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Inadequate holistic training of tower crane operators significantly impacts health and safety in Gauteng, South African construction projects.

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INADEQUATE HOLISTIC TRAINING OF TOWER CRANE OPERATORS SIGNIFICANTLY IMPACTS HEALTH AND SAFETY IN GAUTENG, SOUTH AFRICAN CONSTRUCTION PROJECTS.

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A Research Report submitted to the Faculty of Engineering and the Built Environment of the University of the Witwatersrand, Johannesburg in partial fulfillment of the requirements for the degree of Master of Science in Building in the field of Project Management in Construction

Johannesburg, 2012

DECLARATION

I declare that this Research Report is my own, unaided work. It is submitted in partial fulfilment of the degree of Master of Science (Building) in the field of Project Management in Construction at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any degree or examination in any other university.

_____

(Signature of Candidate)

_____ day of _____ (year) _____

ABSTRACT

The research investigated the current inadequate holistic training practices given to tower crane operators which significantly impact health and safety in Gauteng, South African construction projects. The primary motivation for conducting the research was due to tower crane related accidents, fatalities and related project delays which have become endemic in the construction industry. These occurrences have not been researched from the perspective of the basic training given to tower crane operators in the SA construction industry.

The study sought to examine the current structure and characteristics of the training programmes used in developing the skills of tower crane operators. This included exploring the current barriers and the effectiveness experienced in the training programmes given to tower crane operators. The study also sought to find the major improvements or restructuring that is still needed in skills development and training of tower crane operators from the perspective of tower crane operators.

It consisted of a sample of 25 tower crane operators trained in various skills development programmes used in the South African construction industry. The research also included interviews from 9 site foremen and managers who manage the operations of tower cranes during construction project delivery, who also provided key data in relation to the training practices of tower crane operators from the manner in which their contractors conduct them.

The study found several major factors contributing to inadequate holistic training of tower crane operators related to the following: the manner in which the current training programmes were structured in terms of theoretical and practical training; lack of effectiveness of the training programmes in terms of safety, communication, rigging and hoisting and the important knowledge of tower crane operations; inefficiency of tower cranes in terms of the technological aspects that relate to giving a clearer site view of the environment in which lifting and unloading of construction materials was conducted; inadequately trained banksman or signalers and lack of training in general personalities needed in operating tower cranes as the main contributing factors. These major factors that the study found to contribute to tower crane related accidents need to be addressed if the continuing accidents and fatalities are to be significantly reduced in Gauteng, South African construction projects during project delivery and execution.

DEDICATION

I dedicate this Research Project to God Almighty for being with me throughout my academic career and helping me to complete the Master's degree

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ABBREVIATIONS AND ACRONYMS

ABET - Adult Basic Education and Training

CIDB - Construction Industry Development Board

CM - Construction Management

CPHA - Contractor Plant Hire Association

CRs - Construction Regulations

NDoL - National Department of Labour

DoPW - Department of Public Works

FEMA - Federated Mutual Assurance company

FIFA - Federation of International Football Association

H&S - Health and Safety

HSRC - Human Sciences Research Council

IES/OHS - Inspections Enforcement Section / Occupational Health and Safety

ILO - International Labour Organisation

NQF - National Qualification Framework

PAYE - Pay As You Earn

RPLs - Recognition of Prior Learning

SA - South Africa

SDPs - Skills Development Programmes

SETAs - Sectoral Education and Training Authority

SAQA - South African Qualifications Authority

SARS - South African Revenue Services

UK - United Kingdom

US - United States of America

VET - Vocational Education and Training

CHAPTER 1: INTRODUCTION

1. Background to the Study

The causes of tower crane related accidents have recently attracted interest in the United Kingdom because of the important role tower cranes play in the delivery of construction projects (Sertyesilisik, Tunstall and McLough, 2009:72). The important role played by tower crane operators in project execution has necessitated that further and different ways be implemented and explored for better project delivery due to low standards of health and safety that remain a concern as found in Hong Kong (Tam and Fung, 2010:208). A previous study in the United States found that the *high rates of construction injuries and fatalities associated with cranes clearly indicate that current safety procedures and devices are not completely effective in preventing accidents* (Neitzel, Seixas and Ren, 2001:1115). It is for these reasons that the research sought to close the gaps in literature arising from the current inadequate holistic training practices given to tower crane operators that significantly impact health and safety in Gauteng, South African construction projects.

Previous research on tower crane operations focused on the various causes of accidents emanating from the operation of tower cranes. Aneziris *et al* (2008) in Netherlands concentrated on developing models that seek to reduce the risks of accidents occurring on sites when operating a tower crane. An earlier study (Rosenfeld and Shapira, 1998) in Israel investigated how the efficiency of tower cranes could be improved because it takes longer to operate a tower crane on sites in delivering construction projects.

Most recent study (Dongl, Xu and Cheul, 2010) in China concentrated on developing a virtual reality system of training tower crane operators which did not address the adequacy of basic training provided to tower crane operators. Unfortunately, a number of previous researches did not seek to investigate why the current basic training practices given to tower crane operators lack adequacy in terms of the learning outcomes and competency from the perspective of tower crane operators.

The delivery of construction projects is associated with high costs of tower crane related accidents due to poorly trained tower crane operators (Edwards and Nicholas, 2002:78). The

authors emphasize that this also affects the delivery of construction projects through lost production or downtime and the injuries sustained by operatives in construction sites. Equipment breakdown or downtime arising from lack of basic plant maintenance training to tower crane operators also affects the delivery of construction projects through *reduced productivity, extended contract duration, loss of profit and increased probability of accidents occurring* (Edwards and Cabahug, 2002:23). Limited research has been conducted in South Africa to show the extents to which the different ways and forms of training tower crane operators affect the health and safety delivery of construction projects.

Tower cranes depend on the skills and competence of operators in order to achieve greater performance and productivity and are not self-reliant like robotics (Yang, Edwards and Love, 2004:279 citing Cabahug, 2003). A recent study (Ma, Fang and Zhang, 2008:12194) in Korea argued that the greater performance and efficiency of tower cranes remains a concern, this is because they are manually operated by tower crane operators who lack adequate holistic training. Other reasons contributing to tower crane related accidents are due to *lack of expertise and operational skills, poor quality of safe operation* and recklessness in lifting operations which presents the need to investigate the basic training practices in tower cranes (Dongl, Xu and Cheul, 2010: 206).

Construction project execution and delivery has been found to have many incidents of equipment breakdown and plant related accidents arising from poorly trained tower crane operators. The poor training of tower crane operators has been recognised as a major cause of concern and a contributor to tower crane related accidents which also affects the delivery of construction projects. (Prasertrungruang and Hadikusumo, 2007:228-229 citing Stewart, 2000; Edwards and Holt, 2002; Edwards and Nicholas, 2002; Gann and Senkar, 1998)

A prior research (Hamid, Majid and Singh, 2008:247 citing Lubega *et al*, 2000) in Malaysia emphasized that the main causes of accidents on sites are caused by the *lack of awareness and enforcement of the applicable health and safety regulations*, the delegation of responsibilities to people without the skills and competency to manage health and safety, fatigue and stress arising from longer working hours, and equipment breakdown or mechanical failure of construction plant and equipment such tower cranes, excavators and others.

The Health and Safety Executive (2003, viii – ix) in Britain found that the major causes to site accidents are those related to poor communications and noise levels; people moving around the site unnecessary; poor housekeeping, site layout, space availability; inadequate baseline risk assessment before construction work; designers not addressing health and safety from specifications; lack of commitment and skills in conducting incident or accident investigation by contractors themselves; commonplace hazards associated with construction work; most importantly are the inadequate skills of operators in using equipment or machinery like tower cranes, excavators and others.

Another recent study (Mthalane, Orhtman and Pearl, 2008: 3-4) investigated the causes of site accidents in South Africa and argued that the main factors are those that emanate from people falling from scaffolds, walkways, excavations; falls on the same level due to slippery conditions; struck by falling or stationery or moving objects; contact with electricity; transport accidents where people are struck by vehicles delivering materials; fires and explosions; the use of machinery and plant due to mechanical failure or lack of competency in their operation by operators; and importantly the contribution of operations associated with lifting and moving of construction materials by tower or mobile cranes.

In the United States (US), tower crane related accidents were found to account for 25 – 33% of all deaths in construction and maintenance projects (Surada, Eggar and Liu, 1997:4 citing MacCollum, 1993). Another investigation (Neitzel, Seixas and Ren, 2001:1106) emphasized that tower cranes were responsible for 33% of construction fatalities, permanent disability and related casualties in the United States construction industry. The United Kingdom (UK) for example, had accidents in the range of 17% tower crane related accidents annually (Neitzel, Seixas and Ren, 2001:1109).

In a developing country like South Africa, the statistics in Table 2 below obtained from the Federated Mutual Assurance (FEMA, 2011) company, indicated that the Lifting machines and Hoisting apparatus mainly related to tower cranes are responsible for 28% of the proportion of the cost of accidents attributed to the use of construction plant and equipment. The figure could be higher because of widespread underreporting of construction plant related accidents and that FEMA represents 20% of predominantly larger contractors (CIDB, 2009:2; Venter (2009) citing Milford, 2009). The disturbing issue is that a developing country like SA has a higher rate of

tower crane related accidents similar and comparable to developed countries like the US and the UK.

Cost of accidents in the SA construction industry (both those that are direct costs such as wages and medical expenses and indirect costs such as pain and suffering, incident investigations, production loss and delays, overtime and legal fees, funeral and compensation due to fatalities) are estimated at R3.5 billion per year (CIDB, 2009:8). The CIDB (2009:9) further claims that these costs of accidents in individual projects are estimated at 5% of the contract value of construction costs which are then passed to clients. This indicates that the lack of adequate training to tower crane operators increases the costs of procuring construction projects to clients in a manner that is not cost effective.

To date, the only study conducted on improved training for black operators of earthmoving equipment in the South African construction industry by Shall (1977) concentrated on the feasibility aspects of training black construction plant operators. Given the importance of adequate training to tower cane operators which is conducted in a manner that concerns health and safety risks to contractors, clients and operatives on sites, adequate training investigation of this study focused on the basic training aspects and skills development programmes used in the SA construction industry.

1.1 Skills Shortages in Tower Crane Operation

The concept of skills is defined as the "*necessary competencies that can be expertly applied in a particular context for a particular purpose and skills shortages or scarce skills only occur when the demand for that skill outstrips its supply*". The main contributing factors to lack of training and skills development are *extensive subcontracting, temporary and insecure employment and poor working conditions.* (Yudelowitz, 2004:8 citing NACI Report (2003:24) and English (2001) and Wells, 2000)

These are barriers where tower crane operators are not trained directly by the contractors who hire them for the construction of their projects. Working conditions attributes to the problems of poor coordination and communication between the tower crane operators, the subcontractors, site managers who all need the services of tower crane operators.

Skills shortages have the tendency of increasing wages and demand for these scarce skills by contractors (Yudelowitz, 2004:14 citing HSRC (2002) and CIETS Report, 2004). In other instances, large contractors face the constraint and challenge of being compelled to employ the skilled operator from the hire company at a better salary in order to reduce delays in the delivery of their projects. This normally arises in the event they experience wage payments problems to the skilled operator or poor plant management and maintenance problems by the hire contractor.

1.2 Problem Statement

The National Department of Labour[1] (NDoL) in Pretoria Offices, IES/OHS division explained that the construction industry in South Africa kills between 75 – 121 people from estimated 7000 sites notified per year. The difference is that the United Kingdom construction industry kills the estimated same number of people from an estimated 100 000 construction sites per annum. The South African construction industry is said to be killing an average of 1.5 - 2 persons every week. The Compensation Commision within the NDoL pays an estimated R400 million annually in claims associated with injuries, fatalities, diseases in the construction industry. FEMA (2012)[2] emphasized that in other years fatalities from 20% contractors represented by them amounted to 47 people. This means that the statistics from NDoL may be higher in a year.

The DoL[3] acknowledged the problem they are facing in relation to the data capturing system of accidents and those currently being investigated. The investigation reports do indicate the origins of the accidents whether they are caused by cranes, excavators or graders. The problem is that the data capturing system makes it difficult to quantify and present the relevant numbers of accidents in terms of percentages and figures attributable to construction plant and equipment such as cranes, excavators and graders in the Gauteng Province. The National Department of Labour (NDoL) is in a process of introducing an integrated data capturing system which will makes it easier to represent all the accidents caused in the South Africa.

[1] Personal discussion with Mr Doug Michell from the Gauteng Masters Builders Association, the statistics were also emphasized by Mr. Phumi Maphaha from the National Department of Labour in a Construction Health and Safety Roadshow, who is a Manager in the Inspections Enforcement Section / Occupational Health and Safety Division

[2] Personal discussion with Mr Katlego Bagadi from FEMA on fatalities or deaths reported by the 20% contractors represented by FEMA

[3] Personal discussion with Mr Isaac Mohapi at Braamfontein Regional Office of the Department of Labour who works in the Inspections Department.

Table1. Costs of accidents associated with tower cranes in SA from 2009 -2010

Description	Outstanding Claims	Cost of Claims Paid
Striking Against	4 211 806.84	5 555 606.57
Struck By	29 194 707.38	28 030 890.59
Caught in. On. Between	8 214 806.57	10 739 850.16
Fall on to same Level	3 667 142.63	4 895 921.86
Fall on Different Levels	30 492 403.12	29 992 391.31
Total	**75 780 866.54**	**79 214 660.49**

Source, FEMA (2011)

The total of all cost of accidents claimed by companies represented by FEMA from the Compensation Commission was R117 937 744.60 with R136 524 378.71 outstanding from January to September 2010. The claims represented a direct and indirect contribution of 67% which is mainly due to the inadequate training practices given to tower crane operators who mainly work with material handling, moving and lifting operations.

From January to September 2009 a total of R64 682 795.64 was actually paid due to accidents arising from the use of lifting equipment such as tower cranes from a total of R97 827 282.46 claimed by all companies represented by FEMA from the Compensation Commission. The claims represented a contribution of 66% which is mainly due to the inadequate holistic training practices given to tower crane operators.

Table2. Costs of accidents associated with tower cranes and other construction plant in SA from 2009 -2010.

Description	Outstanding Claims (Jan - Sept 2010)	Cost of Claims Paid (Jan - Sept 2010)	Cost of Claims Paid (Jan - Sept 2009)
Drilling, Boring & Turning Machines	13 382.34	36 601.9	30 888.04
Miscellaneous Machines i.e Excavators & Graders	7 696 959.52	3 793 105.1	4 109 158.00
Lifting Machinery and Lifts	2 065 801.37	378 638.74	960 404. 23
Hoisting Apparatus	906 967.50	1 1119 751.52	1 475 640.69
Total	**10 683 110.73**	**5 328 097.26**	**5 711 726.96**

Source, FEMA (2011)

The statistics reveal that the contribution of lifting machinery, lifts and hoisting apparatus is 28% to the total costs of accidents arising directly from the use of tower cranes or related machinery in the SA construction projects between January 2009 and September 2010. This reveals the contribution of inadequate holistic training of tower crane operators to site accidents which remain not addressed through studies focusing on basic training given to them in the SA construction industry.

1.3 Significance of the Study

The goal of the study was to generate recommendations on the important constraints affecting adequate training of tower crane operators for enhanced construction project execution in the South African construction industry. It is hoped that the strategies needed to develop and train the skills of tower crane operators to be encouraged as a result of the study will reduce tower crane related accidents, equipment breakdown and delayed delivery of projects in the South African construction industry.

The research project sought to contribute to the body of knowledge through the restructuring of training programmes given to tower crane operators so as to reduce the high costs of tower crane related accidents, equipment breakdown and related project delays emanating from the current inadequate holistic training practices given to tower crane operators in Gauteng, South African construction projects. This was in order to deliver construction projects that have desirable standards of health and safety with less equipment breakdown and delayed project delivery in their execution and delivery.

1.4 Research Objectives

The study was aimed at investigating the current inadequate holistic training practices given to tower crane operators in project execution. It sought to understand how the training and skills development of tower crane operators could be improved or restructured in order to have desirable standards of health and safety with less incidences of equipment breakdown and related project delays.

The objectives of the study are:

"To examine the nature and characteristics of training given to tower crane operators in the construction industry."

"To establish the barriers that affect skills development in relation to tower crane operators in the construction industry."

"To examine the effectiveness of the current training practices in preparing tower crane operators to deliver construction projects."

"To establish whether the training given to tower crane operators needs to be restructured or improved for enhanced construction project execution and delivery."

1.5 Research Questions

The research questions emanate from the need to address the problem related to the lack of adequate training and skills development of tower crane operators. The research questions are:

"What are the current structures and characteristics of the training programmes given to tower crane operators in the South African construction industry?"

"What are the barriers that affect skills development in relation to tower crane operators in the construction industry?"

"How effective are the current training practices given to tower crane operators in delivering construction projects?"

"What are possible aspects of training in relation to tower crane operators that need to be restructured or improved for enhanced construction project delivery?"

1.6 Scope and Delimitations

The research utilized a qualitative research design consisting of a sample of 25 tower crane operators employed by the large, medium sized and crane hire contractors who actively contract

in the Gauteng province. The sample also included the insight, perspectives and views of 9 site managers and foremen who willingly participated in the interviews conducted with the tower crane operators. The primary objective was to obtain the experiences, views and perspectives of tower crane operators in regards to the manner in which the training of tower crane operators is given, the insight into the factors which affect adequate holistic training and how it could be improved for better construction project delivery.

Tower crane operators were particularly focused on because of the high costs of accidents attributed to the nature, quality of training and operation of tower cranes in SA which were sampled at 28% between 2009 and 2010 (from the problem statement above) in comparison to developed countries such as the United States and the UK which have a 33% and 17% crane related accidents annually respectively.

Plant hire organisations were also included because they also train their own tower crane operators who are normally hired together with the tower crane.

The study was limited to one academic year due to time constraints and to the Gauteng Province due to geographical location and financial constraints.

The study did not interview tower crane operators in relation to their health problems but was more towards the aspects of training and skills development that need to be improved or restructured so as to achieve enhanced standards of health and safety with less equipment breakdown during project delivery.

The study did not include the views and perspectives of trainee tower crane operators but included tower crane operators currently working on construction projects. This was because a prior study by Yang, Edwards and Love (2005) investigated the factors that affect or improve the performance of construction plant operators by concentrating on trainees.

1.7 Assumptions

The study assumed that tower crane operators had the experience and skills necessary to operate tower cranes. This was irrespective of whether they were employed temporarily or permanently by the contractors or plant hire companies owning or renting the tower cranes.

1.8 Structure of the Research Report

The research report is structured in the following manner:

Chapter 1 is the Introduction to the study, it presents the important background to the study which outlines the current problem in relation to the lack of adequacy in respect to the training practices given to SA tower crane operators. This also includes topics such as the problem statement, significance of the study, research objectives, research questions, assumptions, scope and delimitations and research methodology.

Chapter 2 is the Literature Review which critically examines the current inadequate holistic training practices and skills development programmes of SA tower crane operators in the construction industry. It seeks to justify the focus of the study on the training practices by finding the researchable gaps in literature.

Chapter 3 is the Research Methodology which presents and justifies the selected methodology used in conducting the study. It explains and justifies the important topics such as the research sampling method used, how external and internal validity was improved in the study, research design and philosophy selected, why the method of addressing bias in the study was chosen and used, and the data collection and analysis method applied which emanated from the qualitative research design.

Chapter 4 is the Data Analysis which gives the analysis obtained from the data and the findings of the research. The chapter started by presenting the response rate from the sampling method used and focused on the analysis of the data and the findings obtained.

Chapter 5 is the Conclusions and Recommendations of the study which gives the implications arising from the findings and data analysis of the research project. The chapter also addressed whether the research objectives were achieved or adequately addressed by the study and whether the research questions were also answered by the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The chapter sought to review literature on the current inadequate holistic training practices given to tower crane operators in Gauteng, South African (SA) construction projects. This was in order to find the areas in literature that remained not researched and still contribute to tower crane related accidents and fatalities from the training given to tower crane operators.

Literature was reviewed because prior studies focused on the non-basic training practices that also contribute to tower crane related accidents. Recent studies in Netherlands on the risk aspects that contribute to tower crane related accidents focused on developing models that reduce the risks of accidents occurring (Aneziris *et al*, 2008). A study (Rosenfeld and Shapira, 1998) in Israel looked at how the efficiency of tower cranes could be improved. An investigation (Dongl, Xu and Cheul, 2010) in China researched how virtual reality training systems could reduce tower crane related accidents. The integration of 3D visualization and simulation of tower cranes for planning purposes was also researched (Al Hussein *et al*, 2005). The above studies indicate that the current basic training practices given to tower crane operators have not been a major focus in research and a concerning contributing factor to tower crane related accidents.

The study reviewed literature that exists in tower crane operations with focus on the training aspects. The motive was to investigate and explore why the current structure and characteristics of the training methods continue to lack adequate holistic training. This included finding the effectiveness of the current inadequate holistic training practices in terms of the learning outcomes expected from the training programmes or the knowledge areas needed to ensure competency in operating a tower crane. Lastly, it sought to find out how the training practices could be improved or restructured for better project delivery.

2.2 Definitions

A tower crane is defined (Shukri, 2010:7) as an equipment that is:

> *Rated by the maximum weight it can lift at minimum radius and minimum boom length*
> *It is a tower that is equipped with cables, pulleys, ropes and slings that are used to lift and unload construction materials*

Either a temporary structure fixed to the ground or mounted on a purpose built structure

Controlled by a crane operator in a cab mounted along the crane

The further it goes from its center point, the less load it can lift and carry

Figure1. Construction Tower Crane



Source, Stockphoto (2012)

The control that the tower crane operator has in relation to the safe operation of the tower crane ensures that he takes responsibility of safe operation of the crane in a manner that does not pose health and safety risks and hazards to the site personnel, those not working on site and the crane itself in terms of equipment breakdown and damage (Shukri, 2010:8). A recent study found that lifting and hoisting equipment such as the tower crane not only pose danger to those working on sites but also to those not associated with the construction work directly such as the third parties and pedestrians (Tam and Fung, 2010:208 citing Shepherd *et al*, 2000).

Tower cranes can be constructed inside or outside the building project to be constructed in facilitating the delivery of construction projects. Tower cranes that are over 61 meters, with boom lengths of 15 to more than 76 meters normally have a load capacity of 0.5 to more than 22 tons that they can carry during construction project delivery. In many construction projects, tower cranes are used as a pair or more than three due to the complexity of construction projects with the assistance of mobile cranes also used. (Neitzel, Seixas and Ren, 2001:1107)

The word artisan which refers to an operator who uses a tower crane was taken from the Latin word "*artire*" which describes to "*instruct in the arts*". The word refers to *a skilled worker who makes things by hand.* (Mukora, 2009:219)

Due to industrial revolution, introduction of new technologies and the scope of work required in executing construction projects, the *definition of artisan was extended to include skilled workers who use tools and machinery in a particular craft.* These are artisans who use machinery and equipment such as the tower crane in the execution of civil, building and infrastructural projects who are referred to as tower crane operators.

The Construction Regulations of 2003 (2003:4) define a competent tower crane operator as the person who has the *knowledge, training, experience and qualification specific to* tower crane operations. The Construction Regulations emphasize that the qualification and training shall be registered in terms of the South African Qualifications Act of 1975. It does appear from the definition that the lack of adequate *training, knowledge, experience and qualifications* are the key influences which contribute to the lack of safe operation of tower cranes by operators where many injuries, fatalities and casualties have been attributed to.

The key activity done by tower crane operators during construction project execution, the Erection Operation is defined *as the practice of lifting loads vertically, swinging them, and holding them in a set position for securing* the load until the equipment is released. The *lifting needs to be controlled so that the loads maintain the alignment orientation that is horizontal, vertical or inclined and required for its placement.* The operation requires two or more pick up hooks or slings in order to maintain safe lifting. The importance of the erection practice is the requirement that the tower crane operator be adequately trained in a manner that facilitates the efficient erection of building, civil and infrastructure projects. (Day and Benjamin, 1991:237)

2.3 Procurement of Tower Cranes in Construction

The decision to use certain construction plant and equipment such as the tower crane influences the construction method needed to deliver projects, the timely and cost effectiveness of construction delivery. The selection and actual use of tower cranes depend on the raw materials and the process required in converting them into finished buildings, roads and infrastructural

projects. The main contributing factor to a successful delivery of building, civil and infrastructure projects lies with the selection or procurement of suitable plant and equipment such as the tower crane. This includes the skills and experience of the plant operator which contributes significantly to the performance of the tower crane and the productivity in the construction project delivery. (Day and Benjamin, 1991:1-3)

The selection or procurement (Day and Benjamin, 1991:12) of tower cranes is also influenced by factors associated:

> "*The time allowed by the construction contract*" to deliver the project and its nature such as building, road or infrastructure.
> "*The necessary and economic timing of sequential construction activities*"
> "*The relative effect of overhead costs on the total costs of the construction project*"
> "*The variance of equipment rentals rates with the time it takes to complete the project*"

The factors associated with the time allowed to complete projects, costs on total construction costs which affect the profitability of projects to contractors and the variation of tower cranes rentals rates in relation to the construction projects place more pressure on contractors to effectively and efficiently utilize tower cranes. This is because tower cranes are inefficient in their nature in terms of the time (cycle time) it takes to lift, move and unload and the lack of technology to view the whole site. Prior studies also found that tower cranes are used for 50 – 80% of the time they spend on sites due to lack of efficiency in relation to the cycle time. (Rosenfeld and Shapira, 1998:288)

2.4 Role of Tower Cranes in Construction Projects

It is interesting to note that Karl Marx claimed that *the value of a commodity is equal to the labour required to produce it* (Yang, Edwards and Love, 2004:279 citing Gingrich 1999). The authors further argue that the amount of labour required to produce construction projects has been reduced through the use of construction plant and equipment such as tower cranes. Tower cranes have improved the efficiency and productivity that labourers and site personnel could not provide on their own (Shepherd, Kahler and Cross, 2000:83).

Modern construction methods are now more dependent on the efficient and effective use of construction plant and equipment such as the tower crane. The tower crane has also proven its reliability to contractors in terms of generating lower production costs, increased production rates or productivity, creating a non-stop production system where works could be undertaken on a twenty four hour basis, increased competitiveness and enhanced profit margins. (Yang, Edwards and Love, 2004:279 citing Sherwin, 2000)

Tower cranes depend on the skills and competence of the crane operators in order to achieve greater performance and productivity and are not self-reliant like robotics. Prior studies revealed that machine utilization rates in construction projects range from 40% to 80% primarily because of the skills and competence of operators of plant and equipment. The productivity is affected and generally lower where tower crane operators are not well trained in facilitating the execution of construction projects. (Yang, Edwards and Love, 2004:279 citing Cabahug, 2003 and Atkinson, 1999)

Tower cranes are an integral part of many construction project delivery processes and *they are associated with a large fraction of construction deaths*. The *tower cranes are involved in up to one third of all construction and maintenance fatalities*. Previous research presented the need to have adequate training and skills development of tower crane operators and banksmen or signalers in relation to the safe operation of tower cranes and to adequately apply the necessary techniques in the delivery of construction projects. (Neitzel, Seixas and Ren, 2001:1106)

An issue that raises many concerns is that the current inadequate holistic training practices given to tower crane operators have accidents and fatalities associated with the use of tower cranes (Ma, Fang and Zhang, 2008:12194). It becomes important to understand the current structure and the characteristics in which tower crane operators are trained in and determine the factors that continue to affect adequacy in the training and skills development of tower crane operators.

An earlier study (Neitzel, Seixas and Ren, 2001:1107) acknowledged that tower crane operators play a significant role in lifting, carrying and moving different types of construction materials and unstable loads in a construction project where there are many other operatives working. They also carry the responsibility of unloading construction materials next to workers who are not associated with the work of the crane. In many instances they cannot see the exact place to

load and unload the construction materials during project execution due to the complexity and nature of construction projects. This also shows that the technology in tower cranes is not yet enabling the tower crane operators to see the site environment to which loading and unloading can be done with training also lacking in managing those challenges.

When a load is mishandled, not properly dropped or when the crane eventually tips, injuries and fatalities do occur and damages to the important phases of project delivery also occur and lead to related project delays challenges. In other instances, personnel not employed directly by the contractor responsible for the tower cranes and pedestrians do also get injured and killed from the use of tower cranes due to the inadequate training of tower crane operators. (Neitzel, Seixas and Ren, 2001:1108)

Adequately trained tower crane operators have been found to be amongst the highly trained and highly paid part of the non-management personnel of many contractors (Neitzel, Seixas and Ren, 2001:1108). This is also the problem in the SA construction industry where adequately trained tower crane operators are paid more than the operators who utilize the excavators, TLBs, rollers and compactors due to the significant role they play in project execution and delivery.

This has increased the scarcity of well-trained crane operators which results in contractors relying on workplace based training of banksmen or signalers as crane operators. In many instances these crane operators earn lower than those not trained by the contractors which further reduces their morale and motivation in delivering projects without plant related accidents and equipment breakdown.

A critical observation in tower cranes was that the *cranes differ from industrial cranes in that each lift typically involves a load with unique properties and characteristics. This makes every lift to have the potential to modify the crane maneuverability, stability and load capacity*. The changing circumstances of lifting loads require crane operators to be adequately trained so that they can use the *tower crane handling properties and limitations* safely in the delivery of construction projects. (Neitzel, Seixas and Ren, 2001:1108)

What remains a curious situation is the observation that tower cranes are less efficient in their nature since they are manually operated and susceptible to accidents and fatalities on sites and require adequately trained tower crane operators (Ma, Fang and Zhang, 2008:12194). It is also

unavoidable that the operation of tower cranes is conducted in an environment that is interdependent between the site operatives and the construction materials necessary to be moved, lifted and unloaded during a busy construction project delivery which poses crane related accidents that have become endemic in many countries (Shepherd, Kahler and Cross, 2000:83).

It becomes interesting to examine and explore from the perspective of tower cranes operators from the manner in which they were trained in dealing with the factors that cause accidents during a busy construction project delivery process from the training practices they were given.

2.5 The International Labour Organization Standards on Tower Crane Training

The International Labour Organisation (ILO, 1995:51) emphasizes that before a tower crane is utilized on construction sites, site managers and contractors should consider all the key factors that could affect its safe use. These are factors such as:

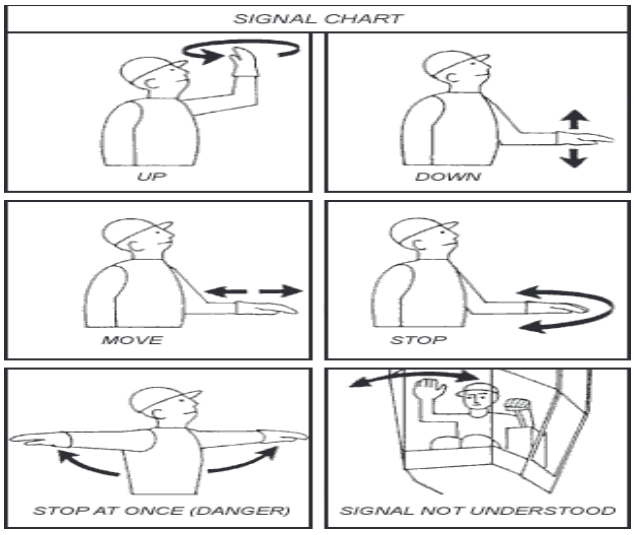
The weight, size and type of load it will have to carry and lift
The maximum reach and radius required for it, the state of the site and the type of the ground
The need for trained crane operators and signalers

This indicates that the need for adequately trained tower crane operators and signalers or banksmen is one of the key factors affecting the safe use of tower cranes in delivering construction projects.

Key attributes emphasized by the ILO (1995:51-53) in relation to the training and skills development necessary for tower crane operators are that:

They must be *over the age of 18*
They must be *assisted by signalers or banksmen* during the operation of the crane
They must be able to *utilize the signaling system such as the radio or telephone when the crane operator cannot see* the load throughout the lift
Hand signals should be clear and distinct and follow a recognized code or system

Figure2. Hand Signals and Communication of Tower Crane Operators.



Source: ILO (1995:51)

Crane operators must not *exceed the marked safe working load to which the slings and ropes should be used for in the operation of the crane*

Loads must be lifted vertically because any out of vertical lifting may result in crane collapse

Loads having a larger surface area must not be lifted in windy conditions

The crane operator *must understand the positioning of the tower crane so as to ensure that the crane boom is free to turn through 360º around the tower*

Crane operators *must understand the maximum wind speed at which tower cranes may be safely operated as recommended by the manufacturers*

It is this key attributes that the study focused on examining because of the manner in which tower crane operators are trained in the signaling or listening of instructions from banksmen or signalers in the loading, moving and lifting of construction materials which continues to result in accidents and fatalities. This includes the concern that many tower crane related accidents are also due to overloading of construction materials.

This is because many accidents related to tower cranes are due to poor communication from the signaling tactics used by banksmen or signalers and misunderstood by tower crane operators. A previous study found that in many instances tower crane operators do not have a clear picture of the material to load, unload and lift and rely on signalers or banksmen for proper communication and hence safe operation of tower cranes (Rosenfeld and Shapira, 1998:285).

The ILO (1995:51) also observed that overloading of tower cranes causes the vital parts to be stressed beyond the rated capacities of the tower cranes. Previous research also found that overloading of tower cranes by banksmen was a factor contributing to accidents on sites (Tam and Fung, 2010: 208 citing Shapiro *et al* 2001 and Beavers *et al* 2006). Overloading of tower cranes results in the crane losing its stability and the strength necessary to lift materials on sites with cracks in the crane structure remaining (Aneziris *et al*, 2008:872).

This is normally caused by a crane operator and banksmen who are not properly trained in estimating the amount of load or the construction materials to be lifted and moved on sites. The problem is that the inadequately trained operators may lower a load at a speed that is too high so that when he applies the brakes, the load jib or tie jib snaps and result in fatalities, accidents or damages to materials and the structure under construction.

The ILO (1995:53) further emphasized that in order to prevent overturning of the tower crane, it must either be anchored to the ground or securely counterweighted or ballasted in order to prevent accidents and ensure safe operation of the tower crane during construction project delivery. This was also the problem where a tower crane collapsed at New Canada Square in 2000 and at Liverpool in 2007 where the crane operator and operatives died due to lack of training in the ballasting or in counterweighting of the cranes (HSE, 2009:5)

The ILO recommends that because a ballast material may be moved, a diagram of the counterweight or ballast should be fixed to the tower crane and the ballast should be checked against this whenever the crane is erected and after bad weather.

It appears that the training in counterweighting or ballasting of the tower crane forms an important part of the basic training given to tower crane operators because it contributes to crane related accidents. This is also because cranes in many construction projects are not owned by the contractors who use them on a day to day basis but hired from plant and equipment hire organisations. The general contractors rely on the training and experience of the crane operators in assessing whether there was a movement in the ballast or the counterweight which may further cause tower crane related accidents in our construction projects.

It was proposed that future research on the safe operation of tower cranes should focus on the risk aspects emanating from the manner in which tower crane operators including banksmen or

signalers are trained in operating a tower crane (Neitzel, Seixas and Ren, 2001:1109). This is the gap that exists in literature that remains not researched which also forms part of the key aspects of basic training given to tower crane operators.

2.6 South African Legislation Governing the Training of Tower Crane Operators

The Construction Regulations of 2003 which emanate from section 43 of the Occupational Health and Safety Act No 85 of 1993 play an important role in influencing the operation of tower cranes. The Minister of Labour is empowered to make regulations such as the Construction Regulations which affect the training and skills development of tower crane operators in a manner that seeks to promote the health and safe operation of tower cranes during the delivery of construction projects.

The Construction Regulations of 2003 section 20 (2003:56) place an obligation to the contractor to ensure that every time a tower crane is used:

> *Tower crane operators are competent to carry out the work safely*
> *The tower crane operators are physically and psychologically fit to work in such an environment by being in possession of a medical certificate.*

The Construction Regulations place an obligation on contractors to ensure that tower crane operators are competent in carrying the construction works in a manner that does not pose a health and safety threats to those working in the delivery of construction projects on sites. It does appear from the Construction Regulations that contractors carry the responsibility of training tower crane operators to adequately utilize tower cranes such that there are no injuries, fatalities and casualties emanating from the use and operation of construction tower cranes.

The Construction Regulations (2003:13-14) also place an obligation to the clients in relation to the use of construction plant and equipment such as the tower crane in order to ensure compliance with the Act to:

> *Prepare health and safety specifications for the construction work and provide them to any principal contractor who is bidding or appointed* and will result in the use construction equipment and plant such as the tower crane.

To take reasonable action and steps to ensure that each principal contractor health and safety plan is implemented and maintained on site in relation to the use of construction equipment and plant such as the tower crane.

This include *periodic audits at intervals mutually agreed upon between the client and the principal contractor but at least once a month* in order to ensure that the tower crane is operated in accordance with the safety specification of the client and does not pose risks and hazards to those working on sites. (Construction Regulations, 2003:13-14)

The Construction Regulations clarify the responsibility carried by clients in ensuring that tower crane operators used by contractors are adequately trained, possess the necessary qualifications and experience in order to conform to the health and safety specifications prepared by the clients necessary for the use of tower cranes. This is because clients also carry the costs of accidents that occur on construction projects emanating from the use of inadequately trained tower crane operators during construction project delivery (CIDB, 2009:9).

Cost of accidents in the SA construction industry (both those that are direct costs such as wages and medical expenses and indirect costs such as pain and suffering, incident investigations, production loss and delays, overtime and legal fees, funeral and compensation due to fatalities) are estimated at R3.5 billion per year (CIDB, 2009:8). The CIDB (2009:9) further claims that these costs of accidents in individual projects are estimated at 5% of the contract value of construction costs which are then passed to clients.

It does appear that the costs of accidents emanating from inadequate training and skills development of tower crane operators increases the costs of managing and delivering construction projects to clients in manner that is not sustainable and cost effective.

2.6.1 Skills Development Act in relation to Tower Crane Operators

The Skills Development Act of 1998 (1998:24) defines a Skills Development Programme (SDP) as a learning programme that is occupationally based, when completed leads to a qualification that is recognized by the South African Qualification Authority, uses training providers and complies with prescribed requirements

Basic skills development programmes used to develop tower crane operators are defined as comprising *specific and general* training programmes. The *general or basic skills refer to training in which the employee gains the skills that can be used at most workplaces*. (Grobler and Warnich, 2005:300)

These are skills that the tower crane operator acquires so he can apply in operating a tower crane in delivering and executing a construction project in lifting, unloading and moving of construction materials from one place to the other without causing accidents. It does appear that the basic skills given have not yet enabled the tower crane operators to deliver projects in a manner that is not associated with accidents and hazards.

Specific training refers to the method of training in which the tower crane operator "*gains information, knowledge and skills that are tailored specifically to their own workplace*". This includes the specific company strategies, methods and techniques of delivering and handling different construction contracts such as building, civil and infrastructural projects. (Grobler and Warnich, 2005:301)

It also appears that the specific training continues to lack adequacy since there is a lack of *information, knowledge and skills* required for construction projects in operating tower cranes. These are aspects which remain a concern that need to be addressed or improved in the training and skills development of tower crane operators.

Tower cane operators learn the necessary skills of operating the equipment on the job, with formal training which includes both theoretical and practical training understood to provide more specific and necessary training. Given the nature of construction equipment such as tower cranes and the construction materials they handle, it becomes expensive to adequately train construction plant and equipment operators such as those who operate tower cranes. (Wang, Dunston and Skibniewski, 2004:1)

This is the practice which continues to contribute to tower crane related accidents due to the use of poorly trained operators primarily due to costs reasons in the construction industry.

Skills development in the SA construction industry is governed by the Skills Development Act of 1998. A recent study (Mayet, 2010) investigated the Skills Development Programmes (SDPs)

which lead to a recognized qualification in the construction industry. These are Skills Development Programmes where tower crane operators receive their training in tower crane operations. The SDPs were found to be the following:

Learnerships
Apprenticeships
Recognition of Prior Learning
Private training providers

These are SDPs that the study sought to explore and examine in relation to the current constraints or bottlenecks being experienced in their implementation. This is because the SDPs have differences in the manner in which tower crane operators acquire the *skills, training and knowledge* needed in the operation of tower cranes. The main differences which influence the performance of tower crane operators in a construction project environment from the SDPs are those associated with:

a. *Structure and Curriculum* received from training
b. *Methods of assessment*
c. *Workplace experience*
d. *Requirements for entry* in the training programme. (Mayet, 2010: 22)

It is the abovementioned differences which the study sought to examine, explore and research as they lead to the current lack of adequate training and skills development in tower crane operations due to the manner in which they are implemented by contractors and private training providers.

The Industry Training Authority (2008: 6 - 12) in Canada attributes a competent tower crane operator to be trained in five main *Knowledge Areas* which is the recommended *Structure and Curriculum* necessary in a classroom and site environment for operating a tower crane:

Safety

This is in regards to the safe working practices of operating tower cranes in a manner that does not prejudices the health and safety of those working on site and members of the public in general including the use of tower crane related PPE. It also ensures that tower crane

operators understand the obligation of applicable Occupational Health and Safety Act or the Construction Regulations in a site environment. The knowledge area also ensures that the tower crane operator understands the applicable regulations in regards to the use of tower cranes close to power lines, cable hazards and high or low voltage environment.

Communication

Communication ensures that the tower crane operators are able to use and interpret hand signals in lifting loads; effectively use radios where he cannot see the environment of loading and lifting to effectively communicate with the signalers or the banksman.

Rigging Knowledge

The knowledge area ensures that an operator is competent in the applicable lifting theory and forces or loading of materials; the installation, inspection and storage of wire ropes which ensures that no breakage occurs; types and functions of wire ropes and the chains necessary for lifting loads; rigging hardware, tools and manuals. The knowledge area also ensures that the operator is able to assess the weight of loads and their lifting in order to avoid overloading of materials.

Maintenance and Servicing

The knowledge area ensures that tower crane operators are able to conduct daily, monthly, annual, special or start of work shift inspections in order to recommend the necessary maintenance and service required to technicians. It also include the skills of conducting load limits and travel tests on sites and keep the necessary logbook of all maintenance and services required or conducted in the tower crane so as to ensure that it is operated in a mechanically sound operating condition.

Tower Crane Operations

The knowledge area ensures that the operator knows the duties and responsibilities of operating a tower crane in general and in a multi crane site; applicable protocols of leaving a tower crane unattended during and after days work so as to avoid unforeseen circumstances that can pose danger to the structure under construction or the neighbouring properties; how

weather conditions affect the use of tower cranes due to winds or rains; the protocols of dismantling and erection of tower cranes to avoid poor ballasting and anchoring of the crane.

The knowledge of tower cranes ensures that the operator is able to differentiate the types of tower cranes used in construction projects, the craning concepts, hoisting terminology and its functions and the related regulatory requirements in tower cranes

The South African Qualification Authority (2011a; 2012b; 2012c; 2012d) registered Unit Standards which are recommended by the Department of Labour (2011: 12) National Code of Practice for Training Providers of Lifting Machine Operators to be the ones applicable in ensuring that tower crane operators are competently trained to operate a tower crane also recommend the above main *Knowledge Areas* or *Structure and Curriculum*. The problem from literature appears to be the actual enforcement or application of all the Knowledge areas recommended in the Unit Standards to Training Providers of tower crane operators. The result has been demonstrated by shortened training programmes with fewer competencies attained.

However, National Code of Practice (2011:12) for Training Providers of Lifting Machine Operators does not stipulate all the knowledge areas that a tower crane operator needs to be trained on. The National Code of Practice refers to the Unit Standards registered with SAQA for the training of tower crane operators. The Code of Practice requires that *the accredited training provider to keep available training system documents as required by the ETQA accreditation criteria*. It also says that "*the accredited training provider must lead to the competent operation of the lifting machine/equipment within the specific code against the registered unit standard."* The major parts that remain missing from the National Code of Practice are the knowledge areas which ensures competency in the operation of tower cranes.

The practical or workplace based training from the Unit Standards are also the ones that do not emphasize the duration of practical work experience that a tower crane operator needs to gain before he can be issued a tower crane operator certificate.

It becomes important to understand how the implementation of the above-mentioned Skills Development Programmes adequately and effectively addresses the problem of tower crane

related accidents and fatalities from the manner in which tower crane operators are trained and skill developed from the perspective of the tower crane operators themselves.

2.6.2 Learnerships in Tower Crane Operation

The Skills Development Act (1998:12) defines a Learnership agreement as an agreement that is entered into for a specified period between:

A learner
Employer or a group of employers
Or training providers or group of training providers accredited by SAQA

Learnerships are skills development programs which aim to address the problem of skills shortages through offering a combination of workplace or on the job training and the theoretical aspects of training. The author acknowledges that the learnerships provide a qualification which is nationally recognized in terms of the National Qualification Framework (NQF) to successful learners. The common qualification obtained by tower crane operators is the NQF level two national certificate which has been found to be offered by few organisations which are registered by SAQA (2011) in the applicable Unit Standards. (De Louw, 2009:2)

The problem is that other training certificates currently being obtained from private training providers by crane operators do not contain the necessary outcomes or the knowledge areas needed for the operation of tower cranes in a manner that does not pose health and safety threats to those who work in construction projects, the crane itself and those not working on sites such as pedestrians and third parties.

Learnerships are divided into two categories or sections. These are section 18.1 which is a learnership aimed for people who are already employed and aimed at improving their skills and competence in a workplace environment. The learnership agreement does not affect the employment contract which already exists between the learner and the employer. Section 18.2 is aimed at learners who are unemployed. In this case the contract of employment between the learner and the employer is then agreed to with the employer in the presence of the learnership agreement. (Mummenthey, 2008:11)

The Skills Development Act of 1998 places obligations between the learner, employer and the training provider in the provision of learnerships.

The Employer is obligated to:

Employ the learner for the period specified in the agreement
Provide the learner with the specified practical experience
Release the learner to attend the practical and educational training specified in the learnership agreement

This emphasizes the aspects of learnerships as an agreement which contain practical and theoretical aspects of training.

The Learner is obligated to:

Work for the employer
Attend the specified education and training specified in the learnership agreement

The Training Provider is obligated to provide:

The specific education and training for the learnership agreement.
The learner with the support specified in the agreement for the fulfillment of the training aspect.

A recent study (Mummenthey, 2008:12) defined and holistically summarised the concept of learnerships as the "*work based, demand-led route of learning that enables the employed and unemployed learners to acquire a nationally recognized qualification in a regulated (contractual and legislative) environment, while being employed and earning a minimum allowance. The learning approach is holistic in a sense that it consists of both the on the job practical workplace experience (min 30% – max 70%) as well as off the job institutional learning. Its core focus is on the outcome of the learning process."*

The recent study (Mummenthey, 2008:12) further stressed that *"the outcome is intended to equip the learner with applied competence closely linked to labour market needs, which provides a thorough basis for employment and continued lifelong learning. The dual system of learning forms a central element of South Africa Vocational Education and Training (VET) system"*

The VET system aims to encompass the wide range of courses and skills necessary to help and prepare tower cranes operators for entering workplace and employment. Its primary scope and objective is to provide learners with:

> *Knowledge and skills or competence directly related to work or employment either with one sector, other sectors or for specific employment*
> *Enhanced labour market opportunities for those currently in work or employment* (Niassembly, 2008:1)

Learnerships are a system which is based on the levies paid by private employers and are regulated by the Skills Development Levy Act of 1999. These are employers which have a Pay As You Earn (PAYE) employee payroll which exceeds R500 000 and are obligated to contribute 1% to the fund. (Mummenthey, 2008:18)

A previous study noted that CETA experienced problems with the grants arising from the levies paid by employers in the construction industry. This were challenges and constraints arising from *double payments, fraudulent claims by unscrupulous training providers and increased size of the grants relative to the funds in its disposal.* The financial mismanagement of the grants and levies resulted in the *loss of trust by contractors and industry practitioners which further affected training and skills development* in the construction industry. (Mummenthey, 2008:18 citing Christionson 2007 and Thejane 2007)

2.6.3 Apprenticeships in Tower Crane Operation

The Apprenticeship Act of 1922 required black Africans who wanted to participate in apprenticeships to have a minimum level of education of Standard VII. It is noted that these measures prevented and ensured that blacks who had little opportunity of obtaining or passing Standard VII do not participate in apprenticeships. This was because of separate development and segregation policies of the previous government of SA. (Okoth, 2006:158)

The apprenticeships in the construction industry and in tower crane operations prior to 1994 became inclusive of the Black population after the Wiehan, Riekart and De Lange Commision which was conducted from 1977 to 1981. This was because of the acute shortages of skilled

construction artisans such as the tower crane operators and increased demand from Blacks to have access to "*formal education, technical colleges and enterprise training*". The apprenticeships declined due to reasons associated with:

> "*General quality of the training and their control*
> *Ability of the system to meet current technological skills requirements and the low quality of workplace training*
> *Unsupervised and unstructured on the job training*
> *Lack of theoretical input*
> *Artisan status was attributed after 5 years irrespective of passing the trade test*
> *Did not cater for all age categories, gender and groups, was generally male dominated and primarily used in industrial sectors*" (Mummenthey, 2008:24 citing HSRC, 1984)

The HSRC argued for a *more responsive, inclusive and flexible skills development system that meets the needs of all stakeholders* in the construction industry (Mummenthey, 2008:24 citing Akojee *et al* 2005, Carton and King 2004, Kraak 2004a: b)

There were 351 people enrolled in apprenticeships with CETA from 1 April 2001 to 31 March 2005 compared to 1042 in learnerships by 2004 in the construction industry. The apprenticeships will be replaced by learnerships and there will be no new apprenticeships in the construction industry registered with the Department of Labour. A specific date will be made public where all existing apprenticeships will be converted to learnerships. (Mummenthy, 2008:27 citing Erasmus *et al* 2007)

The apprenticeship is one of the pathways that lead to a recognized qualification in tower crane operations as found by Mayet (2010). The current use and decline of apprenticeships in training and developing tower crane operators in the construction industry by contractors and contractor plant hire organisations becomes interesting to understand. This would then clarify the extent to which the training received in apprenticeships may be a contributing factor to the fatalities and accidents associated with the use of tower cranes in the construction industry.

2.6.4 Recognition of Prior Learning in Tower Crane Operation

The Recognition of Prior Learning (RPL) is defined as a system which makes "*formal acknowledgement of skills, knowledge and competencies that are gained through work experiences, informal training and life experiences*" The international community "*recognizes learning acquired outside of formal working environment*". This is because of reasons and factors associated with "*social equity and improved access to education for traditionally underrepresented groups*". The National Qualification Framework legitimized the knowledge and working experience gained by previously disadvantaged individuals during the previous government through the Recognition of Prior Learning (RPL). (Alexander *et al*, 2011:153 – 154 citing Conrad, 2008)

In Australia, institutions of higher learning are obligated to recognize non-formal learning and work experience gained into credits leading towards a tertiary qualification. The SA construction industry "*RPL system allows candidates the opportunity to demonstrate their knowledge and skills gained through a series of assessments specifically designed to assist them in displaying their competence*". At the end of the assessment each candidate tower crane operator is "*issued with credits for the learning that they have been able to display*". These credits lead to a nationally recognized qualification through "*recognition of skills acquired from formal training, workplace experience or general experience*". (Alexander *et al*, 2011:153 citing Pitman, 2009)

The RPL system is important to tower crane operators who were also trained through non formal system such as the trial and error system of training where employment was what they could only obtain during the previous government of SA as noted by Shall (1977:3). It is worth exploring the extent to which previously disadvantaged tower crane operators are assessed and recognized of their prior learning in tower crane operations in the RPL system. This is because of the different backgrounds and the type of training they receive in the industry being associated with many undesirable accidents in the delivery of construction projects.

2.6.5 Private Training Providers in Tower Crane Operation

Despite workplace based training programmes which are seen as beneficial, the SA construction industry is still facing the challenge and constraint of having private training providers who offer programmes which are not accredited by Construction Education and Training Authority or South African Qualification Authority (Yudelowitz, 2004:141). These are training providers who offer training programmes ranging from 5 -15 days to novice tower crane operators (Learning exchange, 2011).

It also shows the non-standards and lack of uniformity in relation to the duration of the programmes currently offered in plant operation and the expected learning outcomes or knowledge areas needed to be obtained in the different training programmes. Learnerships offered by Contractor Plant Hire Association (CPHA) take up to twelve months to complete where a learner is then issued with a NQF Level 2 certificate in construction plant operation primarily in earthmoving plant and equipment (CPHA, 2011).

The key factors that constrain private training providers in complying with the National Code of Practice or the National Certificate in Plant Operations for courses which includes tower cranes becomes significant to explore and examine from the training obtained by the tower crane operators themselves. These constraints will bring to the attention of policymakers the challenge of having training providers offering courses which are not aligned to the needs of the industry and also not aligned with SAQA registered Unit Standards. This will help make the training and skills development of tower crane operators to have more reliability and credibility in relation to quality and the learning outcomes expected.

It is noted that training programmes of plant operators in the UK have received enormous criticisms by industry practitioners due to lack of consistent standards in their implementation and actual training of operators (Edwards and Cabahug, 2002:29). Part of the reason there are tower crane accidents is because the *teaching methods and processes* have not been improved (Dangl, Xu and Cheul, 2010:206). The training programmes are characterized by the problem related to outdated curriculum which is not at par with industry demands with practical training very limited (Dangl, Xu and Cheul, 2010:206). The importance of the curriculum or the knowledge areas that ensure competent operation of tower crane is that a recent study (Mayet,

2010: 22) found the curriculum to be one of the key factors affecting the performance of tower crane operators from the Skills Development Programmes offered.

This is also valid to the South African environment where training received in learnerships, apprenticeships, workplace based training programmes and that from private training providers differs in terms of the training period, the content of the training programme or knowledge areas in relation to the practical aspects, maintenance training, health and safety training, the duration spent in a site environment and the classroom learning offered before a tower crane operator is issued with a certificate in tower crane operations.

The standards of quality and competence of UK construction plant operators remain questionable and doubtful (Edwards and Cabahug, 2002:28). This is because of operators without formal training continue to operate construction plant and equipment primarily due to the existence of unscrupulous training providers. These are training providers who offer the shortened training programmes and also claim to be registered with the Construction Education and Training Authorities (CETA) in the SA construction industry.

The lack of efficient and effective training of plant operators is also because many Construction Management (CM) professionals who work as site managers, engineers and foreman lack formal training in plant management and operations. This is because plant management courses in the UK in courses such as in Civil Engineering and Construction Management are not compulsory to the programmes but optional. The contributing factor is that the CM professional lack the proficiency to determine the competence required from operators and they rely on operator certificate or qualification in assessing their competence. (Edwards and Cabahug, 2002:29)

This also brings into question the extent to which CM professional who also work as site health and safety officers are trained to manage construction plant such as tower cranes in the South African construction industry. This is because plant management also do not form the important aspect of training graduates despite the investments and the role they play in delivering construction projects. This are factors the study sought to explore and examine from the tower crane operators in relation to the contribution they make to tower crane related accidents during construction project execution and delivery.

2.7 Challenges facing Skills Development in Tower Crane Operation

The section covers the general challenges affecting skills development in tower crane operations. This was examined from the nature of construction projects, contractor practices and attitudes towards skills development, impact of poverty related diseases and life skills training, challenges and constraints affecting the operation of tower cranes.

2.7.1 Nature of Construction and Building Projects

Construction projects are volatile and characterized with proximity values. The cyclical and volatile nature of construction projects presents a crucial challenge in the implementation of Skills Development Programmes (SDPs) such as learnerships. Contractors do not have certainty in relation to continued workflow or new contracts so as to commit to long term learnership agreements such as those in tower crane operations which normally take up to four months to complete. Contractors exercise caution in signing and committing to learnership agreements. This has also affected the intake of young or new tower crane operators in the learnerships (Mummenthey, 2008:42 citing CETA 2005, Goldman 2003 and CIDB, 2004).

The nature of construction projects is that which relates to extensive subcontracting and the use of casual labour in the construction of projects. Due to subcontracting and casual labour in the construction industry, general contractors have decreased their responsibility of training and developing their own tower crane operators who facilitate the construction delivery process as they are no longer trained and employed directly by them. Tower crane operators are normally trained by the general contractors and the plant hire organizations which own the plant and equipment. (Mummenthey, 2008:42)

Given the current challenges in relation to the current inadequate holistic training practices by contractors, it remains important to explore the factors which continue to affect adequate holistic training of tower crane operators in the SA construction industry by all the training organisations who offer training and skills development programmes from the perspective of tower crane operators themselves.

2.7.2 Contractor Practices and Attitudes to Skills Development Programmes

South African contractors hold the view that skilled tower crane operators are easily employed from other organizations compared to training them in-house. This is because contractors have less incentive to train in-house, have a less favourable traditions and attitudes towards partnering for formal work based training. (Mummenthey, 2008:37 citing Kraak 2003)

This is also the problem that is currently being experienced with other contractors who do not have learnership programmes for their employees or the unemployed in relation to tower crane operations. The contractors prefer to hire skilled operators than to train and develop them from the pool of workers and labourers they currently employ.

A latest study (Shukri, 2010:7) conducted in Malaysia found that there is a disturbing practice by contractors who employ less qualified and inexperienced tower crane operators due to reasons associated with profit maximization, less importance is placed on health and safety issues that may result. The study noted the need to have adequate training of tower crane operators in order to reduce and minimize crane related accidents.

2.7.3 Poverty Related Diseases and Life Skills Training

Prior studies noted challenges affecting Skills Development Programmes (SDPs) and the training of tower crane operators to be those associated with poverty related diseases. These are diseases such as HIV/ AIDS, cholera, malaria and tuberculosis. The illnesses and deaths arising from the poverty related diseases affect the supply, actual productivity, performance and training of skilled tower crane operators. It also results in the loss of investment to contractors on the resources spent on SDPs to tower crane operators. (Mummenthey, 2008:38)

HIV / Aids remains one of the serious threats and a major challenge to developing and training tower crane operators (Mummenthy, 2008:38 citing DoL 2006, McGrath and Akoojee 2007). This is because many of them are coming from previously disadvantaged communities where there are high levels of poverty and diseases.

Lack of adequate training in personal finance management to many tower crane operators indicates that life skills training is also needed in term of savings, budgeting, life and death cover

policies. Primary reason is because construction projects have proximity values as a result tower crane operators work away from their families. Further training is also lacking in terms of furthering their own training in tower cranes operations and management. The problem is that a majority of tower crane operators have 10 – 20 years work experience with no further training or development provided by their contractors in terms of becoming plant managers, site assistant foreman or assisting with offering training in tower cranes in a site based environment.

2.7.4 Challenges and Constraints facing Tower Crane Operation

Due to the uniqueness of the South African society, tower crane operators face the challenges and constraints associated with socio-economic issues arising from their backgrounds in the operation of construction plant. These are issues associated with growing up in previously disadvantaged communities where there is high unemployment, lack of financial resources in obtaining quality training and lack of career guidance in relation to blue collar trades. (Mafiri, 2002; Angus, 2008)

Other challenges and constraints are those associated with the poor image of blue collar occupations which are not seen as professional careers like those of engineers and accountants (Angus, 2008: par 12). The perception discourages youngsters in considering a career in blue collar occupations such as in tower crane operations with the result that many tower crane operators are ageing. It also becomes important to examine the current factors that discourage or constrain the training and skills development of the youth or youngsters in tower crane operations in the SA construction industry.

2.8 Tower Crane Related Accidents in the Construction Industry

Tower crane related accidents have required serious attention in the Netherlands due to the fatalities and deaths which emanate from the lack of adequate training and skills development of tower crane operators (Aneziris *et al*, 2008:872). A recent study (Sertysilisik, Tunstall and McLouglin, 2009:72) on tower cranes found that the causes of accidents in relation to the operation of tower cranes are attributable to:

Human error which relates to the lack of adequate operation of the tower crane by the crane operator

Failure of the equipment which also relate to the lack of adequate training in the basic maintenance of tower cranes

Different types of tower cranes because of the ease to which one is operated

Instability and lack of communication between the operator and the banksmen

The previous research showed that human error which is directly attributable to the lack of adequate training was a factor contributing 60% of all crane related accidents. Equipment breakdown or downtime where a tower crane stands idle on site due to lack of adequate maintenance and servicing was found to be contributing 30% to all crane related accidents. (Sertysilisik, Tunstall and McLouglin, 2009:72 citing Beavers *et al* 2005)

A study in Turkey (Arslan and Kaltakci, 2008:288 – 290) investigated the causes of a tower crane collapse which also killed the operator and badly damaged his car because the tower crane was not well anchored or fixed to the structure, lacked the adequate foundation support, did exceed the maximum load than the one it can carry from its end point which caused overturning of the tower crane. The importance of the study showed how adequate training in the risk factors that can cause accidents could have been avoided, the tower crane could have not collapsed had the operator insisted on the correct aspects of assembling a tower crane in a manner that does not cause accidents to occur. This also remains an important factor that requires adequate attention in the training and skills development of tower crane operators in the SA construction industry.

Prior studies (Neitzel, Seixas and Ren, 2001:1109) found that *the US Bureau of Labour statistics reported 23 states with over 1000 construction related injuries involving cranes and hoisting equipment, but had no specific information on the activities or actions leading to the injuries*. The study also showed that cranes in Britain are involved in 17% of all construction fatalities in that nation but did not identify the causal factors or environments leading to these accidents. This shows that the injuries related to tower crane operations internationally are not reported accurately so as to show that the inadequate training of tower crane operators is major cause and contributor of crane related accidents.

Tower cranes are responsible for 33% of construction fatalities, permanent disability and related casualties in the United States construction industry (Neitzel, Seixas and Ren, 2001:1106). In South Africa, the statistics released by FEMA (2011) in Table 2 indicated that the lifting machines and hoisting apparatus mainly tower cranes and related equipment are responsible for 28% of the proportion of the cost of accidents attributed to the use of construction plant and equipment in the delivery of construction projects as explained in the Problem Statement above. The figure could be higher because of widespread underreporting of construction plant related accidents and that FEMA represents 20% of predominantly larger contractors (CIDB (2009:2); Venter, 2009 citing Milford, 2009).

The key factor contributing is because of the nature and characteristics of the training and skills development programmes given to tower crane operators where other operators are trained in workplace based type of training with varying theoretical and practical aspects of the tower crane operations, others are trained in a more structured learnership type of training which includes theoretical and practical training and others are trained by private training providers who also offer varying degree of the necessary theoretical and practical understanding of the crane operations. Others were trained in the old system of apprenticeships which the current employers have abandoned. The structure and characteristics appears to be the contributing factor because of the various varying learning outcomes and knowledge areas attained which contribute to crane related accident.

Safety forms the vital part of training tower crane operators and is considered one of the Key Performance Indicators for a well-trained tower crane operator in the construction projects (Shall, 1977:45). It is interesting to note that " *if one considers the number of accidents that occur through operators working incorrectly then one realizes that much time and money could be saved if operators were taught the correct way of approaching tasks*" which also assist and help in reducing tower crane related accidents in construction projects (Shall, 1977:46). This also shows that there were incidences of tower crane related accidents prior to the study by Shall in 1977. The research sought to explore and examine the extent to which current training methods have contributed to the reduction of tower crane related accidents in the SA construction industry.

Large construction companies were utilizing the skills available in completing their projects prior to the 2010 FIFA World Cup. The practice emanates from the problem of having lesser qualified tower crane operators and artisans who passed examination but failed trade tests. Employers were taking advantage of using lesser qualified tower crane operators mainly through paying lower wages and salaries. This is because works do get completed on time and benefited their profitability but continue to pose health and safety risks. (Mukora, 2009:239).

Due to this situation, tower crane related accidents which occur on sites go unreported by some contractors (Venter, 2009). Costs of accidents in the SA construction industry are estimated at R161 676 473 million nationally in construction and the building industry (Seggie, 2011). Average costs of construction related accidents costs R14 800 each in SA (Seggie, 2011). The author argues that plant related accidents affect construction projects through lost construction time, low productivity arising subsequent to the accidents, more work to be done in the event of property damage or closure of the site by the Department of Labour until full investigation is conducted of the possible causes.

Other factors include loss of skills to people no longer able to perform their previous duties due to health and safety. This also involves the time needed to train young workers to carry the work or fill the positions left by those injured. Crane related accidents also results in legal ramifications and litigations to employers because of the responsibility they carry from the Occupational Health and Safety Act No 85 of 1993. In other instances this includes hefty fines, increased insurance costs and penalties, possibility of jail time and bad publicity. (Seggie, 2011)

There is widespread underreporting of plant and equipment related accidents in the SA construction industry. This makes it difficult to make a reasonable assessment of the fatalities and accidents that occur in the construction and building industry. A major contributing factor to plant related accidents in the construction industry is the enforcement of the Occupational Health and Safety Act No 85 of 1993. This is because government inspectors in construction and building works lack the necessary and *requisite construction expertise to spot noncompliance*. (Venter, 2009 citing Milford 2009)

It becomes necessary to establish whether the lack of enforcement of the health and safety legislation is one of the contributing factors to tower crane related accidents in the delivery of construction projects.

2.9 Operating Costs of Tower Cranes.

An earlier study (Day and Benjamin, 1991:32) noted that construction "*plant and equipment operating costs are incurred as the equipment is used* ". The operating costs "*include the costs of fuel, lubricants, filters, hydraulic fluids, parts and labour for maintenance and repairs, tires and operator wages*". The operating costs are directly related to the time the tower crane is utilized and differ with the nature and difficulty of the *operating conditions and the actual nature* of the building, road or infrastructure project constructed.

The maintenance skills of tower crane operators contribute to the reduction of operating costs of using tower crane. These are skills associated with the:

"inspection of machine lubricants and water levels
checking or looking for items working loose or any unpredictable events
listening for audible warning alarms
feeling unusual vibrations
smelling burnt fuses"

during the operation of the tower crane. (Edwards and Cabahug, 2002:23)

The existence of separate training in relation to maintenance of tower cranes and the operation is the practice that also contributes to tower crane operators not having the necessary skills and training in conducting basic maintenance of the equipment. The motive was to find out whether there were overlaps between the training received by operators in crane operations and those in plant maintenance due to the problem of accidents and fatalities which occur as a result of poor basic maintenance skills of tower crane operators.

The operational costs of construction equipment such as the tower crane *"should be the same whether the equipment is owned or rented"*. This is because the economic lifespan of construction plant and equipment is based on the minimum hourly cost of owning and operating

them. This means that the tower crane operator plays a vital role in the economic lifespan of the tower crane through its skillful operation and maintenance obtained from the training in tower crane operations. (Day and Benjamin, 1991:32)

2.9.1 Maintenance Training for Tower Crane Operations

An earlier study (Shall, 1977: 37, 18, 43) conducted in South Africa noted that maximum productivity of a tower crane cannot be attained by previous work experience only, but through fresh input of knowledge, technical training and the site environment the operator works under. The most effective way of reducing maintenance costs is through enhanced practical training of tower crane operators in using the tower crane efficiently. This includes basic daily maintenance in relation to keeping the equipment operating efficiently and effectively. The basic maintenance skills are those associated with checking and assessing the necessary "*engine coolant, engine oil, fuel level, hydraulic oil, transmission, hoist and brake oil, air cleaner services indicator*".

This includes the checking of oil leakages and any other faults which may exist during the construction of the works arising from the operation of the tower crane.

The study noted that a tower crane operator who is not properly trained would have consequences associated with the following factors:

"*Affecting his productivity through underutilization of his machine*"

This was a factor associated with the optimum, efficient and effective use of the tower crane in increasing productivity or the production of the works through skillful use of the equipment.

"*If the operator is not well trained he will decrease the effective life of the plant*"

This means that there would be tower crane breakdown incidences which emanate from poor training in relation to basic maintenance and skillful use of the equipment. Consequences of equipment breakdown are increased maintenance costs and construction project delays or downtime due to replacement or maintenance carried on site.

A previous study (Edwards and Cabahug, 2002:22) in the United Kingdom found that effective maintenance management depends on in-house maintenance training systems and resources of

contractors. This includes the ability of the tower crane operator to conduct basic day to day site maintenance of the equipment in order to ensure enhanced productivity of the tower crane. The failure of adequate maintenance results in plant breakdown and lost production in construction projects.

A prior study in the United States (Odeh and Battainel, 2002:72) found that contractors were of the opinion that the manner in which tower cranes are maintained and repaired immensely contribute to construction project delays. This is in many instances caused by the lack of basic maintenance skills and training of tower crane operators in the operation of tower cranes in terms of dealing with minor incidences that continue to be large problems due to delays in maintenance.

An important earlier study (Edwards and Cabahug, 2002:22) on the maintenance of tower cranes observed that the tower crane operator needed to be trained on manually monitoring machine condition, checking oil levels and assessing its condition in achieving greater performance and on conducting basic monitoring of the tower crane which includes:

Inspection of the machine lubricant and water level gauges
Looking and noticing items working loose
Listening and hearing of audible warning alarms
Detection of unusual vibrations and any burned fuses

Tower crane operators play an important and significant role in the achievement of efficient and effective plant performance. This benefits contractors through increased profitability and timely delivery of construction projects. The maintenance training is intended to give the necessary technical skills to tower crane operators in order to keep the equipment in a good working condition. (Edwards and Cabahug, 2002:22 -24)

2.10 Conclusions

The above chapter presented a critically examined literature review in finding the gaps that exist in literature that also need to be investigated in relation to the current inadequate holistic training practices given to tower crane operators in Gauteng, South African (SA) construction projects.

The above literature also presented the need to examine, research and explore the current structure and the characteristics of the training practices due to the apparent lack of effectiveness and the associated barriers from the Skills Development Programmes of training tower crane operators

The literature showed that the current inadequate holistic training practices fall short of the International Labour Organisations standards needed in the operation of tower cranes which continue to result in accidents and fatalities. It also showed that tower crane operators were not well competent in the operations of tower cranes as required by the Construction Regulations of 2003 section 20 which is an obligation placed to both contractors and the clients.

It also indicated that basic training and skills development of tower crane operators did not constitute a major focus of research as a contributing factor to tower crane related accidents and fatalities. This is the basic training needed in the adequate operation of tower cranes, the maintenance training, life skills and general personality training needed by tower crane operators and the examinations of the effectiveness of current skills development programmes used for the training of tower crane operators in the SA construction industry.

Prior studies examined in literature indicated the need to have adequate holistic training to tower crane operators due to the concerning deaths, fatalities and accidents associated with their operation in the SA construction industry in comparison to developed countries such as the US and the UK. Previous research also focused on the need for adequate basic maintenance training, improvements in the visual aspects of technology of tower cranes, the inefficiency of tower cranes which also increased the operational costs of tower cranes and delays to delivering construction projects

The previous studies have not focused on the current basic training practices given to tower crane operators in the SA construction industry from the perspective of the tower crane operators which continue to result in crane related accidents. It becomes important to have a clear research methodology which seeks to address the gaps in literature from the training given to tower crane operators in the broader filed of construction plant operations and management.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter sought to present and justify the research methodology used in conducting the study in relation to the current inadequate holistic training given to tower crane operators which significantly impacts health and safety in Gauteng, South African construction projects.

Research methodology is defined as a term related to the specific ways and methods used in order to understand the world or the phenomenon studied better (Trochim, 2006d). The research methodology used in the study was concerned with the *practice of how we come to know* or how we gain insight on the current inadequate holistic training practices given to tower crane operators in Gauteng, SA construction projects. The most important objective was in order to examine and explore the factors that remain inadequate in the training given to tower crane operators which still contribute to tower crane related accidents in the construction industry.

3.2 Objectivity

Researchers when undertaking a study seek to achieve objectivity in relation to the problem studied. The concept of objectivity is defined as a situation whereby the conclusions of the study in relation to the problem studied are little influenced by the researcher with his own perceptions, impressions and biases and in ideal circumstances not at all. (Leedy and Ormond, 2005:21)

Recent studies in Germany noted that objectivity refers to the *independency* of the conclusions of the study from the researcher who undertakes the study. This means that other researchers who may research the same problem using the same sample and techniques should arrive at the same conclusions. (Niedergassel, 2011:144)

The study aimed at achieving objectivity in relation to the lack of adequate holistic training given to tower crane operators in Gauteng, South African construction projects. It was achieved through judging the outcomes of research questions from the views and perspectives of tower crane operators and site foreman and managers which were not influenced by the researcher and through measurement.

3.3 Measurement

Objectivity can be achieved through identifying a systematic method of measuring the phenomenon or the problem under investigation. The concept of measurement is defined in research as a principle that seeks to "*limit the data of any phenomenon substantial or insubstantial so that those data may be interpreted and ultimately compared to an accepted qualitative and quantitative standard"*. (Leedy and Ormond, 2005:21)

Recent studies noted that *when the data of a problem studied consist of labels or names* such as the large, medium sized or crane hire contractor *are used to identify an attribute of the element, the scale of measurement is considered nominal. The scale of measurement of a problem studied is considered an ordinal scale if the data exhibit properties of nominal data and the order or rank* (large or medium sized contractors or crane hire contractor) *of the data is meaningful*. (Anderson, Sweeney and Williams, 2009:6)

The study limited the problem of inadequate holistic training of tower crane operators to those employed by large, medium sized and plant hire contractors (order or the rank) who normally provide or take direct control of the operation of tower cranes in the delivery of construction projects. This was because of the important role they play and the responsibility they carry in training and skills development of the tower crane operators, in order to deliver construction projects in a manner that does not pose health and safety hazards and risks during construction project delivery.

The ordinal scale of measurement enabled the study to understand the level and the different types of training and education attained by the tower crane operators in the construction industry (Leedy and Ormond, 2005:26). This is the training emanating from the trial and error system and the Apprenticeships from the previous government, Learnerships, the Recognition of Prior Learning (RPL), workplace based training and the training obtained from private training providers.

The importance of the ordinal scale of measurement, it enabled the study to investigate the effective and commonly used method of training tower crane operators in the SA construction industry. It then helped in understanding the extent to which the current structure and

characteristics of the skills development programmes used in training tower crane operators contribute to crane related accidents and fatalities that affect construction projects in SA.

3.4 Validity and Reliability

The importance of "*validity and reliability of measurement instruments is because they influence the extent to which one can learn something about the phenomenon studied, the probability that the study will obtain statistical significance in the data analysis, and the extent to which one can draw meaningful conclusions from the data*" (Leedy and Ormond, 2005).

The study prioritized validity and reliability of the data collected and the data analysis methods so that the conclusion drawn were meaningful and explained the exact factors of training tower crane operators that need to be improved for better project delivery.

3.4.1 Internal Validity

Internal validity of a research project seeks to find and determine causality in respect to cause and effect relationship (Trochim, 2006a). It tries to eliminate all other possible explanations which may be attributed to the phenomenon or problem studied (Trochim, 2006a). Recent studies (Rubin and Babbie, 2009:157) emphasize that internal validity also refers to the confidence we have in that the conclusions of the research project show that the lack of adequate holistic training is or not a cause to tower crane related accidents.

The research strived to find experiences, insights and perspectives of tower crane operators in relation to the factors contributing to the inadequate holistic training and skills development currently being given. This included the necessary aspects which still need to be developed in order to deliver construction projects in a manner that is not associated with crane related injuries and accidents in the construction industry. This ensured that there could be less or no possible explanations that could be claimed other than those obtained from the sampled tower crane operators selected and the site managers and foremen who willingly participated.

3.4.2 External Validity

External validity of a research investigation is the degree to which the conclusions reached would hold for other persons in other places and at other times" Trochim (2006b). Previous studies (Krishnaswamy, Sivakumar and Mathirajan, 2006: 145) in India emphasized that external validity refers to the extent to which the conclusions of the research project are generalizable.

The threats to external validity relate to how other people, at other places and times may prove that due to certain conditions peculiar to those existed while carrying the study may give different results (Trochim, 2006b).

The representativeness of the sample size used in the study which comprised tower crane operators from the larger and medium sized contractors who normally contract as general contractors in delivering projects and the plant hire contractors who extensively provide the training of tower crane operators, the study strived to make the conclusion generalizable. This means that if other people within the SA environment using the same sample and research methods carry the study again, will obtain similar results or conclusions to the one found by the study.

3.5 Addressing Bias in the Study

Bias in research is defined as any *influencing condition or set of conditions that singly or together distort the data* (Leedy and Ormond, 2005:208).

Bias in research is also defined as an influence that produces error in the problem under investigation. *Bias affects the quality of evidence in both qualitative and quantitative studies, threatens validity and trustworthiness.* In Qualitative research, reflexivity is the most common tool used in addressing bias as it guides against *personal bias in making judgments* and choices made during the interviews and surveys. *Reflexivity is the process of reflecting critically on the* nature and characteristics of the problem studied, *and of analyzing and making note of personal values that could affect data collection and interpretation.* (Polit and Beck, 2010: 107 - 110)

Bias in the study was also addressed by using face to face or telephonic interviews with the tower crane operators. The reason was that many tower crane operators did not have access to e-

mails and computers and would not have appreciably responded to questionnaires as compared to face to face or telephonic interviews.

Tower crane operators either employed by large, medium sized or plant hire contractors had an equal chance of being selected in the study. This was irrespective of whether they were working in government or private sector construction projects. Other reasons were because they were approached in current construction projects in Gauteng Province and their plant yards where their contact details were given and interviews arranged accordingly.

Bias in regards to interviews was addressed by using face to face and telephonic conversations with the site foremen and managers of the contractors on the construction sites visited. It was not the objective of the study to target them as part of the sample. They were included as the unforeseen sources of data as the interviews were continuing.

3.6 Data Collection

The word data comes from the Latin word "*dare*" which means "*to give*". Data in research are those pieces of information that any particular situation gives to an observer or researcher. Data is not the actual reality of the phenomenon studied or researched. *Research seeks through data to uncover the underlying truths* about a problem or a phenomenon under investigation. (Leedy and Ormond (2005:88 - 89)

The data collected in the study was from the perspectives and experiences, views and opinions of tower crane operators who play a pivotal role in the delivery of construction projects and who provided their insight in a manner in which training and skills development of tower crane operators could be enhanced for better construction project delivery. The data included the views, perspectives and insights from site managers and foremen who willingly participated during interviews.

Data in a qualitative and quantitative research design comes from many sources that the researcher may utilize (Leedy and Ormond, 2005:144). An earlier study (Goodwin and Goodwin 1996:130 citing Patton 1990) noted *the need for multiple methods of collecting data within a*

study in qualitative research *so as to corroborate the data collected and enhancing the trustworthiness of the information, different methods and different data sources can be utilized.*

This is the data that emanates from tower crane operators, insight from site foreman and managers and the literature which form the research sample of the study. Qualitative and quantitative research includes many forms of data in a single study. These are data obtained from the administered questionnaires, interviews and literature review. The main objective and goal of using multiple sources of data in qualitative and quantitative research design is to answer the research questions. (Leedy and Ormond, 2005:143 -144)

The participants being researched "*must know the nature of the study and be willing participants and any data collected should not be traceable back to particular individual so as to maintain their right to privacy*" (Leedy and Ormond, 2005:144). The research project sought to observe the dignity and privacy of the tower crane operators through informing them that their participation was voluntarily and only for the purposes of carrying the research project.

The operators were made to understand that the data they gave could be used to further educate other researchers in the training and skills development of tower crane operators in the construction industry. This was in line with the education institution ethics policy which administered the research project and which they were made to understand.

The justification of using different data collection methods emanated from the need to gather data from sources on construction sites surveyed with the relevant and in-depth knowledge in training and skills development of tower crane operators. The *aim was to take advantage of unforeseen data sources as they occur* but not initially included as part of the sample (Leedy and Ormond, 2005:144). The reason was because other tower cranes were not immediately available on sites surveyed but the site managers and foremen were willing and available in providing their understanding of training practices implemented by their contractors. Their response was valuable in terms of the factors that continue to contribute to tower crane related accidents from the manner in which the tower crane operators were trained.

3.7 Inductive and Deductive Reasoning

Inductive reasoning is a method of discovering knowledge by starting from specific interviews and facts in order to end by generalizing and forming new theories. It is sometimes called a bottom up approach. Inductive reasoning relates to when "*a research starts with specific interviews and measurement, detect patterns and regularities that the research can explore and finally end up developing some general conclusions and theories*". Inductive reasoning is *more open ended and exploratory especially at the beginning* of the research project. This is because it seeks to discover patterns and influences of the phenomenon studied. (Trochim 2006c)

In contrast, deductive reasoning is narrower in nature and is concerned with testing and confirming the hypothesis. The deductive reasoning approach starts from general theories and narrowed down to more specific hypothesis that the research can test. The research is then narrowed further to collect specific interviews so as to test the hypotheses. The main objective of the deductive reasoning research approach is to confirm the original theories through testing the hypotheses. (Trochim, 2006c)

Deductive reason is the paradigm that underlies qualitative research (McNabb, 2008:8). Contemporary studies (Johnson and Christensen, 2012:33) noted that *researchers use deductive reasoning if they concluded that a theory is false* or true. *If they draw this conclusion, they will then move on to generate new ideas and theories* in regards to the problem under investigation

The research project utilized both the inductive and deductive reasoning aspects of gaining and acquiring knowledge as a data analysis method (Leedy and Ormond, 2005:96) in relation to the current inadequate holistic training practices given to tower crane operators in Gauteng, SA construction projects. The study started by making general interviews of the manner in which plant operators were trained in the SA construction industry from the study conducted by Shall in 1977, reviewed related literature and current interviews in the training and skill development of tower crane operators in the SA construction industry.

It detected patterns of the training methods in tower crane operations which contribute to crane related accidents in construction project delivery. The patterns started from the trial and error training methods and apprenticeships to the current training methods such as Learnerships,

training from private training providers and workplace based training which lack adequacy and non-uniformity in the delivery of construction projects by tower crane operators.

The research project strived to make generalizations in relation to the training practices that lack adequacy and continue to contribute to tower crane related accidents and equipment breakdown in the delivery of building, construction and infrastructure projects in the SA construction industry.

3.8 Positivism and Post Positivism Research Philosophy

The word *epistemology* is derived from the Greek term "*episteme*". The word epistemology is defined as "*a philosophy of knowledge or how we come to know*". (Trochim 2006d)

Positivism is the research philosophy that prioritizes the use of scientific, objective and logic ways of gaining knowledge about a phenomenon studied. The research philosophy utilized the scientific method of gaining knowledge through the use of measurement, observation and the laws of cause and effect in order to understand the problems which contribute to tower crane related accidents from the training given in the industry. (Trochim 2006d)

The primary objectives of positivism research approach are to:

Achieve Objectivity,
Be independent of religious, emotional and ideological / political views.
To get rid of scientific knowledge of speculative and subjective viewpoint

according to Trochim and Ryan (2006d)

Post positivism is a research approach that explores and examines a phenomenon in an in-depth qualitative perspective. The method rejects the main aspects, tenets and doctrines of positivism while recognizing that scientific reasoning, common sense and logic are essentially the same process of reasoning and differ in a certain degree and level. (Trochim 2006d)

Post positivism refers to the thinking after positivism. The main objective of the philosophy being to challenge the "*traditional notion of the absolute truth of knowledge and recognizing that*

we cannot be positive about our claims of knowledge when studying human behavior and actions" (Research design: u,d)

Recent studies (Muijs, 2004: 5) noted that post positivists acknowledge *that we cannot accept the world we are part of as totally objective, they believe in the possibility of an objective reality. While we will never be able to totally uncover reality through our research, we should try and represent that reality as best as we can. Rather than finding the truth, post positivists will try and represent reality as best as they can.*

Post positivism adopts the research philosophy that "*causes probably determine effects or outcomes*" (Creswell, 2003:7). This means that the problem associated with the lack of adequate training of tower crane operators studied using post positivism research approach reflected the need to examine the causes that influence the outcomes such as the challenges and constraints, the nature and characteristics of the skills development problems, the barriers which affect adequate training, the effectiveness of the training practices given which continue to result in tower crane related accidents, related project delays and equipment breakdown.

The research adopted a post positivism research philosophy because it strived to examine and explore the causes of inadequate holistic training practices given to tower crane operators in the SA construction industry from the perspective of tower crane operators who have years of work experience in tower crane operations and not trainees who do not have construction site experience.

The research project strived to study and investigate the causes, effects and outcomes that the inadequate training methods of tower crane operators have in the delivery of construction, building and infrastructure projects in the SA construction industry. The primary objective was to find from the experienced tower crane operators the factors and practices which still need to be improved for enhanced delivery of construction projects in SA.

3.8.1 Quasi Experimental Research Design

The quasi experimental research is often used in a research project where people of groups participating cannot be randomly selected. This is either because of ethical or practical reasons.

The main focus is to find groups comparable in many aspects to what the researcher could find. (Data: u,d)

The study did not utilize the quasi experimental design because it sought randomly to select from the large, medium sized contractors and the plant hire contractors the tower crane operators who have years of work experience in the operations of tower crane operators in the SA construction industry.

3.8.2 Case Study Research Design

A case study is defined as a research investigation into a phenomenon that is unique, special, complex and interesting because of its nature and characteristics. Case studies seek to understand what happened to the problem as it exists in its current form. This is in order to bring attention and interventions to the phenomenon. (Neale, Thapa and Boyce, 2006:3)

Recent studies (Baxter and Jack, 2008:545) emphasize that a case study research design is considered and used when:

> *The research seeks to gain an in-depth understanding of a phenomenon by seeking to answer the how, when qualitative and comprehensive questions.*
> *One cannot singly exclude others in the study or when the researcher cannot use random sampling.*
> *The researcher seeks to make a detailed and rough investigation of the conditions specific to the problem studied.*
> *The research boundaries are not distinguishable between the phenomenon and the context within which the problem exists.*

The problem with case studies is that they are not generalizable because of subjectivity in the manner in which the study is conducted (Neale, Thapa and Boyce, 2006:3). This also limited the use of case study research design in conducting the research on the training practices given to tower crane operators that continue to lack adequacy and contribute immensely to tower crane related accidents in the SA construction industry. The study utilized other aspects of case study

research design such as the use of in-depth understanding of the research problem but sought to generalize the results.

3.8.3 Quantitative and Qualitative Research Design

The quantitative research design utilizes the post positivism tenets and values in acquiring and developing knowledge. These are aspects and values such as establishing the *cause and effect in the phenomenon studied, reduction of interviews to specific variables, use of hypotheses and research questions, use of measurements and interviews and the testing of theories.* (Creswell, 2003:18)

The quantitative research design uses strategies of investigation such as experiments, surveys and questionnaires. These are strategies (surveys and questionnaires) which the study utilized in the collection of data from the sampled tower crane operators which produced important data in terms of numbers and percentages for further analysis and evaluation.

The research project included the quantitative research design through the use of surveys and questionnaires in collecting data from tower crane operators themselves. This enabled data to be analysed and assessed in terms of numbers, percentages and figures. This was in order to understand the extent to which tower crane operators were trained and developed in the various skills development programmes such as Learnerships, Apprenticeships, trail and error which leaded to Recognition of Prior Learning, the training obtained from private training providers and workplace based training practices.

The qualitative research design utilizes the *constructivist tenets, doctrines, beliefs and ideologies* of gaining and acquiring knowledge (Creswell, 2003:18). These are principles and values that the research project primarily adopted. The purpose was to develop an in-depth examination and exploration of tower crane operator training and skills development programmes utilized in the SA construction industry.

The fundamental objective was to also develop a pattern or a theory as to how tower crane operators in the SA construction industry were trained prior to 1994 and after 1994. This was in order to make a critical analysis and assessment of the training practices that remain inadequate

in the training and skills development of tower crane operators that continue to result in tower crane related accidents, equipment breakdown and project delays in the execution and delivery of construction projects such commercial buildings, civil works and infrastructural projects.

3.9 Research Sampling

A research project *does not utilize the entire population of the studied problem, but it uses a subset or a sample of that population* (Leedy and Ormond, 2005:198). The sample of the research project consisted of 25 tower crane operators from the large, medium sized contractors and the plant hire contractors who provide training to crane operators. This was narrowed to tower crane operators who have years of work experience in the operations of tower cranes and did not include the trainees who are not qualified because of lack of work exposure and experience in the delivery of construction projects.

The larger the sample size, *the better* the understanding that could be obtained (Russsel and Purcell, 2009: 175). The study also strived to obtain more data from tower crane operators above the minimum sample size. It included the perspectives and insight from 9 site managers and foremen who willingly shared their experiences and knowledge into how their contractors train tower crane operators.

The results of the sample are generalizable only if the "*sample selected is representative of the entire population studied".* This is important because it influences the external validity of the research problem studied. The sample selected should be carefully chosen so as to examine and explore all the characteristics of the total population in a same manner as when the whole population was researched. (Leedy and Ormond, 2005:199)

It is for this reason the study selected a sample which was representative of the tower crane operations and the training practices given in the SA construction industry. This was because of the important role that the large, medium sized and plant hire contractors play in the training of tower crane operators necessary for construction project delivery

3.9.1 Proportional Stratified Sampling

The proportional stratified sampling method is used when the researcher wants to investigate and examine the characteristics emanating from the proportions of the major players involved in the provision of training practices given to tower crane operators in the construction industry. The advantage is that the researcher chooses his sample based on the proportion of the total number of tower crane operators emanating from the major training providers involved in the operation of tower cranes for the delivery of construction projects. (Leedy and Ormond, 2005:203)

Tower crane training contractors that the study sought to sample were primarily the large, medium sized and plant hire contractors because they take the responsibility of training their tower crane operators to efficiently utilize the cranes in a manner that does not pose health and safety risks and hazards in the delivery of construction projects. To effectively examine the training practices in each strata of tower crane operators, those from the large, medium sized and the plant hire contractors, *the first step is to identify the members of each stratum and then select a random sample from each one* (Leedy and Ormond, 2005:203).

The research identified the tower crane operators from those working on construction sites and those who could be obtained from the plant yards of the contractors, the second step was to select a random sample from the large, medium sized and the plant hire contractors in a manner that proportionally represented the training practices given in the training and skills development of tower crane operators in the SA construction industry. This ensured that the research investigated all the training practices given to tower crane operators necessary for the delivery of construction projects

The important aspect of utilizing the proportional stratified sampling method was to ensure that the conclusions of the research are generalizable since they emanated from a sample which proportionally represented all the training practices given to tower crane operators in the construction industry.

3.10 Questionnaires

Questionnaires are defined as a list of written questions that the researcher seeks to enquire from participants and are normally completed when the researcher is or not present. They are either

posted, e-mailed or administered during interview which is a practice that is referred to as structured interviews. The strengths of using questionnaires in gathering data is that they enable the researcher to contact a larger sample size, especially when other tower crane operators could not be reached for face to face or structured interviews. (Sociology: u,d)

Questionnaires are restricted by what the researcher seeks to find through open ended or closed ended questions. Closed ended questions normally provide the respondent with predetermined responses such as *Yes or No* or *1, 2, 3*. The primary objective and purpose is to obtain quantitative data to be analysed in terms of numbers, figures and percentages. (Sociology: u,d)

Open ended questions are used when the researcher seeks to find the perspectives and opinions of the respondents by not providing preselected responses to choose from but through offering the respondent to answer in his own words. These are words such as "*Please give other reasons or opinion*" or "*Please explain in your own words*". The open ended questions enable the researcher to gain data in a qualitative understanding of the phenomenon studied. (Sociology: u,d)

The study utilized structured interviews where questionnaires which were both open and closed ended were administered but not mailed to crane operators because of lack of access and exposure to internet services since most of them were computer illiterate. Other questionnaires were e-mailed to tower crane operator training providers such as medium sized contractors and plant hire organisations who were outside Gauteng Province in obtaining a larger sample size.

3.11 Interviews

An interview is defined as a "*widely used tool to access people experiences and their inner perceptions, attitudes and feelings of reality*". The interviews are divided into three categories. This consist of structured, semi structured and unstructured interviews. (Zhang and Wildermuth, u,d: 1 citing Fontana and Fray, 2005)

A structured interview is one that has predefined questions which are asked in the same order for all participants in the research project and they are generally used in surveys. The semi structured interviews allow greater openness, variety and flexibility in gathering data. This is because the

researcher can adjust the questions according to the context of the conversation based on the participants experiences and perspectives of the problem studied during the interview. This then enables the researcher to obtain data in a qualitative form where experiences, views and perspectives are openly expressed in the phenomenon studied by the respondents. A semi structured interview uses more open ended than closed ended questions. (Zhang and Wildermuth u,d: 1)

Unstructured interviews are defined as those where there are no predetermined questions and answers expected. The conversation depends on social interactions in order to understand the participant social reality on the problem studied and explored. (Zhang and Wildermuth, u,d: 1-2)

The study used semi structured interview format in investigating through exploring and examining the experiences, perspectives and knowledge in relation to the training and skills development programmes that tower crane operators received in the construction industry. This included the challenges and constraints that continue to affect the delivery of construction projects in a manner that does not have tower crane related accidents, project delays and equipment breakdown from the operation of tower cranes in the construction industry.

3.12 Conclusions

The research methodology presented and justified the approaches and processes that were followed in conducting the study in a manner that was objective, in order to investigate the current inadequate holistic training practices given to tower crane operators which significantly impact health and safety in Gauteng, South African construction projects. These were areas such as the research philosophy and design, the techniques of increasing internal and external validity and reliability, the methods of reducing bias in the study and the sampling methods.

Additional aspects included the necessary methods of collecting data and interviews from the tower crane operators who were illiterate with no access to computers and e-mails. These methods which were followed by the research all strived to make the conclusions generalizable in respect of the important aspects that continue to make the training given to tower crane operators lack adequacy in terms of the learning outcomes.

The fundamental reasons of the research methodology were to structure the research such that when conducting the survey and the structured interviews, the research questions and objectives would be answered and addressed respectively. This was important in order to analyse the data and have clearer findings in relation to the current inadequate holistic training practices given to tower crane operators which significantly impact health and safety in Gauteng, SA construction projects.

CHAPTER 4: DATA ANALYSIS AND FINDINGS

4.1 Introduction

The chapter sought to provide the data analysis and present the findings obtained from the structured interviews conducted in relation to the current inadequate holistic training practices given to tower crane operators which significantly impact health and safety in Gauteng, South African construction projects. The primary objective and purpose was to answer the research questions as posed earlier in the study.

The investigation into the current inadequate holistic training practices given to tower crane operators was motivated by the accidents that result from the practice of lifting, moving and unloading of construction materials during construction project execution and delivery. This was in order to examine the current structure and characteristics of training practices given so as to find the factors that still need to be improved.

The effectiveness of the training practices was also examined in terms of the learning outcomes or the knowledge areas in the training programmes from the tower crane operators surveyed. This was also to find the actual factors that lack adequacy in the training and skills development of tower crane operators that need to be restructured and improved for better training and project delivery.

4.2 Response Rate

The study utilized a purposive stratified research sampling method which necessitated that the crane operators be targeted in the various sites they were working in during office hours in the Gauteng construction industry. The reason for using a purposive stratified sampling method was because the study sought to generalize the conclusions of the research and needed to investigate all the contractors who offer training to tower crane operators. This meant that the researcher had to visit the crane operators in their construction projects and their plant yards in order to obtain data. This was primarily because they could have not appreciably responded to questionnaires sent by e-mails because tower crane operators were computer illiterate.

The study managed to have telephonic and face to face structured interviews with 25 tower crane operators where questionnaires were administered. This included 9 interviews which were views,

perspectives and opinions of site managers and foreman who willingly participated at the time of doing interviews with the operators. This were interviews which were important where crane operators were working longer hours and night shifts due to project delivery pressures and meeting the necessary delivery dates and could not be accessed for a structured interview.

Number of Construction Sites Visited	Number of Tower Crane Operators Interviewed	Number of Site Foreman and Managers Interviewed
Civil / Building / Infrastructural Projects	Civil & Building Contractor (23) / Crane Hire (2)	Civil & Building Contractor
21	25	9

Table 3. Construction Sites and Respondents Sampled

The above justification meant that the response rate depended on the sites visited which were under construction and the willingness to participate from the operators telephoned where their cell phone numbers were given by their site foreman and plant managers. It is noted that other tower crane operators flatly declined to participate in the study. However, the study managed to obtain responses from 25 tower crane operators. The response rate could have been larger had all the large contractors freely gave the researcher the contacts of the tower crane operators who were working outside Gauteng Province especially the crane hire contractors.

The construction projects visited were those that were classified as Civil or Building or Infrastructural projects. The tower crane operators were employed by Civil or Building contractors. There were fewer operators who were employed by tower crane hire contractors.

The target rate was 35 and above since the study was a qualitative research design, this meant that the response rate was 71.4% from the sampled operators. It meant that there could be lesser factors and aspects which could contribute as significant factors affecting adequate training and skills development of tower crane operators other than those obtained from the sampled tower crane operators in the SA construction industry.

4.3 Data Analysis and Presentation of Findings

The section sought to present data analysis of the investigation carried in relation to the training practices given to tower crane operators which continue to have concerning accidents and fatalities. This was also because prior studies have not focused on how tower crane operators receive their basic training in the operation of tower cranes with a direct research methodology of gathering data directly from the perspective of tower crane operators (Rosenfeld and Shapira (1998), Neitzel, Seixas and Ren (2001), Al Hussein *et al* (2005), Aneziris *et al* (2008), Dongl, Xu and Cheul (2010)).

A prior study (Shawaca, Naoum and Fong, 1999:309) in the UK found that the probability of having accidental deaths in construction projects is five times higher as compared to the manufacturing industry with serious injuries and fatalities being two and half times greater. A recent study (Musonda and Smallwood, 2008:81) in Botswana made an important conclusion that deaths, injuries and *fatalities are a source of concern for the current state of health and safety in the construction industry.*

It was on the abovementioned reasons that the research sought to investigate directly how tower crane operators themselves were trained in preventing the accidents, fatalities and deaths which have become endemic and a cause for concern in the SA construction industry.

4.4 The Characteristics and the Nature of Training Programmes

The section provided an in depth nature and the characteristics of the current training programmes given to tower crane operators in the SA construction industry. The section examined the nature and the characteristics from the type and structure of the training, the organisations which offer the training, the duration, entry requirements and the expected outcomes.

This was in order to find the actual factors which continue to contribute to the current inadequate holistic training practices given to tower crane operators in Gauteng, SA construction projects. It was hoped that these factors would assist in improving the current inadequate holistic training practices so as to improve the level of quality, credibility and reduce the endemic accidents

which continue to be associated with the operation of tower cranes in the SA construction industry.

4.4.1 The Type of Crane used and Certificate Possessed in the Operations of Tower Cranes.

The tower crane operators surveyed were primarily those who were in possession of a *tower crane certificate*. The research attempted to find other operators who might have been in possession of other certificates such as the *mobile crane certificates*.

All responses obtained were those from tower crane operators found on construction sites or from plant yards of contractors. This was because the study was targeted to them and sought to investigate whether people who hold mobile crane certificate could operate tower cranes. This also meant that the two cranes required a specific certificate in order to operate them. This was also because of the differences in the training in terms of duration, knowledge areas or curriculum, entry requirements, structure in terms of theoretical and practical knowledge associated with each crane.

The study found that the tower crane certificate is limited to the three types of cranes that are normally used during construction project delivery. This is the Liebherr, Portain and the self-erector tower cranes. The study found that the Liebherr and the Portain were the most used in the construction industry and all the tower crane operators agreed competence and proficiency in using them from the training obtained and that there was little difference in the two most used cranes in the construction industry.

The difference was that when an operator is using the Liebherr he needs to hold a button up while when using the Portain one needs to press a button once as the crane rely on electricity for use. Liebherr was emphasized to be the most resilient and commonly used tower crane in the construction of medium to large and complex infrastructure and building projects (Arslan and Kaltakci, 2008:288)

The self-erecting tower crane is used as the compliment where the first two common types of cranes cannot reach or access the whole site. Its operation is also similar to the Portain and makes little difference when using it compared to when using the Portain.

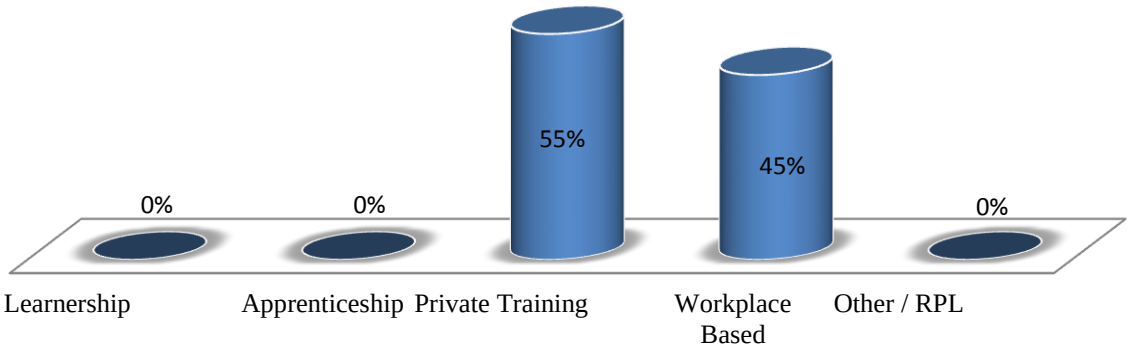
The study also found that there were no tower crane operators who were in possession of a higher level certificate such as National Qualifications Framework level three or Advanced Certificate in plant operations or management. This showed that there is still a lack of education and access to opportunities to many tower crane operators in terms of further training in plant operations or management.

The tower crane operators also shared their experiences that the tower crane certificate expires every two years with retraining provided in a period of one day where the certificate is reissued or renewed in a construction site environment. This was in line with the Department of Labour National Code of Practice for Training Providers of Lifting Machine Operators (2011:15) which makes every card carried for the operations of tower canes to be valid for twenty four months. *The*[4] *opinion from the operators was that other operators who were using a tower crane in the Richards Bay caused a tower crane to collapse which badly injured people and operatives on site due to lack of retraining and renewal of tower crane certificates or cards.*

4.4.2 The Skills Development Programmes that offer Training in Tower Crane Operations

The research found that the skills development programmes used in the construction industry were *Learnerships, Apprenticeship, private training, workplace based training* with no *other* training programme including the *Recognition of Prior Learning* used in the training and skills development of tower crane operators.

Figure 3. Skills Development Programmes in Tower Crane Operations



[4] Personal Discussion with the Tower crane operators interviewed.

Learnerships as a skills development programme in training tower crane operators were found not to be the most commonly used programme. In other instances tower crane operators could not clearly define whether they were trained under a Learnership programme or a workplace based programme. This was because there was no formal agreement between the learner, the contractor and the training provider as an agreement that characterizes Learnership programmes as per Skills Development Act (1998:12).

This was found to tower crane operators who were trained by contractors who outsource training and no longer use their in-house training structures. This was also because there was no stipend of a specific amount that was paid while the operators were undergoing training but remained on the previous pay for a period of 3 - 4 months before they could get a salary or rate per hour increase that justifies the operation of a tower crane.

The study found that other contractors offer formal Learnerships in earthmoving equipment such as grader, excavator, roller and compactor. This was also found to be the case with the Contractor Plant Hire Association (CPHA) which offers Learnerships in earthmoving equipment but not in tower crane operations. This also contributes to the ageing of tower crane operators and also limits opportunities to youngsters in accessing training, skills development and career in tower crane operations. A recent study (Mummenthey, 2008:18) found that Construction Education and Training Authorities (CETAs) have had cases of financial mismanagement of the Learnership funds which might have also increased their scarcity in tower crane operations

Apprenticeship based method of training was not found to have been used in the training and skills development of tower crane operators sampled. This was both to those who were trained prior to 1994 and those who were trained after 1994 to present. This confirmed the difficulty in terms of accessing training by African people in Apprenticeships prior to and after 1994 in tower crane operations since the system was racially based as noted by Mummenthey (2008 :24).

The decline in the training of tower crane operators in crane operations also showed that apprenticeships were no longer the most used skills development programme in their training and skills development.

There were 55% tower crane operators who agreed obtaining training from private training providers. This was found to be the most accessible form of training to tower crane operators

primarily because of costs reasons which was more affordable. Respondents felt it was easy for contractors to retrain someone with a tower crane operator certificate compared to someone who does not possess a certificate in tower crane operations. The accessibility and costs reasons of acquiring training in private training afforded many tower crane operators the opportunity to acquire the certificate with less practical training obtained.

There were 45% tower crane operators who agreed that they were trained by the contractors on site. This varied in terms of being directly administered by the contractor and where other contractors would outsource the training from other training providers who would then train the learner in a construction site environment. This also varied from those who were also trained prior to 1994 and those trained after 1994 in a similar manner.

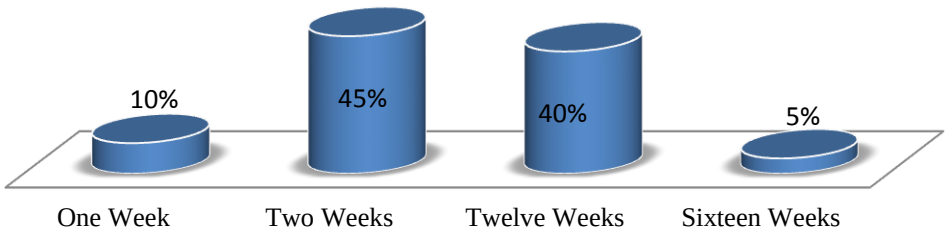
There were no tower crane operators who were found to have been assessed on site of their learning obtained elsewhere in a Recognition of Prior Learning programme while they did not have a recognized tower crane certificate. All the tower crane operators were in possession of the training certificates either obtained from the private training provider or the contractor. Other reasons are those associated with the enforcement of Occupational Health and Safety Act of 1993 as from the Construction Regulation of 2003 which requires that a competent person be the one who operate a tower crane. This was verified on sites with possession of the tower crane certificates or card.

There was no other training programme provided in tower crane operation other than those provided above.

4.4.3 The Duration of the Training Programme in Tower Crane Operations

The duration of the training programmes were found to range from *one week, two weeks and three to four months or twelve to sixteen weeks*. There was *no other* duration which was found to be greater than four months

Figure 4. Duration of Training Tower Crane Operators



The training duration received from private training providers ranged from one week to two weeks. There were no tower crane operators from those sampled who agreed that they were trained by private training providers in a period that was greater than two weeks. This was irrespective of whether the person had previous knowledge of working or exposure in lifting equipment.

Interviews made with crane operators trained by the private training providers was that the ten working day training was a standard of training set by the Department of Labour and that these training providers were accredited by Construction Education Training Authority (CETA) to offer the training programmes. However, the National Code of Practice for the Training Providers of Lifting Machine Operators (2011:12) refers the duration of training to the one provided in the Unit Standard approved for training tower crane operators which is a duration not clearly differentiated or stipulated between the theoretical and workplace based training before an operator could obtain a tower crane certificate.

The tower crane operators agreed that the first week of training consisted of the theoretical aspects of operating a tower crane while the second week concentrated on the practical aspects of operating a tower crane.

There were tower crane operators who agreed that they were trained in a one week training programme with the four days consisting of the theoretical aspects of training and the fifth day used as a six hour practical training thereafter the operator was issued with a tower crane certificate. The number of hours on site depended on the willingness of the general contractor and the project complexity which in other in instances it could be as low as two or one hour per

day inside the tower crane cab. This also showed that these operators received less practical training due to the willingness of contractors which most of them agreed that was the situation.

There were tower crane operators who were trained on sites who agreed that there were trained in a period that ranged between one to two weeks. This was because of prior experience or exposure in lifting or unloading of construction materials where they worked as banks men or elsewhere in lifting or unloading of materials.

The operators who were taken as labourers and trained on site to operate a tower crane were trained in a duration ranging from 3 – 4 months. The four months duration was specifically applied to women or the labourers who knew nothing from the start of the training programme because they were deemed to be more prone to accidents. This was because they needed to learn all the basics of operating the tower crane from the signaling system to the health and safety aspects of lifting operations. These were factors such as understanding the levers, buttons, the actual operations, the recording and reporting of crane related issues such as oil and the need for maintenance.

After the duration of the training, the contractor would call the assessors from the CETAs to come and assess the tower crane operator in all the necessary aspects of operating a tower crane and the competence required. If the operator is found to be competent, he is then issued with a tower crane certificate in operations which is at National Qualifications Framework (NQF) level two.

The study found that tower crane operators were trained by contractors both the large and medium sized contractors in a manner that consisted of 1 - 2 weeks for those with prior learning and related work experience in tower crane operations. The duration of the training was 3 - 4 months to those crane operators taken as labourers on sites. In both cases the learner operator works with an experienced tower crane operator for a period of two to six weeks until he becomes competent in operating the tower crane on his own.

The research found that the private training providers were offering training which was limited to one or two weeks of training which included both the theoretical and practical aspects of operating a tower crane. The operators who were trained by private training providers agreed that the limited duration of training did not give the full practical competence required to operate a

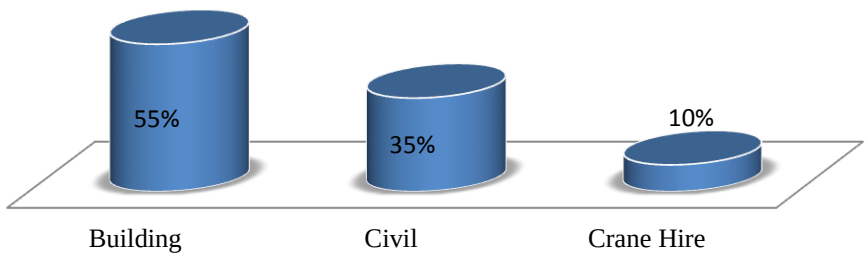
tower crane but assisted in getting the tower crane certificate with further training provided by contractors on sites. Interviews conducted with site managers and foremen found that a six months period of training tower crane operators would do more in terms of giving them the necessary competencies required to operate a tower crane.

The nature and the structure of the training practices offered in the construction industry in relation to tower crane operators showed variances in regards to the duration of training which also influenced the level of competence in terms of the expected outcomes from the training programmes. These are outcomes such as the competency in safe operation of construction materials in a manner that does not pose health and safety risks during construction project delivery. This included the management of the subordinates working under the authority of the tower crane operator such as banksman and labourers in terms of the necessary communication skills, the rigging and hoisting skills, the knowledge of tower crane operations and the necessary maintenance and servicing skills.

4.4.4 The Contractors who offer work in Tower Crane Operations

The contractors who were found to offer work or employment in the operation of tower cranes were the *building, civil and plant hire* contractors. There were no other contractors found to be employing tower crane operators

Figure 5. Contractors Offering Employment in Tower Cranes



55 % of the tower crane operators were employed by building construction companies or the building divisions of the large contractors. 35% were employed by civil contractors with building

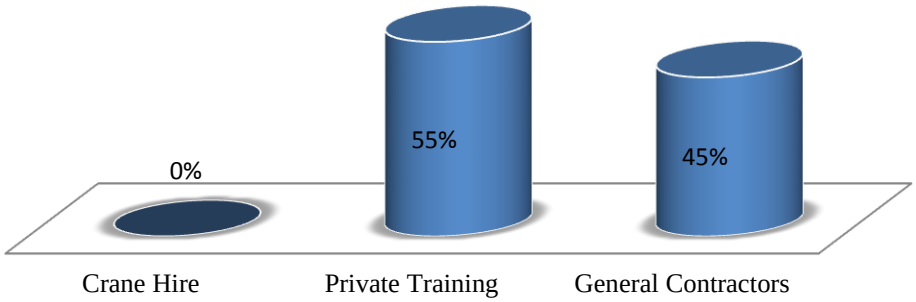
projects since there were less major infrastructure projects which utilized tower cranes during the time the study was conducted. There were only 10% of tower crane operators surveyed employed by crane hire contractors. This was because most of crane hire contractors were employed by emerging contractors outside Gauteng Province or in major mining projects.

The study found that it was accessible for tower crane operators to find employment with building contractors as compared to civil and crane hire contractors. This was found to be due to the nature and complexity of building projects compared to major infrastructure and mining developments which mainly required experienced and competent crane operators to be employed.

4.4.5 Contractors who offer Training in Tower Crane Operations

The contractors who offer the practical and theoretical aspects of training in tower crane operations were found to be the *contractors with in house plant and equipment training programme*, *private training provider* and no *other* contractors were found

Figure 6. Organisations which offer Tower Crane Training



There were no crane operators sampled who agreed that they were trained by the crane hire contractors. This was because a hired crane needs someone who is experienced and not one who is under training. The interviews with site foreman and managers found that it was difficult for crane hire contractors to offer training in house since they normally have people on their waiting list looking for employment. This also showed that it was difficult to have a crane hire contractor who would offer training to learner crane operator in a site environment. This differed to

building and civil contractors who were able to train their tower crane operators in a construction site environment.

45% of the respondents agreed that they were trained by contractors with in house training programmes in crane operations primarily building and civil contractors. This showed that the contractors are actively offering skills development programmes in a manner that is linked to the work they were doing when there were project delivery pressures and shortages of skills in the labour market.

55% of the tower crane operators sampled were trained by private training providers. These operators were now working either for the crane hire, building or civil contractors. This also showed that employment is obtainable when one has a tower crane certificate than when one does not possess the certificate to contractors with further training closing the gap of practical training that was not obtained during private training.

4.4.6 The Entry Requirements in Tower Crane Training

The entry requirements in the training and skills development of tower crane operators were those associated with having the *necessary work experience in a site* when one was considered as a labourer. There were actually other entry requirements which ranged *from educational requirements, medical certificate, valid driver's license*, letter *from the employer* or any *other* related requirement

Site Work Experience	Medical Certificate	Educational Requirements	Drivers Licence	Other i.e Letter from Employer
45%	45%	Not Clear	None	None

Table 4: Requirements for Acceptance in the Training Programme

The tower crane operators who were trained by private training providers agreed that there were no specific requirements needed when they were accepted in the training programme. This also included the minimum educational requirements or medical certificate of fitness.

Interviews with the site foreman and managers carried in relation to *private training clarified that it remained difficult to train someone with an education level that is below Grade 9 or Standard 7.* This was in line with the National Code of Practice for the Training Providers of Lifting Machine Operators (2011: 14) which requires that the learner in tower crane operations be in possession of a Grade 10 Certificate or equivalent. The reason was because in many instances, private training providers would experience problems with the person in relation to the basic understanding required in operations and the basic recording and reporting of crane related issues and the need for basic maintenance because of illiteracy.

The 45% tower crane operators who were trained by contractors on sites acknowledged that an important requirement to be trained by contractors on site was a site work experience of between 4 – 9 months. This also dependent on how the person was behaving in terms of non-absenteeism and respect of instructions from foreman and seniors. The same operators also agreed that a Medical certificate of fitness was also important from contractors.

There were no other training requirements needed in terms of a valid license of driving which normally become a prerequisite for someone wishing to train in mobile crane operations. Interviews made with site foreman and managers also confirmed that a letter from the employer is normally required when one wishes to obtain a Learnership in earthmoving equipment such grader, excavator, rollers and compactors from the Contractor Plant Hire Association which does not offer Learnerships in lifting equipment such as tower cranes (CPHA, 2011).

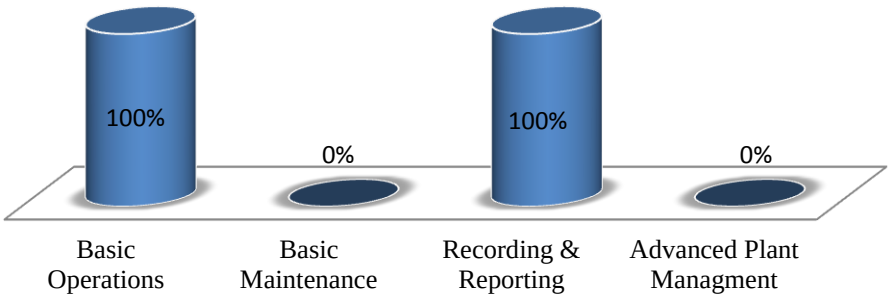
The research found that the entry requirements in tower crane operation do not become an entry barrier to someone who wishes to become a tower crane operator. Training was found to be dependent on the affordability in terms of being able to pay for the 1 – 2 week training courses which normally gives entry to employment in the building and civil construction industry. General good behavior on site has also been found to be the major factor in accessing training and skills development in a site based training programme to those who start as labourers.

The entry requirements were also found to be a key factor that influences the performance of a tower crane operator from a recent study in South Africa conducted (Mayet, 2010: 22) in the Skills Development Programmes in the SA construction industry.

4.4.7 Aspects or Type of Training given in Tower Crane Operation

The aspects of training tower crane operators ranged from conducting *basic operations, routine or basic maintenance, recording and reporting plant related issues, advanced plant management* in tower crane operations

Figure 7. Type of Training in Tower Cranes



All of the tower crane operators agreed that they were trained in the basic operations aspects of tower cranes. This included all the necessary use of the equipment in terms of loading, unloading and material control. Basic operations also focused on the health and safety aspects which may result in accidents and how they could be avoided. Operations also included the safe switching off practices so that the tower crane does not result in accidents to neighbouring properties after hours in the event of storms which may cause danger.

Basic operation training also included the ballasting or the counterweight of the tower crane which is needed to be achieved before the crane could be operated. This included the understanding that if the tower crane lifts loads which are more than what it could carry, the tower crane could result in it falling (HSE, 2009). The operators also agreed that training included the maximum loads that each tower crane could lift because of dangers that may happen to it in terms of breakage, and that the tower cranes have the limited number of loads they can carry.

The research found that the operations aspects were mainly taught on site as opposed to the basic aspects of operating a tower crane in private training. The private training providers focused on the basics of lifting and unloading and material control. The respondents who were trained by private training providers agreed that there was less operations training due to the limited time

they manage to get on the hired tower crane from contractors to give them the necessary practical experience in a period of one week or one day in the event the training was in a period of one week.

There were no respondents who agreed that they were trained in the basic maintenance aspects of tower cranes. This was because the maintenance was done by the technicians employed by the contractors and their duty was on detecting and reporting when there was a need to carry maintenance of the equipment. This included both those who were trained by contractors on sites and those who were trained by private training providers.

The research found that the basic maintenance training associated with operations of tower cranes was offered separately to the operations aspects of tower cranes. This showed that the training practices in tower crane operations have separation in relation to the operation and maintenance aspects. In other instances, interviews carried with site foreman and managers found the need to have basic maintenance conducted by tower crane operators was something that other contractors were looking at incorporating in their training and skills development programmes.

The reasons were because of the time that is lost or downtime in a construction project delivery where the in-operation of the tower crane was due to something that was too small and the technicians would have to travel distances to the site and conduct simple and basic maintenance. These were instances where the levers or buttons were not working properly and the tower crane operator did not have the necessary skills to conduct the basic maintenance and even detect where exactly the problem was.

This was what Edwards and Cabahug (2002:22) in the UK found to be a problem that still needs to be improved in the training of tower crane operators. This is also because the maintenance costs rises due to little aspects that could be done by the crane operator as noted by Shall (1977:43)

Interviews with site foreman and managers also confirmed the important need to have operators who could conduct basic maintenance of the equipment especially in earthmoving equipment. This was found to be lacking in the training and skills development of tower crane operators. The primary reasons indicated that there were no recognized knowledge areas of training tower

crane operators that enable them to be competent in all areas associated with the operation of tower cranes.

All the respondents agreed to have been trained in the basic reporting and recording of tower crane related issues. This were in issues such as recording the oil levels, any strange sounds, condition of hoists and slings and hooks, buttons and levers, whether the crane slewing is working as expected. This was done every day because the tower crane has a weekly report card that is used by contractors to assess the condition of the tower crane. This also helps in terms of carrying the necessary maintenance and service of the tower crane since it is dependent on how the tower crane operator reports and records issues related to its condition.

The research found that the basic reporting and recording of tower crane related issues was done by both those operators who were trained on sites and those who were trained by private training providers. More experience and expertise was found to have been offered on sites as opposed to the private training. This raised concerns in relation to the reliability of training provided by private training providers where most of the tower crane operators obtained their training from.

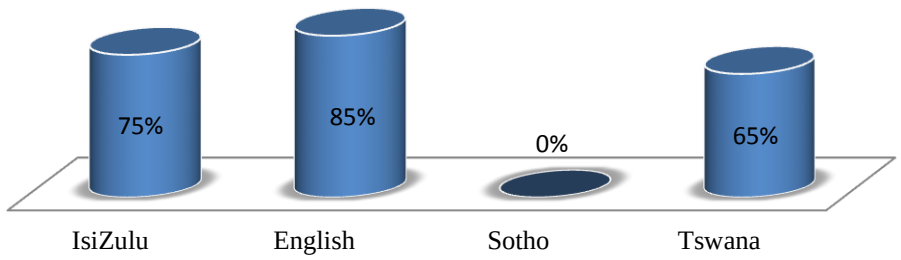
Interviews with site foreman and managers indicated that tower crane operators still needed Adult Basic Education and Training (ABET) since most of them were illiterate and lacked skills needed to write basic technical reports in English of the tower cranes they operate. Tower crane operators are able to say that they experienced certain type of problems with the equipment but could not write it in words and numbers.

There were no operators who were found to have been trained in advanced crane operations and management. This showed that the training given in the industry is the basic training needed to operate a tower crane. It also showed that there could be fewer opportunities in the industry for further training that contractors make available to their tower crane operators. Part of the reason is also that most of the tower crane operators are illiterate with fewer skills in reading and writing basic, technical English.

4.4.8 The Medium of Instruction offered in Tower Crane Operations

The medium of instruction used in the training programmes of tower crane operators ranged from *English, IsiZulu, Sotho or Tswana* and the *language requested* by the learner operator.

Figure 8. Medium of Instruction used during Tower Crane Training



85% of the respondents agreed to have been trained in a language that was dominated by English. This was because of being trained in a group environment where other people were Xhosas, Vendas, Zulus, Tswanas and Shangans. Other instructions were then translated in Zulu or Tswana but specifically to the language that the operator understands. This was mainly with private training providers. Interviews from the tower crane operators trained by private training providers found that Zulu and Sotho which is similar to Tswana were also used where the person could specifically ask for the language to be used during his training.

75% and 65% of the respondents agreed to have been trained in IsiZulu and Tswana respectively on sites where the operator would work with someone who speaks the language during the 2 – 6 weeks of training that contractors use to train someone with the skilled operator on site until he becomes competent in operating a tower crane.

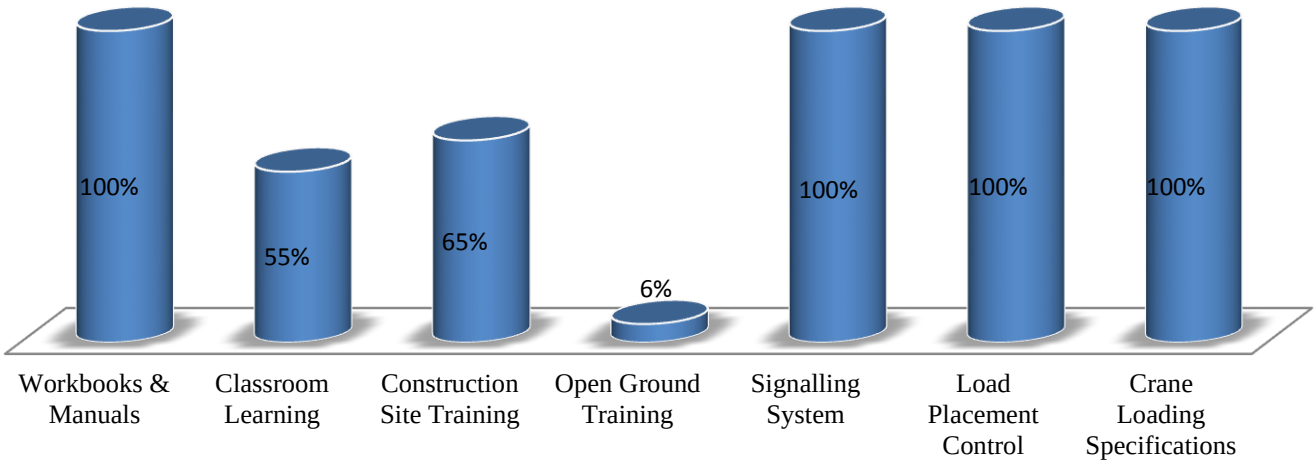
The study found that the medium of instruction used during the training programme could not be considered as a contributing factor to the crane related accidents in the construction industry. The reason was that the respondents agreed that the medium of instruction used during their training was specifically suited to their needs. There were no concerns raised with the language not being clearer during the training. This was also a factor to be considered to those who were trained by private training providers because the instructors were said to be sometimes a white person

teaching in English mainly to black people who do not possess a Matric or a Grade 12 Certificate.

4.4.9 The Structure of the Training Programme in Tower Crane Operations

The structure of training tower crane operators ranged from the *use of work books and manuals, classroom learning, construction site training, open ground training, signalling system used by banksmen, load placement control and crane loading specifications*

Figure 9. Structure of the Training Programme in Tower Crane Operations



All the tower crane operators agreed to have been trained using the workbooks and the associated manuals. The workbooks and manuals indicated that the training was also intended to give the thorough theoretical training needed in the operation of tower cranes in the SA construction industry. The workbooks and manuals were intended to show what each section of the crane is intended for in the operation of tower cranes.

55% of the tower crane operators agreed to have been trained in a classroom environment. This was primarily to those who were trained by private training providers. This included those operators who were trained by contractors who outsource training of tower crane operators because of costs reasons associated with training and up skilling of crane operators. The classroom environment was found to be characterized by the use of demonstrations using the

chalkboard and videos as to how the tower crane works, the key factors to be competent in and the important aspects of health and safety in the lifting and unloading of materials.

65% of the tower crane operators sampled agreed to have been trained in a construction site environment. This was primarily to those who were trained in a workplace based training programme and those who were trained in one to two weeks training programmes. The difference was the duration in relation to those who were trained in 3 – 4 months site based training and those who were trained in a one week or one day construction site exposure which was not necessary full construction site training because of limited hours in the cab due to tight project delivery schedules. Others agreed that they learnt almost all the operations aspects on site with the assistance of the person who was supposed to assess them before he could be employed

6% of the operators sampled agreed to have been trained in an open ground environment. This was the plant yards of the operators and not necessarily a construction project environment. The operators were found to have been trained in this environment prior to 1994 as they had more than 18 years of operating a tower crane. This confirmed what Shall (1977) noted as contributing factors to black people not receiving or accessing adequate training in Apprenticeships because the system was racially based.

All the operators agreed to have been trained in the signaling system used by banksmen and the use of radios for proper communications in relation to the safe operation of the tower crane. The signaling system where hands are used in different ways to show to the operator whether to lift up or down, turn left or right was normally used when the operators could see the banksmen. The radios were normally used when the operator could not see the banksmen and relied on the radio for proper communication.

The research found that the signaling system and the manner in which the operator interprets it were used by contractors on site to assess the understanding and the competence of a new operator who wants to be employed. If the operator is found to interpret the hand signals well and can lift the load safely according to the instruction of the banksmen, the contractors normally employ that particular operator. This indicated the importance of the signaling system in following a recognized code or system that is understood by all in the construction industry as formalized by the ILO (1995:51-53). This also showed that a competent tower crane operator

who knows the recognized code of lifting or signaling ways by banksmen can be trusted by contractors to be well trained.

All the crane operators agreed to have been trained in load placement control. This was important because it formed one of the important key attributes for safe operation of a tower crane. Operators agreed it was a bad practice when every time a load is lifted, materials get damaged, people get injured and there are damages to the structure as a result. This was also found to be dependent on how well the operator works with the banksmen and the communication between them.

All the tower crane operators also agreed to have been trained in crane loading specifications. This was because overloading of the crane results in structural damages of the tower crane and increases the maintenance costs of the crane. The operators motivated by saying that the crane itself does have a minimum and maximum load capacity it can carry. The crane stops working if it is overloaded which also damages the slings and the hooks.

The research found that the structure of the training was not adequate to the majority of the crane operators who were sampled and trained by private training providers. The operators agreed that there was inadequate training provided to tower crane operators mainly by private training providers. This was because of training outcomes where many of them finished the one or two week training programmes without being competent in the lifting and unloading of construction materials due to the short duration of time they spend in the tower crane during their training. In other instances a person could spend an hour inside the crane cab on the fifth day and be told that the project is very busy and could not be accommodated for longer hours in order to get the necessary practical training. Even on those circumstances, the persons were then issued with a tower crane certificate.

4.5Effectiveness and the Barriers Affecting Tower Crane Operator Training

The section examined the effectiveness and the barriers that continue to affect the adequacy of training and skills development of tower crane operators in the SA construction industry. Effectiveness of the current inadequate holistic training practices was examined and explored

from the health and safety aspects of operating a tower crane, communication, rigging and slinging, the contributing factors that still continue to cause tower crane related accidents, the experiences of tower crane operators in accidents witnessed, the equipment breakdown, the training in conducting basic productivity tricks and methods and the training in recording and reporting tower crane related issues. The above factors are what the Industry Training Authority (2008: 6 - 12) in Canada noted as key in ensuring competency of tower crane operators which also provide a measure of the effectiveness of training programmes.

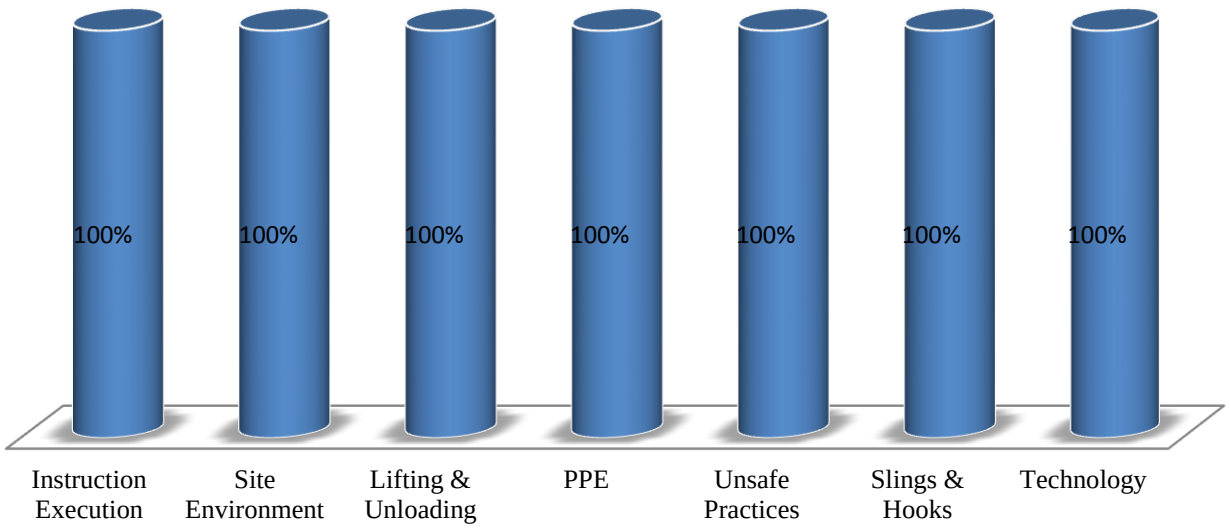
The barriers were also examined from the factors affecting the training of youngsters or the youth, the age structure and the work experience and the general life skills training needed in tower crane operations.

It was hoped that the effectiveness and the barriers affecting the current training and skills development of tower crane operators would reveal the key and major influences and considerations that continue to contribute to the inadequacy of training practices given to tower crane operators. The important contributions were to address the main factors which result in tower crane related accidents in the SA construction industry.

4.5.1The Health and Safety Training of Tower Crane Operators

The health and safety training of tower crane operators ranged from *receiving and following instructions, checking site environment before operation, lifting, moving and unloading loads, wearing of PPE, reporting unsafe practices to the employer or site foremen, loads carried by slings and hooks and the reporting technology in tower cranes*

Figure 10. Health and Safety Traning of Tower Crane Operators



All the operators surveyed agreed that the Health and Safety (H & S) training prioritized most of the abovementioned factors. This was because they were related to the general site environment, the manner in which the tower crane was operated and the communications or instructions normally followed from the banksmen.

The operators agreed that the H & S training prioritized the need to check the hoist or the slings and the hooks before using the tower crane. This was also observed to be the duty that laid with the banksman to also report on the worthiness of the slings, hooks and the overall hoisting. This was because if the material to be lifted was not in good condition or not properly fastened, it normally causes accidents or damages to the materials themselves or the structure with injuries also sustained by the operatives on site.

The operators also agreed that carrying, lifting and moving of materials from one point to another on site needed concentration on the part of the operator in order not to cause H&S risks on sites. This was motivated as the factor that was prioritized during training because materials do fall down when the operator does not fully concentrate and focus on lifting and moving the load until it is offloaded.

The operators also agreed that checking site environment in the morning or lunch before operating the tower crane was an important factor because in many instances they cannot see the

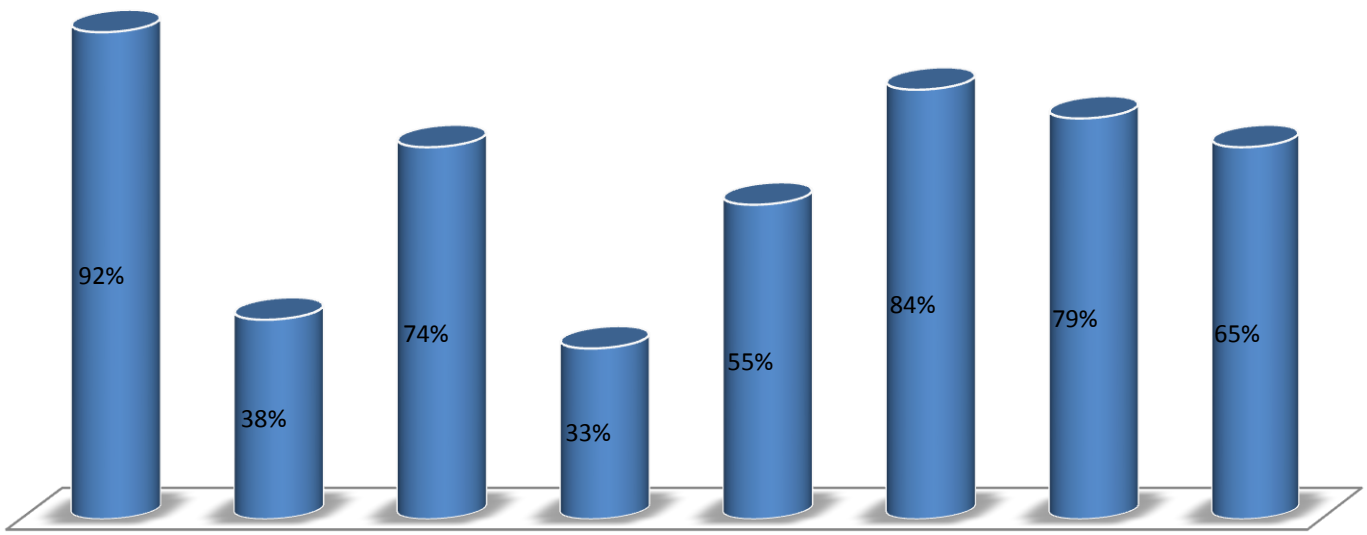
whole site where the material is lifted to where it is unloaded. They rely on banks men to provide them with the necessary instructions to follow. An important clarification from site managers and foreman was that tower cranes lack the enabling technology such as a video camera which showed the whole site environment. The hope was that it could also assist the tower crane operators in safely lifting, moving and unloading materials where they cannot clearly and appreciably see the whole site environment.

The operators also agreed that the crane do make a sound and stops working when the materials to be lifted are above their capacity to lift. This was found to be causing crane breakage or structural damages to the crane and also contributing to wearing of the hoists and also damages the hooks.

4.5.2 Contributing Factors to Tower Crane Related Accidents

Tower crane operators interviewed mainly believed that the main contributors to tower crane related accidents are those caused by lack of adequate training to *banksmen*, inadequate skills in the use of *crane hoist and hooks* for lifting, *poorly trained tower crane operators*, the *site management practices from site foreman and managers* and the *health and safety officers*. Interviews carried found that *poorly trained operators* were the main cause leading to accidents

Figure 11. Contributing Factors to Tower Crane Accidents



4.5.2.1Banksmen

92% of the operators surveyed felt that poor communication between the operator and the banksman was the major factor contributing to crane related accidents. This was because there were apparent poor training practices of banksmen who in other instances do not understand the recognized signaling system used in the industry as advocated by the ILO (1995:51-53). This was found to be affecting load placement control and the speeds to be used by the operator in unloading of materials or in moving the materials up, down, left or right.

Other motivation was that the carelessness of banks man results in the operator not applying the appropriate gear selection and that the operators rely heavily on the banksmen in the lifting and unloading of materials. The inappropriate gear selection and poor communication results in a speed that is higher than the one necessary, which then leads to either materials falling during lifting or accidents and damages to the structure under construction.

Another motivation was that the banksman is the first person that the operator talks to in the operation of tower cranes. The research found that other banksmen were not fully trained in the lifting and fastening of materials and lack the adequate skills necessary for load control and

lifting of construction materials on sites. This was found to be a factor that contributes to materials falling down and injuring people during the delivery of construction projects. Aneziris *et al* (2008:878) also found that the improper connection and loading of materials by banksman leads to disconnection between the load and the slings that are supposed to carry the load.

An important clarification from the operators was that load fastening and control was different when there was a qualified banksmen with the necessary training certificate which is normally offered by the contractors on sites. The reason was because banksmen were trained on the important factors that make load fastening to be safe unlike when contractors use someone who was not fully trained and competent as a banksmen

Other respondents felt that if there were two banksmen in a site whereby one will be where the load is fastened and the other where the load is unloaded, that could contribute to efficient lifting practices in a construction site environment. This was not happening in many medium sized contractors who contract as general contractors because of costs reasons.

4.5.2.2Crane, Hoist and Hooks

38% of the respondents felt that medium sized general contractors normally use tower cranes that are older than five years. The problem was that the equipment had mechanical inefficiencies in other parts affected the lifting and moving of materials on sites and the safe operation of the tower crane. This was because of inadequate maintenance largely because the tower cranes were second hand equipment compared to those used by large contractors who are normally first hand and well maintained.

Others felt that tower crane operators and the banksman needed to check the condition of the hooks and slings every two weeks. This was because rains cause rusting of the hoisting parts of the crane which result in the slings breaking or failing to lift the load that it is supposed to carry.

Crane conditions in terms of small cracks were also found to be a contributing factor. Small cracks were caused by the overloading of the crane whereby the banksmen would lift a 5 ton load in a 4 ton crane. The crane stops working and not lifts the load until the extra load is reduced or taken off. This also leads to oils leaks in the hydraulic pipes. Tonnage check becomes

a problem when the banksman is not well trained which also contributes to overloading of the materials. This was what Aneziris *et al* (2008:878) also claimed to result in the crane losing its stability and the strength necessary to lift materials on sites. Adequate training of tower crane operators was found to be affected by the differences in the separate training of banks man and the operators whereby a fault of the banksman becomes that of the operator. The tower crane operator also does not have much influence in the fastening of the loads due to lack of clear sight

The research found that it remained a challenge to tower crane operators to check the necessary tonnage to be lifted and the manner in which it is lifted by the banksman because of the distance and the way they are situated between the tower crane cab and the load to be carried. Training was also found to be a concerning factor in checking the manner in which the load was adequately fastened by banksman because of the differences in the training of banksman and the tower crane operators.

4.5.2.2Crane Operator Health, Illiteracy and the Site Health and Safety Officer

74% of the respondents felt that the poorly trained tower crane operators from the 1 – 2 weeks training programmes were a major factor contributing to tower crane related accidents. The respondents felt that they normally learn the required expertise and skills of operating a tower crane during construction project execution, they continue to pose risks such as accidents because of poor training and exposure to lifting and load placement control from the training given. Prior studies (Wang, Dunston and Skibniewski, 2004:1) in the United States observed the continuing and disturbing practice where tower crane operators will learn the skills necessary to operate a tower crane in site environment than in a training programme where they are trained which continues to cause tower crane related accidents.

The overall health condition of the tower crane operator was also found to be a contributing factor to crane related accidents. This was because a tower crane operator who had been diagnosed with high levels of sugar or other sicknesses that remain not detected on site remains not competent to operate a tower crane. The reason is that the health of operatives on sites is normally conducted once in a year and not on quarterly basis.

Important interviews carried with site foreman and managers found that tower crane operators were not able to write full technical report of the tower cranes they operate due to low levels of education. Many of them were battling to read and write basic English. This leads to inadequate maintenance being carried due to insufficient data written down or fully reported. In many instances tower crane operators were found to be able to state in Zulu or Tswana all the possible problems they were experiencing with the equipment but not able to write a full technical report in English because of the previously disadvantaged background they come from as they were illiterate.

Drinking problem or lack of alcohol management of operators was also cited as a major contributor to accidents and poor load placement control due to weekend hangover. An important clarification from site managers and foreman carried in the study found that the drinking problem was also a major stumbling block to youngsters or the youth gaining opportunities in tower crane operations because of apparent red eyes and headaches after weekend of earning wages. It becomes difficult to have confidence that they will operate the tower crane efficiently during an expected busy Monday.

Too much confidence from tower crane operators was also found to be a factor leading to accidents on sites. This was when the operator would not listen or take instructions from other people on the safe lifting practice recommended by surbordinates, because they believe they know too much in lifting and load placement of construction materials. In other instances it was because they earn more than the labourers or the banksmen with lack of respect to them a factor affecting safe lifting of construction materials. Too much confidence was also found in instances where the operator would fail to ask the banksman to refasten a load that does not look safely fastened or hooked, they end up taking chances believing that they would lift them and end up causing fatalities on sites when the load falls down.

People on sites do not listen or observe the tower crane rules even when this is emphasized on site health and safety induction and weekly meetings. This was the practice whereby people would move on site even when the crane was in motion or lifting materials.

Health and safety management was also found to be not well enforced on many construction sites which affected tower crane operation. It is noted that the South African Council for the

Project and Construction Management Professions (SACPCMP) which is established by Section 2 of the Project and Construction Management Act No.48 of 2000 is currently taking the necessary steps and measures in addressing health and safety management in construction sites by seeking to register and certify the competence and skills of Construction Health and Safety Officers / Managers / Agents (SACPCMP, 2012). The Project and Construction Management Act, Section 14(j) mandates the SACPCMP to take any steps it considers necessary where construction and project management related undertakings including the use of construction plant and equipment such tower cranes prejudices public health and safety.

Site agents and foreman normally do not take full responsibility of the operation of tower crane on their sites on issues relating to their control, management and maintenance. This was also found to be delaying projects where the equipment would be in a position that it requires maintenance or service urgently because of poor reporting and recording of issues that require maintenance by the operator. These was also in important issues that relate to incorporating the tower crane operations with their programmes in terms of day to day or weekly supervision and the technical report of the issues affecting its lifting and operation during construction project delivery.

This was also a problem found by Edwards and Cabahug (2002: 29) in the UK in relation to the training of Construction Management graduates in managing tower crane operations on sites because they also lack formal training in plant management and operations from universities. It is a problem that the study found to be affecting the safe delivery of construction projects in the SA construction industry

55% of the respondents felt that health and safety officers were also found not to take an active role in enforcing site procedures on the load placement control and lifting practices on sites. This included tonnage check on the loads to be carried by the cranes. The practice was found to contribute to overloading and poor fastening of construction materials that continue to cause accidents because of poor training of banksmen on construction sites.

Poor training of operators in risk factors associated with working at high heights was also found to be a contributing factor to tower crane related accidents. This was because tower cranes do have speed controls ranging from 1 – 5 that require necessary skill in their application. The

higher speed is normally riskier when the building was a multi storey building. Slow speed was also found to result in the load disintegrating due to slow speed. This was because many operators felt that thorough concentration of the material lifted compared to the cycle time was important in lifting materials.

79% of the operators felt that the lack of clear sight on the ground on what is happening and the risk environment in general to tower crane operators contributed to accidents. This also confirmed the inefficient nature of tower cranes and the need to have technological improvements in the operations of tower cranes that would seek to enable the operator to assess the load carried and observe the site environment. This was a factor investigated by Lee *et al* (2006) in Korea where the use of wireless video technology was found to improve the crane productivity and safe operation during construction project execution, compared to the tower cranes without the wireless video technology installed. This shows that tower cranes have a serious need to be improved in relation to the technology that is applied in order to increase the safe operation and productivity of tower cranes. This will also require extra training to be provided to tower crane operators because of newer technology.

Wind blowing at 25 - 35 miles was also found to be a factor contributing to accidents in the construction industry. Operators felt it was difficult to lift or move materials when the wind was blowing at high speeds. Normally site managers and foreman would stop lifting operations until the wind does not pose danger to accidents. Training in this regard was also found to have been obtained in a site environment for factors the pose accidents and risks in lifting practices during construction project execution.

84% of the operators felt that night shifts and long working hours such as overtime were found to be factors contributing to accidents especially when there are no spare operators. This was because operators felt that adequate concentration in lifting loads was demanding more attention on them and increasing fatigue. This was found on sites where project delivery constraints and tight time schedules were major concerns for site foreman and managers.

A prior study (Salminen, 2010:17) in Finland conducted on night shifts and long working hours found that there was a high risk of injuries and accidents occurring at workplace because of inadequate and lack of health and safety inspection which also go unreported as compared to

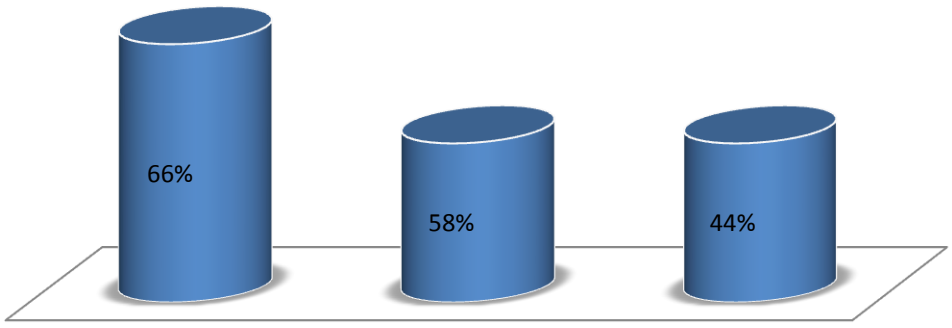
working during the day. Operators felt it was difficult to work night shifts using tower cranes and the need to have adequate concentration in lifting and unloading of materials contributed to accidents which in many instances remain unreported.

The tower crane operators did not feel that the small vibrations they experience when lifting construction materials affected their health and also contributed to tower crane related accidents. It is noted from a previous study (Malchaire and Ptette, 1991) in Belgium that the vibrations and shock experienced by tower crane operators might have been a contributing factor to their health problems which also affect adequate operation and lifting of construction materials during project delivery.

4.5.3 Tower Crane Operator Experiences of Accidents during Project Delivery

The experiences of tower crane operators in relation to the accidents they experienced during construction project execution and delivery ranged from those *who did not like to share their own experiences*, others who felt that there were *construction materials damaged* during nightshift and those who felt that there were *damages to the structure* due to miscommunication.

Figure 12. Experiences of Tower Crane Accidents by Operators



66% of the operators surveyed did not agree or apparently refused that they had incidences which lead to accidents as a result of inadequate training received in the construction industry. In many instances the operators did not feel happy to share their experiences mainly because they thought about giving the idea of being the main culprits in tower crane related accidents. This

was despite strict adherence to research ethics whereby their names or the organisations they work for were not used. They were only happy to say that accidents occurred as a result of poor communication between the banks man and the operator because the operator heavily relies on the banksman for safe operation of the equipment.

This also gave the research the perspective that there are tower crane related accidents which go unreported in our construction sites due to lack of adequate training to tower crane operators. Other reasons were those where the operator relied on the work experience they had gained in tower crane operations.

58% of the operators surveyed agreed that they had incidences where construction materials fell down or got broken such as tiles and the 44% agreed that there were structural damages due to poor communication and load fastening by the banksmen. This did not result in fatalities but only in the loss of materials. This explains that the lack of adequate training of banksman and poor communication contributes to accidents in construction sites which also increase the costs of delivering projects in terms of lost materials that need to be repurchased again.

Damages to the structure were due to the banksmen signaling to the operators that it is open or free using hand signals which means that he can use high speed when lifting because there were no potential disturbances. This practice resulted in the load damaging the structure because of disturbances between the load and the structure. There were also no fatalities reported or occurred as a result. This also indicated the need to have similar training of banksman and tower crane operators in the lifting practices and delivery of construction projects especially in the use of hand signals. This was found to be a problem in night shifts as opposed to day shifts

The research found that the training of tower crane operators has incidences which result in loss of materials and damages to the structure during construction project delivery. Other accidents that occur as a result of tower cranes do also go unreported which was observed because of the reluctance of tower crane operators to share their experiences in relation to accidents that they had experienced during construction projects. This also shows that the current inadequate holistic training practices given to tower crane operators lack adequacy in terms of delivering projects without accidents or losses to construction materials. This is because the safe operation of tower cranes forms an important objective of the learning outcomes from the training of tower cranes.

4.5.4 Equipment Breakdown during Construction Project Delivery

The operators felt that the maintenance that is given to a tower crane every three months is adequate to prevent equipment breakdown during construction execution. This dependent on the type of project executed and the complexity involved where an adequate check on the grease, the oil becomes important and how smooth the operator uses the equipment. The tower crane has a report card that is checked every week by the contractor for any unusual conditions that happen during construction project.

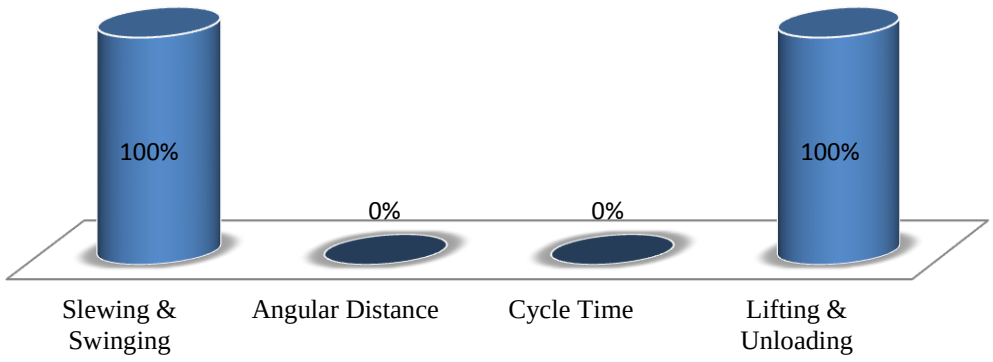
Operators felt that it took a year before there could be an equipment breakdown which is highly dependent on the service and the maintenance it receives. Since the equipment is serviced every three months there was a plus or minus 90% chance that the equipment would operate for the whole year without tower crane breakdown.

The study found that tower crane operators were reporting and recording well all the tower crane related issues which require maintenance so as to prevent tower crane breakdown. This was found because they were also not told or given the authority to examine or conduct basic maintenance on the equipment but to call mechanics who were competent in repairing or servicing the crane should it require immediate attention.

4.5.5 Training in Basic Productivity methods in Tower Crane Operations

The training in basic productivity methods of operating a tower crane ranged from *swinging or slewing, angular distance, cycle time and the loading, lifting and unloading* of construction materials such as the concrete or construction materials from one place to the other during construction project delivery.

Figure 13. Basic Productivity Methods Training



The importance of the basic productivity methods were that they enabled the operator to understand and have the necessary basic skills in lifting and unloading of construction materials as a key attribute needed in the operation of tower cranes. This was what Day and Benjamin (1991:237) found to be the key activity done by tower crane operators during construction project execution, the erection operation which is the *practice of lifting loads vertically, swinging them, and holding them in a set position for securing* the load until the equipment is released

All the operators surveyed felt that the swinging or slewing of the tower cranes in the basic productivity tricks of operating a tower crane were key factors considered in lifting materials during the training given. This was the factor considered important because when the crane was rotating, people are not supposed to be moving under load carried. Despite these rules on sites, operators felt that site operatives do ignore this rules and normally move even when the crane was slewing with the load. This also increased the risks of accidents because when the loads fall by mistake people could also get injured. It remained a challenge to them to safely operate tower cranes or move loads from one point to another because of poor health and safety enforcement practices in many sites they were working in by the Health and Safety Officers.

The study found that the operators surveyed in relation to the angular distance were not adequately trained in manipulating it to the extent that accidents were reduced. Operators acknowledged that there was a lack of training in understanding and utilizing the angular distance from the point in which the load was carried to the point where it is being moved which formed the important part of safe operation of tower cranes. This was because when the load was

lifted, tower crane operators do not move the load to the center of the load jib but move the load at the end point of the tower crane which is not adequate training in tower crane operation.

The safe method of lifting was found to be related to moving loads to the center of the load jib before it is moved to its final position after picking it up. The safe method was said to be a main factor that reduces accidents and continues to be lacking in the training of tower crane operators in the SA construction industry. This was because when the load was at the center of the load jib, if it falls due to poor fastening it would be already further away from the people who fastened it.

A tower crane overturned and caused deaths and damages to a structure due to maximum load being carried at the end of the load jib which was not moved to the center of the load jib during construction project execution primarily due to negligence and the lack of adequate training from the tower crane operator (Arslan and Kaltakci, 2008:290). This was also a factor that the study found to be contributing to accidents and fatalities in the SA construction industry.

The cycle time was found to be a factor in which the all the operators felt it was not important because they were not working against speed or in hurry. This was because the important aspect of lifting and unloading of construction materials required thorough and careful concentration from the operator in seeing that the load is carried safely from the lifting point to its unloading point. The operators felt it was not important to keep a certain time limit necessary for lifting and unloading because speed and hastiness were the main contributing factors to tower crane related accidents. The study found that the training of tower crane operators prioritized concentration as opposed to the cycle time needed in lifting construction materials on sites.

A prior study conducted in Israel in relation to the cycle time in lifting and unloading of construction materials found that it would take operators less time to lift and unload materials if tower cranes were improved in their cycle time so as to obtain greater efficiency in the delivery of construction projects. This was because tower cranes have been found to be used for 50 – 80% of the time they spend on sites because of factors such as the cycle time in the lifting and unloading of construction materials. (Rosenfeld and Shapira, 1998: 285 - 288).

It remained a factor that needed to be incorporated in the training and skills development of tower crane operators in the SA construction industry because it currently takes longer than it is necessary for tower crane operators to lift, move and unload construction materials on sites.

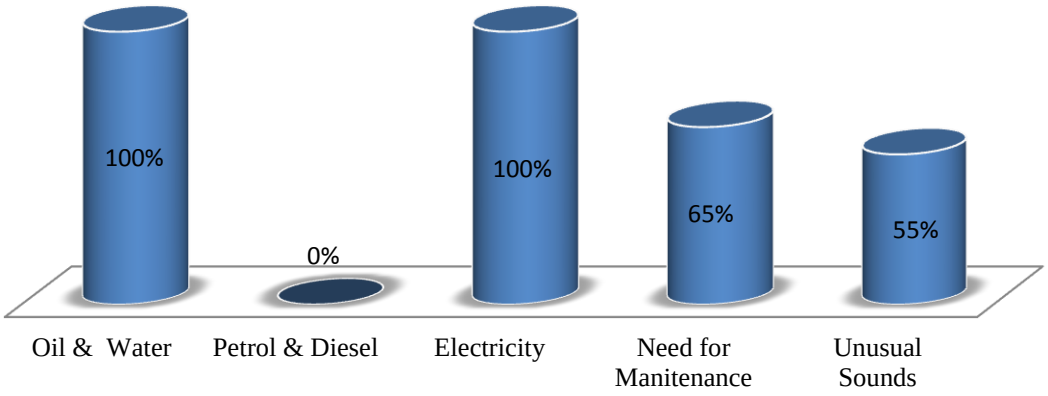
The study found that there was a need to improve the efficiency of tower cranes in relation to the cycle time because operators were not concerned with how much time it takes them to lift a particular load but rather on the concentration required. It also showed that general contractors and clients were paying more than what was necessary for the use of tower cranes in the delivery of construction projects. Training was also found not to prioritize the cycle time needed in the lifting operations of tower cranes which pointed to the need to improve the current inadequate holistic training practices given to tower crane operators in the SA construction industry.

The lifting and unloading of construction materials were found to be the primary aspects of training given to all tower crane operators. The practice was found be dependent on the communication between the banksman and the operator in the safe lifting of construction materials. The operators agreed that the training in private providers was actually not adequate since the signaling system required in the lifting and unloading of materials was only practiced for a day or two with proficiency not ascertained during training. This affected the lifting and unloading of construction materials especially when the banksmen was not well trained and radios not adequately used for communication. The operators trained in a site environment felt that the lifting and the communication were the key aspects that were prioritized.

4.5.6 Training in Basic Reporting and Recording of Tower Crane Issues

The training in the recording and reporting of tower crane related issues ranged from the *oil and water consumption, need for maintenance and the hearing and noticing of unusual sounds from the equipment*. This type of training was found to have been offered on construction sites since training by private training providers lacked ownership of tower cranes with little time spent on the tower cranes hired during training.

Figure 14. Recording and Reporting of Tower crane Issues



All the operators surveyed agreed that the tower crane does not have a need for diesel or petrol consumption since they were working using electricity. This reduced issues related to the reporting and recording of diesel and petrol consumption by tower crane operators. It is only electricity cuts that disturbed their use during construction project delivery which in many cases contractors did not have a backup in terms of generators.

The tower crane operators also agreed that training was given in recording and reporting the level of oil and water consumption. This was in checking the minimum and the maximum allowable oil and water levels necessary in the operation of tower cranes. Others felt that it was similar to a car or a tractor whereby the operator would need to the check the oil and water available every morning before he starts using the crane.

65% of tower crane operators were found to have been trained in the recording and reporting of the need for maintenance of the tower cranes. The maintenance of tower cranes was found to be conducted every three months. This was because the tower crane operators were not trained in conducting basic maintenance of the cranes but in their operations. The operators surveyed agreed that they only needed to call the mechanics in the event of unexpected need for maintenance but also not conduct the basic maintenance themselves since there was a separate structure of mechanics working on maintenance. The training in this regard was also obtained in a construction site environment.

55% of the operators surveyed felt that hearing and noticing of unusual sounds from the operation of tower cranes was also noted as an important factor that made up the training in the

reporting and recording of tower crane related issues. This were factors normally found in busy construction projects where the tower crane operator would also work in night shifts and carrying heavy loads in major infrastructural projects as compared to a normal building project. Training was also given in a construction site environment and not from private training providers due to shortened training programmes

4.5.7 Nationality of Tower Crane Operators

All the tower crane operators surveyed were found to be SA citizens by birth. Interviews carried with site foreman and managers revealed that foreigners are more prone to accidents compared to the locals because of in adequate communication between the banksman and the operator where English was to be used as a medium of instruction. This also showed that there could be reluctance by contractors to employ foreigners who were qualified tower crane operators because of lack of fluency in one or two of the major African languages such as IsiZulu and Sotho or Tswana.

Fluency was found to influence communication between the operator and the banksman in the lifting operations since tower crane operations relied more on communication and clearer instructions. The study found that fluency in African languages used in the SA construction industry also influenced the employability of tower crane operators. The reason was that other operators agreed that there were foreign tower crane operators working in the SA construction industry, but fluency in Zulu or Sotho was an important part which influenced their employability because of the communication expected between the banksman or the signalers, the labourers who are illiterate and the operator.

4.5.8 Experience of Tower Crane Operators in the Operations of Cranes

The average work experience of tower crane operators was found to be 9.7 years ranging from 4 – 19 years in a sample of 25 tower crane operators. This showed that many of the tower crane operators prefer to stick to tower crane operations than moving to other careers such as in plant management, construction management in a role of assistant foreman or in offering the training and skills development to the young operators to be employed by the contractor. Few tower

crane operators sampled agreed that there were other tower crane operators who got further training in becoming assistant site foreman from their contractors. This also showed that there were fewer operators who had work experience that was less than three years. It also highlighted that there were little employment opportunities or training given to youngsters in tower crane operations.

4.5.9 Average Age of Tower Crane Operators

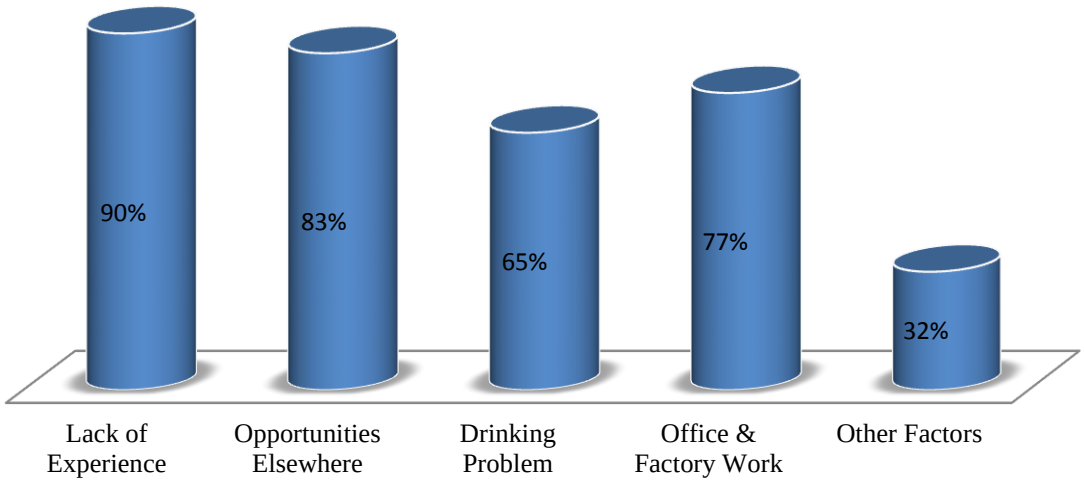
The average age of tower crane operators was found to be 38.5 years in a sample of 25 tower crane operators ranging from 30 – 53 years. This was lower than the average age of an artisan in the construction industry which was found to be at 54 years (Mayet, 2010:17 citing Grawitzky, 2007). The reason was due to the ease to which the operators access the crane cab to be the main factor that makes the majority of tower crane operators not reaching an age of 50 and above operating a tower crane.

The tower crane operators gave an important perspective and insight in regards to accessing the cab. The perspective was that if the tower cranes were to be equipped with a lift that takes off the pressure of using stairs in accessing the cab, that could also contribute to more efficient operation of tower cranes and experience retained. Reasons given were that operators felt it was tiring to take the stairs up every morning, during lunch time and when they knock off.

4.5.10 Factors that make Youngsters not to Consider a Career in Tower Crane Operations

Interviews conducted with tower crane operators and site foremen and managers found the factors that make the youth or the youngsters not to view tower crane operations as a career ranging from *lack of experience, more opportunities in the construction industry and the economy, drinking problem and obsession with office or factory work.*

Figure 15. Factors Affecting the Youth in Tower Crane Operations



4.5.10.1Lack of Experience and Contractor Practices

90% of the operators surveyed felt that lack of experience was a factor constraining access to tower crane operations where many youngsters were trained in operating tower cranes during the preparations of the 2010 FIFA World Cup, contractors continue to view them as more prone to accidents compared to the experienced operators who were unemployed or looking for better working conditions. Contractor practices have been found to be a factor restraining training and skills development in tower crane operations, contractors believe it is expensive to train and develop inexperienced youngsters as compared to employing someone who is already experienced (Mummenthey, 2008:37). This was also found to be compounded by the current low availability of major construction projects in the industry.

Interviews carried with site foreman and managers found that the fly by nights private training providers who offer the one to two weeks training certificates in tower crane operations were limiting opportunities to train youngsters, they were flooding the market with people who have certificates in tower cranes but poorly trained. Contractors were found to prefer to look in the labour market first before they could consider training youngsters which many poorly trained operators were given preference because of the expensive costs of training youngsters to become competent tower crane operators (Wang, Dunston and Skibniewsk, 2004:1). A previous study in Malaysia found that contractors were engaging the practice of employing less qualified operators

than to train youngsters because of reasons associated with profitability and costs minimization (Shukri, 2010:7). It is a practice which also affects the training and skills development of youngsters or the youth in tower crane operators in the SA construction industry.

4.5.10.2Better Opportunities Elsewhere

83% of the operators surveyed felt that the youth does not see a long term career in tower crane operations because they felt there were better opportunities elsewhere in the construction industry or in other sectors of the economy. The operators felt that the main influence was because of the existence of Learnerships offered by government in the construction industry especially when the youngster was in possession of a Matric Certificate. Some felt that youngsters dreamt of becoming engineers and accountants compared to becoming site foreman and managers because the industry was still white dominated.

4.5.10.3 Drinking Problem and Lack of Alcohol Management

65% of the operators felt that drinking problem and lack of alcohol management were factors constraining opportunities to youngsters in tower crane operations. Youngsters were found to have the problem of coming to work on Monday after the weekend of earning their wages with a hangover, demonstrated by red eyes and headaches which indicated that they lack adequate personal control in alcohol. This was found to be a factor limiting their opportunities to contractors who viewed them as more prone to accidents and injuries on sites. This was also coupled with lack of discipline in terms of absenteeism especially after the weekend of earning wages.

4.5.10.4 Obsession with Office or Factory Work

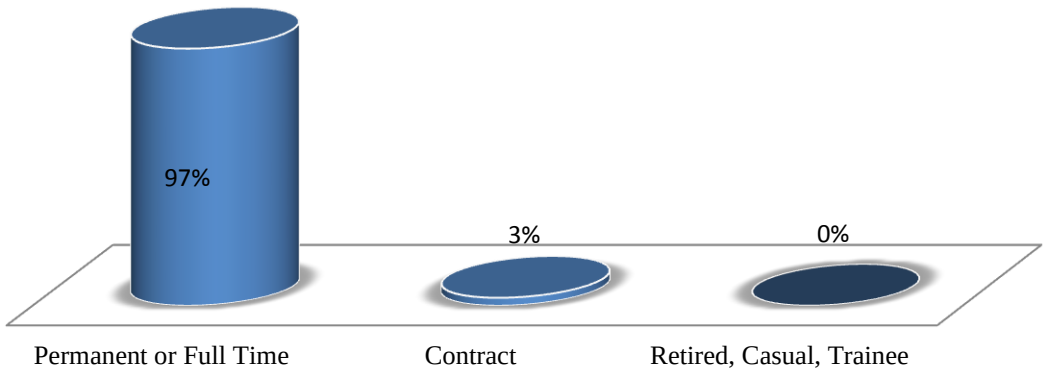
77% of the operators surveyed felt that youngsters viewed office or factory work as offering more opportunities as compared to construction work. This was also the problem of working with overalls, plaster and concrete as more inferior compared to working in a factory or office environment.

Interviews with site foremen and managers also found that other youngsters viewed working in the high heights as scary with some not willing to work in higher floors of multi-story buildings when working as labourers. This was because of poor Health and Safety enforcement practices by Health and Safety Officers in reducing the factors that cause accidents when one works in higher floors such as adequate fall arrest, people were also falling from multi storey buildings despite adequate measures being put in place to prevent such occurrences.

4.5.11 Subcontracting of Tower Crane Operations

The study found that most of the operators were *full time employees* of the contractors they were working for primarily because of work experience. There were few operators who were *on contract or not permanently* employed by the contractors. There were also no operators who were *retired, casual or trainees*.

Figure 16. Subcontracting in Tower Crane Operations



The study found 97% of the operators who were full time or permanent employees of the contractors which was mainly due to the number of years that the operators had been working for the same contractor. The operators were either employed directly by the larger, medium sized or crane hire contractors. This indicated that contractors prefer to retain the skills they have in tower crane operations than to subcontract the practice of the operations of the crane.

3% of the operators sampled were found to be under contract or not directly employed by the contractor as permanent employees in tower crane operations. This also indicated the practice of

subcontracting tower crane operations by employing people directly from labour brokers or recruitment agencies. It showed that contractors when faced with heavy workload prefer to subcontract the operations of the tower crane and not train youngsters due to lack of experience and project complexity. This also indicated that the contractors would not prefer to have someone who is a trainee when operating a tower crane as compared to finding in the labour market first someone who is experienced and less prone to accidents.

The study did not find operators who have retired but recalled or those who were working as trainees, part time or in a casual position contrary to what was found by Dithejane (2005: 49). This was primarily because there was less work or major construction projects available in the market at the time the study was conducted as compared to during the preparations of the 2010 FIFA World Cup. Interviews with site foreman and managers revealed that it was easy at the moment to find an experienced tower crane operator in the market to such an extent that two large contractors surveyed agreed to have stopped training in tower crane operations because there were many operators available in the labour market compared to the work available in the construction industry.

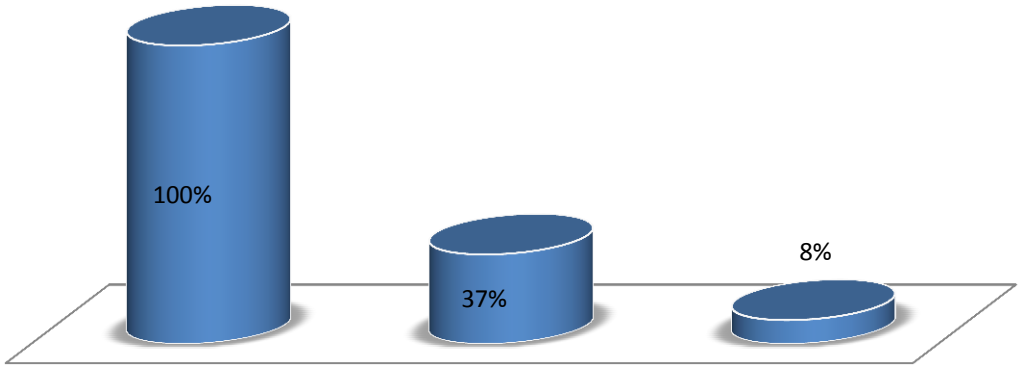
Other reasons were because many operators after getting their certificates in tower crane operations would resign after applying for a position offering a better pay or a rate per hour greater than what they were currently earning. This was irrespective of whether they were trained by the contractor or not. The interviews with site foremen and managers found that contractors do not protect themselves in terms of having clauses in their contracts of employment which put a maximum time that a tower crane operator must remain under their employment after offering training and skills development to the tower crane operator.

4.5.12 General Life Skills Training in Tower Crane Operations

The general life skills training relevant to the operations of tower cranes were found to range from *HIV/AIDS* training, the aspects of managing *personal finances including savings and debt management* and *further training in plant operations and management.* The research found that some life skills training were offered by the contractors while others dependent on the operator

to seek such life skills training. In other instances contractors only offered the HIV/AIDS training.

Figure 17. Life Skills Training in Tower Crane Operations



4.5.12.1 HIV / AIDS Training

The study found contractors employing tower crane operators to be offering HIV / AIDS counseling and advice to their operators every year. This was conducted at the start of each year in terms of assessing the overall health of the operators by having blood tests conducted to each operator. Primary reasons were also associated with finding out whether the operator started the year with the sickness or he got the sickness while working for the contractor. This was also related sicknesses such as loss of hearing or sight due to the nature of the construction industry which is characterized by noise emanating from excavations and other vibrations related to the use of the tower crane.

The interviews with site foreman and managers also revealed that issues of HIV/AIDS also formed team talk on sites every week or month depending on the contractor. This was also emphasized during site induction every time new operators were employed to work for the contractor. It was also found that there were incidences of deaths of operators due to lack of training in life skills such as HIV/AIDS at the workplace. This was also observed in a recent study (Mummenthy, 2008:38) in South Africa and confirmed that contractors were also losing on

the investment offered in training and skills development of tower crane operators. The deaths have since stabilized due to increased training offered by contractors on sites.

4.5.12.2 Personal Finance, Savings and Debt Management Training

There were 37% of tower crane operators surveyed who agreed to have been trained in life skills such as managing their personal finances, saving and debts. The aspects of training tower crane operators in life skills such as in personal savings, finance and debt management was found to depend on the contractor where other contractors offered the training once in a year while others did not offer it at all.

Tower crane operators surveyed were found not to have proper training in issues relating to policies such life cover, death cover, savings and education policy for their children despite the average work experience of 9.7 years as found above. Counseling on managing their personal debts and finances were also not found to have been offered by contractors in many sites from the operators surveyed. The importance of managing personal finances was because many tower crane operators were working away from their families due to construction work having proximity values. Other motivations were that construction projects were of a short term nature and needed adequate savings in personal finance, continued employment also dependent on the availability of contracts and construction work.

The research found that contractors were covering the tower crane operators in terms of death cover and pension funds. However, most of the operators did not have pension policies which was primarily due to being covered by the contractors in the event of early retirement as regulated by the Pension Funds Act of 1956 (2001) which obliges the contractors to register the pension fund and deduct it from the salaries of their permanent employees.

The investigation also showed that there was a lack of adequate training of tower crane operators in relation to the life skills necessary such as personal finance management in the operation of tower cranes.

4.5.12.3 Further Training in Tower Crane Operation and Management

A small number, 8% of the tower crane operators surveyed agreed to have been given knowledge about internal structures and processes on how to get further training in tower crane operations and management as implemented by their contractors.

The study found further training and development of tower crane operators to be dependent on the operator seeking those opportunities inside the contractor structures. This was because other operators have been found to only concentrate on earning their salaries and not looking for further training in this regard. Tower crane operators were found to be visiting the Human Resource department of the contractors seeking available further training structures and opportunities, in order to work more with skills development than in the site based tower crane operations because of many years of work experience.

Other operators were found to have been offered the opportunity to assess new operators who were looking for employment in a period of one to two weeks and make recommendations on the suitability of the unemployed operator who was looking for employment. Others were also found to have been offered the opportunity to train new operators in a site based environment that usually lasted for 4 – 6 weeks practical training until the operator was competent in the lifting and unloading practices of tower cranes.

These opportunities were found to be given to lucky operators with no clear policy or structure as to how one can become involved in the site based training and skills development of new tower crane operators in a site based training programme.

The study also found that there were few incidences of people who started as tower crane operators and got further training and skills development opportunities in a site based environment. This was because of the few operators who were found to have progressed to become an assistant site foreman in a site based training and skills development programme offered by contractors.

The research found that there were no operators who were given further training in areas not related to the operations of tower cranes other than in becoming an assistant site foreman. This was primarily because most of them were illiterate with low skills in reading and writing especially in writing full technical reports in relation to the tower cranes they operate. It was also

not found that further training or assistance were given in becoming plant managers or in obtaining a further certificate such as Advanced Plant Operations and Management certificates which were National Qualifications Framework (NQF) level three. All the operators surveyed were in possession of NQF level two certificates which were the basic tower crane operations certificates.

4.6 Improvements or Restructuring of the Training Programmes

The section presents the improvements or the restructuring of the training programmes that is needed in order to have adequate standards of training tower crane operators in the SA construction industry.

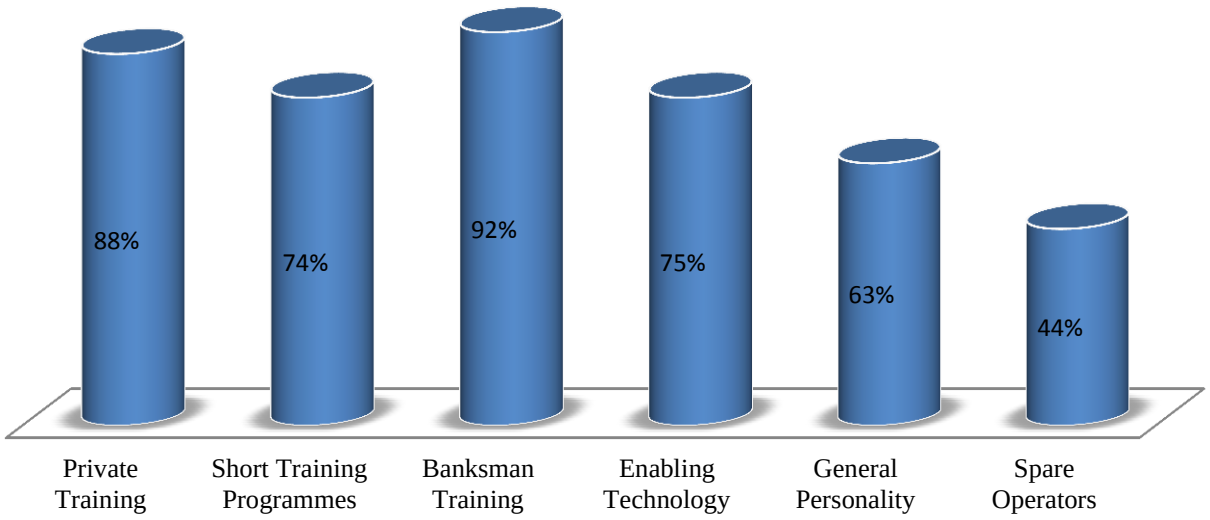
The improvements needed or the restructuring of the tower crane training practices were examined from the major factors that continue to affect the training and skills development of tower crane operators in the SA construction industry. This were the salient features that the tower crane operators themselves felt were needed in order to improve the current inadequate holistic training practices given to tower crane operators.

It was hoped that the improvements and the restructuring aspects needed to improve the training and skills development of tower crane operators would reduce related project delays from the current inadequate holistic training practices which significantly impact health and safety in Gauteng, South African construction projects.

4.6.1 The Major Factors Affecting the Training of Tower Crane Operators

Adequate training of tower crane operators was found to have been affected by the use of *private training providers*, *short programmes of training* tower crane operators, *general personalities* of the operator, in *adequately trained banks man*, poor *loading and fastening techniques* and lack of *enabling technology* in tower cranes in the SA construction industry

Figure 18. Improvements or Restructuring Needed in Tower Crane Operations



4.6.1.1 Private Training Providers

88% of the tower crane operators sampled felt that the training given to tower crane operators by private training providers was not meeting the minimum standards of competence required from the training given. The study found that there was a need to revamp the training given to tower crane operators in the one to two weeks training programmes, operators felt it was not well structured and people obtained the certificate without obtaining the adequate skills needed in training and developing tower crane operators.

This was also compounded by the lack of ownership by private training providers of the tower cranes used in training tower crane operators. This was found to be a major factor because the training providers hire the tower cranes from contractors for hours ranging from two to six hours a day, depending on project complexity which in other instances people end up having touched the tower crane once a day in their training.

It was proposed that government needed to assist with their financing in terms of offering tower cranes that could be used in a construction project environment in order to assist with the training of tower crane operators in the SA construction industry. This was felt to be a factor that could contribute to adequate training and skills development of tower crane operators since interviews with site foreman and managers confirmed that they were not adequately trained.

Operators also made a concerning factor that other training providers reduce the duration of the training programme below that which is stipulated by law or even their own two weeks duration. This also contributed in having operators with tower crane certificates but not enough practical training gained.

Shortages of Learnerships by government was also found to contribute to the inadequacy of training tower crane operators, government was not a major player in the training and skills development of tower crane operators in the SA construction industry. Operators and the interviews made with the site foremen and managers felt that government assistance in the training of tower crane operators could contribute to more practical training being given in major government projects such as the Eskom power stations or other infrastructure projects under construction.

The study found that the training given by private training providers needs to be restructured in terms of the duration of the programme, the theoretical aspects, the practical aspects of training tower crane operators before a tower crane certificate could be issued. The operators felt that a training programme ranging from one to three months provided by the private training providers could be more credible and would result in increased learning outcomes in terms of having operators who have the necessary skills in operating a tower crane. The private training providers also needed to have their own tower cranes in assisting with the practical aspects of training tower crane operators.

4.6.1.2 Shortened Training Programmes in Tower Crane Operations

74% of the operators surveyed felt that the shortened duration of training was not giving them the all-round training needed in the operations of tower cranes. In many instances the training did not include carrying out of basic maintenance necessary for the tower crane. This was in areas such as assessing the causes which makes slewing to be slower than usual or conducting basic maintenance such as greasing the slings at every end of the month.

This also showed that the training received in Apprenticeships which was an all-round training covering all the aspects of tower crane operations remains a missing factor in the training of tower crane. The current skills development programmes do no encompass all the aspects of

training tower crane operators but are more towards the understanding of operating a tower crane and little theoretical, health and safety training, no maintenance and servicing training, lack of adequate rigging and hoisting training, applicable important communication training and general management of the site staff under the authority of the tower crane operator. The decline of Apprenticeships type of training appeared to outweigh the benefits they provided in other disciplines such as in tower crane operations as noted in a recent study in South Africa (Mummenthey, 2008:24).

A small and basic operation which sometimes means that the mechanics will have to arrive on site before they could be done was also a factor contributing to related project delays in the construction of projects. Even when the oil and the water were leaking they were told that they should only phone the mechanics who would deal with those aspects of basic maintenance. This was found to increase the operating costs of tower cranes due to lack of basic maintenance training and the skills necessary. A prior study in the UK also found that the maintenance skills of tower crane operators were also assisting in reducing the operating costs of tower cranes (Edwards and Cabahug, 2002:23)

The study found that there was a need to restructure the current programmes and the manner in which training was structured in the SA construction industry. This was because of apparent lack of adequate holistic training in the current programmes offered in tower crane operations.

4.6.1.3 General Personalities of the Operator.

63% of the operators felt that there was a need to improve or give training in relation to the personalities or personal attributes needed in the operation of tower cranes. The HSE (2011: 13) investigated the personality attributes of operatives on sites to examine their contribution to site accidents. The HSE found the more experienced operatives including operators to be more prone to accidents due to *work fatigue, over-familiarity and over-confidence, complacency and omission of or low safety awareness*.

Interviews with operators, site managers and foreman found that the operators lacked the necessary personalities needed in the operations of tower cranes. Most of them were earning more than the banksman and the labourers on site, they lacked the necessary respect and

cooperation needed for safe operation of tower cranes from the training provided. In other instances they were found to be using cellphones in the cab with the banksman issuing instruction which also showed recklessness in the lifting and unloading of construction materials. Lack of listening to instruction (*omission of safety awareness)* and respect to fellow subordinates such the banksman and the labourers were also found to be personality issues affecting the use of tower cranes where the operator would rely on the experience (*over-familiarity and over-confidence*) he has in the lifting of construction materials which resulted in accidents.

They were also found to be lazy (*complacency*) at other times in terms of assuring that the load is adequately fastened. This were instances where they lacked the necessary skills of asking the banksman to recheck the load or refasten it where it could be seen that it posed danger on sites

4.6.1.4 Banksman and the Load Fastening Techniques

92% of the tower crane operators surveyed felt that the poor training of banksman was a major factor contributing to tower crane related accidents. It remained a challenge to them to have adequate communication between themselves and the banksman on the safe lifting and unloading of construction materials in a manner that does not pose health and safety hazards. Training was found to be lacking in aspects related to the signaling system and code that is recognised in the SA construction industry as recommended by the ILO (1995:51-53) in the training of tower crane operators.

Other operators felt that training of tower crane operators needed to be done concurrently with the banksman since they do similar operation of load lifting during construction projects. This was because it remained difficult to lift loads where the tower crane operator was assisted by one banksman. The operators felt that there was a serious need to have two banksmen who will assist the operator, one being on the ground where the load is lifted and the other where the load is unloaded. This would assist in the load control practices where the banksman on the ground would also whistle so that people could not move when the load is lifted up.

The training of banksman was found to be a major factor affecting proper lifting and unloading of construction materials, the need to have adequate and proper curriculum and structure of training banksman was promoted in the construction industry since they were currently trained

differently by individual contractors. This was also found to be a factor resulting in heavy loading or poor hoisting and rigging practices in tower crane operations.

Checking of load slings, chains and hooks every time the tower crane is to be used in the morning was also a responsibility that was shared between the operator and the banksman. It is a factor which continues to result in accidents and fatalities in construction sites and shows the concerning lack of adequate training by contractors.

4.6.1.5 Lack of Enabling Technology in Tower Cranes

75% of the operators surveyed felt that the lack of enabling technology on tower cranes was a major factor that also affects adequate lifting and unloading of construction materials since it was missing in all tower cranes operated by them.

The research found tower crane operators who were trained in contractor site based programmes clarifying that lifting and unloading is also done in areas of the site where they cannot appreciably see or assess the whole site environment before they can unload construction materials. Communication between the operator and the banksman could not assist in other instances where projects were complex with higher heights.

Training in seeing aspects of loading at a higher heights could not assist but pointed to the need to have an enabling technology which could assist with seeing the site environment and the load being fastened, in many instances the operators could not appreciable see what is happening in the ground where the load is fastened and where the load was delivered or where it was unloaded. The operators felt that the video technology would greatly assist and reduce tower crane related accidents in the lifting and unloading practices.

A prior study (Lee *et al,* 2006) in Korea conducted on the feasibility of using video technology in construction projects showed that tower crane related accidents reduced dramatically and productivity increased as a result of assisting and enabling the tower crane operator to see and visualize the whole lifting operations, while also increasing communication between the operator and the banksman on the proper lifting practices. Perhaps the experiences of the operators indicated the need of improving the enabling technology in tower cranes because of accidents

that remain beyond their control due to lack of eyesight and reliance on the banksman. The study found that there is an apparent need to introduce video technology in tower crane operations for better project delivery and increased productivity.

The operators were of the opinion that the current tower cranes with the video technology could only be afforded by larger contractor because the medium sized contractors continue to struggle with profitability in their projects. It appeared that the video technology use in our construction project remained very limited due to costs reasons even to large contractors.

4.6.1.6 Spare Tower Crane Operators during Construction Delivery

44% of the operators surveyed felt that construction projects have longer working hours and results in fatigue to many well trained tower crane operators. Fatigue contributes to accidents because people do fall asleep in the cab and work slowly. Operators are not well trained in managing longer working hours where there will be night shifts and overtime work. Part of the solution was to introduce spare operators who will take over from the operators on sites which are complex and demanding projects at certain time intervals.

The study found the practice of using spare operators to be entrenched to large contractors as opposed to the medium sized and plant hire contractors. In many sites surveyed, the operators were found to have one or two spare operators who exchanged with others on sites after working longer hours to construction projects executed by large contractors. It remains a practice that contractors use in order to prevent accidents and fatalities occurring due to fatigue but lacking to the medium sized and crane hire contractors in the SA construction industry.

4.7 Conclusions

The data analysis showed the extent to which adequate training of tower crane operators was lacking which significantly impacts health and safety in Gauteng, SA construction projects. This was because of reasons associated with the manner in which they were trained especially by the private training providers. The research also found operators not to be efficient in the key lifting

operations where they took more time in order to lift, move and unload construction materials due to lack of adequate training and inefficiencies attributed to the tower cranes.

The data analysis and findings also showed that the nature and characteristics of the current inadequate holistic training practices given in the industry lacked the necessary learning outcomes needed in the operation of tower cranes. This also showed that the training practices were lacking effectiveness in terms of safe lifting, moving and unloading of construction materials which continue to be done in a manner that poses accidents and hazards in the SA construction industry.

The analysis and discussions also showed that there were major factors that still need to be addressed and improved in the training and skills development of tower crane operators for safe lifting of construction materials. This were areas related to their practical training, the need to have concurrent training of banksman and tower crane operators due to the important role that communication play between them, the apparent need to train and develop youngsters in the operation of tower cranes and the site management practices by contractors

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study was undertaken with the aim of investigating the current inadequate holistic training practices given to tower crane operators which significantly impact health and safety in Gauteng, South African construction projects.

The section provides a summary in relation to the findings of the study. It also provides the conclusions reached and the recommendations which included how a further study could be conducted in the training and skills development of tower crane operators.

5.2 Summary of the Findings

The study focused on answering the important research questions which gave the necessary methodology in carrying the study. The first research question was on the structure and the characteristics of the training given in the industry:

"What are the current structures and characteristics of the training programmes given to tower crane operators in the South African construction industry?"

The above research question helped to examine the current structure and the characteristics of training practices given to tower crane operators in the SA construction industry. This gave the overall nature which characterizes the current inadequate holistic training practices given to tower crane operators.

Training was found to be offered by private training providers and general contractors. Tower crane hire contractors were not found to be offering training in tower crane operation from the operators sampled who were trained by general contractors or in private training.

Training was characterized by the training given in private training and that which was given in workplace based type of training programmes from general contractors. There were no operators who received training in Learnerships or Apprenticeships.

The structure and the nature of training tower crane operators were characterized by a limited duration ranging from one to sixteen weeks of training. Private training providers were found to offer training which was in a period of one to two weeks. This was primarily due to lack of ownership of tower cranes which limited the duration of what they could offer in the practical training aspects and skills development of tower crane operators. This type of training was also found not to be adequate due to lack of training in the important aspects of operating a tower crane, all the operators surveyed agreed that practical training was given on site and not in the private training programmes due to very limited duration of the training programme.

General contractors were found to be offering training ranging from 3 - 4 months, with two to four weeks given to those with prior work experience in tower crane operations and 12 – 16 weeks to those who did not have prior experience in tower crane operations. Training given by general contractors was found to be focusing on the practical aspects of operating a tower crane, the leaner crane operator would work with an experienced tower crane operator for a period of four to six weeks after the theoretical training in order for the person to be competent in operating a tower crane.

Even though this type of training was found to offer most of the necessary training needed in operating a tower crane, the study found that the operators were not well trained in using the angular distance when lifting in a manner that does not pose health and safety hazards on sites. This included lack of adequate training in using the cycle time to lift and unload construction materials due to more focus on concentration, compared to the inefficiency this has in the delivery of construction projects in terms of the longer time span it takes to lift and unload construction materials

The general structure of the training given to tower crane operators was characterized by training in key aspects such as *use of work books and manuals, classroom learning, construction site training, open ground training, signaling system used by banksmen, load placement control and crane loading specifications.*

Tower crane operators agreed that there was inadequate training in the theoretical aspects needed in the operation of tower cranes, this included the lack of practical training to many operators who were trained in private training. The communication between the operators and the

banksman regarding the signaling system was found to be a major cause to tower crane related accident. This was also coupled with many incidences of overloading of tower cranes which was due to lack of training to tower crane operator assistants such as the banksman and labourers.

The general structure of training and skills development of tower crane operators was found to be inadequate due to the lack of adequate training in the key aspects of training tower crane operators. This was also because the training given was not in the form of an Integrated Training Programme which included all the necessary aspects of training needed in order to adequately operate a tower crane. This was primarily because the training programmes were shortened with the focus being on lifting and unloading without giving adequate attention to the other aspects that affect tower crane operation which result in accidents, hazards and fatalities and related project delays on sites.

This were areas such as lack of basic maintenance training, inadequate training in the operation aspects since they prioritized lifting and unloading without giving consideration in the other aspects of safe operations such as angular distance, cycle time, detecting unusual sounds, hoisting and hooking and other factors.

The first research objective which was aimed at examining the nature and characteristics of training given to tower crane operators in the construction industry was achieved from the investigation undertaken by the study.

The second research question focused on the barriers which continue to affect adequate training and skills development of tower crane operators in the SA construction industry. This was in order to find the aspects which limit adequate training of tower crane operators:

"What are the barriers that affect skills development in relation to tower crane operators in the construction industry?"

The study found that the training given to tower crane operators was mainly offered in private training and in workplace based training programmes. This meant that there were currently no operators trained in an Apprenticeship type of training which offered the all-round training and skills development of operating tower cranes. Reasons found were that the Apprenticeship type

of training took longer and hence not cost effective to contractors while formal learnership agreements were only offered in the operators of earthmoving equipment and plant such as those who operate graders, excavators, rollers and compactors primarily used in road construction. This formed a major barrier in the training and skills development of tower cane operators in the SA construction industry.

The youth and the youngsters were also found to be riskier in the operation of tower cranes due to factors associated with lack of work experience, drinking problem, availability of opportunities elsewhere in the economy and obsession with factory or office work. The research found that the influx of poorly trained operators presented a major barrier in the training of the youth and youngsters due to contractors preferring to give them first preference as compared to training youngsters on site because of costs reasons.

Other barriers were found to be those associated with the lack of involvement by government in training and skills development of tower crane operators compared to training given in electricity or mechanical artisan work. Primary reason was due to contracts being given to general contractors who take responsibility of using their own tower crane operators with no agreement in training local youth in key trades such as tower crane operation as part of contract conditions. This was also found to be a factor where emerging contractors would hire a tower crane with a skilled operator instead of training and developing their own younger tower crane operators in a construction site environment.

The second research objective which focused on establishing the barriers that affect skills development in relation to tower crane operators in the construction industry was also achieved from the investigation undertaken by the study.

The third research question focused on the effectiveness of the current inadequate holistic training practices given to tower crane operators in the SA construction industry. The objective was to find the concerning factors that continue to make the training lack the adequate effectiveness needed in the delivery of construction projects:

"How effective are the current training practices given to tower crane operators in delivering construction projects?"

The comparison from literature and practice regarding the competencies expected from the registered Unit Standards in South Africa and the training also advocated internationally in countries such as Canada through their the Industry Training Authority with Unit Standards that ensures competency of training tower crane operators clarified the lack of effectiveness of tower crane operator training. The lack of effectiveness from the training practices was from knowledge areas such as the low safety standards in operating tower cranes, lack of adequate rigging and hoisting skills, lack of adequate communication practices, lack of adequate maintenance and servicing skills and the skills necessary for tower crane operations.

Effectiveness of the current training practices was examined and explored from the health and safety aspects of operating a tower crane, the contributing factors that still continue to cause tower crane related accidents, the experiences of tower crane operators in accidents witnessed, the extent to which equipment breakdown or downtime occurs during construction project delivery, the training in conducting basic productivity tactics and methods, the training in recording and reporting of tower crane related issues and general life skills training

The research found that the training of tower crane operators lacked the effectiveness needed in the operation of tower cranes in a manner that does not pose health and safety risks and hazards during construction project delivery. There were tower crane operators who apparently refused to share their experiences of where they witnessed tower crane related accidents because of being seen as the people who are responsible for the deaths and fatalities on sites. Others agreed to have had accidents which damaged construction materials and the structure under construction.

These was because of areas associated with practices that continue to result in tower crane related accidents due to factors such as poor communication between operators and load fastening tactics used by banksman, lack of adequate personality training in operating tower cranes, lack of training in managing the inefficiencies of tower cranes such as when there is lack of clear sight with radios found not to be efficiently used in facilitating communication between the operator and the banksman.

Training was also found not to have been given in basic productivity methods and tactics such as in using the angular distance in a manner that reduces accidents with the cycle time training also not to have been given during the training in manner that reduces the longer time it takes to lift and unload construction materials.

General life skills training were also found not to have been given in the training and skills development of tower crane operators with many of them not knowing current means of saving their money for future expenses such as death cover, education policy for their children and retirement policies. The importance of life skills training was because tower crane operators worked away from their families and needed training in personal finance management.

There was also lack of training in relation to opportunities that exist in order for the tower crane operators to develop further in tower crane operations and management than to remain on sites for an average of 9.7 years as found above. Tower crane operators were found not to know the current structures of personal development inside their contractors. This also showed that most of them would have developed further in becoming plant managers, assistant site foreman or training personnel in tower crane operations than to spend many years operating a tower crane.

The third research objective which focused on examining the effectiveness of the current training practices in preparing tower crane operators to deliver construction projects was also achieved from the investigation undertaken by the study.

The last research question focused on the aspects of tower crane operator training that need to be improved or restructured for the delivery of construction projects not to be associated with the concerning and endemic accidents, fatalities and deaths during construction project delivery:

"What are possible aspects of training in relation to tower crane operators that need to be restructured or improved for better construction project delivery?"

This formed the important part or section of the research project which also formed the significant section in relation to the recommendations of the investigation conducted in relation to the training practices currently being given to tower crane operators in the SA construction industry.

The study found that the key aspects of improving or restructuring the training and skills development of tower crane operators relied on the contractors and government working together, the purpose being to form an integrated training programme which includes all the aspects of training that remains not covered in the training of tower crane operators in the SA construction industry. The motivation was that the current inadequate holistic training practices given to tower crane operators were characterised by shortened training programmes, the programmes did not include all the knowledge areas of training needed which were a major contributor to tower crane related accidents in the SA construction industry.

This are factors related to the problem of inadequate holistic training provided by private training providers, the need to have a concurrent training of banksman and tower crane operators in order to improve communication and safe lifting practices, the need by contractors to have spare operators during construction project delivery due to fatigue that comes from longer working hours and nightshifts, improvements needed in the visual technology of tower cranes, lack of training in general life skills necessary in tower crane operations.

The last research objective which focused on establishing whether the training given to tower crane operators needs to be restructured or improved for enhanced construction project execution and delivery was also achieved by the investigation undertaken by the study.

The study managed to answer all the research questions it sought to examine and explore in relation to the current inadequate holistic training practices given to tower cane operators in the SA construction industry. It also achieved all the research objectives regarding the current inadequate holistic training practices given to tower cane operators and their impact on health and safety in Gauteng, South African construction projects.

5.3 Conclusions

It is concluded that the training given to tower crane operators significantly impacts health and safety in Gauteng, SA construction projects is not adequate. Lack of adequacy was arrived at due

to the poor structure and nature of the current inadequate holistic training practices which do not result in all the necessary aspects of training being given during the training programme.

The training lacks the adequate effective skills that need to be gained in order to prevent accidents, deaths, injuries and related project delays during construction project delivery. The motivation was because the training practices prioritizes the operational aspects and not addresses all the other aspects that continue to result in tower crane related accidents

The training provided to tower crane operators needs serious improvements or restructuring in order to address the current challenges that continue to result in undesirable tower crane related accidents during construction project delivery.

5.4 Recommendations

The recommendations below arise from the opinions of tower crane operators as to what they felt should be done in order to improve and restructure the current inadequate holistic training practices given to tower crane operators. The objective was to promote training practices which do not result in tower crane related accidents from the manner in which the tower crane operators are trained in Gauteng, SA construction projects which affect the effectiveness of the training programmes.

5.4.1 Shortened Training Programmes in Tower Crane Operations

The Government through the Department of Labour and the Construction Education and Training Authorities (CETAs) need to review and restructure the current shortened training programmes given to tower crane operators in the SA construction industry. The motivation was because the current inadequate holistic training practices provided by contractors and other training organisations were not holistic and integrated in the training and skills development of tower crane operators. The training programmes should be conducted over a period of six months or more before a tower crane certificate could be offered.

The current problem is that the Department of Labour National Code of Practice for the Training Providers of Lifting Machine needs to be reviewed so as to clarify the duration or period of training tower crane operators. The reason is that the National Code of Practice talks about the duration that is in the Unit Standard applicable for the training of tower crane operators. The study found that site foremen and managers were recommending a six months period as the period from the Department of Labour was not clearer on issues that relate to the duration of training. The National Code of Practice needs to also recommend all the applicable and necessary knowledge areas (or curriculum) of training tower crane operators in order to ensure that they become competent in the operation of tower cranes. This important aspect is referred to the Unit Standard applicable which has been found to be contributing to the current lack of adequate holistic training to tower crane operators.

An integrated training programme of tower crane operators should start by promoting the necessary basic writing and reading skills from the Adult Basic Education and Training (ABET) perspective in English, so that the tower crane operators are able to read and write a full technical report of the tower cranes they operate so as to obtain adequate maintenance of the tower cranes. It should also include a comprehensive health and safety training in all the risk aspects which result in accidents when working at high heights, training in conducting basic maintenance of tower cranes, the current basic training in productivity tactics which remain not covered in the operations training of tower crane operators.

5.4.2 Private Training Providers

Government through the Construction Education and Training Authorities (CETAs) should review the manner in which training and skills development of tower crane operators is conducted by private training providers. This is in order to have a structure of training which is at par with the training which is provided by contractors on site. Important aspects that need to be addressed are those which relate to the lack of practical training, the shorted duration of the practical training and the lack of credibility in relation to the learning outcomes.

Outcomes which affect the effectiveness of the training programmes due to the lack of health and safety aspects include inadequate training in the signaling system recognised in the SA

construction industry, lack of training in conducting basic maintenance and tower crane productivity tactics and methods which promote adequate operation of tower cranes.

It is also disturbing that the current Department of Labour, National Code of Practice for the Training Providers of Lifting Machine Operators is not comprehensive in relation to duration, structure of training programmes in terms of site based learning and theoretical learning and knowledge areas or applicable standard curriculum which ensures competency in the operation of tower cranes. This would ensure that the training providers adhere to best practice as expected in the National Code of Practice.

5.4.3. Concurrent Training of Banks man and Tower Crane Operators

It is of paramount importance that the training and skills development of tower crane operators and banksman or signalers be conducted concurrently or be made uniform and similar in relation to the site factors which hamper safe loading and fastening of construction materials. This is because of the importance of communication and the signaling system which remain a major factor in tower crane related accidents which affect the health and safety delivery of construction projects. Other motivation was that the contractors give the banksman first preference to train as a tower crane operator in the event of opportunities arising due to availability of projects and shortages of skills.

5.4.4 Video Technology in Tower Cranes

The contractors in the SA construction industry need to form partnerships with all industry stakeholders such as government, the private sector and the financiers of projects which will make the cost effective introduction of video technology in the tower cranes. Tower crane operators felt that other accidents are due to the lack of visual technology which enables them to have a proper and clearer site view of how well loads are fastened by banksman in terms of safety. This also included the lack of sight and clear view in the unloading of construction materials due to the nature of sites during construction.

5.4.5 Use of Spare Operators during Construction Delivery

Tower crane operators need to be assisted by spare operators in the delivery of their construction projects. Fatigue and longer working hours such as overtime have been found to be the major contributors to tower crane related accidents in the SA construction industry. The practice needs to be implemented by all contractors in the construction industry, especially the medium sized and crane hire contractors who have been found to be reluctant in using spare operators due to costs reasons.

5.4.6 Training in General Personalities of Tower Crane Operators

Training needs to be provided in the general personalities needed in the operation of tower cranes to the operators. The research found that other accidents are due to lack of respect and taking of necessary instructions from the subordinates of the tower crane operators who earn less than the tower crane operators.

5.4.7 General Life Skills Training

Tower crane operators should be trained in the general life skills needed in the operation of tower cranes. This was because of incidences reported such as the deaths of tower crane operators due to lack of life skills training in poverty related diseases such as HIV/AIDS, malaria and cholera.

It is also of paramount importance that tower crane operators be trained in the personal finance management skills in issues related to personal savings, life, education and retirement policies. This was because most of them are living away from their families due to proximity values of construction projects. This should include training in current structures within contractors and the construction industry at large about further opportunities available for them in skills, personal and career development.

5.5 Further Study in Tower Crane Operations

Further study could be taken in investigating the tower crane management practices in the SA construction industry by the large, medium sized and crane hire contractors. The objective would

be to find out how these contractors continue to have differences in the management practices of tower cranes with the medium sized contractors being the ones who use tower cranes which are older than eight years. This is because the older tower cranes have been found to be difficult to operate due to maintenance inefficiencies and general management practices which continue to result in projects delays and also affecting the performance of tower crane operators in the delivery of construction projects.

Crane hire contractors could be investigated in relation to the most users of their equipment which have been found to be the emerging contractors, the larger problem being that they are unable to train or develop their own tower crane operators in a construction site environment. These issues have been found to be due to contractual arrangements and level of experience needed in the delivery of their projects. Emerging contractors are also enterprises which are in their development stages in construction management delivery, which gives researchable concerns as to their reluctance in using trainee tower crane operators in the delivery of their construction projects.

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APPENDIX

QUESTIONNAIRE TO TOWER CRANE OPERATORS

Please define the type of construction plant that you operate.

i.Tower Crane ii. Mobile Crane

Which type or form of training did you receive in Crane operation?

a.Learnership b. Apprenticeship c. Private training

d. Workplace based f. Other

How long was the training programme

a.1- 3 months b. 4 – 9 months c. 12 months

d. Workplace based e. Other

If Other,

Please explain……
……

What type of a contractor do you work for?

a. Building b. Civil

c Plant Hire Organisation

Where did you receive training in Crane operation?

a. Contractor Plant Hire Organization or Association

b. Contractor with in house plant and equipment training programme

c. Private training provider

d. Other

If Other, Please explain……
……

What were the entry requirements in the Crane operator training programme

a. Valid driver's License. b. 12 months work experience

c. Letter from the employer

Please explain

……
……

Which aspects or type of training did you receive in Crane operation?

a. Operations b. Routine or Basic Maintenance

c Recording and reporting plant related issues d. Advanced Plant Management

Please explain……..

What was the medium of instruction used during your training?

a. English b. IsiZulu c. Sotho d. Other

Please elaborate on the medium of instruction used during your training programme……
……

How was your training programme structured?

a. Use of Work book and manuals
b. Classroom learning
c. Construction site training
d. Open ground training
e. Signalling system used by banksmen
f. Load placement control
g. Crane loading specifications

How was your health and safety training structured?

a. Receiving and following instructions

b. Checking site environment before operation

c. Carrying, moving and lifting loads

c. Wearing of PPE

d. Reporting of unsafe practices to the Employer or Site foremen

e. Loads carried by slings and hooks

f. The reporting technology in cranes

What are your experiences and perspectives regarding the factors that contribute to plant related accidents from the Health and Safety training of Crane operators? Please explain……
……

Did you have any plant related accidents during the operation of Crane ?

Please
explain……
……

How old is the Crane that you operate?

a.0 – 3 months b. 4 – 9 months c. 12 months

d 1 – 3 years e. Greater than 5 years

How frequent is the equipment breakdown of your crane per 3 months?

a.Once b. Twice c. Thrice d. 4 Times

e Other

If Other, please explain……
……

Are you a South African?

a.Yes b. No

How long have you been operating a Crane?

a.0- 2 years b. 3 – 5 years c. 6 – 10 years

d. 11 – 30 years

Which age group do you fall under?

a.20 -29 years b. 30 – 39 years c. 40 – 49 years

d.50 – 59 years

What do you think are the factors that make youngsters (20 – 29) not to view crane operations as a career?

Please explain……
……

What is your current state of employment in Crane operation?

a.Trainee b. Full Time or permanent c. Retiree

d. Part Time e. Contract or Labour Broker f. Casual

Is your current job your new job?

aYes b. No

Did you receive further training on your current job from your employer?

a.Yes b. No

If Yes, How long was your re-training programme?

a.0 – 3 months b. 4 – 9 months c. 12 months

d More than 12 months

What type of Basic Plant Productivity tricks did you receive during your training?

a.Swing or Slewing b. Angular distance

c Cycle time d. Loading, lifting and carrying of concrete

What type of training did you receive in Basic Reporting and Recording of Plant related issues?

a. Oil and water consumption

b. Kilometers travelled

c. Petrol and diesel consumption

d. Need for maintenance

e. Hearing and noticing of unusual sounds from the machine

Where was it received?

a.During training b. At workplace or Site environment

Which type of training did you receive in life skills relevant to Crane operators?

a.HIV/ AIDS b. TB, malaria and cholera

c Further training in plant management d. Finance, savings and debt management

Please state 5 major aspects affecting proper training of Crane operators

a. b

c d.

e.

Please state 5 major improvements needed for proper training of crane operators

a. b.

c d.

e