Plowright (2011:42) further argues that a purposive sampling strategy is a system where the researcher deliberately chooses a sample for a study, having a purpose in mind. O'leary (2010:166) indicated that an adequate sample frame and large enough sample size prevents unbiased research, represents a population and presents a generalizable finding with respect to the population.

3.8.4 Data collection techniques

Data collection techniques entail the exploration of different sources of data for a research project. The framework presented in this study is an outcome of secondary and primary data collected, as presented in the next chapter. Struwig and Stead (2007:80) noted that the two main forms of data are primary and secondary data. This study considers different types of data and determines the sources of data that could best achieve the aim of the research (Creswell & Clark, 2007:114).

3.8.4.1 Secondary data collection

Secondary data are available data explored from sources other than data generated on the current research project (Struwig & Stead, 2007:80). Both qualitative and quantitative research employs secondary sources as a method of data collection. Qualitative research typically takes the form of description (historical and current), while quantitative research explores available numerical information. The secondary data collection for this study is obtained through reviews of literature. Kumar (2011:31) states that a review of literature serves to improve and consolidate the researcher's knowledge base and assists in integrating the findings with the existing body of knowledge. The review of past works on construction labour productivity elucidates the research process by establishing different findings on the research subject. O'leary (2101:71) adds that the production of new knowledge is fundamentally dependent on past knowledge.

The data obtained from the existing body of knowledge reveals diverse factors affecting the effectiveness of the construction workforce, and a significant number of factors explored from existing literature facilitate the formulation of the research questionnaire. Dahlberg and McCaig (2010:77) posit that the review of literature enables a researcher to explore the depth of evidence that has been gathered in a research area and reveals areas that are under-researched. Considering previous research conducted on the efficiency of construction labour, the perceptions of construction craft workers has been undervalued, and too few researches have considered lower management workers' views and perceptions with regard to the enhancement of construction workforce efficiency. The review of literature for this study involves an examination of research objectives and adequately reviews and elaborates each research objective for the study.

3.8.4.2 Primary data collection

Primary data are new data generated for the research project (Struwig & Stead, 2007:80). This method of data collection requires researchers to ensure respondents properly understand the purpose and relevance of the study, especially when using a quantitative approach (Kumar, 2011:140). The primary sources of data collected for this research is the administration of quantitative closed-ended questionnaires to survey participants and semi-structured qualitative interviews. The research instruments (questionnaires) used for the study were administered to respondents of participant construction sites via hand delivery and survey monkey and retrieved through the same medium.

3.8.4.3 The questionnaire

A questionnaire is a data collection instrument containing questions and statements designed to solicit information from study respondents (Adler & Clark, 2008:216). Research questions may be observed from different perspectives but should address a relevant issue (Flick, 2011:23). The process of questionnaire design requires a consideration for future analysis of every posted question. Poorly designed questionnaires lead to obtaining insufficient or useless data that cannot be properly interpreted (Dahlberg & McCaig, 2010:179). Conversely, a well-planned, structured and carefully-designed questionnaire affords increased response rates and greatly enhances summarising and analysis of collected data (Burns, 2000:574). Babbie (2004:256) notes the importance of the wording of questions questionnaire design. Incorrect wording of a question may lead the respondent to provide unintended answers and ultimately affect the reliability of the research.

3.8.4.4 Open-ended questions

Open-ended questions are a form of questionnaire that does not give precise guide to possible responses. In this form of questionnaire, the respondents are allowed to put down their perception on a particular question in their own words (Kumar, 2011:151). Open-ended questions are appropriate and suitable for a study that intends to explore the way respondents think, and discover what is really important to respondents with the use of questions with many possible answers (Neuman, 2000:260).

3.8.4.5 Closed-ended questions

Kumar (2011:151) describes closed-ended questions as questions that delineate possible responses in questionnaire design. Respondents select the option that best describes the answer to the question being posed. Burns (2000:572) notes that closed-ended questions have the benefit of achieving greater uniformity of measurement and therefore greater reliability in making the respondents answer in a manner fitting the response category. The can therefore be easily coded. Conversely, closed-ended questions invoke the possibility of discouraging respondents that find none of the alternatives suitable, and therefore heighten the probability of inappropriate responses. Therefore, closed-ended questions should provide sufficient possible responses to achieve the purposes of using the questionnaire.

3.8.5 Questionnaire design

Kumar (2011) notes that the questionnaire design is the most essential aspect of survey research. He further stresses that the underlying principle is to ensure the validity of research questions by ensuring correlation between research questions and study objectives. Therefore clearly articulated objectives play an essential role in research work (Kumar, 2011:156). The research questionnaire design adopts structured questions utilising a five-point scale. The closed-ended questions provide factors affecting construction workforce efficiency, as explored from the review of literature produced by previous research and exploratory studies conducted at the early stage of the study. The questionnaire is designed in consonance with the study objectives. The questionnaire for the study is designed in sections, where each section aims at achieving a particular objective of the study. The first section of the questionnaire requires the biographical information of survey respondents. The second section comprises three parts, and addresses the first objective of the research with the aim of exploring the perceptions of respondents on construction team factors affecting construction workforce efficiency. The section considers construction team-related factors, motivational drive factors, occupational health and safety.

The third section of the questionnaire identifies design team-related factors affecting construction labour efficiency, purposely to address the third objective. In this section, construction production information, and other design-related factors were taken into consideration. The fourth questionnaire section requests information on machinery, materials and labour-related factors impinging on construction labour efficiency. Finally, the last section explores external conditions disrupting the effectiveness of workers on construction sites. The majority of the questionnaires were hand-delivered to respondents and the remainder were administered through electronic mail. The underlying purpose for selecting construction professionals (architects, quantity surveyors, site engineers, project managers, contract managers and site managers) as participants for the quantitative part of the study relies on the extensive experience of professionals concerning factors affecting the delivery of construction projects. The questionnaire design for the study was undertaken under the following criteria, as stated by Adler and Clark (2008:244):

- Avoid loaded words – the words that trigger an emotional response
- Avoid ambiguous words – the words that can be interpreted in more than one way
- Avoid the usage of double negative questions – the questions that require respondent to disagree with a negative statement
- Avoid the usage of leading questions – the questions that encourage the respondents to answer in a certain way
- Avoid threatening questions – the questions that make respondents feel afraid or embarrassed to give an honest answer
- Avoid compound questions – the questions that ask two or more questions in one
- Administer questions in the language of the respondents.

3.8.6 Interview

The form of interview adopted for a research purpose is dependent on the purpose to be achieved. However for the purpose of this study, a semi-structured qualitative interview was adopted, as earlier stated. Flick (2011:112) opines that qualitative interviews should be able to initiate dialogue between interviewer and interviewee. Due to the probing power and flexibility advantage of semi-structured interviews, the method was employed to explore in satisfactory depth and more importantly for validating the most significant factors affecting construction workforce efficiency, as obtained in the quantitative data. Plowright (2011:16) posits that a less structured interview design may be more appropriate to explore interviewee’s feelings and complete opinions on the subject being studied. Flexibility, freedom and spontaneity makes the unstructured interview one of the most commonly used methods of data collection in qualitative interviews (Kumar, 2011:160).

Three construction sites were selected for the qualitative part of this study. The interview was conducted with site supervisors on each construction site selected. The interview was fundamentally restricted to site supervisors for validation of quantitative data. On each construction site visited in the course of the study, two experienced site supervisors were engaged to participate in the interview process. Site supervisors are directly involved in fieldwork with construction labour and are adequately aware of workers' performance challenges confronted on sites. The interview was designed to explore the perceptions of construction site supervisors on what constituted the most critical factors affecting construction workforce efficiency, as obtained in the quantitative survey.

The execution of basic construction operations is significantly directed by construction site supervisors. Serpell and Ferrada (2007:591) describe the site supervisor as being responsible for communicating construction project objectives to labourers. Dingsdag *et al.* (2008:630) further posit that site supervisors are the most noticeable people on construction sites and generally believed by workers as *"the most visible people of the construction sites".* The basic motivation for selecting construction site supervisors was to allow involvement of lower-level management workers who are seldom involved in construction performance research, and, most importantly, due to the direct supervisory relationship between construction labour and site supervisors. Arguably, site supervisors have significant knowledge of the factors affecting the efficiency of labour on construction projects.

3.8.7 Research aim and objectives

The aim of this study is to develop a framework to improve construction workers' efficiency during the building production process in the South African construction industry. The study objectives are outlined to achieve the aim of the research. Table 3.2 indicates the medium through which the research objectives were achieved

Table 3.2: Achieving research objectives

Objectives	Purpose	Achieving objectives
To identify construction-related factors affecting construction workers' efficiency	The objective aims at exploring factors attributed to the construction team that are affecting construction workers' efficiency	The objective is achieved through review of literature, semi-structured qualitative interviews and questionnaire administration
To ascertain design-related factors reducing the efficiency of construction labour	The objective aims at investigating design-related factors affecting the performance of construction employees	The objective is accomplished through review of literature, semi-structured qualitative interviews and questionnaire administration
To identify the impact of construction resources on construction labour efficiency	The objective examines material, machinery and labour-related factors affecting the performance of construction projects	The objective is achieved through review of literature, semi-structured qualitative interviews and questionnaire administration.
To ascertain the external factors affecting the efficiency of human assets in the construction industry	The objective explored factors caused by external conditions that affect construction project delivery	The objective is accomplished through review of literature, semi-structured qualitative interviews and questionnaire administration.
To develop a framework for improving the efficiency of the South African construction workforce	The framework is developed to improve the efficiency of construction workforce for improved construction project performance	The objective is achieved through analysis of qualitative and quantitative data obtained.

3.8.8 Data analysis

Quantitative data gathered during the exploratory study was analysed with Statistical Package for Social Science (SPSS) software 21. Subsequently, the exploratory study enhanced modification of questionnaires for the main study, as earlier stated. The quantitative and qualitative data gathered for the main study is presented in the subsequent chapters. Quantitative data obtained from the structured questionnaire design was analysed with descriptive statistics, while qualitative data gathered from interviewees was analysed with qualitative content analysis. The underlying purpose is to validate quantitative data and ensure reliability of research findings. Frequency tables, bar charts and pie charts were drawn from analysed quantitative data and presented accordingly.

3.8.8.1 Descriptive statistics

Descriptive statistics involves the act of describing or summarising quantitative data obtained in a study in a meaningful manner (Quartaroli, 2009:75). One of the most important initial analyses is to describe the participant of a study, and the finding must present the characteristics of the sample (Russell & Purcell, 2009:282). Descriptive statistics are used for describing the basic features of a data set and are the key for summarising variables (O'leary, 2010:237). The basic summary of each variable is presented by showing a proportionate breakdown of categories for each variable (Henn *et al.,* 2006:206). The purpose of this statistical tool is to provide an overall and straightforward picture of a large amount of data (Stead & Struwig, 2007:158). Henn *et al.* (2006) identify the three measures of central tendency as: mean, median and mode. The study variables are broadly described with mean values and respective percentages of respondents. This study adopts research questions designed to elicit the most significant factors affecting construction labour efficiency by ranking the identified factors with the aid of mean, percentage and standard deviation. Hence, the study adopts descriptive statistics for quantitative data obtained with the purpose of answering research questions.

3.8.8.2 Content analysis

Content analysis is essentially a system of coding that involves transforming of raw data into a standardised form. The process involves coding of communication (oral or written) or classification in line with some conceptual framework (Babbie, 2007:325). This is an approach to data analysis that is deeply rooted in the qualitative research strategy, with the purpose of producing the quantitative accounts of the raw material in terms of the category specified (Bryman, 2000:182).The approach involves the summary of content, while the information is paraphrased to skip less relevant passages (Flick, 2011:137). The fundamental idea in content analysis is that numerous words in the text are classified into considerably fewer content categories (Struwig & Stead, 2007:14). Content analysis is a suitable method for answering a great host of research questions, although when compared with analysis of quantitative questionnaire, content analysis of the same quantity of data consumes more time than questionnaire analysis (Thomas, 2003:60). Content analysis is an inductive and iterative process where similarities and differences in text are explored to support or disconfirm a theory. Within the context of this study, important content obtained from the interviewee is reported in the simplest form to validate the quantitative data obtained, while less important information was discarded in the reporting process.

3.8.9 Validity and reliability

Testing for validity and reliability of research instrument(s) is significant to credibility of a research project. Validity refers to the ability of the research instrument to demonstrate that the instrument fulfils the desired purpose of design, while reliability ensures consistency in findings when continually used (Struwig & Stead, 2007:158). Hence, discarding the need to consider reliability and validity of a study might distort the validity of a research project.

3.8.9.1 Validity

Validity refers to the trustworthiness of research findings (Struwig & Stead, 2007:159).The logic that underpins the formulation of research tools and the statistical evidence gathered through the use of research instruments combine to form the basis of establishing validity of research instruments (Kumar, 2011:179). Validity is further described as the quality of research to reflect the true report of a phenomenon that is being researched and ultimately confirms the accuracy of the result obtained (Plowright, 2011:135). For the purpose of this study, the validity of the result was achieved through validation of quantitative data obtained from construction professionals, with qualitative interviews conducted with construction site supervisors.

3.8.9.2 Reliability

Research reliability refers to the ability of future researchers to undertake the same research project and come up with the same results, interpretations and claims. Reliability in quantitative research approach implies the extent to which an experiment, test or measurement provide the same result or regular measurement on continual trials (Silverman, 2006:282). The greater the degree of consistency and stability of an instrument, the greater the reliability of the instrument (Kumar, 2011:179). Struwig and Stead (2007:158) suggest the necessity of determining the reliability scores before examining the validity. For the purpose of this research, reliability was ensured by testing scaled research questions with Cronbach's alpha coefficient in SPSS (Version 22) software.

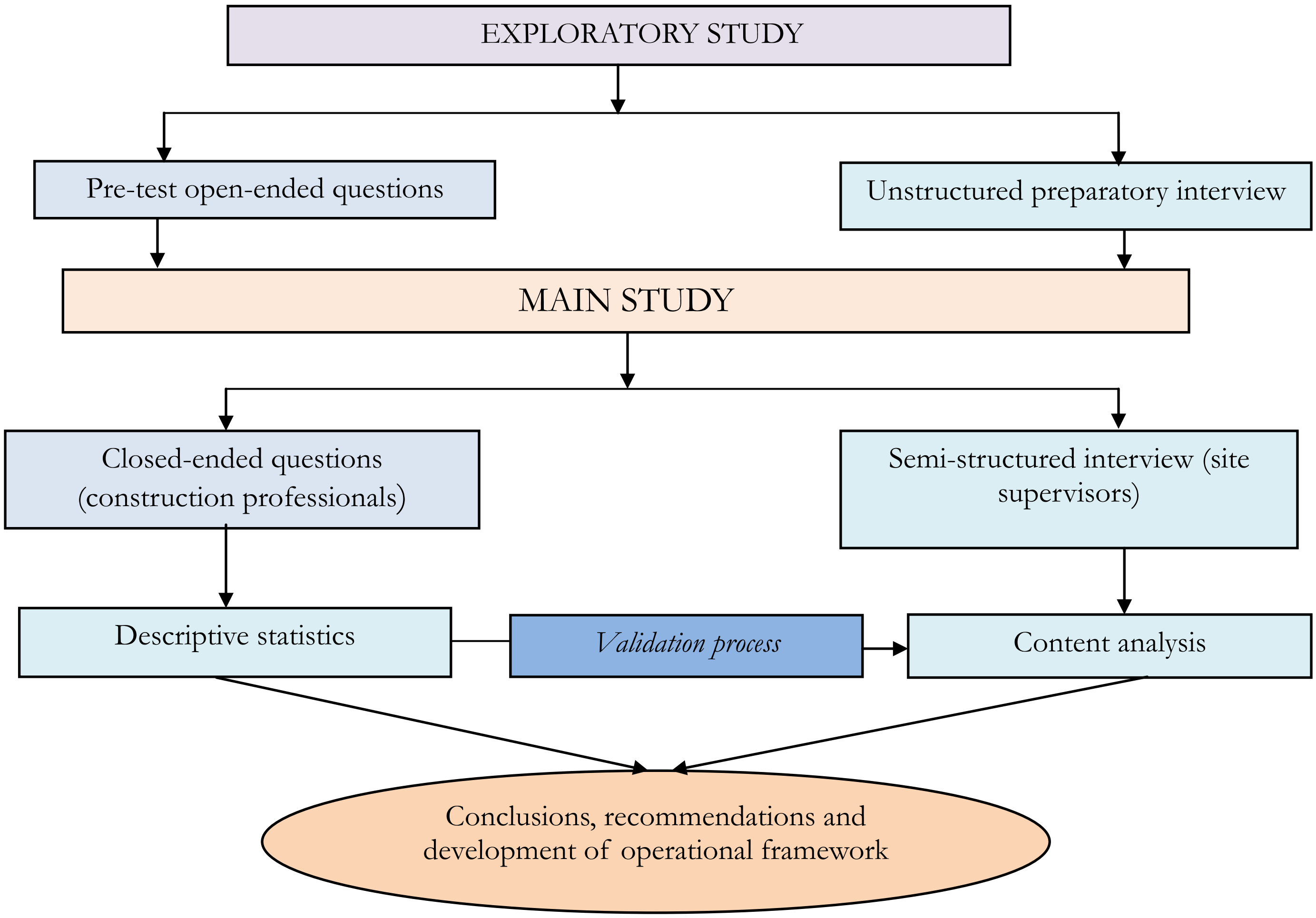

Figure 3.2: Research method

3.9 Chapter summary

The study adopts a mixed methodological approach, exploring quantitative questionnaires from construction professionals (architects, quantity surveyors, site engineers, project managers, contract managers and site managers). Due to a high level of awareness of site supervisors on the performance of construction labour, the quantitative data obtained from construction professionals was subsequently validated with a semi-structured interview with site supervisors. The research questionnaire is structured and designed to elicit the perceptions of construction professionals on various identified factors affecting the efficiency of construction workers in Gauteng and Western Cape provinces in South Africa. The questionnaire used was piloted among Construction Management Master of Technology degree students and a population of construction professionals on sites to ensure validity of the research instrument. Reliability of result was ensured by testing scaled questions with Cronbach's alpha coefficient reliability test.

CHAPTER FOUR

DATA ANALYSIS

4.1 Introduction

This chapter presents the analysis of data collected from the questionnaire survey conducted with construction professionals and interviews conducted with construction site supervisors The chapter describes the response rate in the questionnaire survey, the characteristics of respondents, exploratory studies undertaken for modification of research instruments and testing of research instrument for reliability purposes, while the interview section was reported on and then summarised and presented in a table. The chapter subsequently presents the interpretation and discussion of findings in respect to; construction-related factors affecting construction workers efficiency, design-related factors reducing the efficiency of construction labour, impacts of construction materials, machinery and labour on the efficiency of construction operations and external factors affecting the efficiency of human assets in the construction industry.

4.2 Pilot study

To achieve the appropriateness and clarity of questionnaire used for the study, the research questionnaire was piloted among Master of Technology degree students in the Construction Management and Quantity Surveying department, Cape Peninsula University of Technology. The students were requested to read through the research instrument and make necessary comments. A total of twenty five questionnaires were subsequently administered to construction professionals in Cape Town, South Africa. The respondents were requested to answer research questions and make comments where necessary. The inputs of the students and construction professionals were considered and slight adjustments were made in the formulation of the main questionnaire with respects to comment received.

4.3 Questionnaire survey response rate

Quantitative data for the study were collected through questionnaire surveys, with a total number of two hundred and sixty-five (265) questionnaires administered to construction professionals in the Western Cape and Gauteng provinces of South Africa. Respondents to the study were architects, quantity surveyors, site engineers, project managers, contract managers and site managers. The construction experience of the selected respondents for the quantitative section of the study was sufficient to be capable of providing valid results for the subject under study. Two hundred and fifty (250) questionnaires were physically hand delivered to respondents. From this number, fifty-nine (59) questionnaires were duly completed and retrieved. Fifteen (15) questionnaires were administered via electronic mails, and three (3) of the questionnaires were completed and returned through electronic medium. The total number of retrieved questionnaires was sixty-two (62) which represents 23.39% of the total questionnaires administered.

4.4 Biographical information of respondents

4.4.1 Participants companies

The respondents in the study held different positions and organisations. As presented in Figure 4.1, the participant companies involved in the study include contracting firms (59.68%), architectural firms (11.29%), project management firms (8.06%) and quantity surveying consulting firms (20.97%).

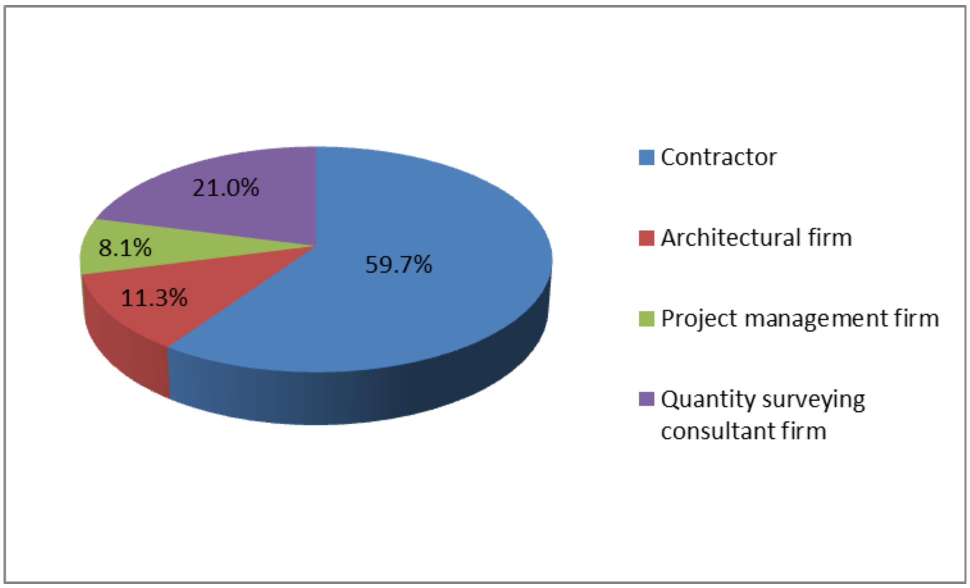

Figure 4.1: Participants' companies

4.4.2 Respondents' gender

Table 4.1 shows that the majority (82.3%) of survey participants are male, while female participants represent 17.7%. This gender distribution indicates that male participants are significantly higher than their female counterparts.

Table 4.1: Respondents' Gender

Category	Frequency	Percentage
Male	51	82.3
Female	11	17.7
Total	62	100

4.4.3 Age group

Table 4.2 presents the age groups of survey respondents. It was found that 21.0% of the respondents were below the age of twenty-six. The highest percentage of respondents falls between the ages of twenty-six and thirty years and represents 30.6% of the total study respondents. The age group between thirty-one to thirty-five years makes up 19.4% of study participants. Respondents found to be between age thirty-six and above represents 29.0% of survey respondents. The table indicates that 71% of survey respondents were not older than thirty-five years of age, while 29% respondents were above thirty-five years of age. This implied that the majority of survey respondents were young.

Table 4.2: Age group of respondents

Category	Frequency	Percentage
Below 26	13	21.0
26-30	19	30.6
31-35	12	19.4
36 or older	18	29.0
Total	62	100

4.4.4 Highest formal qualifications

Figure 4.2 presents the formal qualifications obtained by the participants in the study. Respondents with only matric certificates represented 9.80% of total participants. Respondents having diploma certificates as the highest formal qualification represented 20.97%, which is significantly more than the matric certificate holders. Respondents holding post graduate diplomas represented 11.29%, a slightly higher percentage than matric certificate holders. The largest group of survey participants (33.87%) had bachelor degrees in their respective fields. Respondents with honour degree had an equivalent percentage (20.91%) with respondents with diploma certificates. A minority of respondents (3.23%) hold Master's degrees in their various fields. Figure 4.2 indicates that 69.30% of survey respondents held bachelor degree certificates and above, while 30.70% of respondents had educational backgrounds below this level .

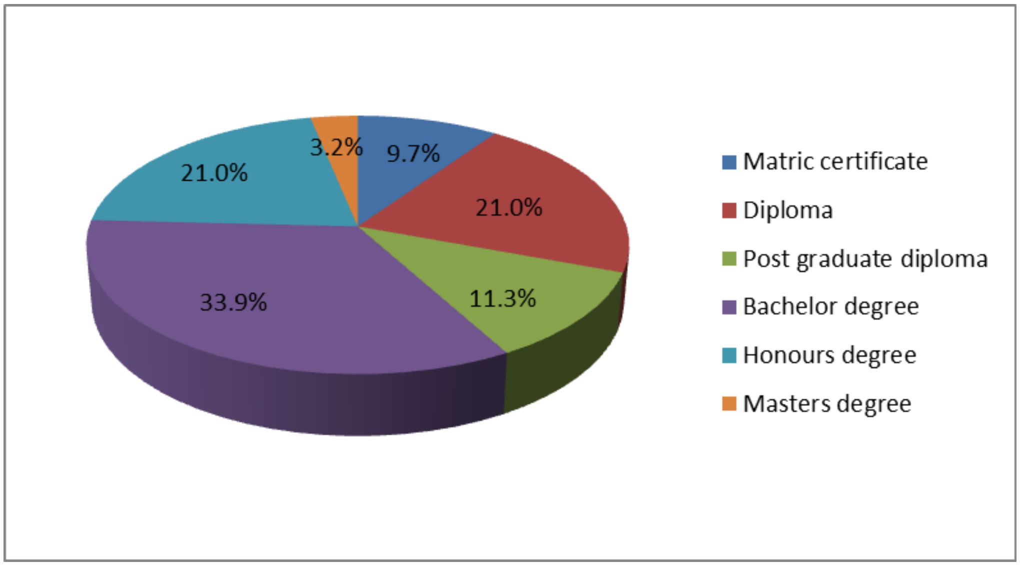

Figure 4.2: Highest formal qualifications

4.4.5 Experience of respondents

Table 4.3 presents the work experience of respondents in the construction sector. The table reveals that respondents with one to five years' work experience in the construction industry represented 46.8% of the total respondents. Respondents having six to ten years construction work experience represented 22.6% of the total respondents. 11.3% of study participants had been involved in construction work for eleven to fifteen years. Respondents with work experience above sixteen years represented 19.3%. From Table 4.3, the working experience of the majority of respondents 69.4% in the construction industry spanned between one to ten years, while 30.6% of respondents had been working in the construction sector for more than ten years. The years of experience of respondents were sufficient to provide useful responses to achieve the purpose of the study as 53.2 % of study respondents have more than six years work experience in the construction industry.

Table 4.3: Experience of respondents in the construction industry

Category	Frequency	Percentage
1-5 years	29	46.8
6-10 years	14	22.6
11-15 years	7	11.3
Above 16 years	12	19.3

4.4.6 Position of respondents

Figure 4.3 presents the positions held by survey participants. The largest group of respondents 30.6% were site managers. Participants who were project manager represented 21.0%, site engineers 17.7%, quantity surveyors 12.9%. Respondents who were contract manager made up 11.3% and the least represented participant group was made up of architects, with 6.5% of total respondents.

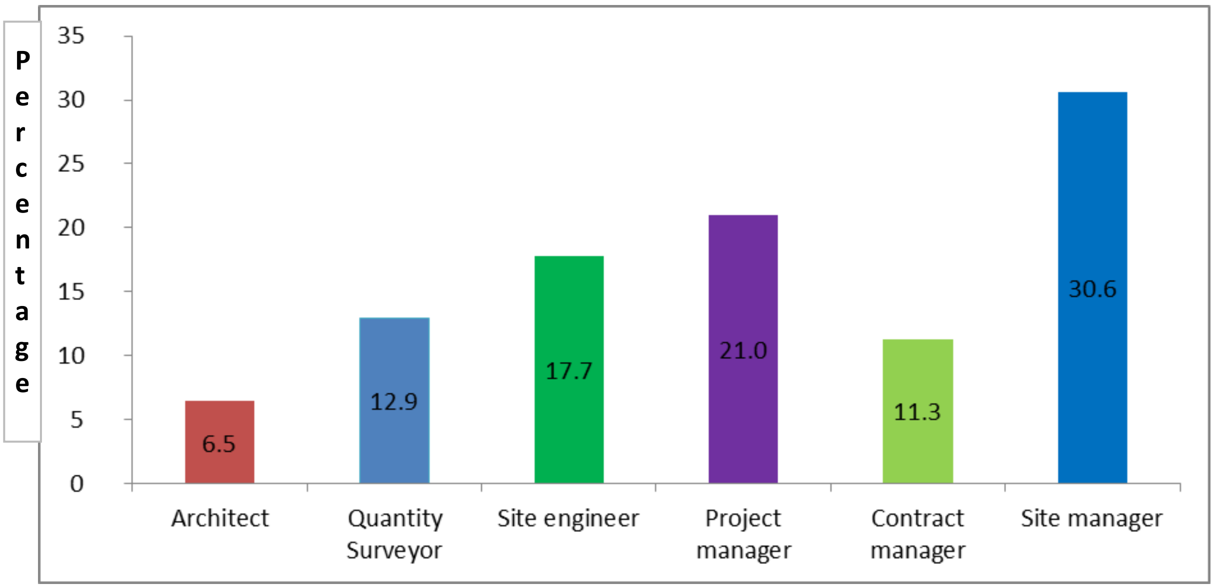

Figure 4.3: Position of respondents

4.4.7 Number of years in present position

Figure 4.4 shows that 72.6% of respondents had been in their current position between one to five years, while 27.4% had been working in their present position for six years and above. Figure 4.4 shows that the majority of survey respondents had not worked more than five years in their present positions.

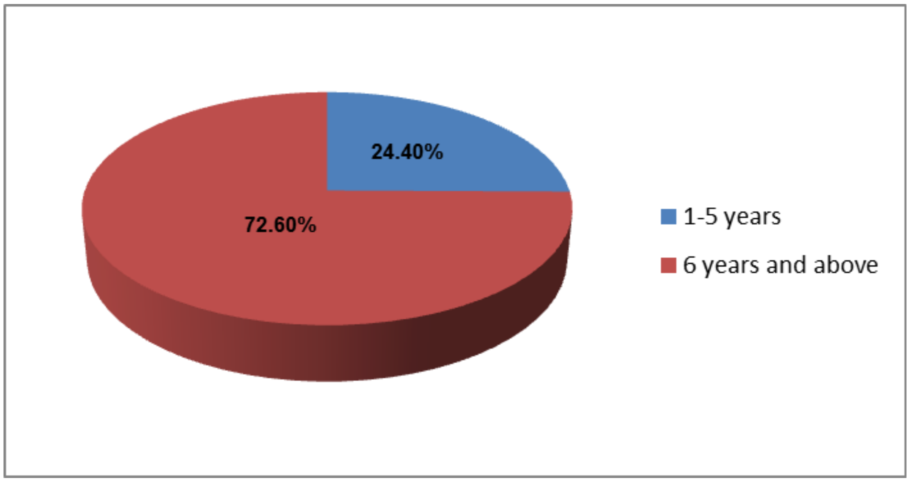

Figure 4.4: Years in present position

4.5 Reliability of research instrument

The scaled questions used in the study were tested with Cronbach's alpha coefficient, using Statistical Package for Social Sciences software (version 22) to ensure the reliability of research questions. Table 4.4 presents the summary of reliability tests conducted on scale questions. The results of the Cronbach's alpha co-efficient tests were found satisfactory in term of reliability test requirements.

Table 4.4: Reliability of research instrument

Question number	Headings	Number of items	Cronbach's alpha coefficient values
8	Construction-related factors	30	0.9
9	Workers' motivational factors	20	0.9
10	Construction occupational health and safety	22	0.9
11	Design-related factors	50	0.9
12	Construction resources-related factors	39	0.9
13	External factors	17	0.8
Sum	All questions combined	178	0.9

4.6 Presentation of findings

The study is designed to identify the predominant factors affecting the efficiency of construction labour in the South African construction industry. From the findings, the significant factors affecting the performance of construction workforce are presented.

4.6.1 Contractor-related factors

Table 4.5 presents the perceptions of survey respondents in the order of severity of contractor-related factors affecting the efficiency of construction labour. Respondents were requested to indicate the extent to which each of the identified factors interfered with the efficiency of construction labour using a five-point scale: 1= strongly disagree, 2= disagree, 3=neutral, 4=agree and 5=strongly agree. In Table 4.5, effective site planning ability, with a mean value of 4.26, is identified as the most significant contractor-related factor affecting the efficiency of construction labour. 87.1% of respondents strongly agreed that this factor affects the efficiency of construction labour, while 11.3% of respondents were undecided. A minority 1.6% of respondents disagreed that effective site planning ability does not affect the performance of construction labour. It can be inferred that this factor is widely regarded as a major contributor to low efficiency of workers on construction sites. Contractor's construction experience, with a mean value of 4.26, was indicated as a notable factor in construction workers' efficiency. This factor maintained the same mean value as effective site planning ability, although less significant than site planning ability, considering the standard deviation of the two factors. 83.3% of respondents agreed to contractor construction experience as a factor affecting construction workers efficiency. 12.9% of respondents were undecided and 3.2% of respondents disagreed that this factor was significant. Inadequate co-ordinating ability of workforce (Mv=4.23), rework due to construction error (Mv=4.18), relationship with subcontractor (Mv=4.11) and method of construction (Mv=4.00) were also perceived as notable contractor-related factors affecting construction labour efficiency (Table 4.5).

Table 4.5: Contractor-related factors

Contractor-related factors	N	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Effective site planning ability	62	0	1.6	11.3	46.8	40.3	4.26	0.71	1
Contractor's construction experience	62	0	3.2	12.9	38.7	45.2	4.26	0.81	2
Inadequate co-ordinating ability of workforce	62	0	4.8	8.1	46.8	40.3	4.23	0.80	3
Rework due to construction error	62	1.6	4.8	17.7	25.8	50.0	4.18	1.00	4
Relationship with sub-contractors	62	0	3.2	19.4	40.3	37.1	4.11	0.83	5
Method of construction	62	0	3.2	25.8	38.7	32.3	4.00	0.85	6
Contractors delay of instruction to employee	62	0	8.1	22.6	32.3	37.1	3.98	0.97	7
Inadequate facilities for construction workers	62	1.6	12.9	19.4	30.6	35.5	3.85	1.10	8
Contractor financial problems	62	4.8	3.2	33.9	29.0	29.0	3.74	1.01	9
Access to construction sites	62	8.1	6.5	17.7	45.2	22.6	3.68	1.14	10
Profit intention of contractors	62	6.5	4.8	27.4	41.9	19.4	3.63	1.01	11

4.6.2 Site supervisor-related factors

Table 4.6 presents the findings of factors related to construction site supervisors' effect on the efficiency of construction workers. A five-point scale was again adopted to determine the perceptions of respondents: 1=strongly disagree, 2= disagree, 3=neutral, 4=agree, and 5=strongly agree. From the Table, 90.4% of respondents agreed that the construction skill of site supervisors (Mv=4.31) significantly affects construction labour efficiency. 4.8% of respondents were undecided and 4.8% of respondents disagreed that this factor was significant. 80.7% of respondents agreed that communication between supervisors and construction labour (Mv=4.27) was a factor contributing to inefficiency on construction labour. 19.3% of respondents were undecided and none of the respondents disagreed that this factor was significant. The quality of instructions given by site supervisors was seen as significantly important to the efficiency of construction workers, as 82.3% of respondents perceived inadequate instruction from supervisor to labour (Mv=4.24) as one of the major contributory factors to the inefficiency of construction labour. 14.5% of respondents were undecided and 3.2% of respondents disagreed. The recruitment of competent supervisors and poor coordination of workers by supervisors were among the significant site supervisor-related factors affecting construction workers' efficiency, as indicated by respondents.

Table 4.6: Site supervisor-related factors

Factors	N	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Construction skills of supervisor	62	0	4.8	4.8	45.2	45.2	4.31	0.78	1
Communication between supervisors and construction labour	62	0	0	19.3	33.9	46.8	4.27	0.77	2
Inadequate instructions from supervisors to labourers	62	0	3.2	14.5	37.1	45.2	4.24	0.82	3
Recruitment of competent supervisors	62	0	3.2	12.9	43.6	40.3	4.21	0.79	4
Poor coordination of workers by supervisors	62	0	0	17.7	45.2	37.1	4.19	0.72	5
Relationship between supervisors of different trades	62	0	3.2	17.7	41.9	37.2	4.13	0.82	6
Trade supervisors' absenteeism	62	1.6	4.8	19.4	32.3	41.9	4.08	0.9	7
Rework due to unclear instruction from supervisor	62	3.2	8.1	8.1	38.7	41.9	4.08	1.06	8
Supervision delay by trade supervisors	62	0	1.6	19.4	56.5	22.6	4.00	0.9	9
Poor relationship of supervisor with employer	62	1.6	4.8	22.6	43.5	27.5	3.9	0.9	10

4.6.3 Site manager-related factors

The perceptions of respondents on factors related to construction site managers are presented in Table 4.7. Respondents were requested to indicate the extent to which each of the factors affects the efficiency of construction workforce. A five-point scale was adopted, where 1= strongly agree, 2= disagree, 3=neutral, 4=agree and 5=strongly agree. From Table 4.7, the communication ability of site manager (Mv=4.45) is perceived as important to the efficiency of construction workers. 95.1% of respondents identified communication ability of site manager as the factor with the greatest impact on the performance of construction workers. 3.2% of respondents were undecided and 1.6% of respondents disagreed that the factor was essential to the efficiency of construction labour. Site managers co-ordination skill (Mv=4.39) was perceived by respondents as an important factor impacting the efficiency of construction workers. Respondents indicated planning ability of the site manager (Mv=4.34) and level of education of the site manager (Mv=4.34) as significant site manager-related factors affecting construction labour efficiency (Table 4.7).

Table 4.7: Site manager-related factors

Factors	N	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Communication ability of site managers	62	0	1.6	3.2	43.5	51.6	4.45	0.64	1
Site manager's coordinating skill	62	0	1.6	11.3	33.9	53.2	4.39	0.75	2
Planning ability of site managers	62	0	1.6	6.5	48.4	43.5	4.34	0.67	3
Level of education of site managers	62	0	1.6	6.5	51.6	40.3	4.34	0.67	3
Decisions of site managers	62	1.6	0	6.5	51.6	40.3	4.29	0.73	5
Inadequate instructions of site managers	62	0	4.8	4.8	54.8	35.5	4.21	0.75	6
Technical skill of site managers	62	1.6	1.6	11.3	45.2	40.3	4.21	0.83	7
Site manager's relationship with project team	62	0	1.6	19.4	40.3	38.7	4.16	0.79	8
Administrative experience of site managers	62	0	1.6	6.5	48.4	43.5	4.16	0.79	8

4.6.4 Worker motivational factors

The perceptions of respondents were explored on the subject of workers' motivational factors, as presented in Table 4.8. A five-point scale was used whereby respondents were requested to indicate the extent to which they agree with the significance each of the identified motivational factors: 1= strongly disagree, 2= disagree, 3=neutral, 4=agree and 5=strongly agree. Unfair wages of construction workers (Mv=4.23) was a factor indicated by employees as having the highest level of impact on the efficiency of construction workers. 87.1% of respondents indicated that construction workers wages were unfair, 9.7% of respondents were undecided while 3.2% of respondents disagreed with the proposition that unfair wages of workers are a contributory factor to poor efficiency of construction labour. Delay in payment of construction employees (Mv=4.19) was also identified as a notable motivational factor adversely impacting the performance of construction workers. Inadequate financial motivation of workers, poor relationships of labourers with superior and excessive overtime work with mean values of (4.06), (4.03) and (4.03) respectively are identified by respondents as significant motivational factors affecting efficiency of construction labour.

Table 4.8: Worker motivational factors

Factors	N	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Unfair wages of construction workers	62	1.6	1.6	9.7	46.8	40.3	4.23	0.81	1
Delay in payment of construction employees	62	1.6	6.5	11.3	32.3	48.4	4.19	0.98	2
Inadequate financial motivation	62	0	8.1	12.9	43.5	35.5	4.06	0.90	3
Poor relationship of labourers with superiors	62	1.6	1.6	17.7	50.0	29.0	4.03	0.82	4
Excessive overtime work	62	3.2	1.6	19.4	40.3	35.5	4.03	0.95	5
Inadequate motivation of individual worker	62	1.6	1.6	29.0	35.5	32.3	3.95	0.91	6
Lack of employee team belonging	62	1.6	3.2	21.0	56.5	17.7	3.85	0.80	7
Insufficient general workers motivation	62	1.6	4.8	22.6	48.4	22.6	3.85	0.88	8
Unfavourable working condition in construction	62	3.2	4.8	19.4	48.4	24.2	3.85	0.95	9
Inadequate bonus for workers	62	3.2	6.5	30.6	27.4	32.3	3.79	1.07	10
Lack of promotion	62	1.6	8.1	24.2	45.2	21.0	3.76	0.93	11
Lack of responsibility for workers	62	3.2	6.5	27.4	40.3	22.6	3.73	0.99	12
Discontinuity of construction works	62	3.2	9.7	17.7	50.0	19.4	3.73	0.99	12
Non-recognition of subordinates by superiors	62	3.2	8.1	22.6	48.4	17.7	3.69	0.96	14
Poor overtime allowance	62	4.8	8.1	24.2	38.7	24.2	3.69	1.08	15
Lack of participation of employee in decision-making	62	6.5	6.5	27.4	41.9	17.7	3.58	1.06	16
Poor policies of organisation	62	6.5	11.3	21.0	40.3	21.0	3.58	1.13	17
Distance of construction site from home	62	6.5	17.7	19.4	33.9	22.6	3.48	1.21	18
Reputation of firm	62	1.6	19.4	38.7	24.2	16.1	3.34	1.02	19

4.6.5 Construction occupational health and safety

Table 4.9 presents safety culture on construction projects. A five-point scale with regard to level of importance was adopted to explore the perceptions of respondents on the subject of construction safety. Not important =1, Neutral = 2, slightly important =3, moderately important =4, Very important = 5. From the table, a majority of the respondents 96.8% agree that fall protection is used on construction sites when working from a height (Mv=4.68). A significant percentage 93.6% of respondents also agree that helmets are made compulsory for site visitors (Mv=4.68). Most respondents (95.2%) indicated that edge protection is always in place on decks. 95.2% of respondents also perceived that it is important that every worker on site wear a helmet. None of the respondents indicated any of the above factors to be unimportant. These findings imply a good safety culture on South African construction sites.

Table 4.9: Construction occupational health and safety

Factors	N	Not important (%)	Neutral (%)	Slightly important (%)	Moderately important (%)	Very important (%)	Mean value	S.D	Rank
Fall protection is used on site when working from height	62	0	3.2	0	22.6	74.2	4.68	0.64	1
Helmets are made compulsory for site visitors	62	0	4.8	1.6	14.6	79.0	4.68	0.74	2
Edge protection is always in place on decks	62	0	4.8	0	19.4	75.8	4.66	0.72	3
Every worker on site wears a helmet	62	0	4.8	0	19.4	75.8	4.66	0.72	3
Health and safety induction is compulsory for site visitors	62	0	8.1	1.6	12.9	77.4	4.60	0.87	5
First aid treatments are readily available for workers on site	62	0	4.8	0	27.4	67.7	4.58	0.73	6
Workers always wear safety boots on construction sites	62	1.6	6.5	0	19.4	72.6	4.55	0.91	7
Safety boots should be made compulsory for site visitors	62	3.2	6.6	1.6	19.4	69.4	4.45	1.03	8
Safety officer is always present on large construction sites during operations	62	0	11.3	3.2	19.4	66.1	4.40	0.99	9
Health and safety induction is compulsory for construction workers	62	0	8.1	1.6	12.9	77.4	4.40	1.12	10
Eye protection is always used by workers with specific tasks	62	0	12.9	0	22.6	64.5	4.39	1.01	11
Safety signage is always displayed when carrying out hazardous activities	62	0	11.3	3.2	25.8	59.7	4.34	0.99	12
Toolboxes are always available on construction sites	62	0	14.5	0	29.0	56.5	4.27	1.04	13
Ear protection is used by workers on site for specific tasks		0	16.1	0	24.2	59.7	4.27	1.08	14
Employees always wear reflective vests when working around mobile plants	62	1.6	12.9	3.2	22.6	59.7	4.26	1.11	15
Hand protection is used by workers working with concrete	62	1.6	14.5	0	24.2	59.7	4.26	1.13	16
Staff apart safety officers are concerned with instilling safety discipline	62	1.6	16.1	1.6	24.2	56.5	4.24	1.08	17
Safety signs are prominently available on construction sites	62	0	14.5	4.8	22.6	58.1	4.18	1.16	18
Construction site is always clean	62	0	25.8	0	21.0	53.2	4.02	1.26	19
Management workers have better safety culture than craft workers	62	1.6	22.6	1.6	32.3	41.9	3.90	1.22	20
Peer group pressure influences safety culture of construction workers	62	1.6	21.0	1.6	40.3	35.5	3.87	1.16	21

Older construction workers exhibit better safety culture than younger workers	62	6.5	25.8	3.2	25.8	38.7	3.65	1.39	22

4.6.6 Architect-related factors

Table 4.10 presents architect-related factors affecting the efficiency of construction workforce. A five-point scale was used to obtain the perceptions of respondents as follows: not at all =1, to a little extent = 2, to some extent =3, to a large extent =4 and to a very large extent = 5. From the Table, the problem of missing details in architectural working drawings is identified as the most severe architect-related factor affecting the efficiency of construction workers in Gauteng and Western Cape provinces. Almost all respondents (98.4%) agreed to this factor as a challenge to the efficiency of construction workers (Mv=4.48). 1.6% of respondents indicated that this factor does not at all affect the efficiency of construction workers. Slow response of architect to architectural drawing-related questions was indicated by respondents as a significant factor affecting construction labour efficiency. A clear majority (98.4%) of respondents perceived this factor as a challenge to construction worker performance, while 1.6% claimed that slow response of the architect to drawing questions does not affect construction workers efficiency (Mv=4.34). Non- clarity of architectural drawing (Mv=4.27) was rated the third most significant architecturally-related factor affecting the efficiency of construction workers.

Table 4.10: Architect-related factors

Architect factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Missing details in architectural working drawings	62	1.6	0	9.7	25.8	62.9	4.48	0.80	1
Slow response of architect to drawing questions	62	1.6	0	6.5	46.7	45.2	4.34	0.74	2
Non- clarity of architectural drawings	62	1.6	1.6	8.1	45.2	43.5	4.27	0.81	3
Revisions and changes ordered by architect	62	1.6	1.6	12.9	45.2	38.7	4.18	0.84	4
Architect's late issuance of instructions	62	3.2	4.8	11.3	32.3	48.4	4.18	1.03	5
Non-clarity of architectural specifications	62	1.6	3.2	16.1	35.5	43.5	4.16	0.92	6
Incomplete pages of architectural drawings	62	1.6	6.5	14.5	29.0	48.4	4.16	1.01	7
Architect's delay of inspections	62	1.6	3.2	24.2	33.9	37.1	4.02	0.94	8
Complexity of architectural designs	62	3.2	8.1	22.6	38.7	27.4	3.79	1.04	9

4.6.7 Structural engineer-related factors

The order of structural engineer-related factors affecting the efficiency of construction workers are presented in Table 4.11. A five-point scale was used to obtain the perception of respondents as follows: not at all =1, to a little extent = 2, to some extent =3, to a large extent =4 and to a very large extent = 5. 48.4% of respondents agreed to a very large extent that the slow response of structural engineers to drawing questions is a notable factor impinging on the efficiency of construction human capital. 38.6% of respondents agreed to a large extent and 11.3% agreed that the factor, to some extent, was a contributory factor to inefficiency of construction workers. 1.6% of respondents claimed that the factor does not at all affect the efficiency of construction workers (Mv=4.32). Incomplete pages of structural drawings were indicated as the second structural engineer-related factor contributing to poor efficiency of construction labour. 95.2% of respondents indicated this factor as a challenge to the performance of construction workers. 4.8% of respondents perceive that this factor does not in any way affect the efficiency of construction labour.

Table 4.11: Structural engineer-related factors

Factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Slow response of structural engineer to drawing questions	62	1.6	0	11.3	38.6	48.4	4.32	0.80	1
Incomplete pages of structural drawings	62	4.8	1.6	12.9	24.2	56.5	4.26	1.07	2
Non-clarity of structural drawings	62	3.2	1.6	8.1	41.9	45.2	4.24	0.91	3
Missing details in structural drawings	62	3.2	1.6	16.1	27.4	51.6	4.23	0.90	4
Non-clarity of structural specifications	62	3.2	1.6	14.5	33.9	46.8	4.19	0.97	5
Poor structural design information	62	3.2	3.2	12.9	37.1	43.5	4.15	0.98	6
Structural engineer's delay of inspection	62	1.6	4.8	16.1	33.9	43.5	4.13	0.96	7
Revisions and changes ordered by structural engineers	62	1.6	4.8	17.7	35.5	40.3	4.08	0.96	8
Complexity of structural drawings	62	1.6	12.9	16.1	38.7	30.6	3.84	1.05	9

4.6.8 Electrical engineer-related factors

Table 4.12 presents electrical engineer-related factors affecting construction labour efficiency. Perceptions of respondents were obtained with a five-point scale with choices as follows: not at all =1, to a little extent = 2, to some extent =3, to a large extent =4 and to a very large extent = 5. The majority (98.4%) of respondents indicated incomplete pages of electrical engineering drawing as a contributory factor to construction workers' inefficiency (Mv=4.24). 51.6% of respondents agreed that it was a the factor to a very large extent, 27.4% to a large extent, 16.2% to some extent and 3.2% to a little extent. Only 1.6% of respondents perceived the factor as having no impact on the efficiency of construction labour. Revision of electrical drawing (Mv=4.21) was rated as the second-most significant electrical engineer-related factor affecting construction labour efficiency. 45.2% of respondents agreed to a very large extent that this factor was significant to the efficiency of construction labour, 35.5% agreed to a large extent, 16.1% agreed to some extent and 1.6% to a little extent. A small minority 1.6% of respondents identified revision of electrical drawings as a non-contributory factor to construction labour efficiency.

Table 4.12: Electrical engineer-related factors

Factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Incomplete pages of electrical drawings	62	1.6	3.2	16.2	27.4	51.6	4.24	0.95	1
Revision of electrical drawings	62	1.6	1.6	16.1	35.5	45.2	4.21	0.89	2
Slow response of electrical engineers to drawing questions	62	1.6	1.6	19.4	33.9	43.5	4.16	0.90	3
Inadequate electrical design information	62	1.6	3.2	19.4	30.6	45.2	4.15	0.95	4
Non-clarity of electrical drawings	62	1.6	4.8	21.0	30.6	41.9	4.06	0.99	5
Difficulty in obtaining electrical appliances in market	62	3.2	4.8	21.0	30.6	40.3	4.00	1.05	6
Complexities of electrical drawings	62	4.8	9.7	16.1	33.9	35.5	3.85	1.15	7

4.6.9 Mechanical engineer-related factors

Mechanical engineer-related factors affecting construction labour efficiency are presented in Table 4.13. The ranking of the factors was obtained from the input of respondents on each of the identified factors. A five-point scale was used, and respondents were requested to represent not at all with 1, to a little extent with 2, to some extent with 3, to a large extent with 4 and to a very large extent with 5. Among the identified factors, respondents identified slow response to mechanical engineering drawing as the greatest challenge of construction labour on sites (Mv=4.15). 38.7% of respondents agreed with the premise to a very large extent that the factor affected the performance of construction labour, 40.3% agreed to this factor to a large extent, 19.4% indicated that the factor affected construction labour performance to some extent and 1.6% perceived that the factor did not affect construction labour efficiency. The problems related to mechanical engineering specification and non-clarity of mechanical engineering drawings were identified as a contributory factor to construction labour inefficiency, with the same perceived level of impact as construction labour efficiency (Mv=4.13).

Table 4.13: Mechanical engineer-related factors

Factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Slow response to mechanical engineering drawing questions	62	1.6	0	19.4	40.3	38.7	4.15	0.84	1
Mechanical engineer specification problems	62	1.6	1.6	22.6	30.6	43.5	4.13	0.93	2
Non-clarity of mechanical engineering drawings	62	1.6	4.8	19.4	27.4	46.4	4.13	1.00	3
Inadequate detailing of mechanical engineering drawings	62	1.6	3.2	22.6	32.3	40.3	4.06	0.95	4
Difficulties in installation of mechanical devices	62	3.2	6.5	19.4	35.5	35.5	3.94	1.05	5
Difficulty in obtaining specified mechanical devices in market	62	3.2	4.8	32.3	27.4	32.3	3.81	1.05	6

4.6.10 Client-related factors

The perception of respondents on factors related to construction clients are presented in Table 4.14. Respondents were requested to indicate the extent to which each of the client-related factors affects the efficiency of construction workforce. A five-point scale was adopted, with the following choices: not at all =1, to a little extent = 2, to some extent =3, to a large extent =4 and to a very large extent = 5. In Table 4.14, revisions and changes ordered by clients (Mv=4.27) is perceived as a major challenge to efficiency of construction labour. The majority 51.6% of survey respondents indicated that the factor affects the performance of construction labour to a very large extent, 29.0% agreed to a large extent, 16.1% agreed to some extent, 1.6% agreed to a little extent. 1.6% of respondents indicated that the factor does not affect the performance of construction labour. Respondents also identified design approval delay by client (Mv=4.05) as a significant contributory factor to poor efficiency of construction workers. 45.5% of respondents acknowledged that this factor affects construction labour efficiency to a very large extent, 40.3% respondents felt that it affected labour efficiency to a large extent, 11.3% of respondents agreed to some extent and 3.2% of respondents claimed that design approval delay by client only affected construction labour efficiency to a little extent. 1.6% of respondents indicated that the factor does not affect the efficiency of construction labour.

Table 4.14: Client-related factors

Factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Revision and changes ordered by client	62	1.6	1.6	16.1	29.0	51.6	4.27	0.90	1
Design approval delay by client	62	1.6	3.2	11.3	40.3	45.5	4.05	0.89	2
Barrier in in obtaining information from client	62	1.6	0	22.6	43.5	32.3	4.03	0.83	3
Misunderstanding between clients and project parties	62	1.6	4.8	16.1	43.5	33.9	3.98	0.92	4
Poor payment by client resulting in poor construction designs	62	1.6	1.6	29.0	32.3	32.3	3.90	0.93	5
Delay of progress payment after interim valuation	62	3.2	4.8	24.2	33.9	33.9	3.85	1.03	6
Inadequate briefing ability of clients	62	1.6	4.8	29.0	35.5	29.0	3.85	0.95	7
Inadequate construction experience of clients	62	8.1	8.1	25.8	24.2	33.9	3.68	1.25	8

4.6.11 Quantity Surveyor-related factors

Table 4.15 presents factors related to the quantity surveyor's effect on the efficiency of construction workers. Respondents were required to indicate the extent to which each of the identified factors affected the efficiency of construction labour on sites using a five point scale with values as follows: not at all =1, to a little extent = 2, to some extent =3, to a large extent =4 and to a very large extent = 5. Missing details in quantity surveyor specifications (Mv=3.89) is identified as the most significant factor affecting the efficiency of construction labour. 30.6% of respondents indicated that the factor affects the efficiency of construction labour to a very large extent, 37.1% of respondents agreed that the factor contributed to construction labour efficiency challenges to a large extent, 25.8% agreed to some extent and 3.2% to a little extent. A minority (3.2%) of respondents indicated that missing details in quantity surveyor's specifications does not in any way affect the efficiency of construction labour. Inadequate measurement ability of quantity surveyors for required work (Mv=3.84) emerged as the second critical factor affecting the performance of construction labour. 35.5% of respondents identified the factor as affecting construction labour efficiency to a very large extent, 30.6% of respondents indicated agreement to a large extent, 21.0% of respondents indicated agreement to some extent and 8.1% of respondents agreed to a little extent. 4.8% of respondents claimed that inadequate measurement ability on the part of quantity surveyors for required work does not at all affect efficiency of construction labour on sites.

Table 4.15: Quantity surveyor-related factors

Factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Missing details in quantity surveyor's specifications	62	3.2	3.2	25.8	37.1	30.6	3.89	0.90	1
Inadequate measurement ability of quantity surveyors for the required work	62	4.8	8.1	21.0	30.6	35.5	3.84	1.14	2
Errors of omission in the bill of quantities	62	8.1	3.2	27.4	27.4	33.9	3.76	1.19	3
Inadequate schedule of quantities/rates	62	4.8	6.5	24.2	38.7	25.8	3.74	1.01	4
Delay in the preparation of interim valuation	62	4.8	6.5	29.0	29.0	30.6	3.74	1.15	5
Non-clarity of quantity surveyor specification	62	6.5	6.5	30.6	32.3	24.2	3.61	1.12	6

4.6.12 Other design-related factors

Table 4.16 presents other design-related factors affecting construction labour efficiency. The perceptions of respondents were obtained by using a five-point scale, where not at all =1, to a little extent = 2, to some extent = 3, to a large extent = 4 and to a very large extent = 5. 98.4% of respondents indicated inadequate co-ordination among members of the design team as a contributory factor to construction workers' inefficiency (Mv=4.19). 1.6% of respondents indicated that the factor was not significant to the efficiency of construction labour on construction sites. The second-highest rated factor was contract documents conflicting with construction drawings and specifications (Mv= 4.18). Only 1.6% of respondents indicated that contract documents conflicting with construction drawings and specifications did not in any way affect the performance of construction labour. Buildability problems (Mv=4.02) was the third-most significant other-related factor contributing to construction labour efficiency challenges.

Table 4.16: Other design-related factors

Factors	N	Not at all (%)	To a little extent (%)	To some extent (%)	To a large extent (%)	To a very large extent (%)	Mean value	S.D	Rank
Inadequate co-ordination among members of the design team	62	1.6	3.2	16.1	32.3	46.8	4.19	0.93	1
Contract documents conflicting with construction drawings and specification	62	1.6	4.8	11.3	38.7	43.5	4.18	0.93	2
Buildability problems	62	1.6	6.5	16.1	40.3	35.5	4.02	0.96	3
Inadequate time for preparation of contract documents	62	4.8	4.8	19.1	37.1	33.9	3.90	1.08	4
Non-involvement of constructor in the design stage	62	6.5	6.5	17.7	38.7	30.6	3.81	1.14	5

4.6.13 Material-related factors

Table 4.17 presents the perception of survey respondents of the order of severity of construction material-related factors affecting the efficiency of construction labour. Respondents were requested to indicate the extent to which each of the factors interferes with the efficiency of construction labour. A five-point scale was used; where 1 = strongly agree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. From the table, it can be seen that 82.3% of respondents agreed that shortage of construction materials affects the efficiency of construction labour, 16.1% of respondents were undecided and (1.6% of respondents disagree with shortage of construction materials being a contributory factor to performance of construction labour. 79.1% of respondents agreed that late delivery of construction materials to site (Mv=4.23) is a significant factor in construction workers' efficiency, 17.7% of respondents were undecided and 3.2% of respondents disagreed that the identified was significant. Late orders for construction materials as a factor was also perceived to have a notable impact on construction labour productivity with 75.8% of respondents in agreement , 17.7% of respondents undecided and 6.4% of respondents disagreeing.

Table 4.17: Material-related factors

Material-related factors	N	Strongly disagreed (%)	Disagreed (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Shortage of construction materials	62	0	1.6	16.1	32.3	50.0	4.31	0.80	1
Late delivery of construction materials	62	0	3.2	17.7	32.3	46.8	4.23	0.85	2
Late orders for construction materials	62	1.6	4.8	17.7	37.1	38.7	4.06	0.95	3
Ineffective distribution of materials on site	62	0	3.2	22.6	41.9	32.3	4.03	0.82	4
Non-conformity of materials with specifications causing delay	62	1.6	3.2	24.2	37.1	33.9	3.98	0.93	5
Poor site planning preventing easy movement of materials	62	0	11.3	21.0	37.1	30.6	3.87	0.98	6
Problem of arrangement of construction materials	62	3.2	6.5	21.0	38.7	30.6	3.87	1.03	7
Workers' anticipation of materials shortages leading to slow operation	62	1.6	6.5	29.0	32.3	30.6	3.84	0.99	8
Unsuitability of materials' storage location	62	1.6	12.9	16.1	43.5	25.8	3.79	1.02	9
Wastage of construction materials by workers	62	0	12.9	27.4	32.3	27.4	3.74	1.00	10
Increase in cost of construction materials	62	6.5	4.8	30.6	40.3	17.7	3.58	1.04	11
Difficulties in obtaining materials from store due to excessive paperwork	62	4.8	8.1	35.5	30.6	21.0	3.55	1.06	12

4.6.14 Machinery-related factors

Table 4.12 presents machinery-related factors affecting construction labour efficiency. The perceptions of respondents were again obtained with a five-point scale, whereby 1 = strongly agree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. From the table, Inadequate skill of equipment operators is the most notable factor affecting the performance of labour on construction sites. 85.4% of respondents agreed that this was a contributor to challenges in construction labour efficiency. 8.1% of respondents were undecided on the significance of the factor and 6.5% of respondents disagreed. Damage to tools and machinery during operation and obsolete machinery used in construction operations, with mean values of 4.11 and 4.08 respectively, were identified as significant factors contributing to the shortfall of construction labour performance.

Table 4.18: Machinery-related factors

Factors	N	Strongly disagreed (%)	Disagreed (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Inadequate skill of equipment operators	62	0	6.5	8.1	41.9	43.5	4.23	0.85	1
Damage to tools and machinery during operation	62	1.6	3.2	16.1	40.3	38.7	4.11	0.90	2
Obsolete machinery used in construction operations	62	1.6	4.8	21.0	29.0	43.5	4.08	0.99	3
Insufficient number of machinery available for operations	62	1.6	8.1	12.9	38.7	38.7	4.05	0.99	4
Late arrival of machinery on site	62	1.6	3.2	21.0	40.3	33.9	4.02	0.91	5
Poor working condition of tools and machinery	62	1.6	4.8	17.7	45.2	30.6	3.98	0.91	6
Inadequate maintenance of tools and machinery	62	1.6	3.2	22.6	40.3	32.3	3.98	0.91	7
Complexities involved in operation of machinery	62	0	6.5	22.6	40.3	30.6	3.95	0.89	8

4.6.15 Labour-related factors

Factors associated with construction labourers affecting construction operations are presented in Table 4.19. The opinion of respondents was obtained with a five-point scale, whereby 1 = strongly agree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. From the table, respondents identified absenteeism of construction labourers (Mv=4.10) as the major labour-related factor affecting construction operations on sites. 74.2% of respondents agreed that the factor affected construction activities, 19.4% of respondents were undecided and 6.5% of respondents disagreed that absenteeism of construction labour was a contributor to shortfall in construction operations. The problem of recruitment of skilled labour, lack of discipline among labourers and negligence of construction labourers, with mean values of 4.05, 3.98 and 3.94 respectively, were rated as major contributing factors affecting construction labour efficiency on construction sites.

Table 4.19: Labour-related factors

Factors	N	Strongly disagreed (%)	Disagreed (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Absenteeism of construction labourers	62	0	6.5	19.4	32.3	41.9	4.10	0.93	1
Problem of recruitment of skilled labourers	62	3.2	4.8	16.1	35.5	40.3	4.05	1.03	2
Lack of discipline among labourers	62	1.6	4.8	21.0	38.7	33.9	3.98	0.94	3
Negligence of construction labourers	62	3.2	8.1	16.1	37.1	35.5	3.94	1.06	4
Insufficient wages of construction labourers	62	3.2	4.8	24.2	32.3	35.5	3.92	1.04	5
Delay in payment of construction labourers	62	4.8	9.7	17.7	27.4	40.3	3.89	1.18	6
Communication problems between labourers and superiors	62	1.6	12.9	16.1	37.1	32.3	3.85	1.06	7
Labourer alcoholism	62	6.5	4.8	25.8	22.6	40.3	3.85	1.19	8
Misunderstanding among labourers	62	0	9.7	29.0	37.1	24.2	3.76	0.93	9
Transportation problem for labourers	62	4.8	8.1	24.2	32.3	30.6	3.76	1.12	10
Labourer fatigue	62	0	8.1	30.6	40.3	21.0	3.74	0.88	11
Labourers leaving construction jobs for other employment	62	1.6	9.7	35.5	27.4	25.8	3.66	1.02	12
Old age of construction labourers	62	1.6	16.1	25.8	33.9	22.6	3.60	1.06	13
Overtime work of construction labourers	62	4.8	12.9	25.8	32.3	24.2	3.58	1.13	14
Lack of involvement of labourers in decision-making	62	8.1	17.7	24.2	33.9	16.1	3.32	1.18	15

4.6.16 External factors

Table 4.20 presents external factors affecting construction labour efficiency. Respondents were required to indicate the extent of their agreement to each of the identified factors Using a five-point scale where: 1 = strongly agree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The effects of strikes (Mv=4.39) on construction operations emerged as the highest-rated external factor affecting construction operation. 83.9% of respondents agreed that the factor significantly affected construction operations, 12.9% of respondents were undecided and (3.2% of respondents disagreed that strikes affected construction operations. The effect of high winds (Mv=4.11) and effects of rainfall (4.06) on construction were seen as notable external factors, as indicated by respondents in table 4.20.

Table 4.20: External factors

Factors	N	Strongly disagreed (%)	Disagreed (%)	Neutral (%)	Agree (%)	Strongly agree (%)	Mean value	S.D	Rank
Effect of strikes on construction operations	62	0	3.2	12.9	25.8	58.1	4.39	0.83	1
Effect of high winds on construction	62	0	3.2	21.0	37.1	28.7	4.11	0.85	2
Effects of rainfall on construction	62	0	4.8	17.7	43.5	33.9	4.06	0.84	3
Pilfering on construction sites	62	0	6.5	35.5	30.6	27.4	3.79	0.92	4
Public holidays affect progress of construction works	62	1.6	4.8	32.3	35.5	25.8	3.79	0.94	5
Effect of sub-surface conditions	62	0	12.9	29.0	32.3	25.8	3.71	0.99	6
Change in government policies and regulations	62	1.6	6.5	33.9	38.7	19.4	3.68	0.91	7
Technological interference	62	3.2	8.1	33.9	32.3	22.6	3.63	1.02	8
Political interference	62	3.2	12.9	24.2	37.1	22.6	3.63	1.07	9
Poor nature of construction sites	62	3.2	11.3	29.0	35.5	21.0	3.60	1.04	10
Distance of food shops to construction sites	62	0	17.7	30.6	29.0	22.6	3.56	1.03	11
Increases in cost of construction materials	62	3.2	12.9	30.6	33.9	19.4	3.53	1.05	12
Hot weather conditions	62	1.6	11.3	33.9	40.3	12.9	3.52	0.91	13
Increases in cost of hiring construction machinery	62	4.8	9.7	33.9	35.8	16.1	3.48	1.03	14
Construction legislation effects	62	0	9.7	59.7	14.5	16.1	3.37	0.87	15
Cold weather conditions	62	4.8	16.1	32.3	33.9	12.9	3.34	1.05	16
Sunlight effect on construction operations	62	11.3	24.2	30.6	24.2	9.7	2.97	1.15	17

Considering the objectives of the research, the study identified the significant factors impacting construction labour efficiency as perceived by construction professionals and presented in table 4.21. With reference to the tables presented in the findings (Table 4.5-Table 4.20), the two highest-rated factors in each table were selected, considered as the most significant factors and subsequently ranked accordingly, in Table 4.21.

Table 4.21: Significant factors impacting construction labour efficiency (quantitative study)

S/N	Factors	Mean	S.D	Rank
1	Fall protection is used on site when working from height	4.68	0.64	1
2	Helmets are made compulsory for site visitors	4.68	0.74	2
3	Missing details in architectural working drawings	4.48	0.80	3
4	Communication ability of site managers	4.45	0.64	4
5	Site manager's coordinating skill	4.39	0.75	5
6	Effect of strikes on construction operations	4.39	0.83	6
7	Slow responses of architects to drawing questions	4.34	0.74	7
8	Slow response of structural engineers to drawing questions	4.32	0.80	8
9	Construction skills of supervisors	4.31	0.78	9
10	Shortage of construction materials	4.31	0.80	10
11	Communication between supervisors and construction labourers	4.27	0.77	11
12	Revision and changes order by client	4.27	0.90	12
13	Effective site planning ability	4.26	0.71	13
14	Incomplete pages of structural drawings	4.26	1.07	14
15	Incomplete pages of electrical drawings	4.24	0.95	15
16	Unfair wages of construction workers	4.23	0.81	16
17	Late delivery of construction materials	4.23	0.85	17
18	Inadequate skill of equipment operators	4.23	0.85	18
19	Revision of electrical drawings	4.21	0.89	19
20	Inadequate coordination among members of design team	4.19	0.93	20
21	Delay in payment of construction employees	4.19	0.98	21
22	Construction documents conflicting with construction drawings and specifications	4.18	0.93	22
23	Slow response to mechanical engineering drawing questions	4.15	0.84	23
24	Mechanical engineer specification problems	4.13	0.93	24
25	Effect of high winds on construction	4.11	0.85	25
26	Damage to tools and machinery during operation	4.11	0.90	26
27	Absenteeism of construction labourers	4.10	0.93	27
28	Effect of rainfall on construction	4.06	0.84	28
29	Design approval delay by client	4.05	0.89	29
30	Problem of recruitment of skilled labourers	4.05	1.03	30

4.7 Qualitative interview

The purpose of the interview is to validate the quantitative data obtained from construction professionals. Three construction sites were selected for conducting the interviews, and one general site supervisor and an experienced construction site supervisor were interviewed on each construction site. The interview was semi-structured, and interview questions formed its basis, and were formulated using the results of quantitative data after quantitative data analysis. The interviews were conducted with a recording device and subsequently transcribed. A total of six construction site supervisors were interviewed and given of flexibility to identify any other factors affecting construction labour efficiency that were not in the interview questions posed. A copy of interview questions can be found in Appendix B. The interview section conducted with individual respondents started with the introduction of the researcher to the respondents. The researcher afterwards introduced the research topic to respondents.

Respondent one

The first interview was conducted with a site supervisor on May 13, 2014 at 12h17min in the construction site office during the lunch break. The site supervisor interviewed had twenty-five years of site supervision experience in the construction industry. The interview session lasted for about forty-five minutes, as the interviewee responded to each question after a reading by interviewer from a printed copy. The site supervisor indicated that construction workers on the particular site in question were not allowed under any condition to work from height without using fall protection. The respondent further stated that accidents that occur on site are minor and infrequent. The site supervisor stated that helmets were compulsory for site workers and anyone visiting construction sites. The respondent stated that missing information on drawings were commonplace on construction sites. Sometimes, expected information was missing from drawings, which made workers undertake the incorrect tasks on a particular section of work. This sometimes led to rework and affected construction time and cost of production. The respondent reported that site manager communication had a significant effect on worker performance. The site supervisor further stated that, based on past experience, site managers communicated well on site but quite often there was misinterpretation of messages. The respondent stated that strikes had a significant effect on construction workers' efficiency. The site supervisor reported that a strike had recently occurred. The respondent stated that construction operations were planned according to a work programme because the client wanted the job completed at the agreed-upon time. Although some workers came to the site during strikes, they did not always work efficiently, because of the threat of injury from strikers if they were caught working on sites subject to a strike. The site supervisor confirmed that there levels of production on site were low during strikes. The respondent indicated that site manager coordination on construction sites was good, based on experience, but could be improved. The site supervisor stated that sometimes required information from architects arrived in a timely fashion, while sometimes there were delays. The respondent stated that construction sites sometimes encountered structural calculations that were not on the drawings, and *that structural engineers took a long time to respond, while sometimes responses arrived timeously. The site supervisor stated that architects and structural engineers were always called to provide necessary information, although they were not always available at the expected time. The site supervisor stated that the site supervisor's skill was satisfactory on construction sites. The respondent indicated that there were occurrences of construction materials shortage. On construction sites, construction workers might begin executing a portion of work and then discover the materials were not available in store. Construction managers had to put in an order for materials needed, which took a while to arrive and this sometimes delayed construction workers. The site supervisor added that communication problems like language barriers, and inclement weather conditions, were issues that affected the efficiency of construction workers.*

Respondent two

The second interview was conducted with a site supervisor on May 14, 2014 at 12h05min in the worker's common room during the lunch break. The site supervisor interviewed had sixteen years of site supervision experience in the construction industry. The interview session lasted for about thirty-five minutes, the interviewee responding to each questions after the interviewer read these out from a printed copy. The respondent stated that fall protection was always in use when working on heights of 2m and above. The site supervisor specified that accidents seldom occur on the construction sites and that these were generally minor in nature. Helmets were compulsory for everyone on the construction site. The respondent stated that there was always missing information in the working drawings of architects. Sometimes it was the problem of calculations, sometimes architectural drawings contradicted structural drawings, which led to reviews of drawings. The respondent stated that if the drawing problem was minor; construction workers made immediate decisions to remedy the problems and later contacted the designer. On the other hand, if it was a major issue, construction workers asked the planning department or professional team to provide remedies to prevent further delay. The respondent stressed that major drawing issues encountered on sites always delayed, while minor ones did not really cause delays. Some of the construction managers the respondent had worked with communicated well, while the communication skill of some was insufficient. The respondent noted that this depended on the competence of site managers on a particular project. The site supervisor stated that strikes affect construction workers' efficiency, because labour does the actual work. Strikes effected construction efforts *because they reduced the efficiency of operations and site labourers were always threatened by strikers. During strikes, it became difficult for workers to work, because others moved around sites seeking to beat non-striking construction workers. The respondent stated that the coordination efforts provided by construction site managers were not satisfactory on sites, particularly on the site in question. As for drawing, construction sites get responses within two working days if they had issues with architectural drawings. The despondent stated that this affected the efficiency of construction labour on sites. There were similar problems with structural engineers as there were with architects. The site supervisor noted that the efficient performance of site supervisors depended on their construction experience and educational background. The respondent stated that the construction skill of the site supervisor was fair. Sometimes construction sites did experience shortage of construction materials on site, even though there were Enterprise Resource Planning (ERP) measures in place. Efforts were made to order materials ahead of time, but shortages still occurred and this had a predictable effect on worker performance.*

Respondent three

The third interview was conducted with a site supervisor on May 15, 2014 at 10h05min in the construction site office. The site supervisor interviewed had twelve years of site supervision experience in the construction industry. The interview session lasted for about thirty minutes, with the respondent answering questions after the interviewer read them from a printed copy. The respondents stated that fall protection was always used when working from a height above 2m on construction sites and helmets were compulsory for everyone on construction sites. There were cases of accident recorded on site, but these were is minor and did not really affect construction operations. There was always revision of architectural drawings as a result of things like miscalculation. This mostly happened on the construction sites. Construction workers made the decision to fix less complicated cases, but major issues with drawings were directed to the architect and this sometimes affected the progress of construction work. It was the opinion of the respondent, based upon person experience, that the construction site manager's communication skills were not good enough and needed to be improved. Worker strikes caused delay and affected production cost, because they operate with a programme of work. When strikes occurred, it was difficult for the workers to be on site as workers were chased away from the site by the strikers. This affected the efficiency of *labour on site. The respondent believed that site manager coordination was important to achieve good production standards, and was of the opinion that the site manager's coordination skills were average for the industry. The response time of architects depended on the nature of problem encountered on architectural drawings. Minor issue took less time and major issue took more. Generally, this affected the progress of work. Structural engineers responded to structural questions faster than was the case with architects. Based on personal experience, the respondent felt that the majority of site supervisors had adequate construction skills but that there were other factors that affected labour efficiency, like factors that were beyond the control of site supervisors. The respondent stated that construction sites experienced shortage of construction materials, but not on a regular basis. This affected the efficiency of construction labour on site, because sometimes a portion of work had to stop for some time.*

Respondent four

The fourth interview was conducted with a site supervisor on May 15, 2014 at 12h23min in the construction site office. The site supervisor interviewed had ten years of site supervision experience in the construction industry. The interview session lasted for about thirty-five minutes. The interviewee responded to questions read from a printed copy by the researcher. The respondent affirmed that the usage of fall protection could not be compromised on construction sites when working from a height of 2.5m or higher. The site supervisor stated that everyone was expected to wear helmets on site, regardless of their position. Missing information in architectural drawings was perceived to occur quite often on construction sites. Construction workers did not always have detailed architectural drawings at the time of starting the work; they mostly worked with sketches, and therefore could lose hours, days and sometimes weeks if there were complicated issues with the sketches. The respondent stated that sometimes dimensions on plans could be unclear. The site manager's communication skill needed improvement because it was important to project performance on sites. The site supervisor expressed the opinion that the communication skills of site manager were not good enough on construction sites. The respondent posited that worker strikes affected construction workers, regardless of their level of participation in such strikers, because, if some workers did not work, it affected the morale of other workers, who would sometimes perform below expectations. The site supervisor stated that the coordinating skill of the site manager was mostly fair, but sometimes unsatisfactory. The response of architects *depended on the individual consultant/architect. It could take hours, days or weeks. It also depended on what kinds of details were needed. Occasionally, research needed to be done to be able to provide the details required. The response of the structural engineer was similar to that of the architect. The skill of the construction site supervisor was sometimes poor, and this affected the output of labourers. The respondent indicated that sometimes there were shortages of construction materials on sites, but that this was an infrequent occurrence.*

Respondent five

The fifth interview was conducted with a site supervisor on May 16, 2014 at 11h15min in the construction site office. The site supervisor interviewed had twenty-eight years of site supervision experience in the construction industry. The interview session lasted for about thirty minutes while the interviewee responded to the questions read from a printed copy. The supervisor noted that fall protection was always used on construction sites when working from a height. The respondent further expressed that everyone had to wear helmets on construction sites. Occasionally, accidents happened on construction sites, but these were minor and happened only about once a month. The respondent stated that missing details in architectural drawings occurred quite often. Some drawings might work on paper and the same drawing might not work in reality. Workers consulted with the architects on problems related to architectural drawings, and sometimes waited for days before receiving a response. The respondent claimed that sometimes architects took about a week to answer drawing questions, and that this was also true with regard to structural engineers. Before response from designers, the respondent claimed that construction labourers are directed to be involved in other construction activities. The site supervisor further expressed that designer's late response to drawing questions still affect construction productions but to a small extent. The site supervisor stated that the communication ability of construction site managers on construction sites had not been encouraging, while the occurrence of strikes in the construction industry affected the efficiency of construction labour. Based on the respondent's personal experience, the site manager's coordinating skill needed to be improved on this construction project.. The respondent stated that the site supervisor's construction skills were good, but could be improved upon. The respondent stated that the construction firm ordered materials ahead of time and never experienced shortages of construction materials on construction sites.

Respondent six

The sixth interview was conducted with a site supervisor on May 16, 2014 at 12h22min in the construction site office, during the lunch break. The site supervisor interviewed had eight years of site supervision experience in the construction industry. The interview session lasted for about thirty-five minutes, as the interviewee responded to each question after a reading by the interviewer from a printed copy. The site supervisor stated that the use of fall protection was not optional when working from a height. Helmets had to be used by visitors and workers as long as they were on site. The respondent stated that the occurrence of accidents was rare, occurring roughly every six months, and generally only involving minor injuries that did not require an ambulance for the victim. The respondent stated that most of the time, architectural drawings did not work in reality. Construction workers had to stop work in these cases until proper information was obtained. Sometimes it took weeks to be resolved and generally affected progress of work, though labourers would always busy themselves with other construction-related activities on site. The site supervisor stated that the construction site manager communicated effectively on sites, but sometimes the message was not understood by the recipient. The site managers on this site tried his best to coordinate well, but needed to upgrade his skills. The site supervisor noted that strikes affected construction labour efficiency to a small extent, and that the architect sometimes took two or three days before responding to drawing questions, while structural engineers took less time to respond. Many site supervisors had labour skills; construction skill of supervisors was satisfactory, as it was company practice to attend skill development programmes once a year. The respondent highlighted that sometime there were materials shortages due to late delivery of construction materials. This was generally experienced twice a month. The site supervisor confirmed that materials shortages had a negative effect on labour performance. The respondent added that labour absenteeism and faulty equipment also slowed down construction operations.

Table 4.22: Summary of qualitative interview

Factors	Respondent one	Respondent two	Respondent three	Respondent four	Respondent five	Respondent six	Summary
Fall protection	Always used on sites	Always used on sites	Always used on sites	Always used on sites	Always used on sites	Always used on sites	Good safety culture
Helmet usage	Used on sites	Compulsorily used	Compulsorily used	Compulsorily used	Used on sites	Used on sites	Always used
Architectural missing information	Always occur on sites	Always occur on sites	Miscalculation of drawings	Often occur on sites	Always occur on site s	Drawings on paper may not work in reality	Prevalent missing architectural details
Site manager communication	Communicates well but misinterpreted	Depends on individual	Communication is not good enough	Demands improvement	Poor communication	Good communication	Communication barrier
Effect of worker strike	Significantly affects	Significantly affects	Affects production cost	Significantly affects	Significantly affects	Significantly affects	Strike affects construction progress
Site manager coordination	Good coordination	Not satisfactory	Coordination average	Mostly fair and sometimes unsatisfactory	Demands improvement	Coordination demands improvement	Coordination inadequate
Architect response to drawing questions	May be delayed or fast	Responds within two days	Response depends on problem	Response depends on details missing	Response is delayed	Response is delayed	Response may depend on missing information
Structural engineer response to drawing questions	Long time to respond	Responds within two days	Response is fast enough	Response depends on details missing	Response is delayed	Response is faster	Response may depend on missing information
Construction skills of site supervisors	Adequate	Construction skill is fair	The majority have good skills	Some have poor skills	Demands improvement	Skill is satisfactory	Good construction skills
Materials shortage	Often occur on sites	Sometimes occur on sites	Occur but not on regular basis	Occur but not on regular basis	No shortage of materials	Mostly occur on sites	Significant occurrences of material shortage
Other factors	Language barrier and inclement weather	None	None	None	None	Labour absenteeism and faulty equipment	Language barrier, weather conditions, labour absenteeism and faulty equipments

4.8 Discussion of findings

4.8.1 Construction-related factors

One of the objectives of this study is to evaluate the impact of construction-related factors on construction workers' efficiency, as earlier stated. In this section, the study considers worker efficiency factors that are related to contractors, site supervisors and site managers. Construction workers' motivational factors, occupational health and safety culture are also explored under construction-related factors.

4.8.1.1 Contractor-related factors

The study reveals effective site planning ability of construction contractors as being a notable concern with regard the efficiency of construction labour (Table 4.5). The capability and effectiveness of the contractor when planning construction operations will unarguably facilitate construction operations and prevent unnecessary delay of construction activities during production processes on construction sites. Harris and McCaffer (2001:74) posit that, a well-planned, effectively monitored and adequately controlled project ensures construction delivery efficiency and determines contractor's profit. Assaf and Al-Hejji (2006:351) further support the notion that lack of effective contractor planning and scheduling are contributory factors to delays in construction projects. As presented in Table 4.5, the experience of the contractor is a significant factor, having the same mean value (4.26) as the site planning ability of contractors. Site planning ability, however, is considered more significant, because response tends to be more concentrated on site planning ability (S.D=0.71) than contractor construction experience (S.D=0.81). In an effort to prevent poor project performance, Wong (2004:69) contends that the contractor selection process should identify incapable contractors at an early stage and disqualify incompetent contractors in order to ensure that only qualified contractors tender for construction projects. Also, inadequate coordination of the workforce is indicated as a significant factor contributing to poor performance of the construction workforce (Table 4.5). Rework due to construction error is also identified as a factor affecting construction labour efficiency. The review of literature reveals that inability of contractors to effectively utilise human resources in construction may result in delays and loss of construction productivity (Haseeb, *et al.,* 2011:42). Further, Table 4.5 indicates the relationship of contractors with sub-contractors as a challenge to the efficiency of construction workforce. Egbu *et al.,* 2004 posit that the contractor's efforts to improve worker efficiency should be supported by sub-contractors' management personnel.

4.8.1.2 Site supervisor-related factors

The construction skill of site supervisors is considered a paramount tool for improving the efficiency of construction labour (Table 4.6). The study undertaken by Olomolaiye *et al*. (1987), Kaming *et al.* (1997), Jarkas and Bitar (2012) found supervision delays to significantly contribute to construction labour efficiency challenges. Serpell and Ferrada (2007:592); Uwakweh, 2005: (1322) report that construction site supervisors are the link between managers and construction labour, and adequate levels of skill (construction and supervisory) are required by construction site supervisors. Communication between supervisors and construction labour is a significant factor in improving the efficiency of labour in the South African construction sector (Table 4.6). Despite the relevance of effective communication on construction sites, Serpell and Ferrada (2007:588) posit that communication management on construction sites is significantly poor. Conversely, Kines *et al.* (2010:404) contend that there is regular communication between site supervisors and construction labour, but there is a need to improve on the effectiveness of the message. Kine *et al.* (2010:404) further stress that inadequate instructions from supervisors to labour constitute one of the major challenges to construction workers' efficiency. Findings reveal that there is a need to involve competent supervisors in construction process (Table 4.6 & 4.22), since construction site supervisors are the most noticeable people on sites and direct the execution of basic construction operations, as indicated in the literature. Poor coordination of workers by supervisors, as indicated in Table 4.6, is an important factor affecting the efficiency of construction labour. Improved coordination of construction labour can be attained by providing site supervisors with adequate construction and managerial skills in supervisory work and also augmenting the skills of the available supervisors. Difficulty in the recruitment of skilled construction supervisors has a considerable impact on the efficiency of construction operations (Lim & Alum, 1995; Enshassi *et al*., 2009). Construction site supervisor absenteeism is identified by Lim and Alum (1995); Kaming *et al.* (1997), and Makulsawatudom, *et al.* (2004) as a contributory factor to poor labour efficiency in the construction industry. This study, however found that this factor was regarded as one of the least significant site supervisor-related factors affecting the performance of construction labour.

4.8.1.3 Site manager-related factors

Findings reveal the communication ability of site managers to be an important factor in the efficiency of construction labour (Table 4.7 & 4.22). Turner and Muller (2004:335) note that communication contributes to trust building on construction projects and ineffective communication can result in breakdown in trust. The ability of site managers to communicate project objectives to project teams is significant to the performance of construction projects. Also, coordination of construction teams by site managers, as indicated in Table 4.7, is important to efficient labour performance (Table 4.22). Fraser (2000:35) suggests that construction organisations should consider training and professional development of site managers for performance improvement. Further, the planning ability of site managers was found to be an essential factor for improving the efficiency of construction workers (Table 4.7).

Adequate planning and co-ordination ensures proper organisation of construction resources and overall efficiency of construction operations (Egbu *et al.,* 2004:19). Significantly, the level of education of site managers was found to be a challenge to the discharging of site manager responsibilities on construction sites (Table 4.7). Kazaz *et al.* (2008:101) note that the proper qualifications of construction managers are essential to construction workers' performance, while Fapohunda and Stephenson (2010:363) identify the need for training and personal development of construction managers, especially on new technology for improved utilisation of construction resources. The decisions of site managers on construction projects are found to be of considerable importance to the efficiency of construction labour (Table 4.7). Olander (2007:277) claims that a significant challenge confronting site managers is the difficulty of ascertaining the needs of construction project stakeholders, comparing these needs with the project objectives and deciding on the best decisions to adopt.

4.8.1.4 Workers' motivational drivers/health and safety-related factors

The majority of the most critical construction workers' motivational drivers; (unfair wages of construction workers, delay in payment of construction workers, inadequate financial motivation) are financial in nature (Table 4.8). Olabosipo *et al.* (2011:255) note that money is mostly recognised as a good motivational drive. However Parkin (2009:109) recognises the necessity to consider the financial strength of an organisation in determining the right motivational approach. While the quality of worker performance significantly depends on motivation (Kazaz *et al.,* 2008:96), construction organisations may not be able to offer higher wages as motivation, due to financial constraints. Construction managers therefore need to identify the needs of their workforce, and accordingly combine financial and non-financial motivational strategies. The study undertaken by Soham and Rajiv (2013) identifies the late payment of construction workers as a factor affecting construction productivity. Olabosipo *et al.* (2011), argue that the performance of construction workforce is significantly dependent on training and workers' motivation. Parkin *et al.* (2009:109) argue that as soon as a need has been satisfied, that same need ceases to play an effective role in motivating the particular worker. Therefore, construction organisations need to continuously evaluate the workers' needs to provide effective motivation.

Findings reveal that fall protection is used on sites when working from height (Mv=4.68), helmets are made compulsory for site visitors (Mv=4.68), edge protection is always in place on decks (Mv=4.66), every worker on site wears a helmet (Mv=4.66), and health and safety induction is compulsory for site visitors (Mv=4.60). As can be seen from the findings, Western Cape and Gauteng construction sites have a significant health and safety culture in place and this culture is put into practice on construction sites (Table 4.9 & 4.22). Nevertheless, the construction sector should strive towards improving the safety culture on construction projects.

4.8.2 Design-related factors reducing the efficiency of construction labour

The study explores the perceptions of construction professionals concerning design-related factors affecting construction labour efficiency in the South African construction industry. Members of the design team considered for the purpose of the study are; the architects, design engineers, clients, quantity surveyors and other design-related agents. Several studies acknowledge the adverse impacts of client/design professionals on construction project performance. Zakeri *et al*. (1996); Makulsawatudom *et al*. (2004); Enshassi *et al.* (2007); Dai *et al.* (2009); Ameh and Osegbo (2011); Jarkas and Bitar (2012); Soham and Rajiv (2013) report late response of design professionals to drawing questions and production information inadequacies (clarity, complexity and drawing errors) as design challenges on construction projects.

4.8.2.1 Architect-related factors

Findings reveal missing details in architectural working drawings as the most significant architect-related factor affecting the efficiency of construction workers (Table 4.10 & 4.22). Missing details in architectural drawings may result from lack of adequate review of architectural drawings before the construction process is initiated. Campbell (2000:130) reports that, prior to approval of an architect's design for physical development, numerous sets of drawings are generated and distributed for review, whereupon comments are made and the drawings are thoroughly revised. However, considering the nature of construction projects, missing information in architectural drawing may not be completely prevented by this process, but can be limited to an acceptable minimum. An important responsibility of clients is to effectively communicate the design intention to the architect (Cambell, 2000:129). It can be inferred from the finding that missing details in architectural working drawings frequently occur in the South African construction industry and that this significantly affects the efficiency of construction labour. Slow response of architects to drawing questions is also a notable challenge of construction workers' efficiency in the South African construction industry. Late response of architects to drawing questions may occur as a result of questions that architects are not able to answer without consulting with clients or other members of the design team. Arguably, this may lower the efficiency of construction workers, especially if the section of work is on the critical path. Non-clarity of architectural drawings, revisions and changed orders by clients are rated as third and fourth in perceived importance among architect-related factors affecting the efficiency of construction labour. Non-clarity of architectural drawings may result from inadequate review of construction drawings. Revision and changed orders may result from clients' instruction, since the architect is generally the primary client representative on construction sites (Oyedele and Tham, 2006:2090).

4.8.2.2 Engineer-related factors

Among construction design engineers, structural engineers contribute more to poor efficiency of construction labour than electrical and mechanical engineers. Slow responses of structural engineers to drawing questions (Table 4.11 & 4.22) have a significant effect on the efficiency of construction workers. Rivas *et al.* (2011:316) support this, by claiming that waiting for design interpretation and engineer information may cause delays in the activities of construction labourers. The response time of design engineers may be determined by the nature of the design question that needs clarification. Minor issues may be resolved at quickly, while major issues may need necessary consultations before any clarification can be made. Gao *et al.* (2006:89) claim that engineering drawing information may be complex to interpret therefore valuable time is spent on drawings by the end-users. Incomplete structural drawings and lack of structural drawings are identified as engineer-related factors that disrupt the efficiency of construction workers (Table 4.11). Gao *et al.* (2011:1120) suggested the adoption of colour drawings to facilitate communication of the content engineering drawings to construction labourers. Incomplete electrical drawings and non-clarity of structural drawings (Mv=4.24) are seen as possessing the same level of adverse impact on construction labour performance.

4.8.2.3 Client-related factors

Revision and changes ordered by clients is ranked as the primary client-related factor affecting construction labour efficiency (Table 4.14). The factor has a mean value of 4.27, while 98.3% of respondents indicated revision and changes ordered by clients as a factor detrimental to the efficiency of South African construction industry. This revision or change might occur as a result of newly-emerging ideas conceived by the client for the project to fulfil desired functional requirements. Commonly, change ordered by clients to his professionals will arguably have an effect on the duration of construction activities, especially major changes. Delay in approval of drawings is rated as the second-most important client-attributed factor affecting the efficiency of construction labour. Contractors mostly commence construction activities with skeletal drawings, while the designers work on detailed drawings to the satisfaction of the client. Late approval of detailed working drawings may affect the ability of the construction workforce to complete construction activities as planned. Donyavi and Flanagan (2009:58) note delays in clients approval of drawings as a result of technical definitions involved as a factor affecting construction labour efficiency.

4.8.2.4 Quantity surveyor-related factors

The impact of quantity surveyor-related factors on construction labour efficiency is comparatively low. The most significant quantity surveyor-related factors affecting the efficiency of construction labour are missing details in quantity surveyor specifications (Mv=3.89). Inadequate measurement ability of quantity surveyors for the required work (Table 4.15) is ranked as the second-most influential quantity surveyor-related factor affecting the efficiency of human assets in the construction industry (Mv=35.5). Errors or omissions in the bill of quantities emerge as the third ranked factor affecting the performance of construction workers (Mv=3.76). This may result from inadequate time for preparation of the bill of quantities for the required work.

4.8.2.5 Other design-related factors

The perception of respondents was obtained on other design-related factors that may be related to any of the members of the design team. Among the factors identified, inadequate co-ordination among members of the design team is a notable and first-ranked factor affecting the efficiency of construction labour (Mv=4.19). Contract drawings conflicting with construction drawings and buildability problems are also identified factors with significant impacts on the performance of construction workers (Mv=4.18 and Mv=4.02 respectively). Oyedele and Tham (2006:2091) posit that lack of significant consideration for design constructability may cause delays in construction process, building collapse during the construction process, cost overruns and extension of project duration.

4.8.3 Impact of construction resources on construction labour efficiency

4.8.3.1 Material-related factors

Materials unarguably constitute an important resource in the construction sector that attracts a significant share of project cost. Exploring the impact of material-related factors affecting construction labour performance in Gauteng and Western Cape provinces, shortage of construction materials is identified as the most important factor to consider in relation to construction labour efficiency (Table 4.17 & 4.22). Donyavi and Flanagan (2009:1) note the availability of construction materials at the right time and at the right place as an important factor to project success. A study undertaken by Zakeri *et al.* (1996) found that shortage of construction materials on construction sites was the most significant factor affecting construction labour productivity on construction projects. Unavailability and shortage of construction materials is also advanced by Olomolaiye *et al.* (1987:321); Kaming *et al.* (1997:26); Makulsawatudom *et al.* (2004:3); Enshassi *et al.* (2007:252); Dai *et al.* (2009:221); Ameh & Osegbo (2011:620) as significant factors contributing to the shortfall of construction labour efficiency. Late delivery of construction materials to construction sites is ranked as the second highest material-related factor affecting construction labour efficiency in Gauteng and the Western Cape Province (Table 4.17). Late delivery of construction materials could be attributed to the need to argument the present planning for construction materials. Rivas *et al.* (2011:316) claim that late delivery of construction materials is one of the principal challenges to the efficiency of construction labour. Cooke and William (2009: 401) acknowledge the need to establish good communication practices between suppliers of construction materials and construction site managers. An open and frequent communication between materials suppliers, procurement officers and site managers could help to alleviate late orders for construction materials, as indicated in Table 4.17.

4.8.3.2 Machinery-related factors

The most significant machinery-related factor affecting the efficiency of construction operations is inadequate skill of operators, which leads to slow operation (Table 4.18). 85.4% of survey respondents agreed that construction equipment operator skills are generally inadequate and, as such, affect the operation of construction activities. Bernold (2007:889) argues that the present day construction equipment operators require different competencies and skills, because, while construction equipment in the last century often required the use of physical power, modern-day equipment requires primarily mental skills. Survey respondents indicated damage to tools and machinery during operation as a significant factor affecting the efficiency of the construction process (Table 4.18 & 4.22). Cabahug and Edward (2002:22) note that inadequate utilisation of construction machinery leads to incipient breakdown of construction equipment and consequently results in declination of productivity, irrespective of the level of in-house maintenance. Skill of construction equipment operators cannot be disconnected from machinery-related factors affecting construction efficiency (Table 4.18). Also, a significant series of research projects identify tools and equipment-related factors as notable challenges to construction project performance (Dai *et al*., 2009; Rivas *et al.,* 2001; Ameh & Osegbo, 2011; Makulsawatudom *et al*., 2004). These necessitate consistent operational training for construction operatives to prevent the negative impact of delays on construction projects.

4.8.3.3 Labour-related factors

The findings reveal absenteeism of construction labourers (Table 4.19 & 4.22), the problem of skilled labourers (Mv=4.05), lack of discipline among workers (Mv=3.98), negligence of construction labourers (Mv=3.94) and insufficient wages of construction labour (Mv=3.92) as the top five labour-related factors affecting the efficiency of construction labour. Deficiency of skills on the part of construction labour could result in construction rework, reduce pace of work and affects general construction performance (Ameh & Osegbo 2011; Soham & Rajiv 2013; Durdyev *et al.,* 2012). Employee training could be helpful to improve the skill of construction labour.

However, Olabosipo *et al.* (2011:256) argue that the project-based nature of construction is a significant factor that affects training of construction labourers. Contractors feel unmotivated to invest in training workers that are not engaged on long-term employment. Neitzel *et al.* (2007:121) argue that training facilities may be basic, but are not generally available and difficult to implement, due to high construction labour turnover. Findings indicate language barriers among construction employees as one of the factors challenging the efficiency of construction labour (Table 4.22).

4.8.4 External factors affecting the efficiency of human assets in the construction industry

4.8.4.1 External factors

The external factors affecting construction workers' efficiency are the factors that are not attributed to individual participants in the construction sector. Measures are required to be put in place to reduce the effect of external factors affecting the efficiency of construction labour. The most notable external factor affecting construction labour efficiency is the effect of strike on construction operations (Table 4.20 & 4.22). Effect of wind on construction (Mv=4.11) and effect of rainfall on construction (Mv=4.06) are the next two highest-rated factors affecting the performance of construction employee (Table 4.20). Enshassi *et al.* (2007:251) point out that inclement weather such as winds and rain reduces the output of the construction workforce. Srinavin and Mohamed (2003:340) report that the quality of workmanship of construction workers declines at high and low temperatures. Soham and Rajiv (2013) identify high and low temperature, rain and high wind as significant factors, while Olabosipo *et al.* (2011) posit weather and site conditions as external factors affecting construction workers' performance. The literature consulted failed to take cognisance of worker strikes on construction operations, but this was covered in this study as having a major effect on the efficiency of workers in the South African construction sector (Table 4.20).

4.9 Significant factors impacting construction labour efficiency

Tables 4.21 & 4.22 present the outcomes of the quantitative and qualitative studies. The tables indicate significant factors impacting construction labour efficiency in Gauteng and the Western Cape Province. The tables present the perception of construction professionals and experienced construction site supervisors. Examination of the tables presented in the findings (Table 4.5-Table 4.20), reveals that the two highest rated factors in each table were selected, grouped under the significant factors and subsequently ranked accordingly to make Table 4.21, as earlier noted. From Tables 4.21 & 4.22, it is apparent that fall protection and helmets are mostly used on construction sites and this depicts a positive impact on the efficiency of construction workers in the Western Cape and Gauteng construction sites. Missing information in architectural working drawings and slow responses of architects and engineers to drawing questions are among the factors with significant impact on the efficiency of construction workers (Table 4.21 & 4.22). Communication ability of site managers and site managers' coordinating skills are notable site manager-related factors impinging on the efficiency of construction labour. An external factor identified to be critical to the efficiency of construction labour is the effect of strikes on construction operations, with a mean value of 4.39. Construction skills of site supervisors (Mv=4.31) and shortage of construction materials (Mv=4.31) are among the factors of concern to improve the efficiency of labour in Western Cape and Gauteng provinces (Table 4.21 & 4.22).

4.10 Chapter summary

The chapter presents analysis of data, presentation of findings and discussion of results. SPSS software (version 22) was used to analyse the data obtained. Descriptive statistics was used in the study. Analysed data was subsequently ranked in the order of importance to construction labour efficiency. Findings reveal that South African construction sites enforce occupational health and safety on construction workers and visitors. The findings indicate a good safety culture on construction sites in Gauteng and Western Cape provinces. Site manager-related factors are found as essential inputs for good performance of construction labour. Findings reveal that communication ability of site managers, site managers' coordinating skill, and planning ability of site managers cannot be underestimated if one is to ensure better efficiency of construction labour. The impact of inadequacies in designer production information (especially architects and structural engineers) urges intervention, as the efficiency of construction workers cannot be disconnected from missing details in architectural working drawings, slow responses of architect to drawing questions and slow responses of structural engineers to drawing questions, as found in the study. Almost all the respondents agreed about the severity of the effect of these factors on the efficiency of construction labour. Additionally, the effect of strikes on construction operations, construction skills of supervisors and shortages of construction materials were factors found to be significant to the efficiency of construction labour.

CHAPTER FIVE

CONCLUSIONS, LIMITATIONS, RECOMMENDATIONS FOR FURTHER RESEARCH

5.1 Introduction

The chapter revisits the aim and objectives of the study, presents the conclusions of the study, highlights the limitations involved in the study and afterwards presents the study recommendations and areas for further research towards improving the efficiency of construction labour in the South African construction industry.

As stated in Chapters One, Three and Four, the aim of this study is to develop a framework to improve construction workers' efficiency during the building production process in the South African construction industry. The objectives chosen in the interests of achieving this aim include:

- To identify construction-related factors affecting construction workers' efficiency
- To ascertain design-related factors reducing the efficiency of construction labour
- To identify the impact of construction resources on construction labour efficiency
- To ascertain the external factors affecting the efficiency of human assets in the construction industry
- To develop a framework for improving the efficiency of the South African construction workforce

Considering each of the objectives to the study, and with the aid of quantitative questionnaires administered to construction professionals, as well as qualitative interviews conducted with construction site supervisors, the predominant factors found to be affecting the efficiency of construction workers on Gauteng and Western Cape construction sites are identified in Table 5.1.

Table 5.1: Framework towards improving the efficiency of construction labour

CONCEPTS	ISSUES ADDRESSED	FINDINGS
A) Construction-related factors affecting construction workers' efficiency	Issue 1: Contractor-related factors	• Effective site planning ability • Contractor's construction experience • Inadequate co-ordination ability of workforce • Rework due to construction error • Relationship with sub-contractors
	Issue 2: Site supervisor-related factors	• Construction skills of site supervisors • Communication between supervisors and construction labourers • Inadequate instructions from supervisors to labourers • Recruitment of competent supervisors • Poor co-ordination of workers by supervisors
	Issue 3: Site manager-related factors	• Communication ability of site managers • Site manager's co-ordinating skills • Planning ability of site managers • Level of education of site managers • Decision of site managers
	Issue 4: Workers' motivational factors	• Unfair wages of construction workers • Delay in payment of construction employees • Inadequate financial motivation • Poor relationship of labourers with superiors • Excessive overtime work
	Issue 5: Construction occupational health and safety	• Fall protection is used on construction sites when working from height • Helmet is made compulsory for site visitors • Edge protection is always in place on deck • Every worker on site wear helmet • Health and safety induction is compulsory for site visitors
B) Design-related factors reducing the efficiency of construction labour	Issue1: Architect-related factors	• Missing details in architectural working drawings • Slow response of architect to drawing questions • Non-clarity of architectural drawings • Revision and changes order by architect • Architect late issuance of instructions

CONCEPTS	ISSUES ADDRESSED	FINDINGS
	Issue 2: Structural engineer-related factors	• Slow response of structural engineers to drawing questions • Incomplete pages of structural drawings • Non-clarity of structural drawings • Missing details in structural drawings • Non-clarity of structural specifications
	Issue 3: Electrical engineer-related factors	• Incomplete pages of electrical drawings • Revision of electrical drawings • Slow response of electrical engineers to drawing questions • Inadequate electrical design information • Lack of clarity in electrical drawings
	Issue 4: Mechanical engineer-related factors	• Slow response of mechanical engineers to drawing questions • Mechanical engineer specification problems • Lack of clarity in mechanical engineering drawings • Inadequate detailing of mechanical engineering drawings
	Issue 5: Client-related factors	• Revisions and changes ordered by clients • Design approval delay by clients • Misunderstanding between clients and project parties • Poor payment by clients resulting in poor construction designs • Delay of progress payment after interim valuation
	Issue 6: Quantity surveyor-related factors	• Missing details in quantity surveyor's specifications • Inadequate measurement ability of quantity surveyor for the required work • Error or omission in the bill of quantities
	Issue 7: Other design-related factors	• Inadequate co-ordination among members of design team • Contract documents conflicting with construction drawings and specifications • Buildability problems

CONCEPTS	ISSUES ADDRESSED	FINDINGS
C) Impact of construction resources on construction labour efficiency	Issue 1: Material-related factors	• Shortage of construction materials • Late delivery of construction materials • Late order for construction materials • Ineffective distribution of materials on site • Non-conformity of materials with specifications, causing delay
	Issue 2: Machinery-related factors	• Inadequate skills of equipment operators • Damage to tools and machinery during operations • Obsolete machinery used in construction operations • Insufficient amounts of machinery available for operations
	Issue 3: Labour-related factors	• Absenteeism of construction labour • Problems in recruitment of skilled labour • Lack of discipline among labourers • Negligence of construction labourers
D) External factors affecting the efficiency of construction labour	Issue: External condition-related factors	• Effect of strike on construction operations • Effect of high wind on construction • Effect of rainfall on construction

Table 5.2 presents the findings of this study with reference to the significant factors/approaches essential to be considered in fostering a system of augmenting the efficiency of construction workers on Gauteng and Western Cape construction sites.

Table 5.2: APPROACHES TOWARDS CONSTRUCTION EMPLOYEE EFFICIENCY IMPROVEMENT

S/n	CONSIDERED APPROACHES
1	Contractors' or builders' involvement in the review of construction drawings
2	Engaging competent designers with experience in the building design process
3	Active involvement of client or client representatives in the construction design process
4	Effective communication practice among construction design professionals
5	Periodical managerial training of site managers (to include effective communication skills on site)
6	Good working relationship between contractor team and sub-contractors
7	Sufficient formal education of construction site managers
8	Effective record keeping and adequate management of construction resources on site
9	Good working relationship between construction site managers and site supervisors
10	Proactivity of site supervisors and site managers to prevent future delay
11	Enabling good working environment for construction employees
12	Appropriate motivation of construction employees
13	Engaging competent contractors on construction projects
14	Effective communication between site supervisors and construction labourers
15	Avoidance of excessive overtime work for construction labourers
16	Early response of designers to drawing-related questions
17	Good working relationship between client/client representatives and project team
18	Effective skills-development training for equipment operators
19	Early orders for construction materials and machinery
20	Adequate assessment of buildability concepts of design
21	Early payment of construction employees
22	Effective regular training of construction site supervisors

5.2 Conclusions

5.2.1 Construction-related factors affecting construction workers' efficiency

One of the objectives designed to achieve the purpose of the study is the evaluation of the impact of construction-related factors on the efficiency of the construction workforce. This objective was achieved through the review of literatures, exploratory study, administration of survey questionnaires to construction professionals and semi-structured interviews with site supervisors. All the identified factors attract more than 50% agreement rate from respondents, except for the last motivational factor, which is reputation of firm with a 40.3% agreement rate. Therefore, it could be safely concluded that the majority of the identified construction-related factors significantly affect the efficiency of construction labour on sites.

Nonetheless, the most influential factors affecting construction labour efficiency on this subject are essential to be noted, if improvement of construction labour efficiency is to be achieved. Findings reveal that construction sites within Western Cape and Gauteng provinces inculcate safety discipline on construction sites. It is found that the communication ability of site managers, site managers' coordination skills, construction skills of site supervisors and communication between supervisors and construction labourers on construction sites are essential factors to improve the efficiency of construction labour.

5.2.2 Design-related factors reducing the efficiency of construction labour

The second objective of the study is to identify the factors that are related to construction designer production of information and other design-related factors affecting the efficiency of construction labour. Among the members of design teams identified in this study, architect production of information demands great concern in respect to the efficiency of construction labour in the Gauteng and Western Cape provinces. Findings reveals that there are frequently missing details in architectural working drawings and this has a significant adverse impact on the output of construction workers. Quite often, architects respond slowly to drawing questions on sites. The response sometimes take hours or days and this has a significant effect on construction labour efficiency, as indicated by construction professionals and site supervisors. The response of structural engineers to drawings questions also is a source of some concern if improved efficiency of construction labour is to be ensured. Quantity surveyors were perceived as the least likely to contribute to designer-related challenges to the efficiency of construction workers in Gauteng and Western Cape Provinces.

5.2.3 Impacts of construction resources on construction labour efficiency

The assessment of the impact of construction materials, machinery and workers is one of the objectives of this study. This objective is achieved through the review of literature, the exploratory study, the administration of survey questionnaires to construction professionals and the semi-structured interviews with site supervisors. Shortage of construction materials and late delivery of construction materials are among the most significant construction resource-related factors affecting the efficiency of construction labour in Gauteng and Western Cape provinces. These factors adversely impact the efficiency of construction labour, as reported by site supervisors and construction professionals. The skill of operators on construction equipment was found to be inadequate, and to slow down the pace of construction and affect the performance of construction workers, by causing delays in the availability of equipment. Damage to tools and equipment during operation was also found to have a negative impact on the performance of construction workers. Site supervisors stated that repair work on damaged equipment can take some time, and therefore equipment can be out of commission for extended time periods.

5.2.4 External factors affecting the efficiency of human assets in the construction industry

The external factors affecting the efficiency of construction labour may be impossible for construction managers to control. These factors may be attributed to acts of God, force majeure, government or technological factors, subject to minimal or no control. The effect of strikes on construction operations is regarded as a significant factor reducing the efficiency of construction labour. During strikes, workers refuse to come to work and those who do work operate under conditions of fear and intimidation, which predictably affects their efficiency. The effect of high winds and rainfall during construction operations significantly affects construction labour efficiency in Gauteng and Western Cape provinces.

5.3 Limitations

The study was conducted in the Western Cape and Gauteng provinces of South Africa. Collection of data from professionals on construction sites was a challenging task. Construction is a time consuming endeavour and as a result, the professionals selected for the study were busy individuals on active building sites. The majority of the professionals consulted complained about busy schedules and how client expectations of punctual job delivery. Some professionals on construction sites complained of not having the time to answer any questions, and such refusals to assist with this project tended to produce similar responses from their colleagues working in the same office. Due to the time constraints on some professionals, a number of questionnaires were incompletely filled out and therefore had to be discarded by the researcher. Moreover, the findings of the study applicable to construction operations in Western Cape and Gauteng provinces and cannot be generalized.

5.4 Recommendations

The success of construction projects significantly hinges on the efficiency of construction site managers and individual site supervisors. Fraser (2000:35) suggested that construction organisations should consider training and professional development for performance improvement. Work experience of construction managers and site supervisors is insufficient to ensure successful delivery of construction projects. The ability of site managers and site supervisors to effectively communicate project objectives to project teams and effectively coordinate construction labour is affected by variables other than working experience in the construction industry. Construction site managers and site supervisors are required to integrate practical knowledge acquired in the industry and management skills to effectively communicate project objectives to project teams. Irrespective of the working experience of site mangers and site supervisors in the construction industry, management training that includes communication, skills development and site coordination principles is recommended for construction site managers and site supervisors on an ongoing basis on construction projects in Gauteng and Western Cape Provinces.

Essentially, the relevance of designer production information (especially architectural and structural drawings) on Gauteng and Western Cape construction sites cannot be overruled in developing an improved construction labour efficiency framework. The involvement of contractors early in the design stage will have a significant effect on reducing challenges associated with construction drawings on sites. Contractors may notice drawings that will interfere with work progress on construction sites before such disruption occurs, and make helpful inputs before the final working drawings are produced. Additionally, adequate and regular pre-construction and construction reviews of architect and structural engineer production information documents will help to prevent missing information, improve clarity/quality of drawings and specifications, prevent ambiguity, improve buildability and ultimately enhance the efficiency of the construction workforce. The experience of designers on construction projects is significant to the quality of production information produced. It is recommended that employers should carefully select the appropriate designer for the design of a specific facility. In essence, the effectiveness of communication between architects, structural engineers, other design professionals, site managers and clients should be augmented to alleviate discrepancies in construction drawings and design-related factors affecting the efficiency of human capital in the construction industry.

The flow, quality and timeliness of information between procurement officers, site managers and site supervisors demands improvement in the construction industry. The effectiveness of information, adequate record-keeping of stock and frequent inspection of available materials on site will enable procurement officers to make early orders and follow up on materials delivery. Additionally, irrespective of the previous training of construction equipment operators and their certification for operation of construction equipment, periodic refresher courses are recommended to improve skills and competence of operators. Training equipment operators on effective equipment operation will contribute to facilitating the maintenance of construction equipment and prevent equipment breakdown during operation. The adverse effect of strikes, high winds and rainfall on construction operations can be reduced on South African construction sites by taking cognisance of the critical factors affecting the efficiency of construction labour, as presented in this study. Since external factors are mostly acts of God and difficult or impossible to control, consistent tracking of weather forecasts could help to reduce the effect of weather conditions on construction projects by allowing necessary preparations for construction operations to be made. More importantly, site managers and site supervisors maintaining a good working relationship and adopting a suitable employee motivational system for construction labourers is a strategy to ensure efficiency of construction labour during and before the occurrence of unforeseen external factors. The findings obtained in the study aid the development of the framework presented in Figure 5.1 as a possible model to be operationalised on Gauteng and Western Cape construction sites. Adequate application of the recommendations presented in this study will significantly improve the efficiency of construction workers in

Gauteng and Western Cape provinces reduce current construction time and cost overruns and ultimately increase stakeholder satisfaction in the construction sector.

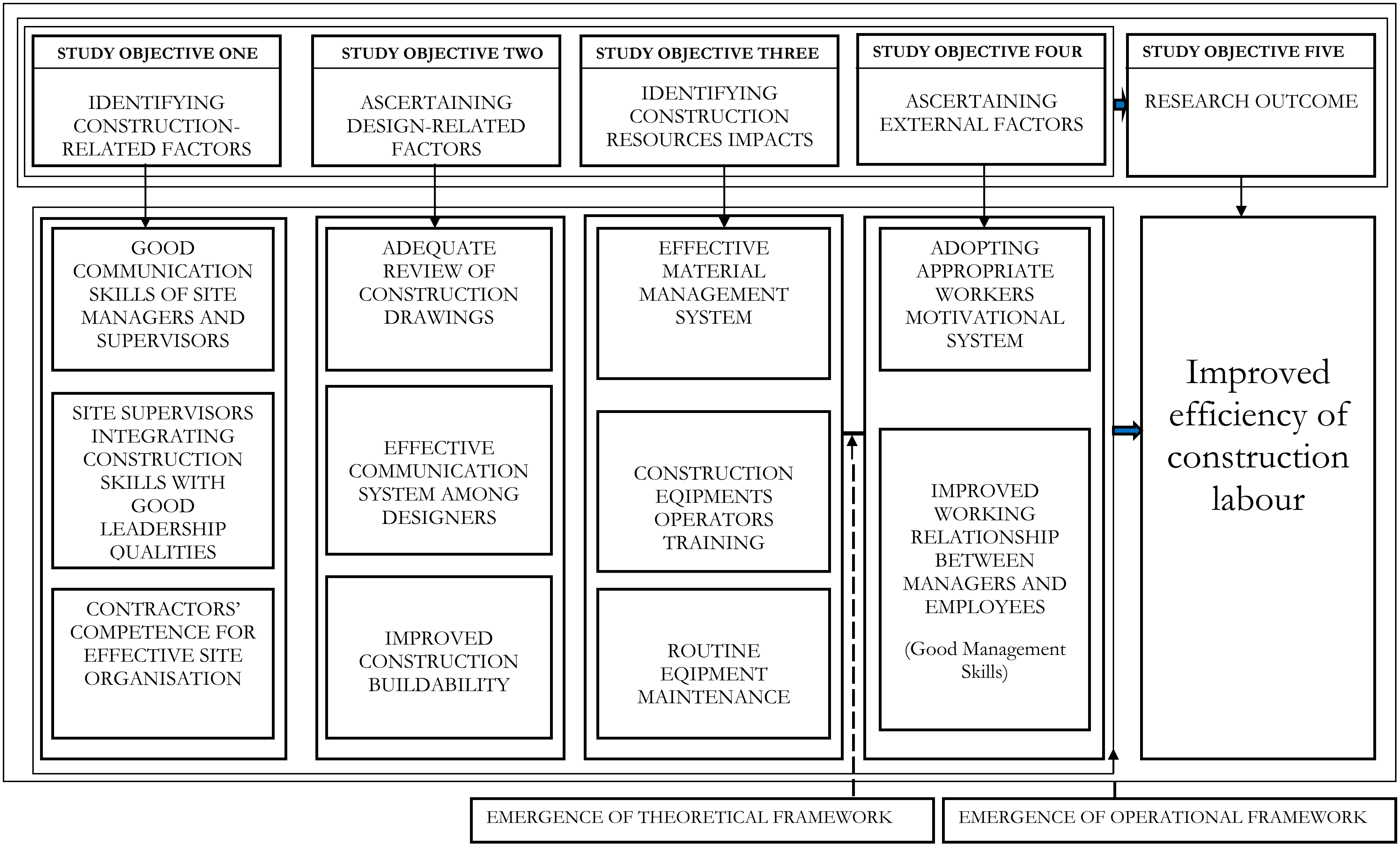

Figure 5.1: Operational formwork towards improving construction workers' efficiency

Figure 5.1 indicates the operational framework to help improve the efficiency of construction labour in Gauteng and Western Cape Province, though the framework may be tested beyond the Provinces. Site managers and site supervisors exhibiting viable means of communication with construction labours is significant to good efficiency of construction operations. Besides, trade supervisor's ability to combine practical skills/knowledge with good leadership qualities in their relationship on construction sites especially with subordinates is an essential tool to ensure good efficiency of construction labours. Moreover, on a consistence basis, contractors through site managers, site superintendents and construction management employees should devise consistence planning and organisation of construction sites to avoid interruption of operations that could interfere with the performance of construction labours. Regular review of construction drawings and effective communication system among construction designers will further help to enhance the buildability of construction drawings that constitute delays on projects. Also, adequate management of construction materials, equipment operator training and time to time maintenance of construction equipments are considerable factors to improve the efficiency of construction labours. The efforts to improve the efficiency of construction labour should also involve adopting appropriate workers motivational system on individual and group of workers basis. This should be considered for implementation on construction projects, while the higher management workers are required to maintain a good working relationship with labours, craft workers and trade supervisors on construction project to ensure good performance of construction labour.

5.5 Further research

The literature consulted revealed that, despite a wealth of research conducted on construction labour productivity and efficiency, the participation of lower management staff in the reduction of labour productivity has been considered insignificant by researchers and construction site management teams. The literature also indicates that the validity of research on construction labour productivity is enhanced by exploring the perceptions of construction craft workers. However, this study does not measure the productivity of construction labour on South African construction sites. The study only explores the predominant factors affecting the efficiency of construction labour in construction sites in Gauteng and Western Cape provinces, and subsequently ranked the factors to obtain the perceived critical factors affecting construction workers' efficiency. Hence, further research is recommended to measure and compare construction labour efficiency/productivity in different trades on a site-by-site basis through work study and other available strategies. Further study is also recommended on establishing the success factors of productive industries to compared and incorporate in the construction sector.

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APPENDICES: APPENDIX A – QUESTIONNAIRE FOR THE STUDY

Cape Peninsula
University of Technology

FRAMEWORK FOR EFFECTIVE MANAGEMENT OF CONSTRUCTION WORKFORCE TOWARDS ENHANCEMENT OF LABOUR EFFICIENCY DURING BUILDING PRODUCTION PROCESS IN SOUTH AFRICA

Dear Sir/Madam,

RE: <u>PARTICIPATION IN A QUESTIONNAIRE SURVEY</u>

I hereby solicit your assistance and support to participate in a quantitative research survey that investigates the factors that affect construction workforce efficiency during building production process in the South African construction industry. I humbly implore construction practitioners to be adequately involved in this study to achieve the success of the study. This study is primarily undertaken for **academic purposes** by a Construction Management Master of Technology degree student from the Department of Construction Management and Quantity Surveying at Cape Peninsula University of Technology, Bellville Campus Cape Town.

Please, **read each question carefully** and endeavour to answer them all. The participants are assured that every piece of information that will be provided for this study will be kept strictly **CONFIDENTIAL** and will only be used for research purposes.

Kindly complete the survey and return to:

Adebowale Oluseyi Julius,

Cape Peninsula University of Technology,

Department of Construction Management and Quantity Surveying,

Faculty of Engineering.

E-mail: **write2seyi@gmail.com or Julifem_2007@yahoo.co.uk**

Mobile: **074 4033 217 or 074 0772 950**

Thanks for your cooperation, understanding and assistance

CONSTRUCTION WORKFORCE QUESTIONNAIRE

SECTION 1**:** **BIOGRAPHICAL INFORMATION OF RESPONDENTS**

Kindly answer all questions, as you are implored to mark or tick **(**x or √**)** the CORRECT box.

1. Kindly specify which of the following categories your company belong:

Contractor	
Architectural firm	
Project management firm	
Quantity surveying consultant firm	
Sub-contractor firm	
Others (Please specify)	

2. Kindly indicate your gender:

Male	
Female	

3. Please indicate your age group:

Below 26	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	65 or above

4. Please indicate the highest formal qualification you obtained:

Matric Certificate	
Diploma	
Post Graduate Diploma	
Bachelor degree	
Honours degree	
Master's degree	
Doctorate degree	
Others (Please specify)	

5. Kindly specify your year of work experience in the construction industry …………………

6. Kindly indicate your present position in your organisation …………………………………

7. How long have you been working in this position? ……………………………………….

SECTION 2A: **IMPACTS OF CONSTRUCTION-RELATED FACTORS ON CONSTRUCTION WORKER'S EFFICIENCY**

8. The following are construction team-related factors that **affect** construction workers efficiency, kindly use the scale below to "**tick as appropriate"**.

Where; Strongly disagree =1, Disagree = 2, Neither agree nor disagree =3, Agree =4, Strongly agree = 5

CONSTRUCTION -RELATEDFACTORS	1	2	3	4	5
Contractors Factors	**1**	**2**	**3**	**4**	**5**
Construction method adopted	1	2	3	4	5
Effective site planning ability	1	2	3	4	5
Contractors delay of instruction to employee	1	2	3	4	5
Contractor financial problems	1	2	3	4	5
Contractors construction experience	1	2	3	4	5
Rework due to construction error	1	2	3	4	5
Inadequate co-ordinating ability of workforce	1	2	3	4	5
Relationship with sub-contractors	1	2	3	4	5
Profit intention of contractors	1	2	3	4	5
Access to construction sites	1	2	3	4	5
Inadequate facilities for construction workers	1	2	3	4	5
Foremen/Supervisor Factors	**1**	**2**	**3**	**4**	**5**
Construction skills of supervisor	1	2	3	4	5
Relationship between supervisors of different trades	1	2	3	4	5
Trade supervisors absenteeism	1	2	3	4	5
Inadequate instructions from supervisors to labourers	1	2	3	4	5
Poor coordination of workers by supervisors	1	2	3	4	5
Recruitment of competent supervisors	1	2	3	4	5
Communication between supervisors and construction labour	1	2	3	4	5
Rework due to unclear instruction from supervisor	1	2	3	4	5
Supervision delay by trade supervisors	1	2	3	4	5
Poor relationship of supervisor with employer	1	2	3	4	5
SITE Managers Factors	**1**	**2**	**3**	**4**	**5**
Technical skill of site managers	1	2	3	4	5
Decisions of site managers	1	2	3	4	5
Level of education of site managers	1	2	3	4	5
Inadequate instructions of site managers	1	2	3	4	5
Site managers relationship with project team	1	2	3	4	5
Site manager's coordinating skill	1	2	3	4	5
Administrative experience of site managers	1	2	3	4	5
Planning ability of site managers	1	2	3	4	5
Communication ability of site managers	1	2	3	4	5

SECTION 2B: **WORKERS MOTIVATIONAL FACTORS**

9. Kindly use the scale below to tick "**as appropriate"** the level at which the under-listed motivational factors affect construction workers' performance.

Where; Strongly disagree =1, Disagree = 2, Neither agree nor disagree =3, Agree =4, Strongly agree = 5

MOTIVATIONAL FACTORS	1	2	3	4	5
Unfair wages of construction workers	1	2	3	4	5
Inadequate bonus for workers	1	2	3	4	5
Lack of participation of employee in decision making	1	2	3	4	5
Reputation of firm	1	2	3	4	5
Non - recognition of subordinates by superiors	1	2	3	4	5
Distance of construction site from home	1	2	3	4	5
Poor overtime allowance	1	2	3	4	5
Discontinuity of construction works	1	2	3	4	5
Poor relationship of labourers with superiors	1	2	3	4	5
Inadequate training for employee	1	2	3	4	5
Inadequate motivation of individual worker	1	2	3	4	5
Insufficient general workers motivation	1	2	3	4	5
Inadequate financial motivation	1	2	3	4	5
Delay in payment of construction employees	1	2	3	4	5
Lack of employee team belonging	1	2	3	4	5
Unfavourable working condition in construction	1	2	3	4	5
Lack of responsibility for workers	1	2	3	4	5
Excessive overtime work	1	2	3	4	5
Poor policy of organisation	1	2	3	4	5

SECTION 2C: **CONSTRUCTION OCCUPATIONAL HEALTH AND SAFETY**

10. Kindly use the scale below to "**tick as appropriate"**, the level of importance of the following statements on construction sites.

Where; Not important =1, Neutral = 2, Slightly important =3, Moderately important =4, Very important = 5

SAFETY FACTORS	1	2	3	4	5
Safety signs are adequately available on construction sites	1	2	3	4	5
First aid treatments are readily available for workers on site	1	2	3	4	5
Workers always wear safety boot on construction sites	1	2	3	4	5
Safety boot should be made compulsory for site visitors	1	2	3	4	5
Every workers on site wear helmet	1	2	3	4	5
Helmet are made compulsory for site visitors	1	2	3	4	5
Toolbox is always available on construction sites	1	2	3	4	5
Eye protection is always used by workers with specific task	1	2	3	4	5
Ear protection is used by workers on site for specific task	1	2	3	4	5
Fall protection is used on site when working from a height	1	2	3	4	5
Hand protection is used by workers working with concrete	1	2	3	4	5
Health and safety induction is compulsory for construction workers	1	2	3	4	5
Health and safety induction is compulsory for site visitors	1	2	3	4	5
Safety officer is always present on large construction sites during operations	1	2	3	4	5
Management workers have better safety culture than craft workers	1	2	3	4	5
Peer group pressure influence safety culture of construction workers	1	2	3	4	5
Not only safety officer is concerned with imbibing safety discipline	1	2	3	4	5
Older construction workers exhibit better safety culture than younger workers	1	2	3	4	5
Safety signage is always displayed when carrying out hazardous activities	1	2	3	4	5
Employees always wear reflected vest when working around mobile plants	1	2	3	4	5
Edge protection is always in place on decks	1	2	3	4	5
Construction site is always clean	1	2	3	4	5

SECTION 3**: DESIGN-RELATED FACTORS AFFECTING CONSTRUCTION WORKER'S EFFICIENCY**

11. The following are design-related factors affecting construction worker's efficiency. Kindly "**tick as appropriate"** using the scale below:

Where; Not at all =1, To a little extent = 2, To some extent =3, To a large extent =4, To a very large extent = 5

DESIGN-RELATED FACTORS	1	2	3	4	5
Architect Factors	**1**	**2**	**3**	**4**	**5**
Missing details in architectural working drawings	1	2	3	4	5
Complexities of architectural designs	1	2	3	4	5
Revisions and change order by architect	1	2	3	4	5
Slow response of architect to drawing questions	1	2	3	4	5
Architect delay of inspections	1	2	3	4	5
Incomplete pages of architectural drawings	1	2	3	4	5
Non- clarity of architectural specifications	1	2	3	4	5
Non- clarity of architectural drawings	1	2	3	4	5
Architect late issuance of instructions	1	2	3	4	5
Structural Engineer Factors	**1**	**2**	**3**	**4**	**5**
Incomplete pages of structural drawings	1	2	3	4	5
Poor structural design information	1	2	3	4	5
Complexities of structural drawings	1	2	3	4	5
Revisions and changes order by structural engineers	1	2	3	4	5
Non-clarity of structural drawings	1	2	3	4	5
Slow response of structural engineer to drawing questions	1	2	3	4	5
Structural engineer delay of inspection	1	2	3	4	5
Missing details in structural drawings	1	2	3	4	5
Non- clarity of structural specifications	1	2	3	4	5
Electrical Engineer Factors	**1**	**2**	**3**	**4**	**5**
Incomplete pages of electrical drawings	1	2	3	4	5
Inadequate electrical design information	1	2	3	4	5
Complexities of electrical drawings	1	2	3	4	5
Slow response of electrical engineers to drawing questions	1	2	3	4	5
Non-clarity of electrical drawings	1	2	3	4	5
Revision of electrical drawings	1	2	3	4	5
Difficulty in obtaining electrical appliances in market	1	2	3	4	5
Mechanical Engineer Factors	**1**	**2**	**3**	**4**	**5**
Legibility of mechanical engineering drawings	1	2	3	4	5
Inadequate detailing of mechanical engineering drawings	1	2	3	4	5
Mechanical engineering drawings revision delay	1	2	3	4	5
Complexity of mechanical engineering drawings	1	2	3	4	5
Slow response to mechanical engineering drawing questions	1	2	3	4	5
Mechanical engineer specification problems	1	2	3	4	5
Difficulty in obtaining specified mechanical devices in market	1	2	3	4	5
Difficulties in installation of mechanical devices	1	2	3	4	5
Clients Factors	**1**	**2**	**3**	**4**	**5**

Revision and changes order by client	1	2	3	4	5
Delay of progress payment after interim valuation	1	2	3	4	5
Misunderstanding between clients and project parties	1	2	3	4	5
Information dissemination from clients to project parties	1	2	3	4	5
Design approval delay by client	1	2	3	4	5
Poor payment of client resulting to poor construction designs	1	2	3	4	5
Inadequate briefing ability of clients	1	2	3	4	5
Inadequate construction experience of clients	1	2	3	4	5
Quantity Surveyors factors	**1**	**2**	**3**	**4**	**5**
Error of omission in the bill of quantities	1	2	3	4	5
Delay in the preparation of interim valuation	1	2	3	4	5
Inadequate schedule of quantities/rate	1	2	3	4	5
Non-clarity of quantity surveyor specification	1	2	3	4	5
Inadequate measurement ability of quantity surveyor for required work	1	2	3	4	5
Missing details in quantity surveyor's specifications	1	2	3	4	5
Others	**1**	**2**	**3**	**4**	**5**
Inadequate co-ordination among design team	1	2	3	4	5
Non-involvement of constructor in the design stage	1	2	3	4	5
Contract documents conflicting construction drawings and specification	1	2	3	4	5
Inadequate time for preparation of contract documents	1	2	3	4	5
Buildability problems	1	2	3	4	5

SECTION 4**: CONSTRUCTION RESOURCE-RELATED FACTORS AFFECTING CONSTRUCTION WORKER'S EFICIENCY**

12. The following are resource-related factors that may be affecting the performance of construction workers in the construction industry. Kindly "**tick the extent"** at which each factor affects construction workers' performance using the scale below:

Where; Strongly disagree =1, Disagree = 2, Neither agree nor disagree =3, Agree =4, Strongly agree = 5

RESOURCE FACTORS	1	2	3	4	5
Construction Material Factors	**1**	**2**	**3**	**4**	**5**
Shortage of construction materials	1	2	3	4	5
Late delivery of construction materials	1	2	3	4	5
Increase in cost of construction materials	1	2	3	4	5
Difficulties in obtaining materials from store due to excessive paper works	1	2	3	4	5
Poor site planning prevents easy movement of materials	1	2	3	4	5
Late order for construction materials	1	2	3	4	5
Non-conformity of materials with specification causes delay	1	2	3	4	5
Wastage of construction materials by workers	1	2	3	4	5
Workers anticipation of material shortage leads to slow operation	1	2	3	4	5
Running out of materials on site	1	2	3	4	5
Ineffective distribution of materials on site	1	2	3	4	5
Unsuitability of material storage location	1	2	3	4	5
Problem of arrangement of construction materials	1	2	3	4	5
Construction Machinery Factors	**1**	**2**	**3**	**4**	**5**
Obsolete machinery used in construction operations	1	2	3	4	5
Damage to tools and machinery	1	2	3	4	5
Poor working condition of tools and machinery	1	2	3	4	5
Difficulties involved in getting spare parts of machinery	1	2	3	4	5
Inadequate maintenance of tools and machinery	1	2	3	4	5
Difficulties involved in hiring construction tools and machinery	1	2	3	4	5
Inadequate skill of equipment operator	1	2	3	4	5
Complexities involved in operation of machinery	1	2	3	4	5
Increase cost of hiring construction machinery	1	2	3	4	5
Movement of machinery on site disrupt progress of work	1	2	3	4	5
Late arrival of machinery on site	1	2	3	4	5
Insufficient number of machinery available for operations	1	2	3	4	5
Labour Factors	**1**	**2**	**3**	**4**	**5**
Insufficient wages of construction labourers	1	2	3	4	5
Delay in payment of construction labourers	1	2	3	4	5
Old age of construction labourers	1	2	3	4	5
Lack of involvement of labourers in decision making	1	2	3	4	5
Overtime work of construction labourers	1	2	3	4	5
Lack of discipline among labourers	1	2	3	4	5
Absenteeism of construction labourers	1	2	3	4	5
Labour alcoholism	1	2	3	4	5
Negligence of construction labourers	1	2	3	4	5

Communication problems between labourers and superiors	1	2	3	4	5
Problem of skilled labourers	1	2	3	4	5
Labour leaving construction jobs for another job	1	2	3	4	5
Labour fatigue	1	2	3	4	5
Transportation problem for labourers	1	2	3	4	5
Misunderstanding among labourers	1	2	3	4	5

SECTION 5**: EXTERNAL FACTORS AFFECTING WORKFORCE PERFORMANCE.**

13. Kindly rate the following external factors as they affect worker's efficiency on construction sites

Where; Strongly disagree =1, Disagree = 2, Neither agree nor disagree =3, Agree =4,

Strongly agree = 5

EXTERNAL FACTORS	1	2	3	4	5
Effects of rainfall on construction	1	2	3	4	5
Sunlight effect on construction operations	1	2	3	4	5
Cold weather conditions	1	2	3	4	5
Hot weather conditions	1	2	3	4	5
Poor nature of construction sites	1	2	3	4	5
Increase cost of construction materials	1	2	3	4	5
Effect of high wind on construction	1	2	3	4	5
Change in government policies and regulations	1	2	3	4	5
Effect of sub-surface conditions	1	2	3	4	5
Increase in cost of hiring construction machinery	1	2	3	4	5
Effect of strike on construction operations	1	2	3	4	5
Public holidays affect progress of construction works	1	2	3	4	5
Political interference	1	2	3	4	5
Technological interference	1	2	3	4	5
Pilfering on construction sites	1	2	3	4	5
Distance of food shops to construction site	1	2	3	4	5
Government legislations	1	2	3	4	5

Thanks for the time spent

Cape Peninsula
University of Technology

APPENDIX B: INTERVIEW QUESTIONS

1. How often is fall protection used when working from height on construction sites?

2. What can you say about site management reaction to the use of helmet by workers and site visitors on sites?

3. Do construction workers experience missing information in architectural working drawings?

4. How would you rate site manager's communication ability/skills on construction projects?

5. Do construction worker strikes have an effect on the efficiency of construction labourers?

6. How would you rate the coordination of site managers on construction projects?

7. How quick do architects respond to architectural drawing questions on construction projects?

8. How quick do structural engineers respond to structural drawing questions on construction projects?

9. How would you rate construction skills of site supervisors on construction projects?

10. What is your experience on shortage of construction materials on construction projects?

11. Based on your experience, which other factor(s) affect the efficiency of construction labour on construction projects?

APPENDIX C: CONFERENCE PAPERS PUBLISHED IN THE COURSE OF THE STUDY

Adebowale O.J. & Fapohunda J.A. 2014. Adverse impacts of design team on construction workforce productivity *In:* Laryea, S. and Ibem, E. (Eds) proceedings *8th Construction Industry Development Board (cidb) Postgraduate Conference,* 10-11 February 2014, University of Witwatersrand, Johannesburg, South Africa, 111-119.

ABSTRACT

The construction industry is generally equated with poor productivity, extension in project duration and cost overruns. Production efficiencies attributed to the construction sector have been comparatively low when compared with manufacturing industries. This poor performance is instigated by several participants in the construction field, and renders the objectives of most construction projects rarely achievable. Due to the significance of design professionals in construction building production, the study explores design team production information, and design-related factors affecting construction workforce efficiency. This will afford adequate control and co-ordination of workforce during the construction production process. As a result of vast growth of construction activities within the city of Cape Town, the research was conducted in the Western Cape Province, Cape Town, South Africa. The study involves professionals in construction organisations; exploring quantitative questionnaire surveys with contract managers, quantity surveyors, site supervisors, site managers and project managers. Being a pilot study to an ongoing research, questionnaires administered to respondents were limited to twenty-five respondents, the questionnaires being delivered by hand. Twelve of the questionnaires were retrieved through direct contacts, and ten of these were valid and analysed with SPSS statistical tool (version 21). From the findings, the prevalent factors affecting the performance of construction organisations include; missing details in architectural working drawings, slow response of architects to drawing questions, non-clarity of architectural specifications, complexities involved in construction drawings, buildability problems, contract documents conflicting construction drawings. The adequate application of recommendations presented by this study will reduce construction wastes and enhance construction workforce efficiency.

Keywords: Buildability, Construction industry, Construction workforce, Design team, Production information

Adebowale O.J. & Fapohunda J.A. 2014. Adverse impacts of construction resources on construction workforce output In: Obuksewajormu, E. and Olalekan O. (Eds) proceedings *3rd International Conference on Infrastructure Development in Africa,* 17-19 march, 2014, College of Environmental Sciences, Bells University of Technology, Ota Nigeria, 286-299.

ABSTRACT

One of the most significant challenges confronting construction industries is low productivity of construction labour. Thus, inadequate construction productivity becomes a focus of industrial and academic concerns. As indicated by several studies, construction industry is a labour reliant sector. Therefore, construction productivity is a product of human efforts and performance. The prevalent of cost and time overruns in the construction sector is a momentous evidence of productivity challenge within the construction industry. Workforce represents the only construction productive resource and identified as the resource that wastes other construction resources during construction production process. As a result of the significant impacts of construction labour, and its relevance to successful project delivery, there is a need to evaluate the factors affecting construction labour productivity. The research adopts quantitative research approach; using closed ended questionnaires to obtain data from contract managers, site managers, contractors, and site supervisors. SPSS statistical software (version 21) was used to analyse quantitative data obtained. The study reveals the factors affecting construction labour productivity. The predominant factors include; missing details in construction drawings, changes order by clients, and communication problem between supervisors and labourers. The adequate implementation of framework presented in this study will improve construction labour productivity, and ultimately increase customer's satisfaction.

Keywords: Construction industry, Construction resources, Customer's satisfaction, Labour Productivity, Project objectives

Adebowale O.J. & Fapohunda J.A. 2014. Factors affecting construction labour productivity *In:* Obuksewajormu, E. and Olalekan O. (Eds) proceedings *3rd International Conference on Infrastructure Development in Africa,* 17 - 19 March, 2014, College of Environmental Sciences, Bells University of Technology, Ota Nigeria, 403-412.

ABSTRACT

Irrespective of numerous studies undertaken towards improvement of construction project performance, construction industry represents an environment with predominant cost and time overruns. The underlying causes for time and cost overruns in the construction sector are mostly attributed to poor performance of construction workforce resulting to poor co-ordination of construction resources. Basically, the major resources in the construction sector directed towards achieving project objectives are manpower, machinery and materials. However, among these resources, construction workforce activates construction materials and machinery, and becomes the central productive resource. Hence, this study explores materials and machinery-related factors contributing to performance shortfall of building construction projects. The study adopts quantitative research approach; administering closed ended questionnaires to contract managers, contractors, site managers and site supervisors in Western Cape Province of South Africa. Statistical Package for Social Sciences (version 21) was used to analyse the quantitative data obtained. Findings reveals shortages of construction materials due to poor planning and late delivery of construction materials as the most severe resource-related factors affecting construction project performance.

Keywords: Construction workforce, Machinery, Materials, Productive resource, Project objectives.

Adebowale O.J. & Fapohunda J.A. 2014. Adverse impact of construction-related factors on construction labour efficiency In: Proceedings for the *8th Built Environment Conference, 27 - 29 July, 2014, Durban South Africa.*

ABSTRACT

Purpose of this paper

Irrespective of significant relevance of construction industry to economic growth of developed and developing nations, labour efficiency in the construction industry remains relatively low to manufacturing industries. This paper aims at exploring adverse construction-related factors contributing to the shortfall of construction labour efficiency in Western Cape Province, South Africa.

Design/methodology/approach

The study adopts quantitative research approach; administering closed ended questionnaires to construction professionals in Western Cape Province. Statistical Package for Social Sciences (Version 22) was used to analyse the data obtained.

Findings

Supervision delay by supervisors, communication ability of site managers, level of literacy of site managers, site manager's coordinating skills and communication barrier between supervisors and construction labour are found as the predominant construction-related factors affecting the efficiency of construction labour.

Research limitations/implications

This study is basically restricted to contractor, site supervisors and site manager-related factors affecting the efficiency of construction labour in Western Cape Province.

Practical implications

Adequate application of findings presented in this study will significantly reduce the current prevalent construction time and cost overruns through an improved construction workforce performance.

Original/value of paper

Enhanced construction productivity is a product of construction labour efficiency that ensures achievement of construction project objectives and heightens contribution to national economic development.

Keywords: Construction productivity, Developing nations, Labour efficiency, National economic development, Project objectives.