



**EVALUATING QUALITY MANAGEMENT ON SELECTED SOUTH AFRICAN  
FREIGHT RAIL CONSTRUCTION PROJECTS.**

**By**

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**Dissertation submitted in partial fulfilment of the requirements for the degree**

**Master of Technology: Business Administration in Project Management in the  
Faculty of Business and Management Sciences at the Cape Peninsula  
University of Technology**

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**Cape Town**

**2019**

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## DECLARATION

I, **GCOBANI SYDNEY MHLEKWA**, hereby declare that this dissertation is a presentation of my original research work and effort, and that it has not been submitted anywhere for any academic examination towards any qualification. Where other sources of information have been used, they have been acknowledged.



**11-03-2019**

.....  
**Signed**

**Date**

## **ACKNOWLEDGEMENTS**

I am convinced that it is virtually impossible to undertake and complete a project such as this without the encouragement, guidance and assistance from a host of my supervisor, family and classmates.

Let me use this opportunity to thank everyone who contributed to my dissertation. Firstly, I must give thanks to almighty God for this impressive opportunity. Secondly, I thank my supervisor, Dr. Larry Enoch Jowah for his great support, encouragement and supervision. Thirdly, I would like to thank Transnet Freight Rail to be specific the Saldanha Depot management for granted me a permission to do this study. Lastly, not forgetting my one and only supportive family without them I would not be completing this qualification, especially my mother for her impressive support, God bless!

## **DEDICATION**

This dissertation is dedicated to my mother, Nomanene Mhlekwa, uMamzondi, uZiyeka omhle for being a mother and a father to me. This is your delayed 57<sup>th</sup> birthday present even though I will benefit more.

## **ABSTRACT**

This study focussed on the evaluation of quality management at one of the selected South African freight rail construction projects. Transnet Freight Rail (TFR) was selected for its high rate of accidents and injuries that happen on daily basis which affect the company's operations and profits. The study's approach was to obtain as much as possible opinions from local and international experts on quality management in construction projects. The opinions were gathered through a number of official journals on the best practices for quality management, comparing all of these practices to that of TFR in order to conclude whether the need for improvement or the change in practicing quality is required. The mixed – method approach was employed, to gather more and accurate data. The strengths of qualitative research approach can make up for the weaknesses of the quantitative research approach, this was the reason why mixed – method was chosen.

The targeted population of this study included the internal stakeholders such as quality assurance officers, project managers, project coordinators and project team members. This targeted population was able to provide the accurate information as they are directly involved in the execution of the projects in terms of quality management of the project. A questionnaire was developed and employed as a tool to gather data to satisfy the research questions. This study was a case study because it only focused on TFR Iron Ore line projects. The focus was that, within TFR Iron Ore line, only those who are affected directly by the above mentioned projects were interviewed. The study has revealed that the Total Quality Assurance measures are being ignored at TFR, such as unscheduled quality tours, quality audits, quality control routines, random sampling of errors and record seen defects, and quality monitoring throughout the project life cycle.

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## LIST OF ACRONYMS

<b>Abbreviations</b>	<b>Explanation</b>
AC	Alternating Current
AISI	American Iron and Steel Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BEE	Broad-Based Economic Empowerment
CAD	Computer Aided Drawing
CRM	Customer Relationship Management
CTC	Centralised Train Control
DC	Direct Current
DIFR	Disabling Injury Frequency Rate
EDM	Electronic Distance Measurements
ERP	Resource Planning
GPS	Global Positioning System
IEEE	Institute of Electrical and Electronics Engineers
IOM	Iron Ore and manganese
ISO	International Standardisation of Organisations
IT	Information Technology
KV	Kilovolts
MDS	Market Demand Strategy
MPCP	Main Process Control Procedure
NEC	National Executive Committee
PDCA	Plan – Do – Check - Act
PLM	Product Lifecycle Management
PPE	Personnel Protective Equipment
QMS	Quality management Software

SAR & H	South African Railways and Harbours
SCM	Supply Chain Management
SDO	Standard Development Organisations
SOE	State Owned Enterprise
TCP	Transnet Capital Project
TFR	Transnet Freight Rail
TOR	Terms of Reference
TQM	Total Quality Management

## GLOSSARY

Terms	Definition/Explanation
	<ul style="list-style-type: none"><li>• <b>Acceptable quality standards:</b> is a statistical measurement of the maximum number of defective goods considered acceptable in a particular sample size.</li><li>• <b>Project undertakings:</b> means projects that are on-going projects that are not yet completed.</li><li>• <b>ISO 9000 Standards:</b> are the set of international standards on quality management and quality assurance developed to assist companies successfully document the quality system element to be implemented to maintain an effective quality system.</li><li>• <b>Stakeholder:</b> is a party that has an interest in a company and can either affect or be affected by the business (e.g, investors, employees, customers, and suppliers).</li><li>• <b>Total quality management:</b> is a system of management based on the principle that every employee must be committed to maintaining high standards of work in every aspect of a company's operation.</li><li>• <b>Quality:</b> is the totality of characteristics and features of a product or service that bear upon its ability to satisfy indicated needs.</li><li>• <b>Project management:</b> is the application of processes, methods, knowledge, skills and experience to achieve the project objectives.</li><li>• <b>Project:</b> is a unique, transient endeavour, undertaken to achieve planned objectives, which could be defined in terms of outputs, outcomes or benefits.</li></ul>

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## Chapter 1

### Background to the Study

#### 1.1 Introduction

Economic growth is defined as an increase in the capacity of an economy to produce goods and services over a certain period of time by a country (Jha and Iyer, 2006:1155-1170). Whilst there may be other slightly different definitions of economic growth, as stated by Kerzner (2009:825), economic growth can be viewed as an improvement in the quality of life of the people of that economy not only as an increase in productive capacity. Both definitions capture the essence of economic growth as innovation as well as investment and these are necessary for any country. Oakland and Marosszeky (2006) posited that some of the critical pillars to sustainable economic growth are; entrepreneurship, education and skills development, and infrastructure. The intention of the study is to thorough review the quality system used (if any) by Transnet Freight Rail (TFR) to guarantee reduction if not eradication of the incidents that occur in daily basis, that result in risks to both human lives and unbudgeted for repairs costs. The researcher intended to achieve the objectives of the study and implement the findings.

#### 1.2 Background and Literature Review

As stated in Transnet intranet, South African government has invested R300 billion to Transnet Freight Rail to upgrade its infrastructure for railway, pipeline and part capacity. As a state owned company, Transnet's aim is to develop South African railway industry, reducing the cost of doing business, while at the same time operating efficiently and profitable. Every day Transnet delivers thousands of tons of goods around South Africa, through its pipelines and both to and from its ports. Transnet market demand strategies are as follows as indicated in Transnet website: Reducing the cost of logistics by moving more traffic from road to rail to stimulate and support rural development, beneficiation and manufacturing initiatives; African connectivity to support regional growth; improve rail, port logistics and South Africa's competitiveness in key global markets; job creation, skills development, localisation, empowerment, and transformation opportunity; and to be in the top five railways in the world.

To achieve the above mentioned market demand strategies (MDS), there was a need to embark on different projects as some of these projects are on its execution phase at the moment. As stated in Transnet business performance 2014/2015 financial year, there are a lot of derailments and accidents that are taking place in these projects. This analysis simply shows that there was a need to undertake a study that focuses in quality management in construction projects of Transnet Freight Rail, to prioritise quality in these projects as Transnet employees are working in high risk environment daily.

There is no specific definition of a successful construction project. A construction project can be considered successful when its goals have been achieved (Moura, Teixeira and Pires, 2007:3294-3306). According to Moura et al. (2007:3294-3306), currently the project performances in cost, time and quality management are used to determine the project success. Quality management in construction projects is related to cost and time management. Corrie (2005:29), argues that a poorly managed construction project may end up experiencing time extensions, extra cost and may also affect client's requirements as well. He also stated that by identifying the causes and the cost of re-work, it is very easy to improve project performance.

Jha and Iyer (2006:1155-1170) suggested that the existing practise of quality management in construction projects have sound features and characteristics. The quality practice in construction industry is fully developed and recognised in which the measures can be seen from the execution of implementation of quality management and the formation of particular body to monitor activities involving the quality management (Jha and Iyer, 2006:1155-1170). Based on the view that improvement is important and needed as well, a framework of quality management is formulated and approved based on the goal of achieving quality management in the construction industry (Husin, Adnan and Jusoff; 2008:45).

According to Chin-Keng and Hamzah (2011:542-552), the involvement of senior management and understanding of customer focus are very important in the success of total quality management. Top management commitment is one of the key elements that would reflect to total quality management measures in construction industry. Company's management commitment is also the key critical factor in the successful implementation of ISO 9000 in the construction industry. Corrie

(2005:34), argues that high levels of management commitments would assist to reduce the occurring of any kind of a problem as total quality management is implemented on construction site. Management actions in continuous quality improvement are very vital in all the project phases. Corrie (2005:36) recommended that top management should not delegate total quality management process implementation, but to fully support and understand the process.

In quality management implementation certain problems have been highlighted. Jha and Iyer (2006:1155-1170) noticed several problems that are experienced by field employees in implementing total quality management on construction sites. These problems are as following: Total Quality Management is regarded as irrelevant to construction by construction workers; the lack of interest by suppliers and subcontractors in total quality management; a lot of paperwork that needs to be done; and measuring results difficulties.

Jha and Iyer (2006:1155-1170) also argued that there are difficulties in implementing ISO 9001 in engineering companies, such as; to enable engineers to accept and understand the system; lack of support from the top management; lack of communication among the employees; there is a different degree of commitment between the top management and site employees; and limit quality management in construction stage only.

According to Corrie (2005:45), total quality management is an effective management philosophy in the service and manufacturing industry. Total quality management could be implemented in the construction industry with some benefits, such as quality cost reduction, and better job satisfaction. He also finds that quality performance management system is the helpful system, which assists in the quality awareness, promoting the understanding of the quality process, facilitates the communication, reducing the quality cost and assisting the management in identifying the areas that need quality improvement. Kerzner (2009:59) argues that the majority of construction project failures occur in the quality of construction and design process, such failures are caused by a lack of management. According to Griffith (2005) the problems that are surrounding the quality achievement can be

categorised into two areas, namely, design and construction. Problems that can be found in these two phases are as follows respectively as in Griffith (2005):

**Table 1.1 – Design and construction phase problems.**

Design	Construction
Detailing – Design concepts are inaccurate	Project priorities – Speed and cost factors outweigh the requirements for quality and workmanship.
Specification – Specify incorrect materials and components	Company – Lack of proper definition of site duties for employees
Legislation – Poor knowledge or disregarded for compulsory legislation.	Information – Poor information flow.
Co-ordination – Lack of co-ordination between designer, client and contractor.	Control – Poor quality control procedures used on site.
Communication – Poor communication between designer, client and contractor	Supervision – Poor site management.
Supervision – Lack of supervision by designer and client.	Workmanship – Poor standards of work at the workplace.
Buildability – Lack of design understanding for construction by contractors.	Motivation – Poor motivated and skilled operatives.
	Co-ordination – Lack of direction and teamwork.

**Source: Griffith (2005:39)**

Oakland and Marosszky (2006) noticed that there is a lot of confusion regarding the aim of quality control and quality assurance and where and when should the principles of quality assurance be applied in the construction process. Any company whose livelihood depends on successful performance in the market place can benefit from quality management, and this includes the construction industry (Ashford, 2005). This does not mean that quality management as practised in factories can be transplanted unchanged into the construction industry. The different between the construction site and the factory cannot be ignored. These special factors that have to be taken into account are the susceptibility to weather, the mobility of labour, the fact that almost every job is a prototype (Husin et al., 2008:44).

Dr. W.E. Deming was called the father of quality and he was the first Western scientist to give seminars in Japan on effective quality management (Metri, 2006:36-37). Metri (2006:36-37) further argues that Dr. Deming also originated his own cycle for easy problem analysis, which called Deming Cycle: Plan – Do – Check – Act (PDCA). Deming's purpose for the use of quality management techniques is to assist in the quality improvement and companies to stay in business with the leadership of management. According to Metri (2006:38-44), Deming originated fourteen quality improvement points as summarised: Create a constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business and to provide jobs; adopt a new philosophy; cease dependence on inspection to achieve quality; end the practice of awarding business on the basis of price tag alone, instead minimize total cost; constantly and forever improve the system of production and service; institute training on the job; institute leadership; drive out fear; break down barriers between departments; eliminate slogans, exhortations, and targets for the workforce; eliminate arbitrary work standards and numerical quotas. Substitute leadership; remove the barriers that rob people of their right to pride of workmanship; institute a vigorous program of education and self-improvement; and put everybody in the company to work to accomplish the transformation.

Deming also identified the following basic principles of the management concepts under the term of quality management (Ashford, 2005): The management of quality is crucial to company survival and merits the personal attention and communication of top management; the primary responsibility for quality must lie with those doing the work; control by inspection is of limited value; to enable production departments to accept responsibility for quality, management must establish systems for the control and verification of work, and must educate and indoctrinate the work force in their application; the costs of education and training for quality, and any other costs which might be incurred, will be repaid many times over by greater output, less waste, a better quality product and higher profits.

Oakland and Marosszeky (2006) suggested the following six methods when checking quality in a company:

- Quality audits – all the areas of a company’s activity are examined, every component is included such as policy, training, operating procedures, and decision features.
- Quality survey – A detailed examination of individual sites, procedures, and common problems in a company as a whole.
- Quality inspection – A routine scheduled inspection in each and every department which will check standards of operation, employee involvement, and the work that is carried out is in line with the agreed processes and procedures.
- Quality tour – This is an unscheduled examination to ensure that errors are removed, and quality standards are maintained.
- Quality sampling – This measures by random sampling the errors and record the seen defect, the results will be used to portray trends in quality situation.
- Quality scrutinises – This is the application of critical examination of the process and technological intentions for existing and new facilities.

### **1.3 Problem Statement**

The continued delay of goods trains because there are ever increasing accidents of goods trains causes a lot of concern. Regularly in the summer, the rail and the sleepers “kick out” (the bending of the rail and the sleepers in response to heat), and this causes delays and derailments costing the company extensively. There are no quality processes used from procurement through to closeout phase for these upgrade construction projects. Consequently many injuries occur and there are constant repairs which could have been prevented. There is a need for a thorough review of the quality system used (if any) by the company to guarantee reduction if not eradication of these incidents that result in risks to both human lives and unbudgeted for repairs costs.

The researches that have been conducted in Transnet Freight Rail does not include the evaluation of quality management in the Iron Ore railway line. This issue has been left out while there is a continuity of derailments that result in risks to both human lives and unbudgeted for repairs costs. In order to prevent risks to both human lives and unbudgeted costs quality management should be evaluated.

## **1.4 Research Objectives**

### **Primary Objective**

The primary objective of this study was to evaluate construction quality management practices at a South African freight rail company.

### **Secondary Objectives**

To achieve the primary objective, the following secondary objectives were developed.

- To determine the perceptions of internal stakeholders regarding Total Quality Assurance (TQA) measures that should be used to reduce unbudgeted expenditures as well as occupational accidents at Transnet Freight Rail.
- To establish the perceptions of internal stakeholders regarding quality standards that could be used on all project undertakings at Transnet Freight Rail.

## **1.5 Research Questions**

- Does the company evaluate all project-undertakings against the set ISO 9000 standards?
- How will the company assure the stakeholders that acceptable quality standards are adhered to at all times?

## **1.6 The Theoretical Framework**

Figure 1.1 below illustrates the relationship between schedule, budget, and scope of the project in order to achieve a successful project with high quality.

### **Figure 1.1 – The Iron Triangle of Project Management**



**Source: Ebbesen and Hope (2013:2)**

According to Ebbesen and Hope (2013:2), the three constraints that are shown in figure 1.1 above are explained as follows:

**Schedule** – Refers to the required time to produce a final product of the project. The amount of time that is scheduled will be related to the scope of the project as well as the available budget for the entire project.

**Budget** – Refers to the estimated amount of money that is allocated to finish the entire project. The budget includes a lot of things, such as; labour of contractors, bills of materials, resources, and risk estimated.

**Scope** – This constrain refers to what needs to be done to complete the project. The project scope can be changed based on different reasons affecting time scheduled and allocated budget.

### **1.7 Research Methodology**

In order to achieve the objectives of the study both qualitative and quantitative research were used, because both types of research contributed to the required information.

- **Research Design**



- According to Fellows and Liu (2008), research design is a detailed plan of how the study will take place. A research design will normally include how the data will be collected, what tools will be employed, how the tools will be used and the proposed means for analysing collected data (Steyn and Nicholas, 2012). In this study the analysis of records, questionnaire survey, and interviews were employed as a data collection methodology.
- **Target Population**

The targeted population of this study included the internal stakeholders such as quality assurance officers, project managers, project coordinators, and project team members at TFR. This targeted population provided the accurate information as they are directly involved in the execution of the projects in terms of quality management of the project. A targeted population in the study simply refers to a collection of individuals or objects that is the core focus of a research question (Schwalbe, 2006).

- **Sampling Frames, Sampling Approach and Sample Size**

The sampling frame for this study is a list of all internal stakeholders at Transnet Freight rail and this list is maintained by the human resources database in the company. The sample size of this study is fixed only to current projects that are under Iron Ore and Manganese line in Transnet Freight Rail. Initially, the sample size was randomly set at 100 participants but only 91 participants responded from different levels of the company that are involved in TFR Iron Ore line projects. Sampling was used to detect the required data from the individuals who are involved in project execution. The site visits were done to interview these project team members to get as accurate as possible information, because they have first-hand experience in terms of quality management.

- **Data Collection Methods and Research Instrument**

A questionnaire, company's written procedures, e-mail correspondence and records were used as a form of data collection to gather the data from different Transnet Freight Rail construction projects in the Iron Ore and Manganese (IOM) line. The project key players were interviewed in order to have access to data for survey and analysis purpose. The data included the quality management plan, quality control, and quality assurance documents. According to Kerzner (2009:277), a questionnaire

is a very brief, pre-planned set of questions designed to produce specific information to meet a particular objective for research information about a relevant topic. The research information is achieved from respondents usually from a related interest area.

- **Data Analysis**

The data that were analysed were drawn from the survey. This data show the different important reasons that cause the lack of achieving quality management in Transnet Freight Rail construction projects. A computer program was used to present the results of the analysed data, by means of bar graph. The data that were collected regarding the quality of these projects were collected from quality officers, project managers, project coordinators, and project team members who undertake the project execution. This data were presented by means of graphs showing the different causes of the lack of quality in Transnet projects.

## **1.8 Research Constraints**

- **Research Limitations**

- The study only focussed on Transnet Freight Rail Iron Ore line construction projects. The reason of this limitation is to achieve the study objectives and to avoid the big scope of the study.
- Initially, the sample size was randomly set at 100 participants but only 91 participants responded from different levels of the company that are involved in TFR Iron Ore line projects between Western Cape (Saldanha) and Northern Cape (Sishen).

## **1.9 Research delimitations**

- The study was conducted only from the area of Saldanha to Sishen railway line, because TFR experienced more derailments on this particular railway line in the financial year of 2016/2017. The other reason why the researcher focused on this particular line is to avoid the big scope of the study.

- The information that was collected only focused in the area of the study.

### **1.10 Research Ethics**

According to Fellows and Liu (2008), research ethics refers to principles that are guiding the research from the beginning through to the completion and publication of findings. Below are the ethics that will be conceded during the study:

- **Informed Consent:** Any participant will participate in a voluntary way; all participants will be informed fully about the nature of the study.
- **Right to Privacy:** The information that will be supplied by any participant will be highly respected and the right to privacy will be conceded as well.
- **Honesty with Professional Colleagues:** Findings will be presented in a complete and honest way, without any changes in what has been done by research participants.
- **Confidentiality:** All the participants and company information will be given the right of confidentiality and anonymity in the study.

### **1.11 Chapter Classification**

**Chapter 1 – Introduction and Background:** In this chapter, the background to the study is discussed, which is quality management in Transnet Freight Rail construction projects. The research design and methodology are explained and research constraints are listed.

**Chapter 2 – Strategies to Manage Rail Derailments and Mitigate Injuries:** in this chapter, the in-depth literature review of railway engineering, different engineering fields that are involved when constructing the railway are discussed.

**Chapter 3 – Project Quality and Ramifications:** This chapter discusses the in-depth literature review of quality management theories and their impact on general construction projects, contractor performance and development as practiced by companies.

**Chapter 4 – Overview of the Study Environment:** In this chapter, Transnet Freight Rail background was discussed. Background information on Transnet's programs and performance, construction development and quality system for contractors was discussed as well.

**Chapter 5 – Research Methodology:** in this chapter, research design, research strategy, research methodology, target population, method of data collection, and ethical consideration are discussed in detail.

**Chapter 6 – Data Analysis and Results Interpretation:** This chapter analyse in detail the data that was collected and interpret this data based on the theme of the study.

**Chapter 7 – Findings, Conclusion and recommendations:** In this chapter, the research problem, research questions, the research process, methodology are revisited and research is concluded. Major findings are discussed and recommendations are identified for future study areas

## **1.12 Chapter Summary**

The study of quality management has been a continuous activity for decades, and is not ending anytime soon. As technology sets in, cultures change, the world turn out to be one global village; therefore there will be changes every time in the circumstances. The next chapter will be the in-depth literature review of quality management theories and their impact on general construction projects, contractor performance and development as practiced by companies.

## Chapter 2

### Strategies to manage Rail Derailments and Mitigate Injuries

#### 2.1 Introduction

This chapter focuses on the different strategies to manage rail derailments and mitigate injuries. The different types of engineering are discussed in detail and the different types of layers of the railway track are presented. The engineering standards are discussed, as well as the history of South African railway system. The discussed different types of engineering are very important when constructing a railway track as explained below.

#### 2.2 History of the South African Railway System

In 1860 (26<sup>th</sup> June) the National Railway Company ran the first railway operation covering 3.2 kilometers linking Durban to Harbour Point. Cape Town had started, by then, building their first 72 kilometers rail between Cape Town and Wellington. Different parts of the country had different companies building the railway systems (Pretoria and Johannesburg built by the Netherlands –South African Railway Company) and these were linked together into one national system by 1910 (South African Railways Power Plan, 1922:914). To date the South African railway system is considered to be the most developed on the African continent (Burman, 1984:27). The merged system resulted in the establishment of the South African Railways and Harbours (SAR & H) became the government agency responsible for the national railway system. Soon after the railway system began to be electrified (1920) with the building of the Colenso Power Station covering the railway from the Glencoe to Pietermaritzburg route and the eventual introduction of the South African Class 1E. Eventually the transport industry was recognised and was modeled (not as a government agency) along business lines to a state owned enterprise (SOE) currently known as Transnet previously known as Spoornet. The railways in South Africa use a 1,070 mm (3 ft 6 in) narrow gauge track which was selected to reduce the cost of building through mountains (Yang, Powrie and Priest; 2009:680-689). The exception to the rule is the Gautrain Rapid Transit Railway which uses 1,435 mm (4 ft 8 ½ in) as its standard gauge.

Approximately 80% of the rail system in South Africa is electrified with different voltages with commuter trains operating at 3 KV DC overhead specifically for commuter trains. Higher voltages of between 25 KV AC and 50 KV AC (both overhead) are used for heavy duty primarily in the transportation of iron ore. There is a need for an efficient railway system, be it to ferry passengers or large amounts of cargo from one place to another. Van Eeden and Havenga (2010:255-267) propose that there is a need to identify key aspects of the railway system that will assist in finding solutions to the freight transport problem of the country. The success of the South African economy is directly linked to the efficiency of the goods distribution network which is intrinsically tied on to efficient transportation of which the railway system is the single largest.

### 2.3 Railway Engineering

Railway engineering can be defined as a broad conglomeration of different engineering disciplines working together to construct one product, a working railway system (Bonnett, 2005:27). Different engineering disciplines involved are, namely; civil engineering, electrical engineering, computer engineering, mechanical engineering, industrial engineering and production engineering. Engineering is applying of scientific knowledge to facilitate the invention, designing, building and or improvement of structures, machines, tools, systems and or processes to find solutions to problems. These disciplines have different appeals and definitions as listed in table 2.1 below.

**Table 2.1 Engineering disciplines forming railway engineering**

<b>Discipline</b>	<b>Definition</b>
<b>Civil Engineering</b>	Engineering discipline dealing with designing, construction and maintenance of structures like roads, bridges, etc.,
<b>Electrical Engineering</b>	Electrical engineering discipline is the study on the application of electricity, electronics, and electromagnetism. This is subdivided into digital computers, power engineering, telecommunications, control systems, radio-frequency engineering, signal processing, instrumentation, and microelectronics.
<b>Computer Engineering</b>	Computer engineering integrates different fields of electrical engineering and computer science through the development of computer hardware and software. This involves software design,

	hardware and software integrating software and or electronic engineering. It also involves the designing of individual microcontrollers, microprocessors, personal computers, and supercomputers.
<b>Industrial Engineering</b>	Industrial engineering deals with optimization of complex processes and systems which work to eliminate possible waste of time, money, materials, man-hours, machine time and energy. This field focuses on the effort to do things better by engineering processes and systems to improve the quality, performance and productivity to generate value.
<b>Production Engineering</b>	Production engineering combines together manufacturing technology, engineering and management sciences. The purpose for production engineering is to accomplish the tasks in the most convenient, efficient and productive way. This includes castings, machining, joining, metal cutting, tool designing, automation, jigs and fixtures, among other things.
<b>Mechanical Engineering</b>	Mechanical engineering involves principles of engineering, physics, material science together with the analysis and manufacturing of mechanical systems. The branch has a lot to do with designing, operation of machinery, thermodynamics and structural analysis. Tools commonly used with are the CAD, PLM in designing and manufacturing plants, heating and cooling systems, transport systems, and robotics.

**Source: Own Construction**

Each one of these aspects of railway engineering requires designing, construction and the operation (putting together) of all these aspects and tasks into one complete project. Predominantly in the civil engineering domain, railway engineering focuses on the designing, maintenance and the behavior of the railroad track infrastructure (Yang et al., 2009:680-689). The railway infrastructure includes among other things, the track, bridges, freight railway and transit systems (both heavy and light rail). This multi-faceted engineering discipline involves short and long term behavior of the track structure and under traffic and environmental loading. The vehicles have an impact on the railway track structure (Indraratna, Shahin and Salim, 2007:27-44) through the wheel rolling over the steel tracks which needs to have the proper quality and take the loads that roll past them. The different engineering disciplines involved in railway engineering are thus, civil, electrical, computer, industrial, production and mechanical engineering.

### 2.3.1 Civil engineering

Considered to be the second oldest engineering discipline after military engineering dealing with the designing and construction of bridges, roads, canals, dams, and buildings in general. Griggs and Eaton (1997:30-34) positions civil engineering as the foundation to structural engineering, and this takes place at the local government through to national governments. Engineering has been an element of the life of human beings, though it may have come in at exceedingly low levels by our standards today. But engineering is indispensable in distribution and transportation (Shroff and Shah, 2003:1-2) starting with the discovery of the wheel and gradual movement to the horse carts. Early civil engineering dates back to 4000 – 2000 BC in Egypt and Mesopotamia. This is seen in the evidence of the presence of the pyramids and other road structures as seen in the Middle East up to the Indus River in India.

Civil engineering and architecture have always been confused with each other and have been merely geographical interchangeable variations. A close discipline of civil engineering is construction engineering, which is equally interchangeably used in the industry (Indraratna et al., 2007:27-44). The planning and the execution of the aspects relating to construction and civil engineering, which is more business like transactions involving contracts, material supply and evaluation of logistical operations and pricing systems constitute what is referred to as construction management today (Van Eeden and Havenga; 2010:255-267). Essentially these operations are part of the construction of structures, this is a critical element of in the construction of a railway system. The emphasis on the reduction of risks and the ability to pre-empt the effects of risks lies at the bottom of the construction of the rail transport system (Drijver and Strabo, 1992:75-76). Some of the sub-disciplines for civil engineering are listed and defined in table 2.2 below.

**Table 2.2 Sub-disciplines of civil engineering**

<b>Sub-discipline</b>	<b>Definition and explanation</b>
<b>Earthquake Engineering</b>	A sub-discipline of structural engineering; concentrates on interface of structures on the railroads; design, construct and maintain structures to earthquake compliance levels.
<b>Environmental</b>	These engineers manage pollution reduction, industrial



<b>Engineering</b>	ecology and green engineering. Environmental engineers also gather information on environmental consequences of suggested actions.
<b>Geotechnical Engineering</b>	Concerned with the soil and rock supporting civil engineering systems. Derives from materials science, soil science, mechanics, and hydraulics is applied to economically and safely design foundations,
<b>Hydraulic Engineering</b>	Concerned with delivery of fluids intimately connected to the water supply network, design of pipelines, drainage facilities (including dams, bridges, channels, levees, culverts, storm sewers), and canals.
<b>Structural Engineering</b>	Structural analysis of bridges, buildings, towers, tunnels and flyovers. Identification of loads that act upon a structure, the forces and stresses which ascend within that structure in line with those loads.
<b>Surveying</b>	Concerned with dimension measurements on the surface of the earth, together with Electronic Distance Measurements (EDM), laser scanning and GPS surveying. Civil engineers, realtors and contractors use this information to design, construct, and trade, respectively. Elements of a structure should be sized and positioned in connection to each other, adjacent structures and to site boundaries.
<b>Transportation Engineering</b>	Concerned with covering, designing, constructing, specifying and maintaining transportation infrastructure. This includes transportation design, transportation planning, railway systems, traffic engineering, Intelligent Transportation System, and infrastructure management.
<b>Forensic Engineering</b>	This type of engineering covers the auditing of materials used, components, and risk factors that may cause damage to property or personal injury.
<b>Municipal Engineering</b>	Concerned with municipal infrastructure; designing, specifying and constructing of streets, water supply networks, sidewalks and street lighting. Coordinating of infrastructure and rail system.
<b>Control Engineering</b>	Civil engineering branch using the control theory when designing systems with preferred behaviors and automatic control like automatic cruise on the trains.

**Source: own construction**

Each one of these sub-disciplines have a role to play in the construction of the railway systems as different aspects of the same product. The quality of the railroad, for instance, will go beyond the laying of railway sleepers to include the type of soil, the rivers to be crossed and bridges to be built and the material (quality).

### 2.3.2 Electrical engineering

This discipline focuses on application of electricity, electronics, and electromagnetism, this involves electric telegraph, the telephone, and electric power distribution (New, 2004:660-665). From the development of electrical engineering came broadcasting and recording media which we experience and use daily. This led to the invention of the transistor, the integrated circuit which allowed the reduction of the cost of electronics to the level of affordability. This discipline is divisible into subfields like, namely; electronics, power engineering, telecommunications, digital computers, control systems, signal processing, radio-frequency engineering, microelectronics and instrumentation.

There is a noticeable overlap of these sub-disciplines including overlapping with other engineering disciplines which involves subjects like power electronics, hardware engineering, electromagnetics, microwave engineering, electrochemistry, renewable energies, mechatronics, and many other related disciplines (Shroff and Shah, 2003:1-2). The major sub-disciplines of electrical engineering have a direct impact on the rail transportation system, these are illustrated in table 2.3 below.

**Table 2.3 – Sub-disciplines of electrical engineering**

<b>Sub-disciplines</b>	<b>Definition and explanation</b>
<b>Electronics Engineering</b>	Concerned with active and non-linear electrical components such as semiconductor devices, diodes, transistors, and integrated circuits which are used to design microprocessors and electronic circuits.
<b>Power engineering</b>	This type of engineering is also called power systems engineering, deals with the generation, distribution, transmission, and utilisation of electric power. The electrical devices that are connected to these systems are generators, transformers, and motors.
<b>Telecommunications</b>	This is the transmission of messages, signals, writings, sounds, and images. This transmission is done by copper cable, fiber optical cable, radio, and other electromagnetic systems. Telecommunication take place when there is exchange of information between the communication participants contains the use of technology.

<b>Control Systems Engineering</b>	Concerned with the transfer functions transient systems, components of Signal flow graphs and frequency response.
<b>Instrumentation Engineering</b>	This is the control of process variables and science of measurement within a manufacturing and production area. The process variable employed in industries are Pressure, Level, Temperature, Flow, Humidity, Force, pH, and speed.

**Source: own construction**

### **2.3.3 Computer Engineering**

Computer engineers normally have training in electronic engineering, hardware-software, software design, and integration instead of only software engineering (Fischer and Kunz, 2004:4). Computer engineers are involved in various software and hardware aspects of computing, such as design of individual microcontrollers, personal computers, microprocessors, supercomputers, and circuit design (Batten, 2012:14). This field of engineering also focuses on the way the computers integrate into large picture, but not only how the computers work. According to Boyer (2010:5), the following duties are performed by computer engineers, writing software, writing firmware for embedded microcontrollers, designing analog sensors, designing operating systems, and designing signal circuit boards. Computer engineers are also appropriate for robotics research, which depends on heavily on using digital systems to monitor and control electrical systems like communications, motors, and sensors (Fischer and Kunz, 2004:10).

In different institutions, computer engineering students are permitted to elect areas of detailed study in their first and second year, because the full scope of knowledge employed in the application and design of computers is outside the scope of an undergraduate degree. Other institutions may need engineering students to complete two years of general engineering before stating computer engineering as their main focus (Boyer, 2010:23).

### **2.3.4 Industrial Engineering**

Industrial engineering is involve in development, implementation, improvement of integrated systems of money, people, knowledge, equipment, information, energy,

analysis, synthesis, mathematical, materials, physical and social sciences together with the methods and principles of engineering design to specify, evaluate and predict the results to be found from such processes or systems (Telsang, 2006:440). The industrial engineering is a venerable engineering field subject and suitable for professional engineering licensure in most authorities; its underlying concepts overlap significantly with certain business-oriented fields such as operations management (Mahajan, 2010:2).

### **2.3.5 Production Engineering**

Production engineering involves the application of castings, joining processes, machining processing, metal cutting, tool design, machine tools, metrology, machining systems, jigs and fixtures, automation, material science, machine designing, design of automobile parts and manufacturing (Khare, Bajpai and Bharati; 2015:21-25). Production engineering also overlaps significantly with industrial engineering and manufacturing engineering.

In industry, when the design is recognised, production engineering concepts regarding ergonomics, work-study, operation research, materials management manufacturing management, and production planning play important roles in competent production processes (Mahajan, 2010:5). These deal with combined design and efficient planning of the whole manufacturing system, which is becoming progressively complex with the emergence of classy control systems and production methods.

The production engineer holds a wide set of competences, skills, and attitudes based on scientific knowledge and market. These abilities are vital for the performance of integrating and coordinating professionals of multidisciplinary teams (Telsang, 2006:342). The production engineer must be able to perform the following duties as stated by (Khare et al., 2015:21-25):

- **Scale and integrate resources** – Normally required to consider physical, financial, and human resources at high competence and low cost, however considering the chance of continuous improvement.

- **Make proper practice of math and statistics** – Model production systems through decision making process.
- **Design, refine products and implement, services, systems and processes** – Taking in consideration that restrictions and particularities of the associated communities.
- **Predict and analyse the demand** – Select among technological and scientific appropriate knowledge in order to improve, redesign or design product functionality.
- **Incorporate concepts and quality techniques** – Beside all the productive system, for auditing and control proceedings organisational standards need to be deployed.
- **Be updated with technological developments** – Enabling them to society and enterprises.
- **Understand the relation between environment and production systems** – This relates to the employment of scarce resources, sustainability and production rejects.
- **Manage and optimize flow** – Information and production flow.

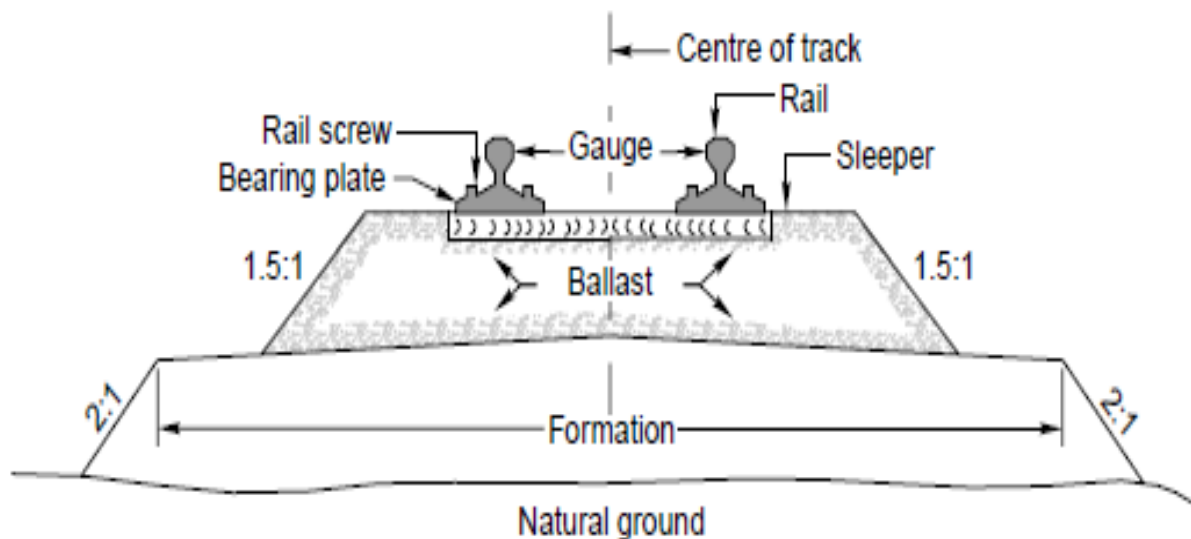
### 2.3.6 Mechanical engineering

Mechanical engineering involves largely designing and eventual operation of machinery (Ronney, 2005:1) which requires a good understanding of mechanics, kinematics thermodynamics, structural analysis, and material sciences. This discipline uses largely computer-aided design (CAD), and product lifecycle management (PLM) to design and analyze manufacturing plants and equipment used for other things like, amongst others; heating and cooling systems, transport systems and robotics. This is closely related to disciplines like aeronautics, metallurgical engineering, civil engineering, and electrical engineering. Mechanics is the study of forces and their effect upon matter (Ciocci, 2006:2), in the case of the rail transport system this assists tremendously with understanding the forces involved in the material used for the transportation – wheels rolling through the railway track carrying loads to long distances (Ronney, 2005:19). In this case, mechanical engineering assists in analysing and predicting the acceleration and deformation of objects under known forces.

## 2.4 The Railway Track

The final construction of the railway track is a coming together of many other disciplines and working to integrate the different disciplines into one product, the rail track. Finally the structure comprises of the rails, fasteners, railroad ties (sleepers) and the slab track not forgetting the underlying subgrade. The ideal structure enables the trains to move by allowing the wheels to roll on the railway track (or railroad track) with comparative ease. The electrification system on the tracks where the electric trains run is equipped with an overhead electrical power. In figure 2.1 illustrates the structure of the railway system.

**Figure 2.1 Structure of the railway line showing the layers**



**Source: Chandra and Agarwal (2007:63)**

Above is the structure of the rail track that is to be built, and this ideal structure assumes that all necessary resources are put in with the correct measure. The ideal railway is expected to have all the parameters as illustrated in figure 2.1 above, which should meet the quality as expected by the project sponsor. Modern technology demands that the structure be made out of approved material (Chandra and Agarwal, 2007:31).

## **2.5 Engineering Standards**

Standards are a communication instrument that permits all users to speak the same language once responding to products or processes. Standards provide the minimum requirements to evaluate, enforce, acceptability and sale-ability of products or services (Donald and Frikken; 2008:4-5). Standards can be educated and applied globally, eventually, are designed to defend the public from questionable practices, designs, and products. They teach engineers, how engineers can best meet health, environmental, safety and societal responsibilities. Standards background is discussed below as stated in (Lindeka, 2007:3).

- The United State federal government is the largest user and creator of standards.
- More than 210 companies are elected Standard Development Organisations (SDO)
- About 90% of these standards come from about 20 of these Standard Development Organisations.
- American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronics Engineers (IEEE), American Iron and Steel Institute (AISI), American Society of Civil Engineers (ASCE) are some of the most vital Standard Development Organisations.

## **2.6 Chapter Summary**

The purpose of this chapter was to discuss the history of the South African railway system and railway engineering. Railway engineering is the merging together of all these different aspects of the process of putting together the final product, an efficient railway system. Needless to say that the construction of the railway line is in itself a grouping together of different engineering specialists with each of them having to practice quality management. The quality of the work would start with the need for certain standards which should be met at all levels and during the implementation of all the small different tasks that build on to this. Each one of the engineering disciplines has its own set of standards that are to be adhered to as part of the total quality management (TQM). The failure of one aspect of the engineering

tasks impacts negatively on the success of the project as a whole in that, that one aspect may make the whole system dysfunctional. Critical to this should be other stakeholders like the supplier (quality and specifics of supply), the workmanship (the technicians and associated), the financing (able to procure the correct quality of material resources), and general expertise of integrating the different tasks into one finished product. TQM is therefore an imperative for the effective operation of the railway system under study. The next chapter discusses project quality and ramifications.



## Chapter 3

### Project Quality and Ramifications

#### 3.1 Introduction

This chapter presents the concepts of quality management in construction projects. Project quality management processes and causes of the accidents on construction sites are identified and discussed as well. The in-depth literature review regarding the impact of quality management on general construction projects as practiced by companies in the construction industry was also discussed in details.

#### 3.2 Definition of Quality

Quality can be defined in many ways depending on the context, but this can generally be referred to as fitness for purpose (Newton, 2006:35). Quality is in a sense is perceptual in that it is due to the interpretation of the customer or the person judging the “quality.” Different people will understand quality in a different way, making it somewhat subjective and that depending on what the judge focuses on. To standardise quality, there has been discussion around developing specific standards or measures used to determine the standard of the quality (Newton, 2006:37), hence the existence of ISO 9001 and other standards. A perception has been created that quality is about procedures and documentation as is evidenced by the development of the Quality Management Systems, Safety Management Systems and Environmental Management Systems. Tools like the Asset Optimization and Six Sigma have been developed to try and address problems of quality (Jha and Iyer ;2006:1155-1170). The survival of a company within the competitive global terrain is prompted by the quest for products and services considered fit for use or superior to the competition (Corrie, 2005:36). Quality in construction may involve measuring performance and correcting the areas that may need attention to boost the organisational image of superior quality. Quality essentially meets the customer’s expectations and relates directly to a specific function or object, this is a combination of the power of the people and of the processes (Elias, 2015:51). Each individual is expected to meet the requirements and expectations according to the specifications of the product or service in order to meet the customer’s needs. The proper management of quality reduces costs and increases production (Deming, 1988:88)

through quality management of design and continuous improvement of the processes. Therefore quality is what the customer is prepared to pay for and not what the manufacturer claims to be appropriate for the customer.

According to Ashford (2005), quality refers to totality of characteristics and features of a product or service that bear upon its ability to satisfy indicated needs. Ashford (2005) continues to clarify the word “needs” in the definition of quality as follows:

- In a contractual environment, needs are specified, whereas in other environments, implied needs should be identified and defined.
- In many instances, needs can change with time, this implies periodic revision of specifications.
- Needs are usually translated into features and characteristics with specified criteria. Needs may include aspects of usability, safety, availability, reliability, maintainability, economics and environment.

According to Summers (2009), Dr. Armand Feigenbaum was the first person to encourage the treatment of quality as a priority business strategy, an approach to make a company to stay in business and to be more effective. Summers (2009) further argues that quality as defined by Dr. Feigenbaum is a customer determination which is based on the customer’s actual experience with the product or service, measuring against customer’s stated requirements, always representing a moving target in a competitive market.

According to Aspinwall and Delgado-Hernandez (2008:1013-1028), the quality in construction industry has been categorised into three different groups, namely, corporate quality, product quality, and service quality. The differences between the above mentioned groups have been explained below as stated by Aspinwall and Delgado-Hernandez (2008:1013-1028).

### **Corporate Quality**

According to Yuejun and Zhichun (2011), corporate quality is the picture that the clients have about a company. This type of quality is really helpful for customer satisfaction achievement. The corporate quality is not constructed at the project level but at the organisational level.

## **Product Quality**

Chin-Keng and Hamzah (2011:542-552) defined product quality as the final construction process in the construction projects. According to Aspinwall and Delgado-Hernandez (2008:1013-1028), Garvin (1984) suggested eight dimensions which are applicable to the product of the construction projects as listed below.

- Performance – The ability of the facility to function.
- Features – The basic characteristics of the facility to be able to function.
- Reliability – The ability of the occupants to use the facility without any failure.
- Conformance – The degree with which the facility is stable with defined standards.
- Durability – The period of time that the occupants can make use of the facility before it requires replacement.
- Serviceability – The speed at which the maintenance of the facility can be done.
- Aesthetics – The satisfaction of the occupants with facility through their experience.
- Perceived quality – The degree of occupants' satisfaction with the image of the facility.

## **Service Quality**

In construction industry, clients are the recipients of the service quality whilst in the product quality are associated with the completed facility. According to Aspinwall and Delgado-Hernandez (2008:1013-1028), Maloney (2002) suggested ten dimensions that could be used in the construction industry. He also stated that these dimensions could be used as a checklist as well when providing the services to the clients. Below are the ten service quality dimensions that could be used in construction industry as stated in Aspinwall and Delgado-Hernandez (2008:1013-1028).

- Access – The ease with which the construction company can be contacted after the construction project has been completed.

- Communication – The flow of information between the client and the construction company regarding the project.
- Competence – The ability of the company to ensure that the service is offered to the client on the agreed time.
- Courtesy – The consideration of the company's personnel to the client in respect of politeness and kindness.
- Credibility – The ability of the company to deliver what they promised to their clients.
- Reliability – The ability to ensure that all the construction activities are done correctly.
- Responsiveness – The ability to resolve the problems that arise during the phases of the project.
- Security – The ability to keep the entire client's information in the safe place and confidential.
- Tangibles – The degree in which the company's personnel and the facilities appear to the clients.
- Understanding the customer – The ability to the company to know the client's needs and provide as required.

### **3.3 Customers**

One observation of quality is that it is defined completely by the end user or customer, and is based upon the customer's evaluation of the entire experience. According to (Chowdhury, 2005:45), the customer experience is defined as the collective of all the interactions that customers have with the company's products and services. For example, any time a customer buys a product, she or he will form an impression based on the way it was sold, the way it was delivered, product's performance, and the way it was supported.

### **3.4 Quality Management**

Quality management refers to the processes that are required to be followed to ensure that the project meets the specified requirements and specifications that are in place in order to satisfy customer's needs and involved stakeholders (Husin et al., 2008:45). Summers (2009) defines quality management as an aspect of the overall

management function where quality policy is determined and implemented and that is the duty of the top management. He also argues that all the management functions are implemented by the means of quality management processes such as quality planning, quality assurance, quality control and quality improvement within the quality system. The quality management processes that are required in order to achieve projects' objectives are discussed below.

### **3.4.1 Quality Planning**

Senaratne and Jayarathna (2012:101-114) define quality planning as a methodical process to ensure that an organised sequence of activities is completed. These structured activities will ensure that a company can definitely provide a quality product on time, at an effectively lowest cost and meet customer's specific specifications. Senaratne and Jayarathna (2012:101-114) understand that quality planning is part of the quality processes which are quality control, assurance and improvement. The key components of implementing company's quality planning are identifying the customers, establishing quality goals, generating measurements of quality, planning processes that will ensure that quality goals are met and producing best results in continuously improvement of the market share (Husin et al., 2008:45).

Husin et al. (2008:40-45) further argued that many other quality planning approaches have been established. Actually, the quality planning process is emphasised in total quality management (TQM) and International Standardisation of Organisations (ISO). However, he also argued that many companies that independently practice different quality management methods fail because they are employing the methods that are not associated with the strategic planning of the company. Jha and Iyer (2006:1155-1170) emphasise that companies need to participate in the strategic planning and quality planning to avoid conflict in the two plans because the quality plan will possibly lose out and result in some disruptive effects, such as quality measurements, tension between quality goals, customers, and non-involvement of employees.

According to Chin-Keng and Hamzah (2011:542-552), a lot of companies currently invest in quality improvement programmes. However, the literature has exposed that many companies fingered that the quality improvement programmes had collapsed

in their expectations and these programmes were not producing the expected improvements. The absence of an effective quality planning leads to the gap between the realisation of benefits and quality improvement expectations before its implementation (Chin-Keng and Hamzah, 2011:542-552). Thus, in a corporate quality management process, quality planning is identified as the most important phase as it requires more attention. The construction industry is seen as industry with a poor focus on quality compared to the service and manufacturing sectors. Some of the criticisms are the final product, employees and materials, and industry's processes are under pressure to provide a higher quality of construction (Rumane, 2013:26).

### **3.4.2 Quality Assurance**

Yuejun and Zhichun (2011:1416-1419) define quality assurance as an organised method to business management and control, which improves the ability to provide products and services constantly to given specifications, programme and cost. This is a procedure that has been used to help in preventing, controlling, and managing the products that are being produced to satisfy requirements, meet up with allocated time objectives and be cost effective (Yuejun and Zhichun, 2011:1416-1419). Khan, Azhar and Mahmood (2008:111) argue that quality assurance focuses on defect prevention, while quality control focuses on defect detection once the product has been produced or constructed. Quality assurance concentrates on the construction management methods to ensure that quality is built into the production process. Mostly, quality assurance is the prevention of quality problems through different activities such as planned and systematic activities (Schweitzer, Kochkine, Schwieger and Berner, 2012:8).

According to Schweitzer et al. (2012:8), quality assurance forms a relationship to both customer and the management of a company. The customer has assurance that the product or service will definitely meet his/her quality requirements while management is confident that the product or service meets up with their own quality requirements, and that of the customer. The activities that are targeted at providing confidence to a customer is called external quality assurance, while internal quality assurance focuses on the activities that are planned at providing confidence to the management of an organization (Senaratne and Jayarathna, 2012:101-114).

Aspinwall and Delgado-Hernandez (2008:1013-1028) argue that quality assurance in construction industry differs from that of manufacturing industry in that the customer is not buying a completed product, so everything is done on confident that it will be completed on time, within given budget and as per specifications. Griffith (2005) proposed the need for quality assurance in construction industry because of the high costs related error in the design phase and management. Below are the cost related errors as identified by Griffith (2005):

- Lack of training and management of the designers who are responsible for providing drawings, which results in continuous changes in the details of the project throughout construction phase and affects the construction costs;
- Incorrect specification when drawing up tender documents;
- Poor definition of responsibility in the management level when deploying employees to the sites;
- Poor communication between involved individuals in the contract which leads to unnecessary costs and delays;
- Poor training and management of employees on site;
- Poor confirmation routines to ensure that materials, design and employees meet given requirements.

### **3.4.3 Quality Control**

Cao (2010:12) defined quality control as activities and operational techniques that are aimed in monitoring and eliminating causes of any insufficient performance of relevant stages of the project in order to result in economic effectiveness. Weihong and Mingming (2009:1162) defined quality control as the use of techniques to maintain, achieve, and try to improve the quality standards of the products or services. Quality control is important because of the following aspects as per Weihong and Mingming (2009:1160-1164):

- It ensures that the correct path of specification required is followed.
- It ensures that the correct design of the product required is done properly.

- It helps in the inspection process of the product during manufacturing to determine if it is in line with the customer's specification.
- It ensures that the monitoring process and giving a feedback if there is a necessity for improvement is done accordingly.

Cao (2010:27) argued that there are three groups of quality control, namely;

- Irregular control – This type of control is used whenever a customer is not satisfied with the product.
- Routine control – This type of control is being taken at different stages of construction to ensure proper control during the project.
- Scientific control – This type of control is implemented through measurement and analysed using statistical sampling theory.

The above mentioned types of quality control are all relatively effective but irregular quality control has a tendency of making customers to lose confidence in the quality of goods produced. Routine and scientific controls are the preferred approaches to quality control because are carried out while the product is still in the production process. The routine and scientific controls ensure the quality of the completed product meets the specified requirements in the long run. The scientific control measures specifically the degree of raw materials, products, and processes to the agreed specification.

According to Summers (2009), the purpose of the quality control during construction is to ensure that the work is accomplished in accordance with the requirements specified in the contract. Inspection of construction works is carried out throughout the construction period either by the construction supervision team or the appointed inspection agency. He also states that quality is an important aspect of construction projects. Normally, the contractor provides on-site inspection and testing facilities at the construction site. On a construction site, inspection and testing is carried out at three stages during the construction period to ensure quality compliance as stated by Rumane (2013:93-94):



- During the construction process – This is carried out with the checklist request submitted by the contractor for testing of on-going works before proceeding to the next step.
- Receipt of subcontracted or purchased material or service – This is triggered by a material inspection request submitted by the contractor to the consultant upon receipt of material. In certain cases, the inspection is carried out at the manufacturing premises of the product or system prior to dispatch of the material.
- Before final delivery or commissioning and handover – Quality control is used to monitor design and construction conformance to established requirements as determined by the contract specifications.

Ashford (2005) argued that quality in construction is achieved through proper control at every stage of execution and installation of works. The contractor should complete the knowledge of the project they have been contracted to construct. Safe and reliable construction should be the objective of all working on the project. The contractor has to submit shop drawings, material, products, equipment, and systems to the owner for their reviews and approval before they can be deployed to the project. Quality of construction has mainly three elements as stated by Ruman (2013:182):

- Defined Scope
- Budget
- Schedule

The contractor has to comply with all the requirements specified in the contract documents and execute the works per the approved quality control plan, which is the contractor's everyday tool to ensure quality. During construction process, the contractor has to submit the checklist to the consultant to inspect the works, submission of checklist or requests for inspection are on-going activities during the construction process to ensure proper quality control of construction.

Below are the targets of quality control in construction industry as stated by Weihong and Mingming (2009:1160-1164)

- To ensure that the construction projects are completed as per the quality plan.
- To ensure that the quality of the projects meets all the terms of the contract, design requirements, and reliable quality.
- To ensure that all the user's expansion, maintenance, and renovation requirements for the project based on all quality documentation provided.

According to Ashford (2005), the quality control in the construction industry can be grouped into four different categories based on the scope and the nature of the project.

- Contract documents – Construction contract documents and the clause regarding the rights and obligations of quality control involving all the parties who are involve in this construction project as well as all the commitments in the contract have been stipulated.
- Design documents – in construction phase, the most vital aspects of quality control are the construction plan, technical specification and other approved documents.
- Laws and regulations documents – These documents are basic documents that should be followed regarding the construction rules and standards that have been put in place in the quality control of construction projects.
- Specialized technical regulations document – These documents lead the quality inspectors to a correct direction when undertaking quality inspection and control. Quality acceptance criteria, quality standards and construction technology based on the use of latest technologies, processes, and materials are stipulated in these documents.

### **3.5 Quality Management Tools and Techniques**

According to Ruman (2013), a device with a clear function is called a single tool, and is normally applied on its own, while a technique has an extensive application and is known as a set of tools. Singh, Khan and Grover (2012:854) argued that McConnell (1989) and Ishikawa (1985) have identified a list of the seven basic Total Quality Management (TQM) tools and twelve techniques as shown in table 3.1 below.

**Table 3.1 – Quality Management Tools and Techniques**

<b>Tools</b>	<b>Techniques</b>
Cause and effect diagram	Benchmarking
Check sheet	Departmental purpose analysis
Control chart	Design of experiments
Flow Chart	Failure mode and effects analysis
Histogram	Fault tree analysis
Pareto diagram	Poka yoke
Scatter diagram	Problem solving methodology
	Quality costing
	Quality function deployment
	Quality improvement teams
	Statistical process control

**Source: Singh et al. (2012:854)**

### **3.6 Evolution**

Quality management is very important even though it is a recent phenomenon for a company. Rose (2005:41) stated that Walter A. Shewhart contributed in quality management evolution by creating a procedure for quality control for production, employing statistical procedure which was first proposed in 1924. This was Dr. Shewhart's initial project in his ongoing effort on statistical quality control. According to Senaratne and Jayarathna (2012:101-114), during the Second World War, Dr. W. Edwards Deming applied statistical process control techniques in the United States, thus effectively improving quality in the manufacture of other strategically important products. Quality leadership from a general perspective has improved over the past six decades. Dr. Deming formulated fourteen points of consideration for managers as stated by Senaratne and Jayarathna (2012:101-114); these fourteen points include key concepts such as:

- Break down obstructions between departments
- Management should understand their responsibilities, and show leadership
- Supervision should be able to help employees, machines, and tools to do a better job
- The system of service and production should Improve continuously
- Institute an energetic program of training and self-improvement

### **3.7 Principles**

The International Standard for Quality management (ISO 9001:2015) approves a number of management principles, which can be implemented by top management to give guidance to their organizations in order to improve performance (Nederpl; 2012).

#### **3.7.1 Customer Focus**

The main focus of quality management is to try to exceed customer expectations and to meet customer requirements.

#### **Rationale**

Continuous success is accomplished when an organization attracts and maintains the confidence of customers and other involved parties that is doing business with. Every aspect of customer contact offers an opportunity to generate more value for the customer. Understanding the requirements of customers and other involved parties contributes to continued success of an organization (Weihong and Mingming; 2009:1160-1164).

#### **3.7.2 Leadership**

Leaders at all levels of the company establish unity of purpose, guidance and create conditions in which employees are engaged in accomplishing the quality objectives.

#### **Rationale**

Formation of unity of purpose and guidance and engagement of people allow an organization to support its strategies, processes, policies and resources to accomplish its objectives.

### **3.7.3 Engagement of People**

Engaged, competent and empowered people at all levels of the company are important to develop its capability to produce and deliver value.

#### **Rationale**

Involving all employees at all levels and respecting all of them as individuals contributes in managing a company effectively and efficiently. Empowerment, recognition and improvement of competence facilitate the engagement of employees in accomplishing the organization's quality objectives (Yuejun and Zhichun; 2011:1416-1419).

### **3.7.4 Process Approach**

Constant and predictable results are accomplished more effectively and efficiently when tasks are understood and managed as interconnected processes that function as a coherent system.

#### **Rationale**

The quality management system involves of interconnected processes. Understanding the way the results are produced by this system allows a company to improve the system and its performance.

### **3.7.5 Improvement**

Successful companies have an ongoing emphasis on improvement.

#### **Rationale**

Improvement is important for a company to sustain current levels of performance, to respond to changes in all conditions and to generate new opportunities.

### **3.7.6 Evidence Based Decision Making**

Desired results are more likely produced from decisions based on the evaluation and analysis of data and information.

#### **Rationale**

Decision making can be a difficult process, and it always includes some uncertainty. It often includes numerous types and sources of inputs, clarification, which can be subjective. It is essential to understand cause-and-effect relationships and possible unintentional consequences. Evidence, Facts and data analysis contribute to greater objectivity and assurance in decision making (Metri, 2006:35-46).

### **3.7.7 Relationship Management**

For constant success, a company monitors and manages its relationships with involved parties, such as suppliers.

#### **Rationale**

The performance of a company is influenced by interested parties. Continued success is more likely to be accomplished when the company monitors and manages relationships with all of its involved parties to improve their impact on its performance. The stakeholders' relationship management is of particular importance.

### **3.8 Quality Standards**

According to Corbett, Montes-Sancho and Kirsch (2005:1046-1059), the Quality Management System (QMS) standards were created in 1987 by the International Organisation for Standardisation (ISO). They were named the ISO 9000:1987 series of standards containing ISO 9001:1987, ISO 9002:1987 and ISO 9003:1987. These standards were relevant in different types of industries, depending on the type of process: production, designing or service delivery. International Organisation for Standardisation reviews the standards every few years. Naveh and Marcus (2007:731-742) stated that in 1994 the version was called the ISO 9000:1994 series, containing of the following versions: ISO 9001:1994, 9002:1994 and 9003:1994. In 2000 the new version replaced the 1994 version and was called ISO 9000:2000

series. The ISO 9002 and ISO 9003 standards were combined into one single certifiable standard which is: ISO 9001:2000. All the companies that were holding ISO 9002 and ISO 9003 standards had to complete a conversion to the new standard after December 2003 (Corbett et al., 2005:1046-1059).

In 2008 International Organisation for Standardisation released another revision which contains no new requirement, ISO 9001:2008 (Heras, Dick, and Casadesus; 2002:774-791). The main reasons for the changes were grammar improvement, facilitating interpretation of the standard into other languages as there were over 950,000 certified companies at the time in 175 countries that use the standard. The International Organisation for Standardisation In 2005 released a standard for the food industry, ISO 22000. The values and principles of ISO 9000 are covered in this standard. International Organisation for Standardisation released Technical Standard TS 16949 for the automotive industry which defines requirements in addition to ISO 9001:2008 series requirements (Naveh and Marcus, 2007:731-742). In 2015 ISO 9001:2015 was published even though the scope of the standard was not changed, however, the core terms and structure were improved to allow the standard to integrate easily with other international management systems (Heras et al., 2002:774-791).

### **3.9 Quality Management Software**

Kelemen (2013:23-24) defines Quality Management Software (QMS) as a type of technologies that is used by companies to manage and monitor the high quality products. Solutions range in functionality; on the other hand, the deployment of automation competences they typically have mechanisms for managing internal and external risk, the quality of processes, compliance and products. Industry-specific and pre-configured solutions are available and normally require combination with existing Information Technology (IT) architecture applications such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM) and Product Lifecycle Management (PLM) (Edelhauser and Ionica, 2008:53-58).

### 3.10 Quality Cost in Construction

Song and Lee (2004:3) defined the quality cost in construction as the total gained cost in the entire project life cycle in preventing non-conformance with project's defined scope. He also stated that cost of quality is really useful in the measuring of progress, budget, and analysing the project. By doing the analysis in the cost categories, a company can be able to determine whether all resources are properly allocated. According to Song and Lee (2004:2), cost of quality has four different categories, as illustrated in the table 3.2 below:

**Table 3.2 – Different categories of cost of quality.**

<b>Internal Failure Cost</b>	<b>External Failure Costs</b>	<b>Appraisal Cost</b>	<b>Prevention Cost</b>
Rework	Breakdown of installed system	Design review	Preventive action
Rectification	Repairs	Preparation of composite	Training
Rejection of checklist	Maintenance	On-site material inspection	Work procedures
Corrective action	Warranty	Off-site material inspection	Method statement
		Pre-checklist inspection	Calibration of equipment

**Source: Song and Lee (2004:2)**

#### 3.10.1 Quality Cost during Design Phase

Weihong and Mingming (2009:1160-1164) stated that construction projects are unique and non-repetitive in nature, and so need specific attention to maintain quality. To a great extent, each project has to be designed and built to serve a specific need. It is the designer's responsibility to develop project documents to ensure the following aspects as summarised in Weihong and Mingming (2009:1160-1164):

- Conformance to the owner's requirements.
- Conformance to requirements listed under the Terms of Reference (TOR).
- Compliance with applicable standards, codes, regulations and practices.



- Development of design drawings and specifications adhere to the economic objectives.
- Great accuracy to avoid any disruption, stoppage, and delay of work during construction.
- Completion within the stipulated time to avoid delay in starting of construction.
- Minimal design errors.
- Minimal omissions.
- Reduction of risk and liabilities.

Weihong and Mingming (2009:1160-1164) suggested that in order to achieve a zero defect policy during the construction phase and reduce rework during the design phase, the designer has to take necessary steps to reduce the cost of quality. According to Cao (2010:28-30), in order to improve the design and reduce hidden costs, a PDCA cycle model can be developed as a process improvement tool. PDCA activities during the design phase are illustrated in table 3.3 below:

**Table 3.3 – PDCA activities during the design phase.**

<b>PLAN-Establish scope</b>	<b>DO – Develop design</b>	<b>CHECK – Review</b>	<b>ACT-Implement comments</b>
Define scope of work	Develop design and drawings	Conformance to client needs and requirements	Implement review comments if any
Establish owner’s requirements	Prepare contract documents	Check project schedule	Take corrective action if required
Establish standards and codes	Develop specifications	Check project budget	Release documents for construction bid
Establish project budget	Coordinate with other disciplines and trades	Check for conflict with other disciplines	
Establish project schedule		Conformance to regulatory requirements, standards, and codes.	

**Source: Cao (2010:28-30)**

### 3.10.2 Quality Cost during Execution

Peinadro, Rico, Canon, and De las Heras (2009:2659-2664) stated that there are certain hidden costs which may not directly affect the overall cost of the project, however they may cost the contractor in terms of money and may affect the completion schedule of the project. Rejection of executed work by the supervisor owing to noncompliance with specifications will cause the contractor loss in terms of the following aspects as per Peinadro et al. (2009:2659-2664):

- Material
- Manpower
- Time
- The contractor will have to rectify the work, which will need additional resources and extra time to do the work as specified.
- This will disturb the contractor's work schedule and affect execution of other activities. The contractor has to emphasize a zero defect policy, particularly concrete works.

Peinadro et al. (2009:2659-2664) identified the measures that need to be taken by the contractor to avoid rejection of work in order to minimise the cost of quality in the construction industry:

- Execution of work per approved shop drawings using approved material.
- Following approved method of statement or manufacture's recommended method of installation.
- Conducting continuous inspection during the construction process.
- Employing a properly trained workforce.
- Maintaining good workmanship.
- Identifying and correcting deficiencies before submitting the checklist for inspection and approval of work.
- Coordinating requirements of other trades, for example, if any opening is required in the concrete beam for crossing of a service pipe.

### **3.10.3 Cost of Poor Quality**

According to Thomasson and Wallin (2013:17), in order to measure satisfaction, an independent product survey can be carried out to discover the reasons and improvement measures to be adopted. Such an assessment can be done through a questionnaire related to the quality of work and functioning, and getting the customer's opinion or reaction. The management can use the information from the questionnaire for quality improvements. All necessary improvements, if required, for proper functioning of the installed system shall be carried out to maintain customer satisfaction. They also argued that the contractor is required to maintain the completed project for a certain period under the maintenance contact and therefore necessary modifications can be carried out during this period. Such defects or modifications have to be recorded by the company as feedback information, and necessary measure can be taken to avoid a repetition in other projects. The cost of carrying out such repairs or modifications is borne by the contractor, which helps improve customer satisfaction.

Moura et al. (2007:3294-3306) argued that poor quality results in higher maintenance and warranty charges. In construction projects, these costs are mainly due to:

- Rejection of works during construction – This results in rework by the contractor to meet the specification requirements. If any extra time and cost is required to redo the work, the contractor is not compensated for the same.
- Rejection of shop drawings – Repeated rejection of shop drawings results in the contractor reproducing the same by spending extra time and cost and at the same time delaying the start of relevant activities.

### **3.11 Total Quality management**

According to Griffith (2005), total quality management is a structured and comprehensive approach to organisational management that pursues to improve the service and product quality through on-going modifications in response to continuous feedback. Levy (2007) defines total quality management as an explanation of the culture, organisation, and attitude of the company that attempts to provide clients with products that meet their requirements. He further urges that total quality

management initiated in the 1950s and has gradually become more common since the early 1980s.

Coble, Hinze and Haupt (2006) have identified the basic requirements for total quality management as following:

- Set company vision
- Identify customers and their needs
- Define critical processes and measures
- Develop strategic plan
- Review planning
- Education and training
- Detect prevention not detection
- Improvement of process
- Identify major products and process
- Systematic approach to total quality management
- Develop team approach by involving everyone in the company

Dale (2004) compared different total quality management gurus based on their quality definition, emphasis on the definition and dominant factor as well as illustrated below in table 3.4.

**Table 3.4 – Comparison of Total Quality Management Gurus**

<b>Guru</b>	<b>Definition of Quality</b>	<b>Emphasis</b>	<b>Dominant Factor</b>
Edward Deming	Customer – led	Process	Control of variation
Joseph Juran	Customer – led	People & Process	Fitness for use
Philip Crosby	Supply – led	Performance Process	Conformance to requirements
Kaoru Ishikawa	Value – led	People & Process	Company-wide quality control
Genechi Taguchi	Supply – led	Process / Design	Quality loss function

**Source: Dale (2004)**

### 3.12 Project Delays

According to the view of the employer the major factors affecting the construction projects are caused by: unobtainability of resources, shortage of materials, and leadership skills for project manager. Contractors also noticed that the absence of employees with high experience and qualifications contributes to project delays. This is the main factor because the availability of employees with high experience and qualifications contribute to execution of the project with a professional and successful method. The involvement of management in the decision making processes assist in the prevention of unnecessary project delays that can occur. Involving the managerial levels in the decision making process assists in better implementation of a project (Enshassi, Mohamed and Abushaban; 2009:269-280).

Haseeb, Lu, Bibi, Dyian and Rabbani (2011:41) argued that project delays happen when the project exceeds the completion time of the project that had been agreed on by involved parties. Project delays result in additional charges that are payable by the contractor and the employer for the completion of the project in some construction projects. The causes of project delays vary according to and due to the errors and weaknesses of the employer and the contractor. It is necessary to conduct an in-depth investigation and identification of delay issues and then choose the relevant actions to counter these delay issues within cost and maintaining quality (Haseeb et al. 2011:41-50). Table 3.5 below illustrates the delay factors relevant to clients, consultants and external delay factors.

**Table 3.5 – Project Delay factors**

<b>Clients Delay factors</b>	<b>Consultants Delay factors</b>	<b>External Delay Factors</b>
Economic ability for the project	Timeliness of project information	Statutory undertakes
Previous working relationship	Build ability of design	Regulations
Main concern construction time	Provision for ease of communication	Weather

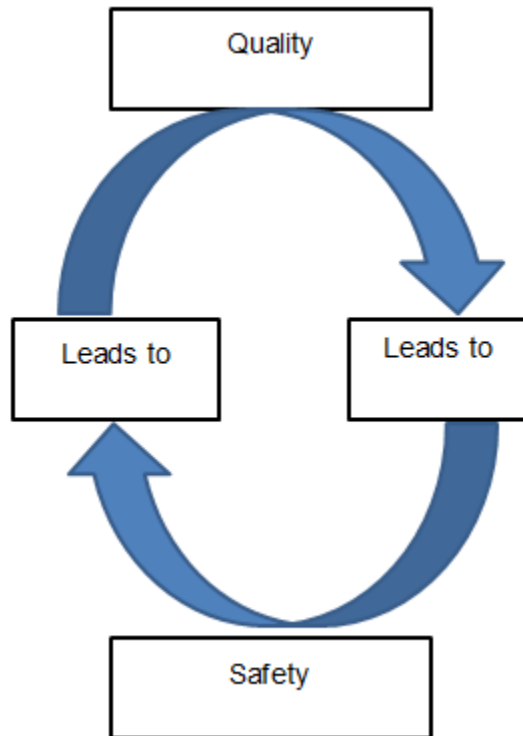
Specified sequence of completion	Previous working relationships	Natural disasters
Changes to initial design	Priority on construction time	Rain
Not definite about material	Missing some detail in drawing	Changes in government regulation and laws
Late payment of bills	Not understanding the client requirements	Effects of subsurface conditions

**Source: Haseeb et al. (2011:43)**

### **3.13 The Relationship between Quality and Safety**

Quality and safety management work hand in hand, for example, if there is a need for a material testing that's a function of quality management but that material testing is also a safety procedure. According to Coble et al. (2006) quality and safety requires well-motivated, well trained employees, as it is in the interests of quality to support safety efforts in order to reduce losses of the company quality assets. Any work that is being done in a safe work environment increases the probability that this work will comply with the quality management standard. Thus safety leads to quality as shown in figure 2.1 below. Husin et al. (2008:45) suggested that safety management can be improved by including it in the existing ISO 9000 quality management system. They further argued that by including safety management in the quality standard that would ensure that safety management can be treated as important as quality management in the construction industry as demonstrated in figure 3.1 below.

**Figure 3.1 – Relationship between quality and safety**



**Source: Husin et al. (2008:45)**

### **3.14 Chapter Summary**

The purpose of this chapter was to discuss the quality management in construction industry. Various project quality management processes were defined and discussed in this chapter, such as quality planning, quality assurance, and quality control. Quality assurance in construction industry consists of three parties, namely, the customer, designer and contractor. Each party has its role which is dependent on the chosen procurement system for the entire project. The importance of quality assurance in construction industry was discussed and it was revealed that the high percentage of errors that lead to the lack of quality achievement in construction industry is caused by poor communication between two parties, namely, the designer and construction management team. The next chapter will presents the background information on Transnet's programs and performance, construction development and quality system for contractors that are executing the construction projects.

## Chapter 4

### Overview of the Study Environment

#### 4.1 Introduction

This chapter focuses on the overview of TFR Iron Ore line, discusses the performance of the division based on revenue, operating expenses and safety. The different project management plans, approval of material, and inspection and test plan are discussed in detail. This chapter also presents the safety of the surrounding communities in detail.

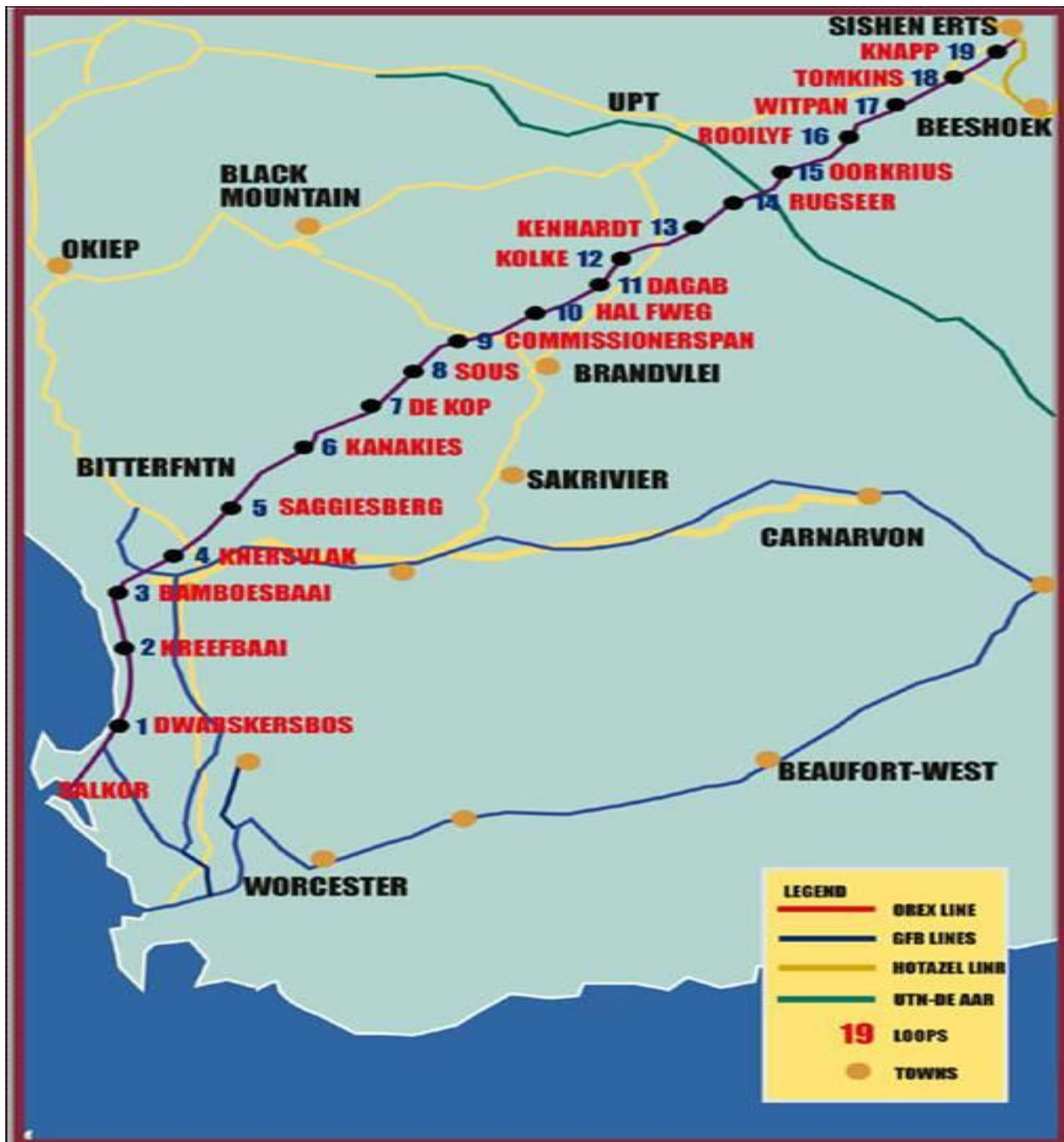
#### 4.2 Overview of TFR Iron Ore Line

The Transnet Iron Ore and manganese (IOM) railway line consists of around 860km of rail infrastructure from the iron ore and manganese ore mines in the Northern Cape Sishen region to the existing port infrastructure at Saldanha Bay (Transnet, 2010). Transnet currently owns and operates this rail and port infrastructure and charges the existing users of the Ore Line a tariff per tonne of ore exported using this infrastructure. According to Transnet (2010) the Sishen to Saldanha iron ore railway line was originally constructed by Italian contractors for Iscor, a South African parastatal iron and steel company during 1973. This railway line was constructed to transport iron ore mined at Iscor's Sishen mine in the hinterland of the Northern Cape province of South Africa to be exported through the Port of Saldanha on the western coast of South Africa. The iron ore is exported from the deep water port of Saldanha to international markets of which China is the predominate market.

The Sishen iron ore reserves and operations were purchased by the Anglo American Corporation and subsequently became known as Kumba Resources as a result of a broad-based economic empowerment (BEE) initiative whilst the steel manufacturing operation at Saldanha was purchased by Mittal Steel an international steel producer when Iscor was unbundled. Saldanha subsequently became a heavy-haul operation within the control of the Western Region of Transnet. Figure 3.1 below illustrates Iron Ore line layout from Saldanha to Sishen with different loops or stations from Saldanha to Sishen.



Figure 4.1 – The Iron Ore Line layout from Sishen to Saldanha Bay



Source: Transnet (2010)

Iron ore is loaded by Kumba Resources onto the wagons of train sets at Sishen mine from three load-out stations. The loaded wagons are then shunted into the Iron Ore line exchange yard by Kumba Resources own shunting locomotives, in the exchange yard 342 wagon trains are then made up by the Iron Ore line shunting operations ready for the coupling of locomotive consists to be hauled to Saldanha. The train driver then requests permission via radio to enter the Iron Ore main line from the Centralised Train Control (CTC) at Saldanha, once authorisation has been granted

and the signals are safe to proceed the locomotive driver and the assistant with the train proceeds onto the Iron Ore line to Saldanha.

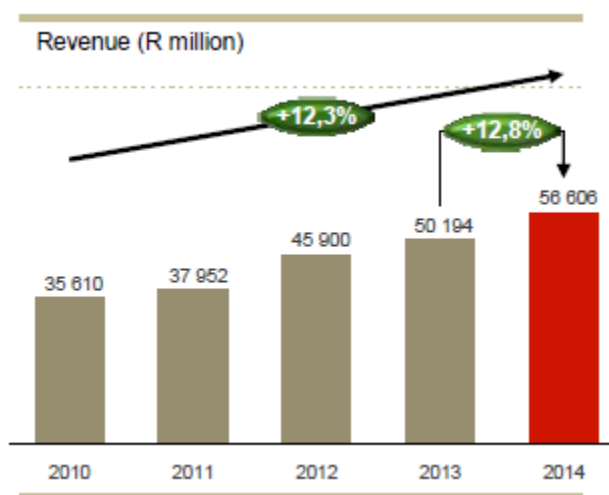
On arrival at the Salkor yard at Saldanha, Salkor yard has been split into two shunting yards designated Salkor A and Salkor B, the locomotive consist is uncoupled, the locomotives undergo routine inspection and maintenance, are re-fuelled and ready to return to Sishen with an empty train. The 342 train set is split into three 114 train sets; each train set is then shunted into the tippler in the port of Saldanha for automatic unloading, two wagons at a time by two wagon tipplers. Once all the wagons have been unloaded, they are shunted back to the Salkor yard ready to be driven back to Sishen for loading again.

According to Transnet Mikatelo Media (2013), an ISO 9001 document which is called as Main Process Control Procedure (MPCP) has been compiled that describes the iron ore handling operation from Sishen mine to the port of Saldanha by the Iron Ore railway. The iron ore from the wagon tipplers is transferred by overland conveyors to the stockyard and deposited onto any of the stockpiles of the seven various grades of iron ore by one of any three stacker-reclaimers.

### 4.3 Transnet Freight Rail Performance

#### 4.3.1 Revenue

Figure 4.2 – Comparing Transnet revenue from different financial years



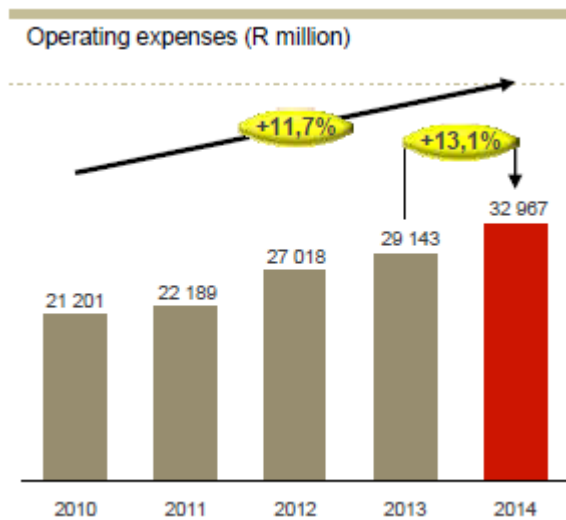
Source: Transnet annual results (2014)

From 2013 to 2014 there was an increase in the revenue by 12.8% mainly due to operational, growth in volumes and productivity improvements as a result of the

progressive impact of the new operations attitude and paybacks of the capital investment programme. Tariff increases were on track with contractual commitments and allowed the Company to get a reasonable return on invested capital.

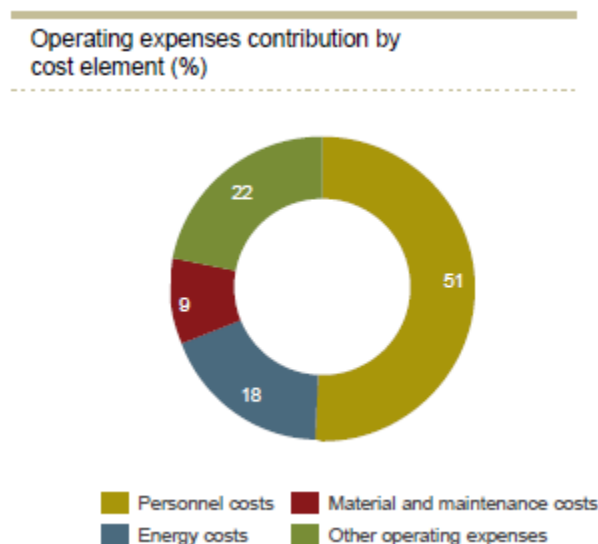
### 4.3.2 Operating Expenses

**Figure 4.3 (a) Operating expenses**



Source: Transnet annual results (2014)

**Figure 4.3 (b) Operating expenses contribution by cost element (%)**



Source: Transnet annual results (2014)

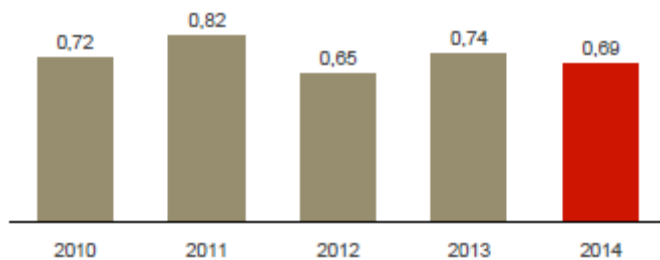
Cost-reduction initiatives were executed by the Company during the year in response to the uncertain economic environment, which resulted in a saving of R2,1

billion, against planned costs. As shown in figure 4.3 (a) expenses increased by 13,1% to R33 billion mainly due to the follow as per Transnet 2014 annual results:

- Increase in energy costs to 18%, due to the fuel price increases as well as higher electricity tariffs impacted by foreign exchange volatility.
- Increase in personnel costs to 51%, due to an average wage increase through the Company relating to the two-year wage agreement concluded with the recognised labour unions of 8,5%, as well as the filling of Market Demand Strategy (MDS) critical vacancies.

### 4.3.3 Safety

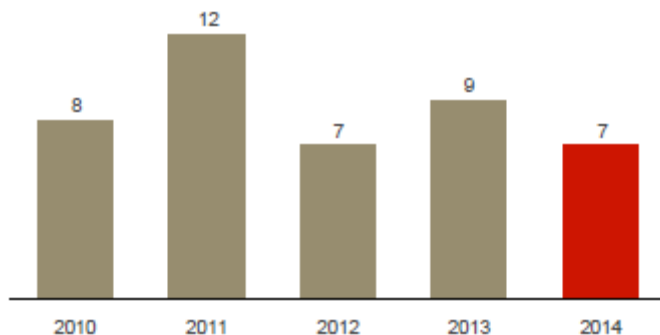
**Figure 4.4 (a) Disabling injury frequency rate (DIFR)**



**Source: Transnet annual results (2014)**

The Company recorded a reduction in the disabling injury frequency rate compared to the 0,75 annual target, which is exceptional by international standards. This is the third consecutive year that the Company recorded a disabling injury frequency rate (DIFR) ratio below 0,75, due to continued focus and investment in safety.

**Figure 4.4 (b) Employee fatalities in numbers**



**Source: Transnet annual results (2014)**

The company remains committed to zero employee fatalities. Sadly, the company recorded seven employee fatalities during the 2014 financial year compared to nine in the prior year.

#### **4.4 Project Management Plan**

Steyn and Nichilas (2012) define a project management plan as an approved document that specifies how the phases of the project will be executed, monitored and controlled throughout the project life cycle. This document may be in detailed or summary form and may include one or more other planning documents. The project management plan identifies the different ideas and actions planned to achieve the delivery of the scope of the project by the involved project team. Transnet Freight Rail Iron Ore line project documents revealed that the project management plan contains two types of documents which are, execution quality plan and the project quality plan.

The flow of design works is documented in a design management plan as per an interview with a TFR design team. After the design has been developed whenever there is a need for any changes in design, the design goes through the reviewing process. The contractors are part of the reviewing process so that they can have an opportunity to go through the design at an early stage of the project. The next step after the design review process is the development of the construction design. In the construction design stage the detailed drawings are developed and the reviewing process is also performed during this stage. There are changes that are being experienced during the construction process and these changes are called deviations. Transnet Capital Projects quality management plan details the processes that are involved in the design plan that allows for deviation. Construction team or design team usually generate the deviation reports.

##### **4.4.1 Project Quality Plan**

According to Senaratne and Jayarathna (2012:101-114), Project Quality Plan which is detailed should cover the following vital headings: management responsibility; documented quality management system; design control; purchasing; inspection testing; non-conformance; corrective actions; quality records; quality audits; and training. The project quality plan identifies the procedures and activities that a project team defines, plans, and executes to assure the quality of the project deliverables

and project management. The purpose of the Project Quality Plan is to define the activities and tasks that are required to deliver products while focusing on achieving customer's quality expectations (Yuejun and Zhichum, 2011:1416-1419).

Quality management within Transnet and particularly in Transnet Capital Projects is seen as a critical integrated part of the overall project delivery for all phases of the project, from Conceptual, Pre-feasibility, Feasibility, Execution and Close-Out Phase. The prime responsibility for quality on the project rests with the Project Manager. The size of some projects does not warrant a full time dedicated quality manager and the inputs from the National Lead for Quality management will be requested as and when required. Quality management will be enforced through the application of the relevant Quality control procedures for each project phase as follows:

- **Engineering Verification** – Quality assurance through the application of the engineering procedures, design review procedures, and procedures for design changes and issue of drawings and documents etc.
- **Contract Administration** – Quality and contractual assurance through the relevant contract administration management procedures, the approval of claims and processes.
- **Construction management** – Quality is ensured through the enforcement of the Personnel Protective Equipment (PPE) and Transnet Capital Project's (TCP) construction management procedures on site by the construction manager, assisted by the various discipline specific quality assurance personnel as identified by the project organogram.

The scope of the Project Quality Plan includes the design and execution of permanent and temporary works within the civil works scope; and related activities such as procurement, document control, non-conformity management and others. The scope excludes partner company internal processes; the preferred bidder period; and the defect liability period. The references and requirements include the Statutory and Regulatory requirements, Concession Agreement, the Project Management Manual and the Project Quality Plan. The responsibilities towards the Project Management Plan are stated and the sources of their definitions are also stated for the purpose of clarity.

#### **4.4.2 Execution Quality Plan**

The Transnet's Execution Quality Plan describes the following aspects namely, the purpose of the document, scope of the document, the references and requirements, responsibilities towards the Execution Quality Plan and terms and definitions. The scope of the Execution Quality Plan covers the civil engineering aspects of the project, specifically the execution phase processes; permanent works; temporary works; and subcontractors. The only part excluded from the scope is the permanent works design, which is the subject of the Design Plan. The Concession Agreement and the Project Management Plan are the two references stated in this document. The Quality Manager prepares and maintains this plan while the construction staff is responsible for the implementation.

The Execution Quality Plan is the most important part of the project management system. The following documents are established at the beginning of the project namely, organisation plan, risk management plan, environmental plan, management system plan, and health and safety plan. The design and work processes are established during the undertaken project as per the designed programme. The organisational structure is described in the organisation plan showing some roles and responsibilities of each and every individual who is involved in the project. The execution of TFR projects is divided into different departments, which are responsible for different duties of the project and are reporting to the Project Manager. Construction managers and site agents are managing some sections in these departments to ensure a proper monitoring, controlling, and management of the projects throughout the project life cycle.

#### **4.5 Approval of Material**

The Approval of Material document shows the approved materials that are to be used in the project based on the requirements as stated in the specification. This type of document consists of the following areas, namely:

- Purpose – Describes the material.
- Scope – Shows the location where the material is going to be used in the project.
- Type – Describes the specific designation, model, and make of the material to be used in the project.

- Requirements & Substantiation – This section identifies the requirements and explanation as stated in the specification.
- Supplier – Shows the details of the supplier, name, contact address, and location.
- Additional Remarks – This section allows the user to make some general comments if any.
- Attachments – if there are any attachments, the page numbers should be clear so that it can be easy to direct to the wanted attachment.

#### **4.6 Inspection and Test Plan**

This document shows the type and procedure that is used when inspecting and testing the materials throughout the project execution. Transnet Freight Rail's Inspection and Test Plan consist of the following sections, namely: Scope; Inspection and Test Plan, and Reference. The reference document includes specifications, drawings, work instructions, and method statements of the project that is carried out. TFR gets the notification of the inspection the day before or by means of the logbooks on site whenever the inspection was made by contractors. The contractors accept that Transnet Freight Rail may audit the test results and be able to access the quality records in any given time for different reasons.

#### **4.7 Surrounding Communities Safety**

At Transnet Freight Rail (TFR), safety is considered to be one of the most critical aspects of daily operations, not just the safety of employees, but also that of people who reside in communities wherein TFR operates. Employees conduct safety awareness campaigns in the areas with the aim of educating residents of the communities about the importance of acting safely and responsibly around the railways. Many members of these communities cross over the railway line illegally, in order to get to town, school and work, hence the need to remind them of the dangers of being reckless and negligent around the railways. The campaign also allowed TFR an opportunity to request the assistance of these communities in combating criminal activities such as cable theft; the stealing of goods on trains as well as the intentional damaging of TFR property by those who live amongst them. The Port of Saldanha lies approximately 120 km north of Cape Town in Saldanha Bay on the West Coast of South Africa (Transnet, 2010).



The main towns in the vicinity of the Transnet iron ore handling facility are Saldanha including Blue Water Bay, Langebaan and Vredenburg, with surrounding formal and informal residential areas. They fall within the Saldanha Bay Local Municipality, which had an estimated population of 81 121 (Census, 2006). Iron ore is currently transported to the handling facility at the Port of Saldanha by train from the mines in the Northern Cape. The iron ore is offloaded by wagon tippers, from where it is transported to stockpiles by conveyor.

Dust is emitted during the handling of the iron ore at the facility, and nuisance and health issues have been identified as primary concerns of the adjacent communities. Transnet has embarked on a dust mitigation programme that includes, amongst others, the covering of most conveyors and installation of sprinklers at important dust generating areas within the operation, water cannons at the stockpiles and dust monitoring systems. Transnet has identified operational inefficiencies at the iron ore handling facility. The higher volume of iron ore the facility will be able to handle once the operational inefficiencies are addressed, will result in the tippers handling more trains than currently required and more ships calling at the Port to receive the iron ore. However, the infrastructure at the handling facility, such as the number of stockyards and amount and type of handling equipment, will not change, as the increased throughput will be achieved by greater operational efficiency, which is expected to result in reduced work stoppage, equipment down time and iron ore spillage.

#### **4.8 Chapter Summary**

The purpose of this chapter was to discuss the quality management specifically in Transnet Freight Rail Iron Ore line construction projects. Various quality management processes and documents were discussed as practised by Transnet Freight Rail Iron Ore line. The next chapter will present the methods that were used to perform data collection, analyse collected data and interpret the results. The next chapter will strictly present the information that was collected in Transnet Freight Rail Iron Ore line to reveal the quality practices that are currently deployed.

## Chapter 5

### Research Methodology

#### 5.1 Introduction

The main objective of this study was to determine the best practices for the quality management on construction projects within TFR Iron Ore line. The findings of this study would assist to improve the processes of quality improvement in Transnet Freight Rail by implementing the different best practices that are recommended by different international and local quality experts. The issue of underperformance, high rate of accidents and derailments has been solved through the findings of the study and the company as a whole has definitely benefited. This chapter discusses the study methods that were employed to obtain the findings and the research's conclusions. It also discuss the target population that was selected during the study, sample size, data collection method used to collect data, data analysis system that was used to analyse the data, research assumptions that were made during the study, scope and limitations, and ethical considerations of the research

#### 5.2 Research Design

Kothari (2004:31) defined research design as the arrangement of circumstances for analysis and collection of data in a method that aims to combine relevance to the research purpose with economy in procedure. According to Rajasekar, Philominathan and Chinnathambi (2006:22), research design is the plan to carry out a study through interpreting one's research methodology into particular research methods, which are the methods that are adopted by researcher in collection and analysing of data. Rajasekar et al. (2006:22-23) suggested that the research design offers a complete guideline for selection of research approach; collection of data; design of sampling plan; and design of questionnaire.

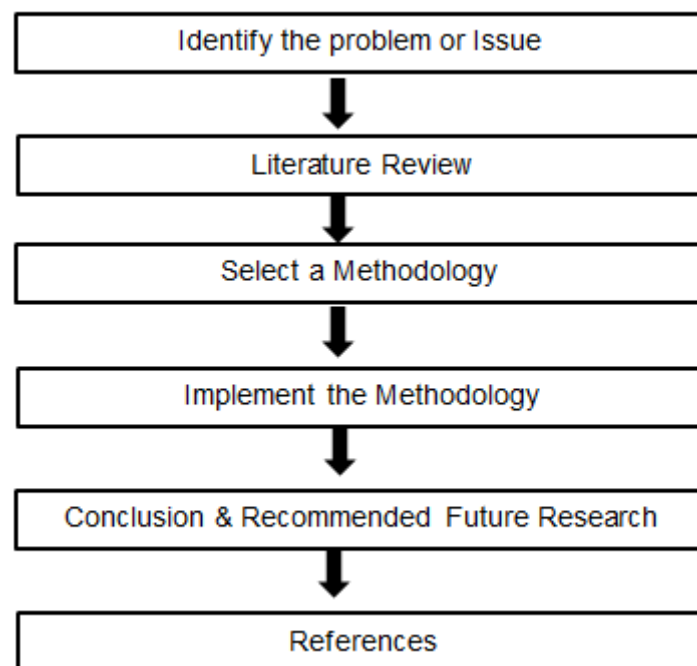
Any study needs a research design as it assists in the smooth sailing of the different research operations, making the study as efficient as possible resulting in the maximal relevant information with minimal expenditure of time, money, and effort (Kothari, 2004:32). Singh (2006:77) argued that a research design also assists in identifying the kind of relevant information to address the problem, collecting relevant data and analysing, and interpreting the collected data. Creswell and Clark

(2007:118) suggested that concurrent mixed method data collection have been employed in many successful researches to validate one form of data with the other form, to address different types of questions, and to transform the data for comparison. In this study the mixed – method approach was employed, to gather more and accurate data. The strengths of qualitative research approach can make up for the weaknesses of the quantitative research approach, this was the reason why mixed – method was chosen.

### 5.3 Research Methodology

Singh (2006:79) defined research methodology as a way to systematically solve the research problem and also understood as a science of studying how research is done scientifically. Rajasekar et al. (2006:5) defined research methodology as the procedures by which researchers follow when explaining, describing and predicting phenomena. Figure 5.1 below illustrates the research method model that the researchers should follow when conducting a research.

**Figure 5.1 – Research Method Model**



**Source: Clarke (2005:57)**

According to Clarke (2005:59), when following the research method model, the researcher begins with identifying a problem or issue; do a literature review; select a

suitable methodology for the identified problem; implement a selected methodology; and then conclude and recommend based on the findings. Rajasekar et al. (2006:5) argued that the research methodology is the study of methods where there is a gain of knowledge and its aim is to develop the research work plan.

The investigation of this study initiated with research of quality management in the construction projects from the official journals. The researcher gathered the relevant information from the previous TFR's project documents to perform the theoretical quality management evaluation. Simultaneously, a questionnaire was also used to gather information from relevant project teams from different departments in TFR Iron Ore line. The questionnaire focused on assessing the evidence of the lack of quality management throughout the project life cycle.

#### **5.4 Research Strategy**

Singh (2006:99) defined research strategy as the general plan for a research problem that includes desired solution in terms of research objectives, structure, and the overview of planned necessary components to implement the strategy. Singh (2006:100) argued that the research strategy is in line with the research objectives, while research method is focusing on the nature of the study problem. According to Wedawatta, Ingirige and Amaratunga (2010:3), research strategy provides the entire direction of the study including the processes by which the study is carried out. Wedawatta et al. (2010:3) suggested that a correct research strategy should be chosen based on study objectives and questions, the level of existing knowledge on the research field, the resources available, and the amount of time. The case study was employed as the research strategy for this study, because the study only focussed on TFR.

#### **5.5 Target Population**

According to Cox (2008), target population is the whole set of units that the survey data are to be employed to make inferences. Fricker (2006:3-27) defined target population as the group of elements that the research wants to make inference. Cox (2008) suggested that target population must be clearly defined as the definition concludes whether sampled cases are suitable or not for the survey. A targeted population in the study simply refers to a collection of individuals or objects that is the core focus of a research question (Schwalbe, 2006). The targeted population of

this study included the internal stakeholders such as quality assurance officers, project managers, project coordinators and project team members. This targeted population was able to provide the accurate information as they are directly involved in the execution of the projects in terms of quality management of the project.

### **5.5.1 Population Validity**

Cox (2008) defined population validity as an examination of possibly incorrect inferences for specific population of interest and of each measure or combination of used measures. According to Fricker (2006:3-27), population validity has been employed in reference to the generalizability of study findings through different population. He continued to argue that generalizability of the meaning of a measure through groups is a valid aspect of construct validity and validates interpretations of data derived from the measure. It is vital that the measure have common patterns and properties of relationships within different populations (Mugo; 2004:8). Cox (2008) employed the term population validity in considering inferences made about the meaning and validity of the test scores and other measures for particular populations. However, an inference is valid for a population to the level that it leads to correct judgements about participants of that population. An inference may be valid for a specific population but invalid for another population (Phrasisombath; 2009:18).

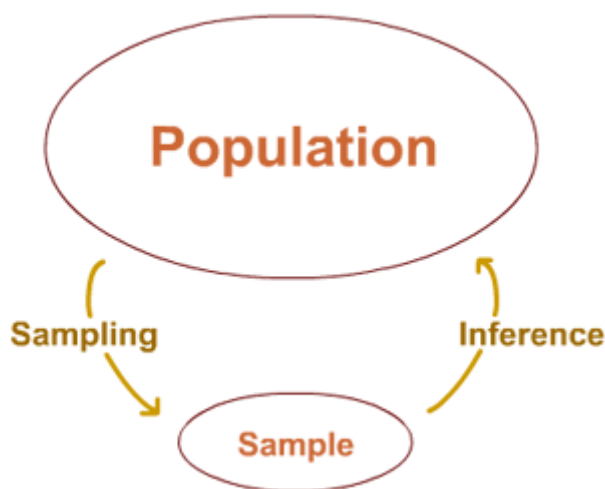
### **5.6 Sample Selection and Method of Sampling**

According to Mugo (2004:1), sampling is the process of selecting a representative part of a population for determining parameters of the whole population. Phrasisombath (2009:31) defines sampling as the selection of a number of research units from a define research population. Mugo (2004:1) continued to argue that the purpose of sampling is to come up with conclusions about populations from samples; researchers should make use of inferential statistics which assist to determine a population's characteristics by observing only a sample of the population. Mugo (2004:3) suggested that it is cheaper and time saving to observe a portion of the population rather than the whole, but researchers should prepare themselves to cope with the consequences of using samples.

Phrasisombath (2009:28) suggested that if researchers want to come up with a valid conclusion, they should make a sample that is representative of the study

population. Phrasisombath (2009:13) continued to argue that probability sampling is generally the most precise type of sampling for quantitative research. The main focus in this research was only in construction projects in Transnet Freight Rail Iron Ore line, which starts from Saldanha (Western Cape) to Sishen (Northern Cape). The second focus was that, within Transnet Freight Rail Iron Ore line, only those who are affected directly by the above mentioned projects were interviewed. Figure 5.2 below illustrates the relationship between the population and study sample.

**Figure 5.2 – Population and Study Samples**



**Source: Phrasisombath (2009:14)**

### **5.6.1 Sample Size**

The sample size of this study was fixed only to current projects that are under Iron Ore and Manganese business unit in Transnet Freight Rail. Initially, the sample size was randomly set at 100 participants but only 91 participants responded from different levels of the company that are involved in TFR Iron Ore line projects. These were mainly project managers, quality officers, project coordinators, and project team members. The site visits were done to interview these project team members to get as accurate as possible information, because they have first-hand experience in terms of quality management. Kothari (2004:152) defined sample as a set of respondents nominated from a bigger population for the purpose of a study. Rajasekar et al. (2006:24) defined sample as a limited portion of a statistical population whose properties are investigated to gain information about the whole population. Kothari (2004:55) continued to define sample design as a certain plan for

obtaining a sample from a specific population. He also argued that sample design refers to the technique the researcher would use in choosing items for the sample. Rajasekar et al. (2006:30) suggested that researcher should develop a sample design that is reliable and appropriate for his/her research study.

### **5.7 Method of Data Collection**

The method of structured interviews was used to obtain information by constructing a structured questionnaire. The main reason for choosing this method is that if there is ambiguity it will be corrected immediately, since the researcher used personal interviews. According to Burgess (2005:5), a questionnaire is the most common data gathering tool in business research. He further defines questionnaire as a set of questions for collecting information from respondents. Siniscalco and Auriat (2005:22) defined questionnaire as a simply instrument for gathering and recording information about a specific issue of interest. Burgess (2005:7) suggested that the researchers can administer questionnaires by telephone, mail, face-to-face interviews, electronically, and hand-outs. Siniscalco and Auriat (2005:24) argued that questionnaire is made up of a list of questions, but should always include clear instructions and space for administrative details. He further suggested that questionnaires should also have a definite purpose that is linked to the objectives of the study, and it needs to be stated from the beginning how the findings will be used.

Burgess (2005:6) pointed out three elements when designing the questionnaire, namely:

- Identify the questions to be asked.
- Choose the question type for each question and identify the wording.
- Design the sequence of questions and complete questionnaire layout.

### **5.8 Data Analysis**

The data that was analysed was drawn from the survey. This data show the different important reasons that cause the lack of achieving quality management in Transnet Freight Rail construction projects. A computer program was used to present the results of the analysed data, by means of bar graphs. Microsoft Excel was employed in analysing the collected data because of its qualities which are user friendly and effectiveness. According to Kothari (2004:256), Microsoft Excel is useful when

analysing research data; examine relationships between variables; compile suitable tables; and perform a check of statistical importance based on study questions. Rajasekar et al. (2006:44) suggested that data should be analysed in a way that certifies that study questions are well addressed and the study objectives are achieved.

Creswell and Clark (2007:120) explained one of the data analysis techniques which is descriptive statistics, as the brief descriptive coefficients that summarise a given data set, which can be either a representation of the entire population or a sample of a population. They further state the benefits of descriptive statistics as to provide additional explanatory, which assist the researcher in survey design and project development. The researcher for this study chose the descriptive statistics as the data analysis technique to measure and record the immediate behaviour of data but also reflect variability and central tendency of scores over a given distribution.

### **5.9 Validity and Reliability**

Weiner (2007:7) defined validity as the degree to which any measurement instrument succeeds in quantifying what it is intended to measure. Golafshani (2003:602) argued that validity is concerned with the effectiveness, soundness of the measuring tool. He further argued that validity reflects all the errors in measurement which are organised or constant. Weiner (2007:6) defined reliability as the degree to which a measurement method can be depended upon to protected stable results upon repetitive application. The study should satisfy certain assessments of validity and reliability. According to Weiner (2007:6-7), validity and reliability are combination of words that the researcher will always come across in research methodology. These two words are employed in linking with measurement tools. The honesty of the study can stand well or collapse on the basis of the knowledge of the researcher regarding the meaning of these words and how wisely the researchers comply with their demands. According to Golafshani (2003:598-600), reliability in quantitative research may be evaluated by repeating a question in a question plan or repeating an entire experiment. Hence, it is very hard to perform duplication in qualitative research, because the conditions and participants can never be identical at a later stage.



## 5.10 Sampling Bias

Taylor-Powell (2009:1) defined sampling bias as a tendency to support the selection of units that have particular characteristics. She further argued that sampling bias is usually the consequence of a poor sampling plan. Cortes, Mohri, Riley, and Rostamizadeh (2008) defined sampling bias as a stable error that ascends due to the sample selection. According to Cortes et al. (2008) sampling bias may occur at any time when the researcher is not using a proper sampling method. Freedman (2004:2) suggested that researchers should always think very wisely about which respondents are being chosen and how they differ. He further suggests that one of the best non-probability sampling techniques is convenience sampling, because of the benefits such as; it is very cost and time effective, easy to use, and can be used when it is impossible to conduct probability sampling. For this study the researcher chose the non-probability technique sampling method which is convenience sampling, and Taylor-Powell (2009:1) stated that convenience sampling involves collecting a sample from somewhere convenient to the researcher.

## 5.11 Ethical Considerations

According to Fritz (2008:3) ethical considerations may assist researchers to decide whether the study should even be pursued, and if so, how the study should be done. He further argued that the way the researchers conduct scientific activities not only affects those directly involved, but as well as the public's view of science and scientists. Roth-Cline, Gerson, Bright, Lee and Nelson (2010:12) stated that findings from research provide a beginning for further studies, may influence public legislation and policy. Challenges to scientific reliability can corrode public belief and confidence in conclusions. Hence, it is very important to be competent, honest, and transparent and follow ethical procedures in regard to research issues (Roth-Cline et al., 2010:14).

Escobedo, Guerrero, Lujan, Ramirez, and Serrano (2007:3-5) pointed out three ethical principles, namely:

- **Respect for Participants** – Respect for participants assumes that individuals are able to make an independent decision about whether or not to take part in the study. Researchers should provide sufficient information so that voluntary and informed decisions can be made. If a participant decides to withdraw from the study involvement, that decision is to be accepted and respected. The

principle, respect for participants, is employed as voluntary informed agreement to participate in the study.

- **Beneficence** – Beneficence in research context means to do no harm, maximize the benefits of the study and minimize risk of harm to protect human well-being. Researchers have the commitment of analysing the benefits and risks of the research. If the possibility and amount of harm is not balanced the benefits, the risks should be justified based on the importance of the study for the society and participants.
- **Justice** – Justice relates to reasonable distribution of benefits and loads of the study. Basically, it means that the study participants are nominated fairly, with all sections of the given population having a chance to be part of the research, as long as the inclusion is ethically and scientifically justifiable.

#### **5.12 Assumptions Made**

- The participants were fair and honest to the best of their ability.
- All the participants were not offended by any question asked; therefore all questions were well understood and answered by participants.
- Transnet Freight Rail Iron Ore line benefitted in this research.

#### **5.13 Limitations of the Study**

- The study focused on Transnet Freight Rail Iron Ore line, which is from Saldanha to Sishen railway line.
- The data were collected in the area of the study.
- The study was limited to approximately 100 people, and any findings might not be generalized to the whole of Transnet.
- More rigorous statistical analysis could be conducted to obtain a more robust set of results.

#### **5.14 Chapter Summary**

This chapter focused on the research methodology which was used to carry out this study. The research design; research strategy; target population; sampling selection and method of sampling; methods of data collection; data analysis; validity and reliability; sampling bias; and ethical consideration were discussed in details.

## **Chapter 6**

### **Data Analysis and Results Interpretation**

#### **6.1 Introduction**

This chapter analyses and discusses the findings of the research, which are presented in graphs. The initial research aims were as follows, to establish from this research the current quality management practices in TFR Iron Ore line and the causes of project delays. Initially the sample was targeted at 100 participants but only 91 participants responded from different levels of the company. The questionnaire was used as the data collection method and it was divided into three sections, namely; Section A dealt with the respondents' biography, where the respondents' working experience and position in the company was revealed. Section B dealt with the functions of the respondents and components that were adopted to collect data for quality management in the projects and the causes of project delays. Lastly, section C dealt with any concerns regarding quality management in the company.

#### **6.2 Data Analysis**

According to Freedman (2004:4), data analysis is the process of scrutinising the collected information from a specific sample and present that collected data in the form of graphs. Collected data was analysed and presented below in the form of graphs for more clarity. Conclusions were made based on the findings from the respondents for each and every question asked in the questionnaire.

#### **6.3 The Method Used to Report**

The reporting method of this survey has been divided into three sections, namely: Section A which covers the biography of the respondents in detail; Section B which covers the functions of the project team and quality officers in TFR; and lastly Section C which covers general concerns on quality management and the impact of quality management in the productivity of the company as a whole. The findings of this study are presented in the form of graphs and each question or statement has been discussed in detail as illustrated below starting from figure 6.1.

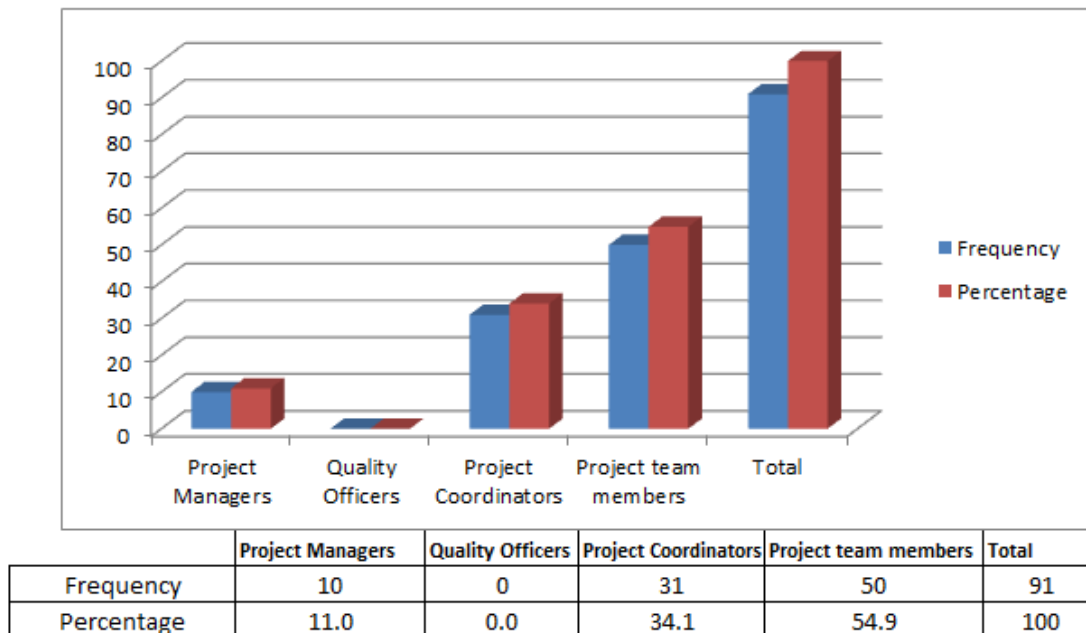
### 6.3.1 Section A: Biography

The following questions were asked in this section to establish an understanding of participants in terms of their positions in the company; and the number of years in that specific position that will reveal their understanding of this research topic. What is your position in the company? How long have you been involved in projects at this level? How often are you involved in project team meetings? How regular are your project team meetings? Who calls for the meetings? Are there managers responsible for the daily basis operations? What department are you involved in?

#### Research question: What is your position in the company?

The position of the respondent in the company does assist in terms of the understanding in that specific department and being able to assess quality management based on the current practices in the department. Gathering information from different employees at different levels of employment contributed a lot towards the findings of this research. Figure 6.1 below shows respondents' positions in the company.

**Figure 6.1 – Position in the company**



**Source: Author's own construction**

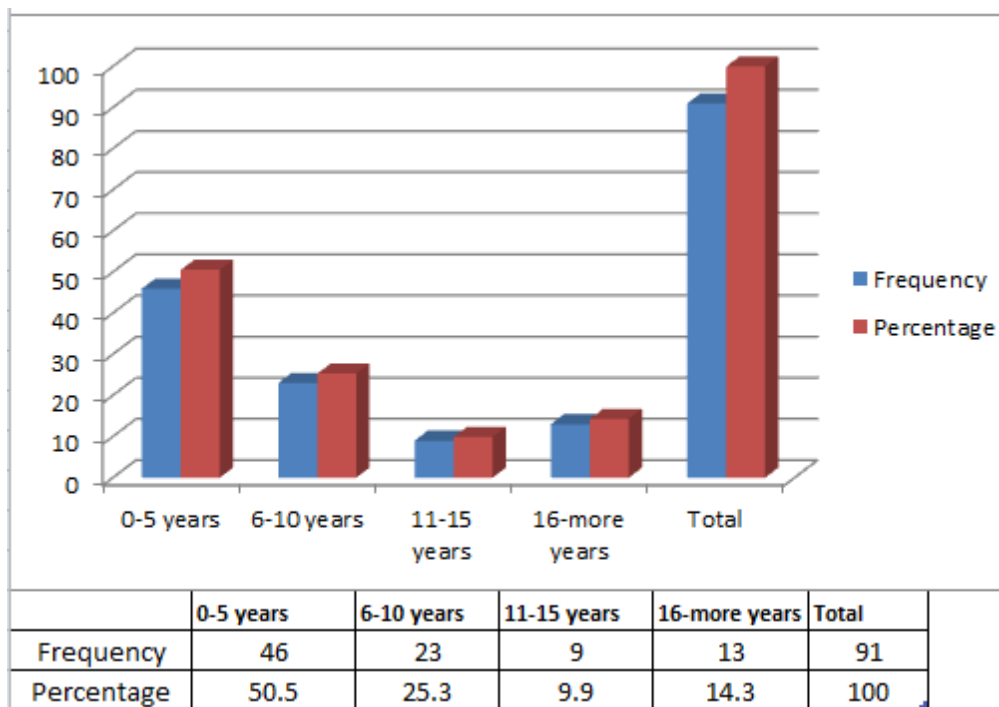
The survey findings show that the highest representation of respondents for project team members at 54.9% (n=50); followed by project coordinators at 34.1% (n=31); project managers at 11% (10); and quality officers at 0%. The results show that there

were no quality officers that responded as the aim of this survey was strictly to evaluate quality management. Due to the absent of quality management department in Transnet Freight Rail Iron Ore line the researcher could not get any respondent in that specific department.

**Research question: How long have you been involved in projects at this level?**

The experience of the respondents does contribute a lot for accurate data collection as it is very easy for someone with more years of experience to evaluate the department’s practices, because of the understanding of the pros and cons of the department’s practices. Figure 6.2 below shows the experience of the respondents in projects.

**Figure 6.2 – Period of involvement in projects at this level**



**Source: Author’s own construction**

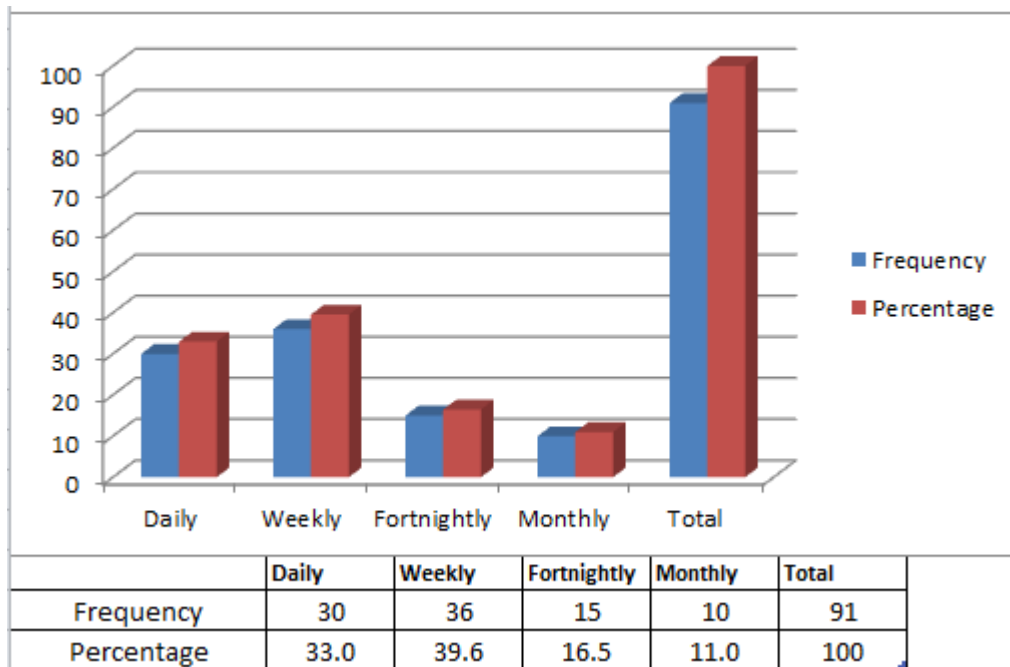
Figure 6.2 above shows that the highest respondents have been involved with projects between 0-5 years at 50.5% (n=46); followed by 6-10 years at 25.3% (n=23); 16-more years at 14.3% (n=13); and lastly 11-15 years at 9.9% (n=9). From figure 6.2 above, it can be concluded that the majority of the respondents are between 0-5 years of experience and are working as project planners with no background of project management. It is advisable for any employee who is working

in project environment to have some project management basics for better project delivery.

**Research question: How often are you involved in project team meetings?**

Involvement of the respondents in the project meetings assist in determining different challenges that can cause project delays and poor quality management in these projects. They should know the solutions that were implemented in each and every problem that were encountered in the life cycle of the project. Figure 6.3 below illustrates involvement of respondents in project team meetings.

**Figure 6.3 – Involvement in project team meetings**



**Source: Author’s own construction**

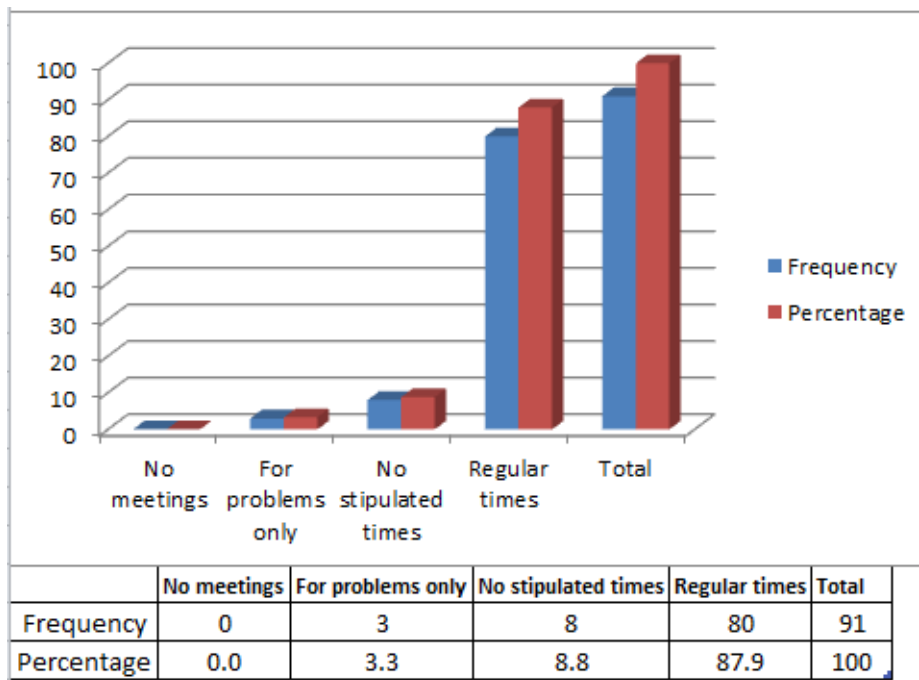
Figure 6.3 above shows the participation of the respondents in project team meetings with other professionals. Highest respondents at 39.6% (n=36) said they participate in the project meeting on weekly basis; followed by those said daily at 33% (n=30); fortnightly at 16.5% (n=15); and the lowest is monthly at 11% (n=10). From the results illustrated in figure 6.3 above it is seen that majority of respondents attend project meetings on a weekly basis. These meetings can be progress meetings, status report meetings, so forth. For a smoothly project flow it is very

important for a project based environment at all the time to attend the meetings for some different updates in the project progress.

**Research question: How regular are your project team meetings?**

The way that the project team meetings are managed is critical to the project success while on the other hand team member and stakeholders will see project meetings as a waste of their valuable time to their real work. All project managers are aware that certain meeting are an important part of good project management. It is advisable that when calling project team meetings a detailed agenda is distributed in advance to avoid meeting ending in frustration. Figure 6.4 below illustrates how often are project team meetings take place in the company that was surveyed.

**Figure 6.4 – Regularity of project team meetings**



**Source: Author’s own construction**

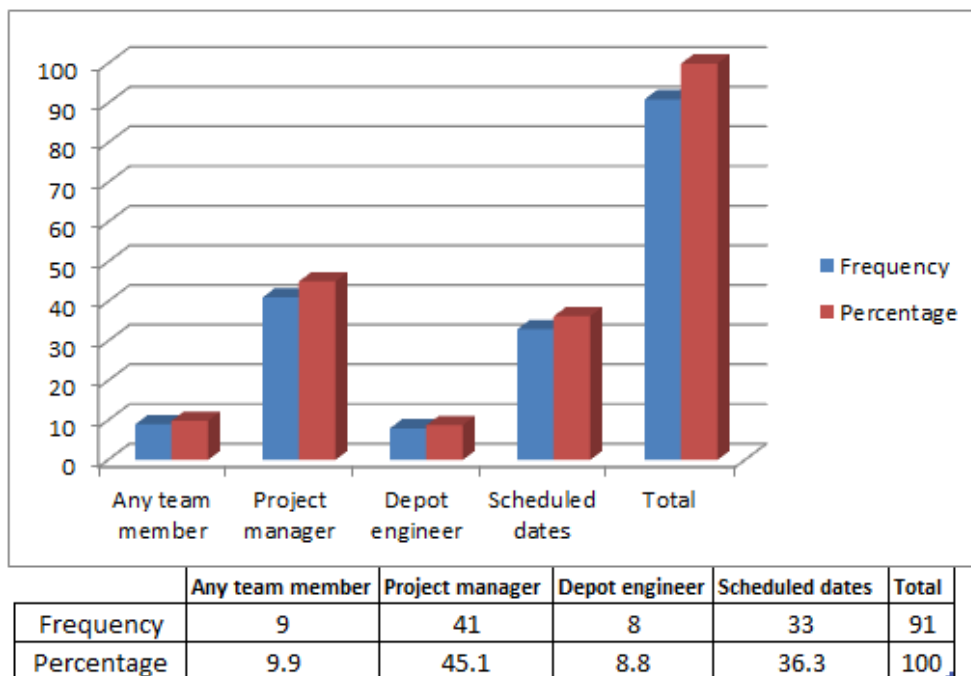
Figure 6.4 above illustrates the regularity of the project team meetings. From the results a majority of 87.9% (n=80) which said the project team meetings are held at consistent times that are agreed on, followed by 8.8% (n=8) of the respondents who said there is no stipulated times, 3.3% (n=3) said that project team meetings are only held when there is a problem that needs to be resolve, and no one said there is no meeting at all. It is very important that all project team meetings are held at a regular times so that everyone who is involve can know and participate accordingly for the

success of the project. One of the advantages of having scheduled meetings is that it allows everyone to prepare necessary information and ensure that all the information is available to decide on the action plans at the end.

**Research question: Who calls for the meetings?**

An effective project manager’s role is to call project meetings, facilitate work and those meetings should be able to deliver measurable outcomes. Team meetings can assist in building trust and working relationship within the project team. Figure 6.5 below illustrates the person responsible for calling project team meetings.

**Figure 6.5 – Person who calls project team meetings**



**Source: Author’s own construction**

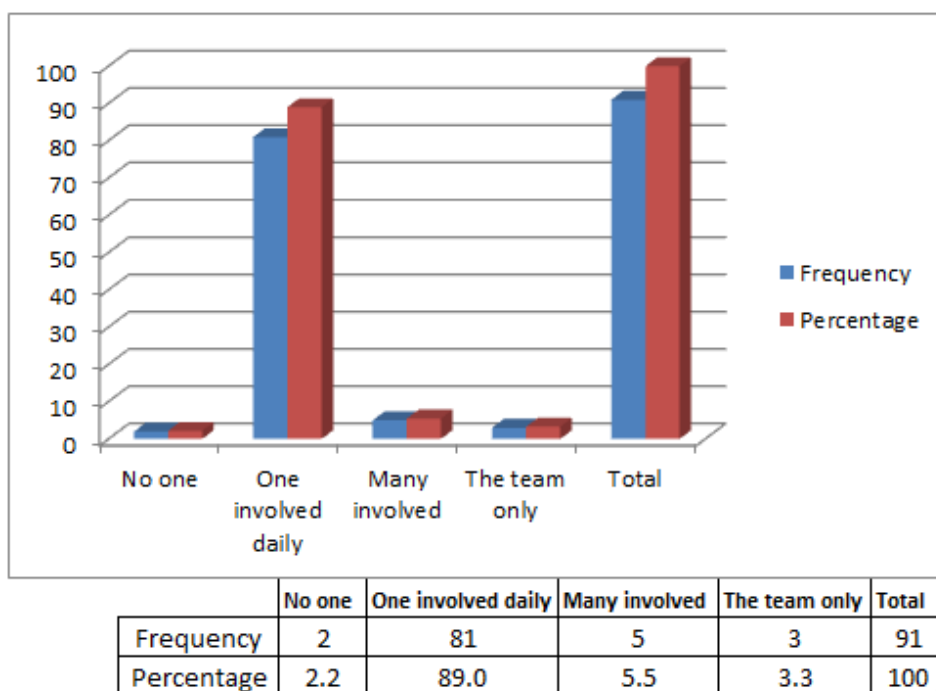
From figure 6.5 above it can be seen that the majority which is 45.1% (n=41) of respondents agreed that it is a responsibility of a project manager to call for a project team meetings, followed by 36.3% (n=33) respondents who said that project team meetings are scheduled, 9.9% (n=9) respondents said that any team member can call a meeting, and lastly 8.8% (n=8) said a Depot engineer calls a project team meetings. Burke (2007) agrees that it is the responsibility of a project manager to assist the project team to establish clear procedures and make a good decision.



**Research question: Are there managers responsible for the daily basis operations?**

The structure of TFR Iron Ore line allows two managers per department, namely; Production manager and Maintenance manager. In order for a manager to be updated with the progress of the projects that are carried out in the department, he/she should be involved on the daily basis operations. Figure 6.6 illustrates the involvement of a manager on daily basis operation.

**Figure 6.6 – Responsibility of managers in daily basis operations**



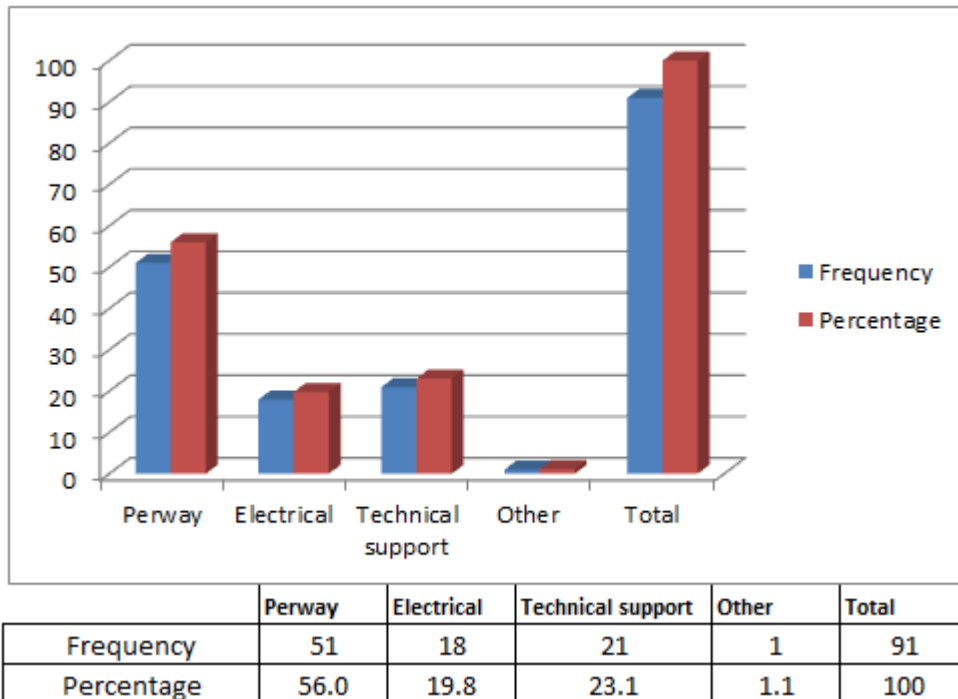
**Source: Author’s own construction**

Figure 6.6 above shows that the majority of respondents which is 89% (n=81) said that only one manager is involve in day to day operations, followed by 5.5% (n=5) who said many managers are involve, 3.3% (n=3) who said only team members are involved, and lastly 2.2% (n=2) said there are no managers involved at all. From the results it is seen that one manager is involve per sub-section as the department is divided into two sub-sections. It is advisable to influence management to be involved in complex projects as there is a need for an effective leadership in those kinds of projects for better delivery.

**Research question: What department are you involved in?**

The targeted respondents for this study were employees who are involve with the projects within TFR Iron Ore line. Those chose employees contributed to the findings of this study with their professionalism. Figure 6.7 below illustrates the different departments of the respondents.

**Figure 6.7 – Department you are involved with.**



**Source: Author’s own construction**

From figure 6.7 above, it can be seen that a majority respondents which is 56% (n=51) come from perway department, followed by technical support at 23.1% (n=21), 19.8% (n=18) from electrical and 1.1% (n=1) from other departments which includes telecoms and signals departments. In generally when carrying out a project all the different departments are needed to deliver successful projects.

**6.3.2 Section B: Functions of the Project Team and Quality Officers**

This section analyses and discusses the functions of company related to project delays and quality management. The research participants were required to rate the functions of the quality officers in order to conclude the survey. The weightings are 1 to 5 on an increasing scale, 1 being Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, and 5 – Strongly agree.

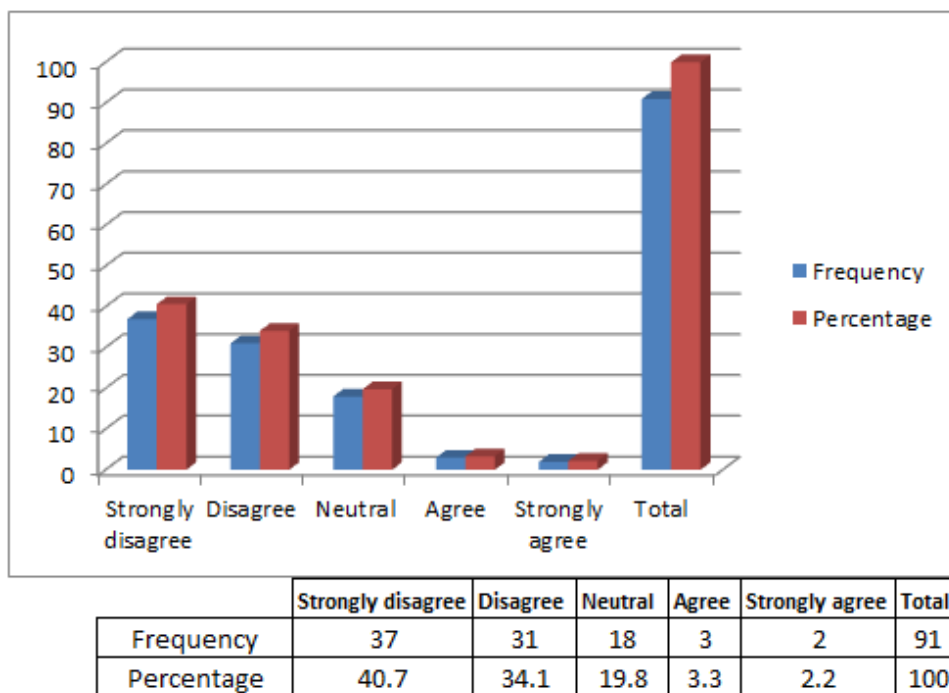
### 6.3.2.1 Project Quality Management

TFR Iron Ore business unit does not have its own quality management department, the absence of this important department causes a lot of challenges when it comes to running of projects. The cost of correcting mistakes is always greater than the cost of avoiding them. This subsection specifically analyses and discusses the quality management tasks that are done during project in order to deliver a high quality and successful project.

#### Research question: I do unscheduled quality tours fortnightly.

This statement was included only to determine whether or not unscheduled quality tours are being done during the project. The results of this statement are shown in figure 6.8 below.

**Figure 6.8 – Unscheduled quality tours are done fortnightly**



**Source: Author's own construction**

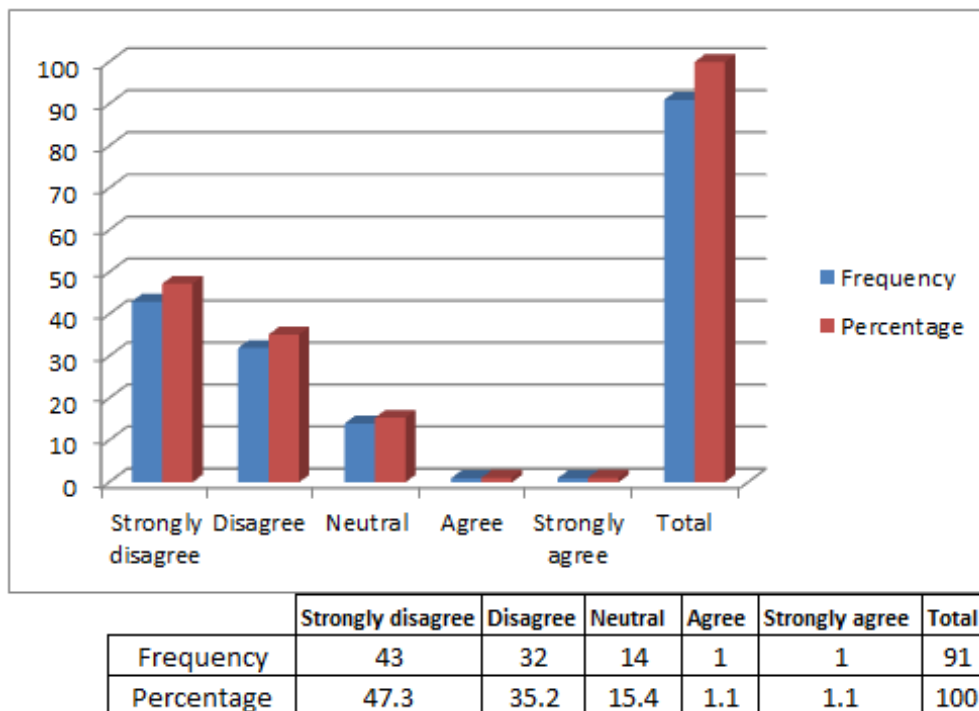
Figure 6.8 above illustrates that a majority which is 74.8% (n=68) disagreed with the statement that unscheduled quality tours are done fortnightly, followed by 19.8% (n=18) remained neutral, while 5.5% (n=5) agreed with the statement. From the results it can be seen that the majority of the respondents which is 74.8% (n=68) in total fully disagree with the fact that unscheduled quality tours are being done. Unscheduled quality tours are simply examining the work that is done to check

possible errors so that can be corrected immediately. These results are not surprisingly based on the absence of quality management department in the Iron ore line business unit.

**Research question: I do random sampling of errors and record seen defects weekly.**

Radom sampling of errors and record seen defects is one of quality management tasks. This statement was intentionally included to prove whether or not this specific task is being done in TFR to achieve high quality. The results are presented in figure 6.9 below.

**Figure 6.9 – Random sampling of errors and record seen defects are done weekly**



**Source: Author’s own construction**

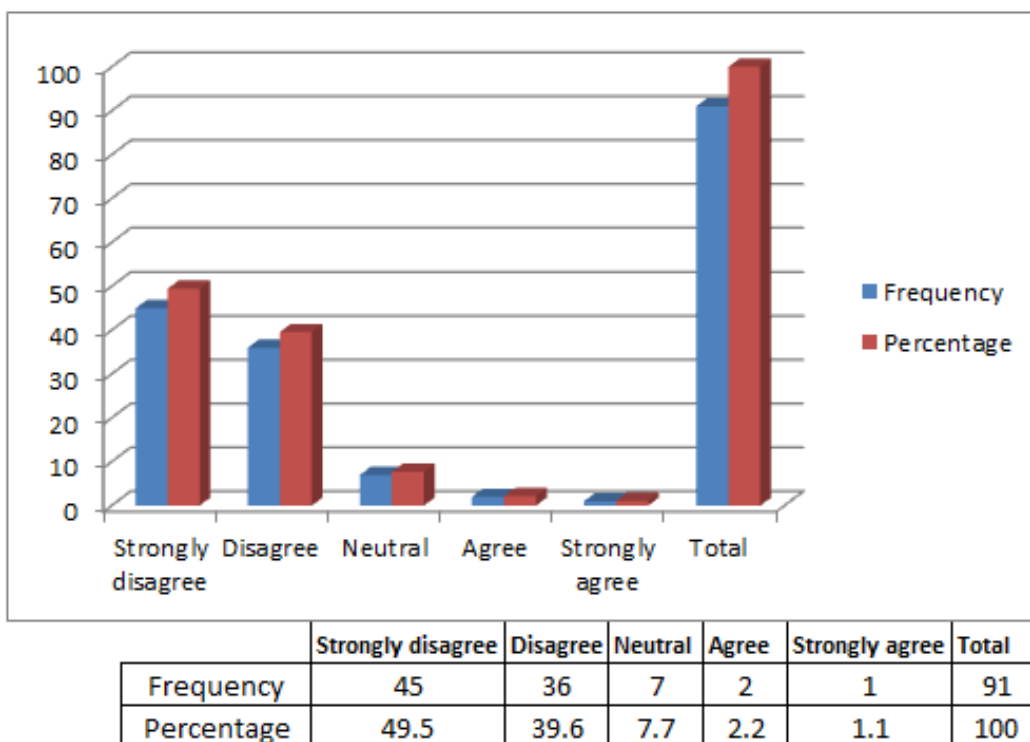
Figure 6.9 above illustrates that a majority which is 82.5% (n=75) disagreed with the statement that random sampling of errors and record seen defects are done weekly, followed by 15.4% (n=14) remained neutral, and while another 2.2% (n=2) agreed with the statement. From the results it can be seen that the majority of the respondents which is 82.5% (n=75) in total fully disagree with the fact that random sampling of errors and record of seen defects are being done. This is one of project quality management tasks that cannot be left out when busy with a project to achieve

high quality. From the results it is not a good quality image what presented in figure 6.9, TFR should introduce quality management department to avoid more problems based on quality of projects produced.

**Research question: I do quality survey weekly.**

Quality survey measures how well the quality is in the specific project. This statement was asked to find out what are the respondents think of TFR projects. The results are presented in figure 6.10 below.

**Figure 6.10 – Quality survey is done weekly**



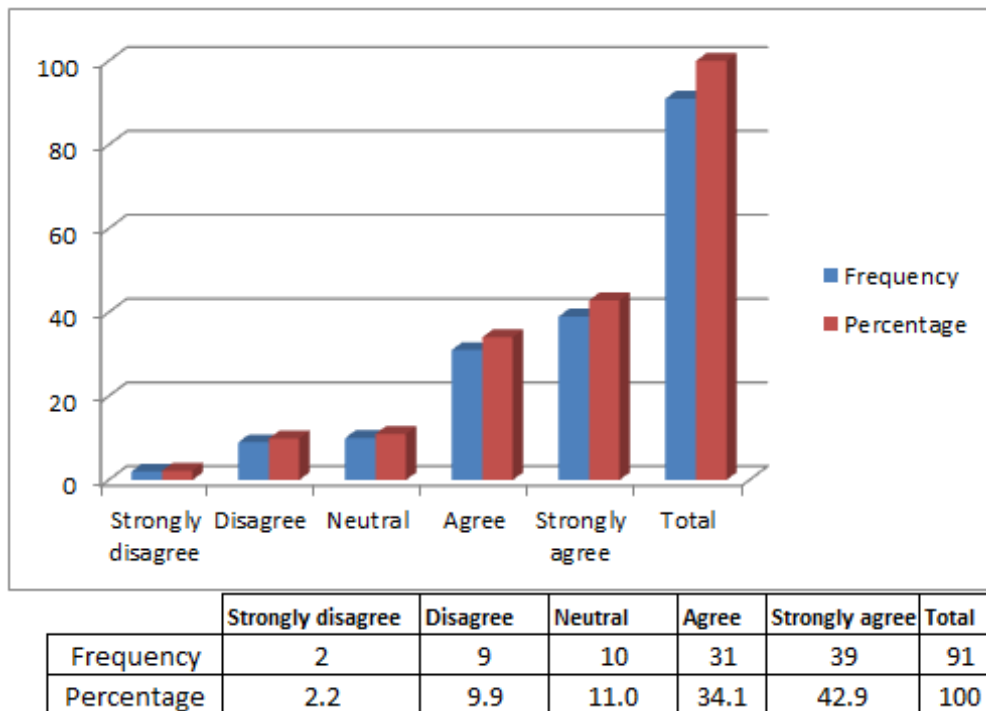
**Source: Author’s own construction**

Figure 6.10 above illustrates that a majority which is 89.1% (n=81) disagreed with the statement that quality survey is done weekly, followed by 7.7% (n=7) remained neutral, and while 3.3% (n=3) agreed with the statement. From the results it can be seen that the majority of the respondents which is 89.1% (n=81) in total fully disagree with the fact that quality surveys are being done. Due to the absence of quality officers in TFR iron ore quality surveys are not done as required.

**Research question: I am aware of the quality policy.**

This statement was intentionally included to reveal from the responses of the respondents the duties of specific departments in ensuring quality in carried out projects. The results are presented in figure 6.11 below.

**Figure 6.11 – Knowledge of quality policy**



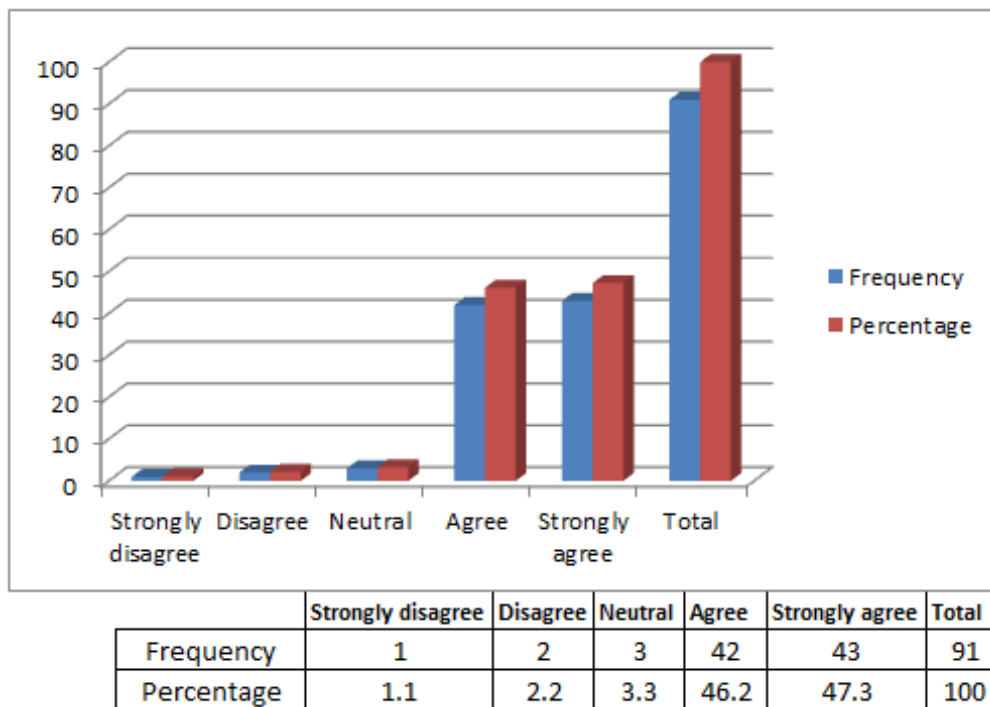
**Source: Author’s own construction**

Figure 6.11 above illustrates that a majority which is 77% (n=70) agreed with the statement that the respondent is knowledgeable about quality policy, followed by 11% (n=10) remained neutral, and while 12.1% (n=11) disagreed with the statement. From the results the majority are aware of quality policy which means that this knowledge contributes in the improvement of quality management in the entire company. It can be seen that the majority of the respondents which is 77% (n=70) in total fully agree with the fact that they are aware of the quality policy.

**Research question: I am aware of the required quality standards.**

Quality standards are sets of statements designed to measure quality improvements in a specific environment. It was very important to pose this statement so that the researcher can be able to determine from the responses whether the respondents are aware of quality standards. The results of this statement are shown in figure 6.12 below.

**Figure 6.12 – Knowledge of quality standards**



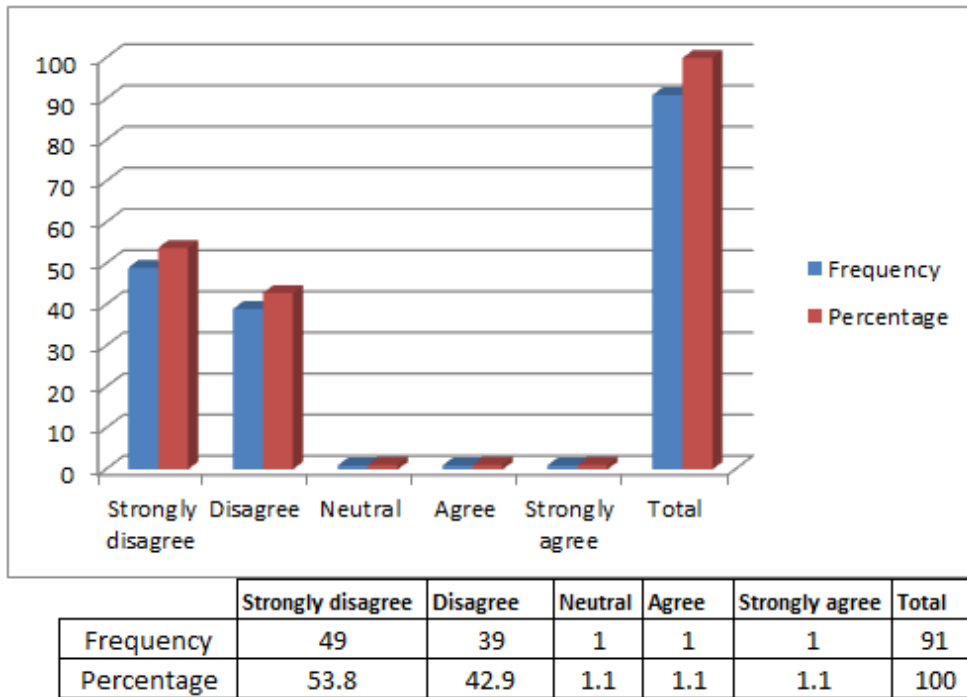
**Source: Author’s own construction**

Figure 6.12 above illustrates that a majority which is 93.5% (n=85) agreed with the statement that the respondent is knowledgeable about quality standards, followed by 3.3% (n=3) remained neutral, and while 3.3% (n=3) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 93.5% (n=85) in total fully agree with the fact that they are aware of the required quality standards. The results show that the respondents have a knowledge of quality standards which is a good aspect when involved with projects even though there is an absent of quality department.

**Research question: I do quality audits monthly.**

Internal and external quality audits are advisable to be done whenever carrying out any project as it is a vital part of company’s quality management. This statement was included to determine whether these types of quality audits are done or not. The respondents’ responses are presented in figure 6.13 below.

**Figure 6.13 – Quality audits are done monthly**



**Source: Author’s own construction**

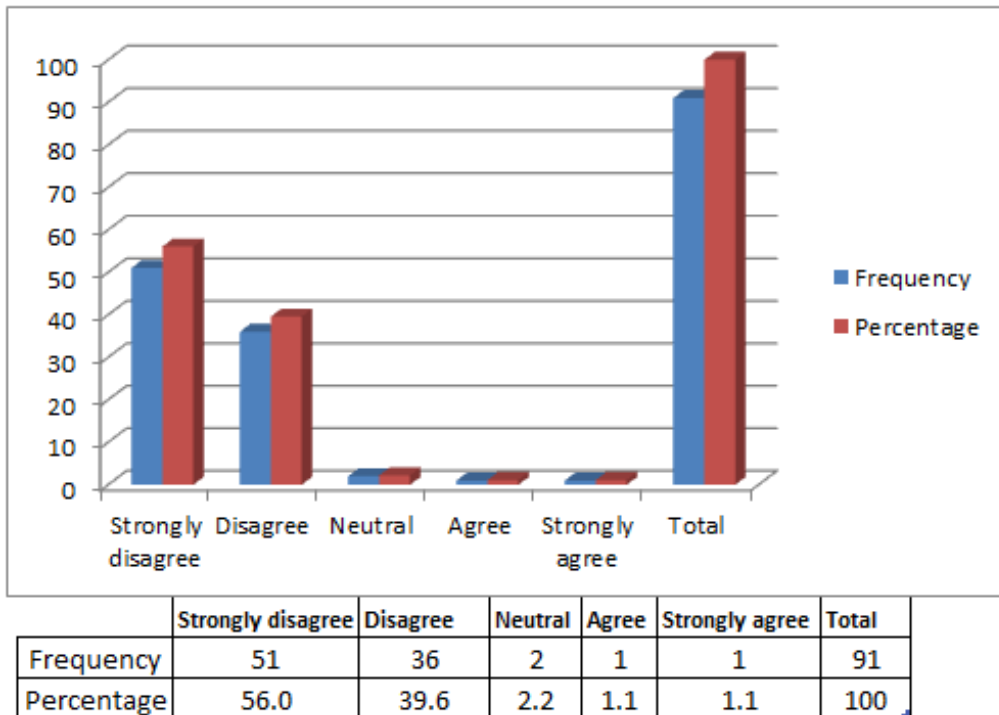
Figure 6.13 above illustrates that a majority which is 96.7% (n=88) disagreed with the statement that quality audits are done monthly, followed by 1.1% (n=1) remained neutral, and while 2.2% (n=2) agreed with the statement. From the results it can be seen that the majority of the respondents which is 96.7% (n=88) in total fully disagree with the fact that quality audits are being done. These results show that quality audits are not done as required to meet high quality.

**Research question: I perform quality control routine weekly.**

Quality control routines contributes more in achieving high quality in project environment so it is very important to do this task whenever involved in a project. This statement was included to reveal from respondents whether this task is done or not in the process of achieving quality. The results of respondents are presented in figure 6.14 below.

**Figure 6.14 – Quality control routine is done weekly**





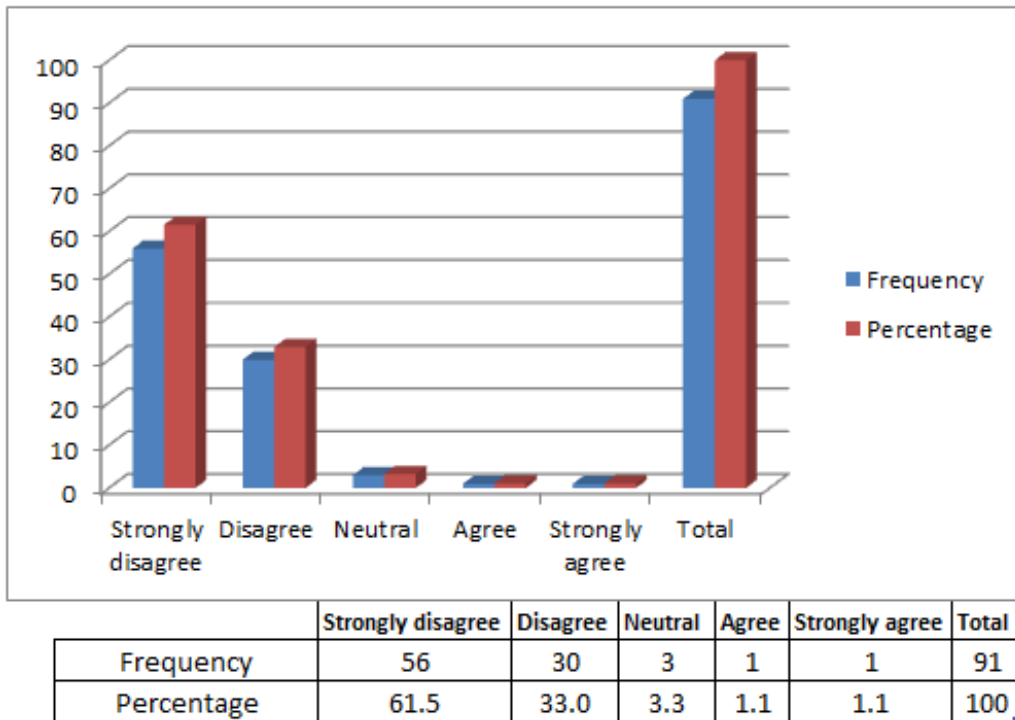
**Source: Author's own construction**

Figure 6.14 above illustrates that a majority which is 95.6% (n=87) disagreed with the statement that quality control routine is done weekly, followed by 2.2% (n=2) remained neutral, and while 2.2% (n=2) agreed with the statement. From the results it can be seen that the majority of the respondents which is 95.6% (n=87) in total fully disagree with the fact that quality control routines are being done.

**Research question: I perform irregular quality control on weekly basis.**

Performing quality control on irregular time contributes a lot towards achieving high quality in projects. This statement was included to determine whether irregular quality control is done and how often if it is done. The results of this statement are presented in figure 6.15 below.

**Figure 6.15 – Irregular quality control is performed on weekly basis**



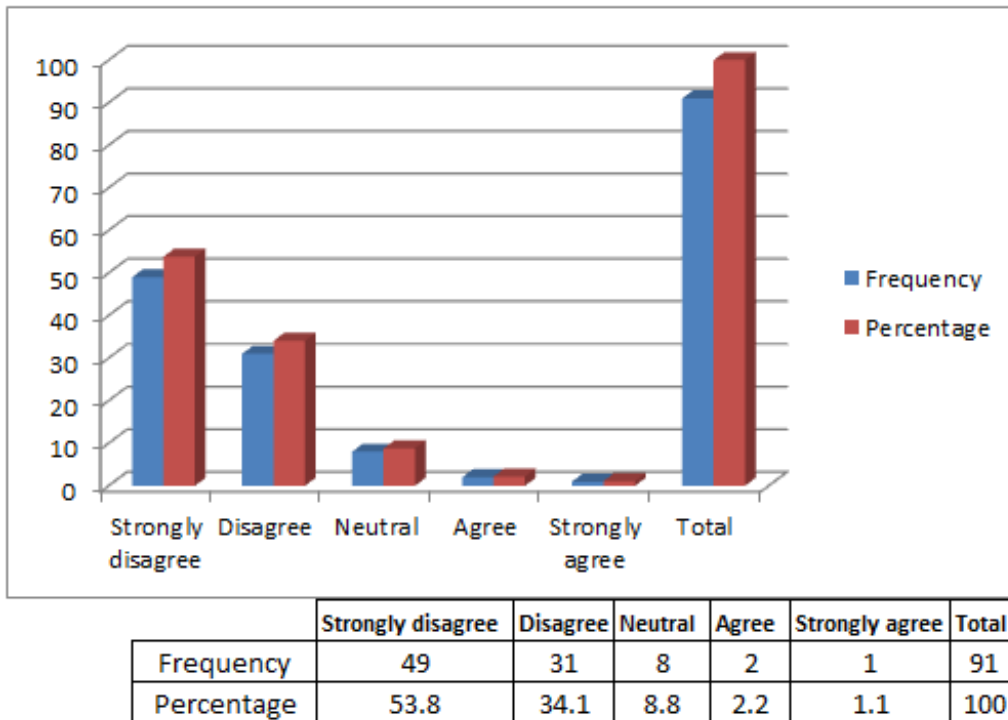
**Source: Author's own construction**

Figure 6.15 above illustrates that a majority which is 94.5% (n=86) disagreed with the statement that irregular quality control is performed on weekly basis, followed by 3.3% (n=3) remained neutral, and while 2.2% (n=2) agreed with the statement. From the results it can be seen that the majority of the respondents which is 94.5% (n=86) in total fully disagree with the fact that irregular quality control is performed. This can contribute to poor quality in these projects that are carried out.

**Research question: I perform quality monitoring throughout the project life cycle.**

Quality monitoring is a continuous task that needs to be performed throughout the life cycle of the project. Performing quality monitoring assists in improving the quality as the projects are still in progress. This statement was included to determine whether quality monitoring is done or not in these projects. The results of this statement are shown in figure 6.16 below.

**Figure 5.16 – Quality monitoring throughout the project life cycle is done**



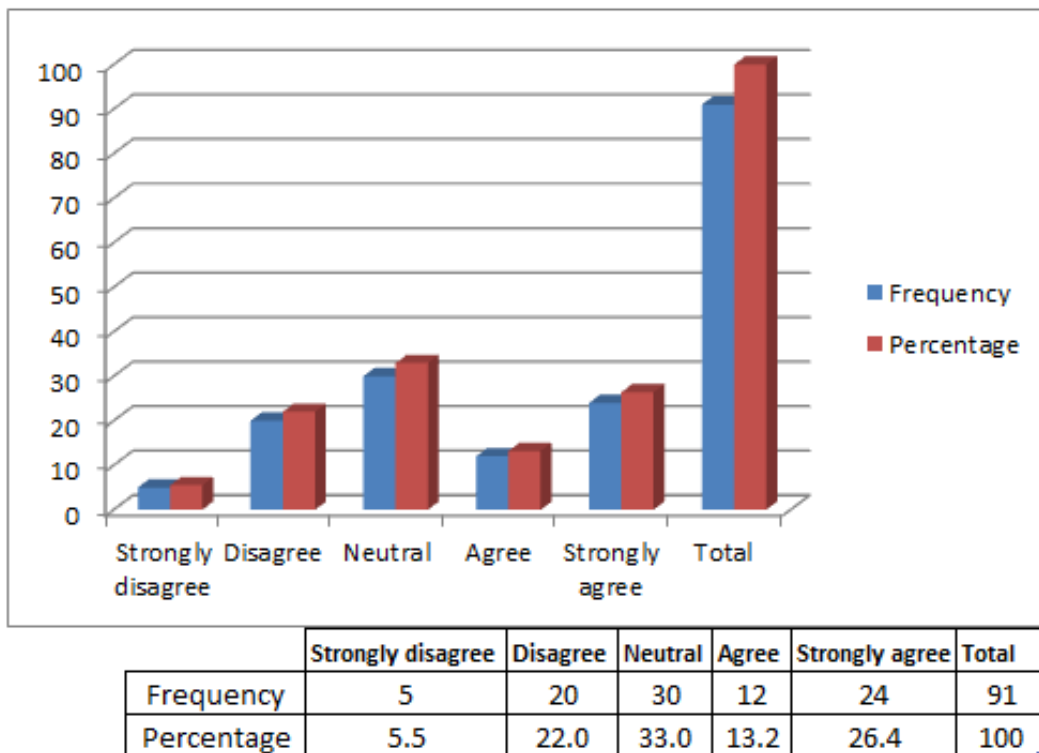
**Source: Author's own construction**

Figure 6.16 above illustrates that a majority which is 87.9% (n=80) disagreed with the statement that quality monitoring throughout the project life cycle is done, followed by 8.8% (n=8) remained neutral, while 3.3% (n=3) agreed with the statement. From the results it can be seen that the majority of the respondents which is 87.9% (n=80) in total fully disagree with the fact that the quality monitoring is performed during these projects as there is no quality management department.

**Research question: Relevant quality documents are compiled by a qualified individual.**

It is the responsibility of an employer to ensure that specific tasks are carried out by qualified individuals for accuracy purpose. There is quality policy that is in place in the company to guide employees in the workplace. This specific statement was influenced by the need to evaluate how qualified are the individuals who compile these documents. Figure 6.17 below shows the results for this statement.

**Figure 6.17 – Relevant quality documents are compiled by a qualified individual**



**Source: Author's own construction**

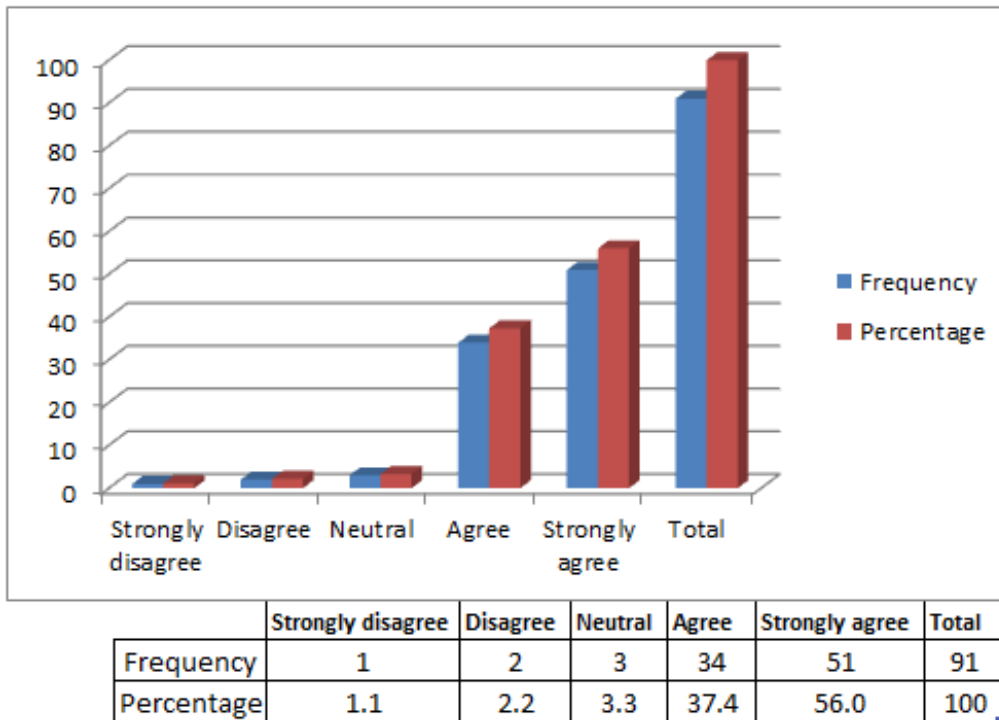
Figure 6.17 above illustrates that a majority which is 39.6% (n=36) agreed with the statement that relevant quality documents are compiled by a qualified individual, followed by 33% (n=30) remained neutral, and while 27.5% (n=25) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 39.6% (n=36) in total fully agreed with the fact that the relevant quality documents are compiled by a qualified individual.

### 6.3.2.2 Project Delays

**Research question: I always give realistic time schedule in contract.**

According to the researcher's experience with running of projects, unrealistic time scheduled can cause a delay in projects. Based on that reason there was a need to ask this statement to evaluate the respondents how do they cope with time schedules in projects. The results for this statement are presented in figure 6.18 below.

**Figure 6.18 – Realistic time schedule in contract**



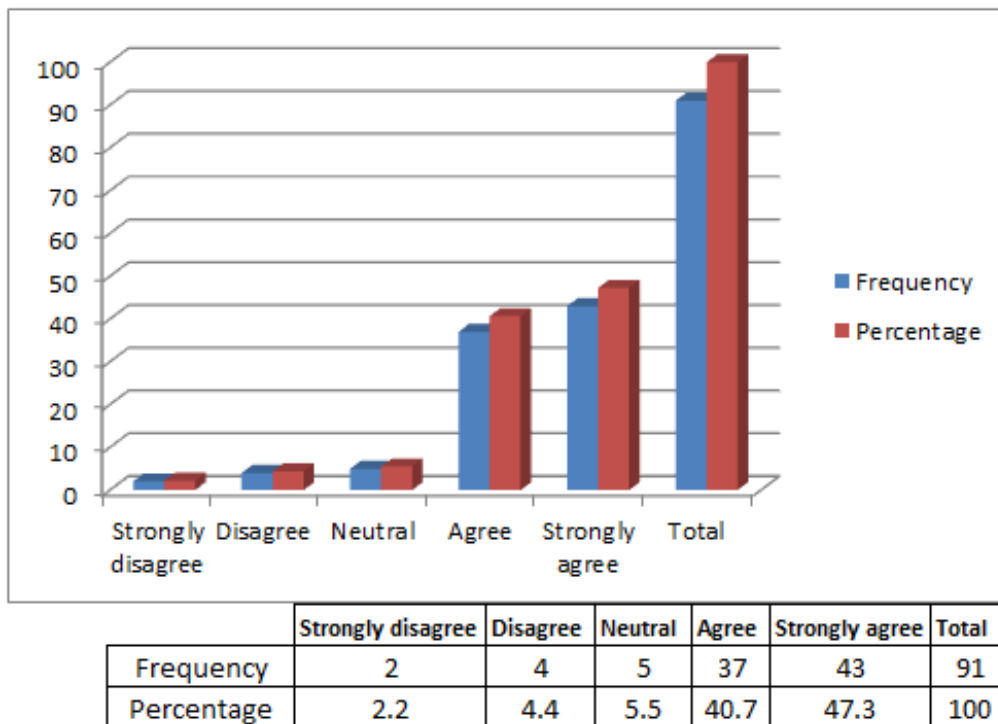
**Source: Author's own construction**

Figure 6.18 above illustrates that a majority which is 93.4% (n=85) agreed with the statement that realistic time schedule in contract is tabled, followed by 3.3% (n=3) remained neutral, and while the other 3.3% (n=3) disagreed with the statement. Project scheduled time is one of the causes of project delay based on how realistic is the given time for the entire project. Based on the presented results the majority of the respondents which is 93.4% (n=85) agreed that they always give a realistic time schedule to avoid project delays.

**Research question: I do have a full control over sub-contractors.**

There are projects that are being outsourced based on different reasons; this question came up to clarify the relationship between the employees and the sub-contractors during this process of outsourcing. The results for this statement are presented in figure 6.19 below.

**Figure 6.19 – Full control over sub-contractors**



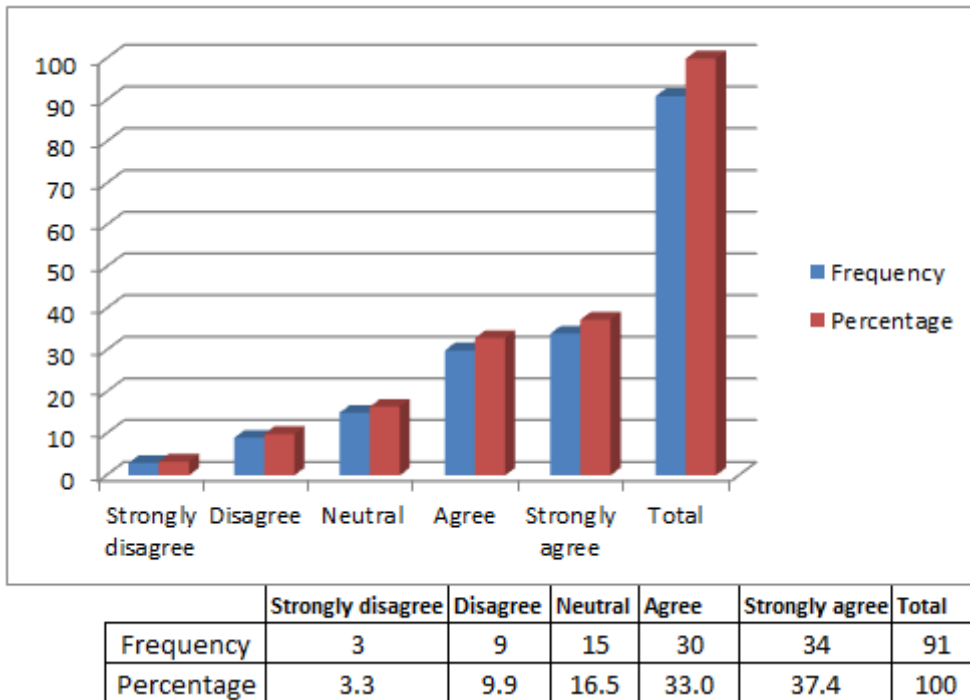
**Source: Author's own construction**

Figure 6.19 above illustrates that a majority which is 88% (n=80) agreed with the statement that employees have a full control over sub-contractors during project execution, followed by 5.5% (n=5) remained neutral, and while 6.6% (n=6) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 88% (n=80) in total fully agreed with the statement. There are different advantages and disadvantages of outsourcing, so before making any decision employees should educate themselves so that they can make an informed decision.

**Research question: I do get material delivery delays from vendors.**

Getting material for a project is a very important task as it may result in delaying the whole projects. This statement was intentionally added to assess the respondents' responses regarding material delivery process. The results from the respondents are presented in figure 6.20 below.

**Figure 6.20 – Material delivery delays from vendors**



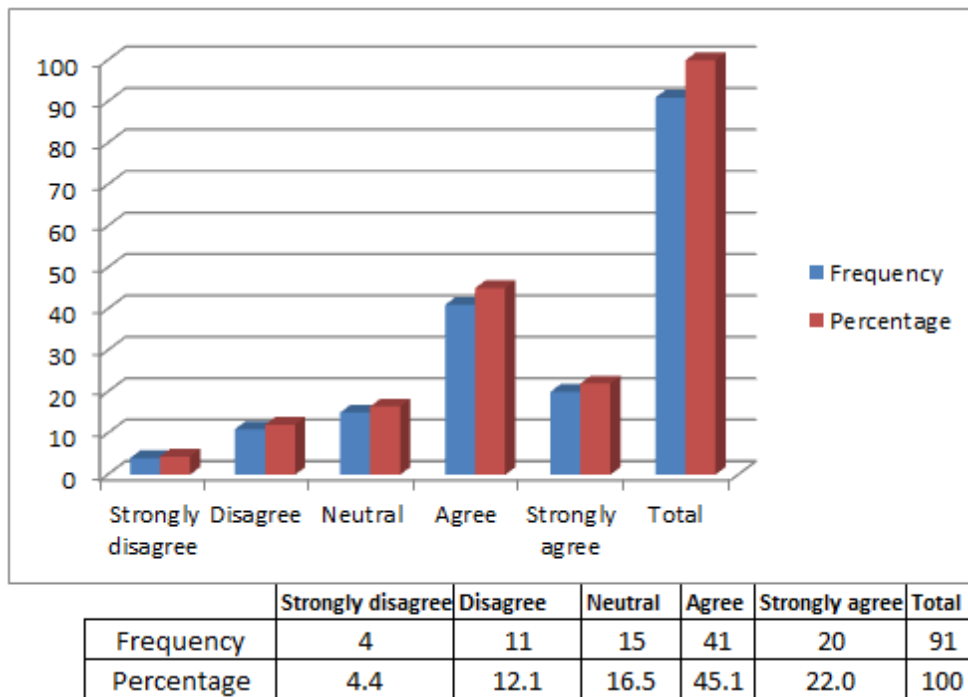
**Source: Author's own construction**

Figure 6.20 above illustrates that a majority which is 70.4% (n=64) agreed with the statement that the delay in material delivery can cause a project delay, followed by 16.5% (n=15) remained neutral, and while 13.2% (n=12) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 70.4% (n=64) in total fully agreed with the statement. The vendors can delay the distribution of material resulting in project delays. It is advisable whenever dealing with vendors to plan in advance so that scheduled time can be met.

**Research question: I do experience rework due to errors in project execution.**

The rework due to errors in a project can be caused by many factors, just to mention few; lack of qualified and experienced designers, and miscommunication can be a reason for rework. This is one of the important statements that cannot be left out when assessing project delays. The results for this specific statement are presented in figure 6.21 below.

**Figure 6.21 – Rework due to errors in project execution**



**Source: Author's own construction**

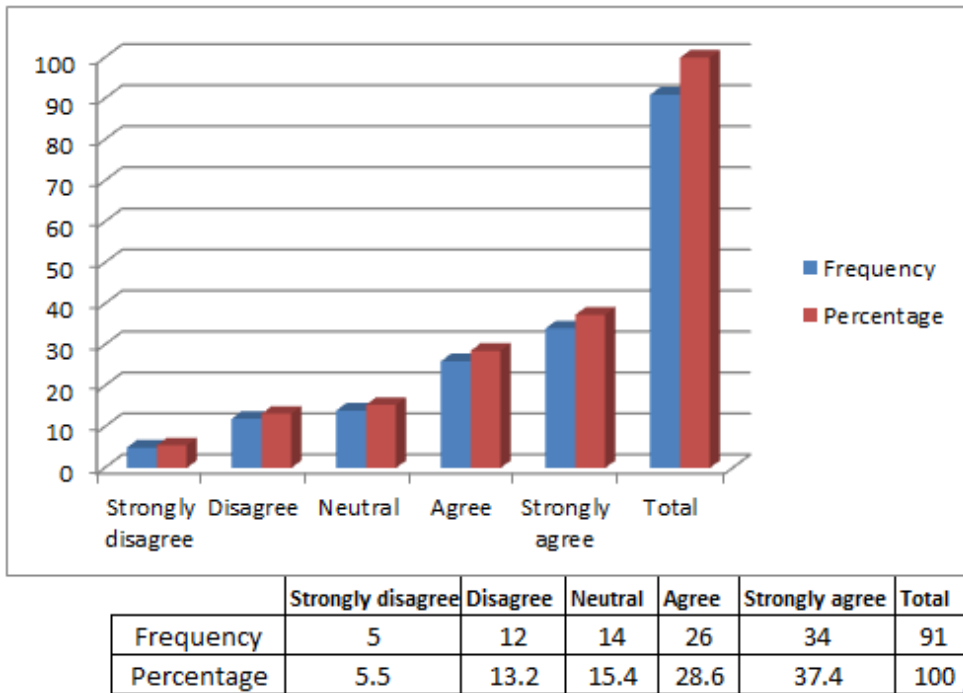
Figure 6.21 above illustrates that a majority which is 67.1% (n=61) agreed with the statement that rework due to errors in project execution cause project delays, followed by 16.5% (n=15) remained neutral, and while the other 16.5% (n=15) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 67.1% (n=61) in total fully agreed with the statement. Rework due to errors is one of factors that cause a project delay as the majority of respondents agreed. To avoid this project delay a proper site management and supervision must be done at all times.

**Research question: I do experience conflict between employer and other stakeholders.**

If there is a lack of flow of communication to project stakeholders, there will be no updates among the stakeholders resulting in the cause of conflict. This statement was included to assess the respondents how they think about the importance of communication during project execution. The results from the respondents are presented in figure 6.22 below.

**Figure 5.22 – Conflict between employer and other stakeholders**





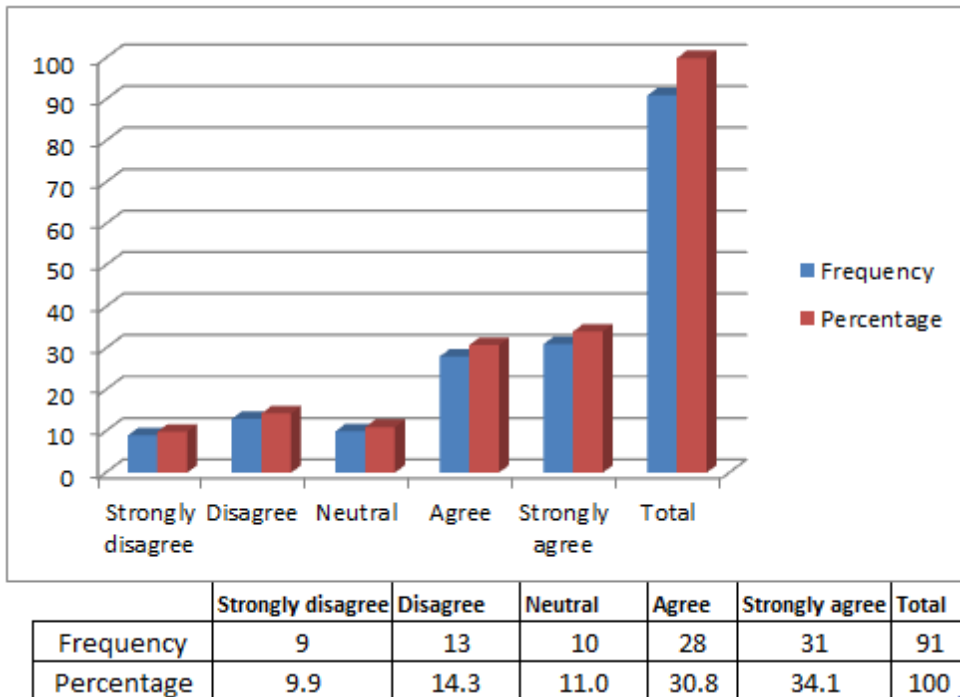
**Source: Author's own construction**

Figure 6.22 above illustrates that a majority which is 66% (n=60) agreed with the statement that conflict between employer and other stakeholders can cause project delay, followed by 18.7% (n=17) disagreed, and while 15.4% (n=14) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 66% (n=60) in total fully agreed with the statement. Due to lack of communication among management and other stakeholders, that can cause a conflict and delay project at the same time.

**Research question: I do experience rework due to change of project scope.**

Project scope change is one of the issues that are stressful to project managers as this issue affects project time scheduled, budget and increases the work load. Based on the above mentioned reasons, this statement was rated as one of the most important one to be asked to the respondents. The results for this statement are presented in figure 6.23 below.

**Figure 6.23 – Rework due to change of project scope**



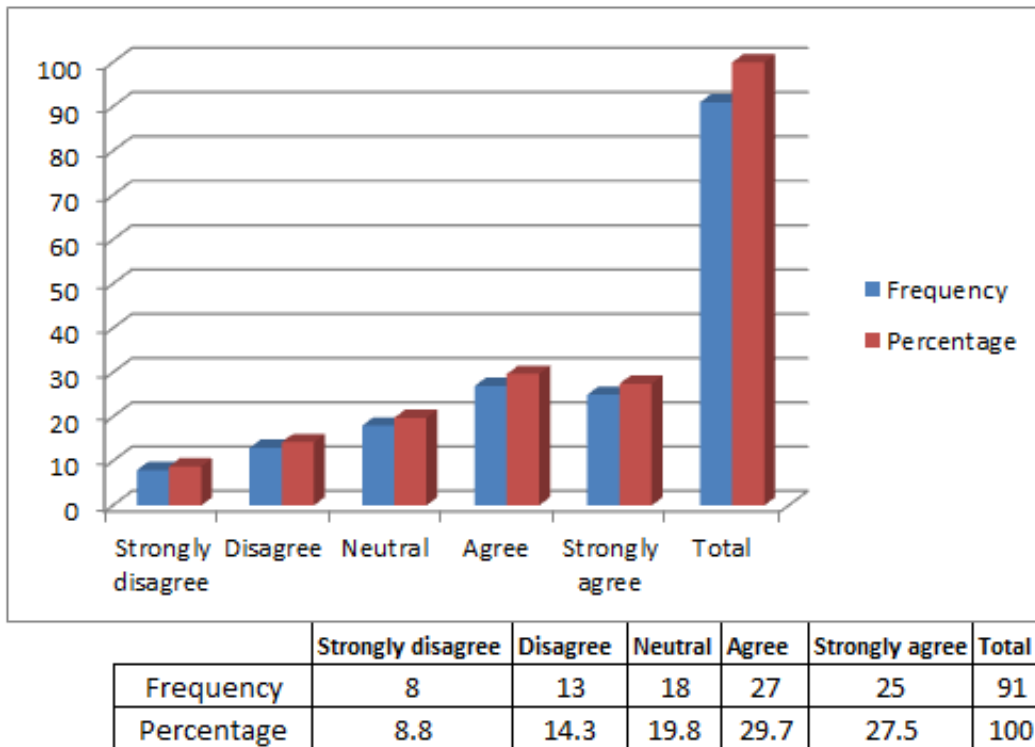
**Source: Author's own construction**

Figure 6.23 above illustrates that a majority which is 64.9% (n=59) agreed with the statement that rework due to change of project scope can cause project delay, followed by 24.2% (n=22) disagreed, and while 11% (n=10) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 64.9% (n=59) in total fully agreed with the statement. Change of project scope does affect the project progress as well as the budget. The majority of respondents agreed that project scope change will definitely delay the project.

**Research question: I do get delays due to payment of contractors.**

Delayed payments to contractors who worked on a project are considered to be a very serious problem, because it was agreed in the contract that when the work is done the full payment must be done as well. This delayed payment can cause cash flow problems to vendors and can have an effect on contractual payment chain as well. This question was asked base on the above mentioned reasons. The results for this question are presented in figure 6.24 below.

**Figure 6.24 – Delays due to late payments of contractors**



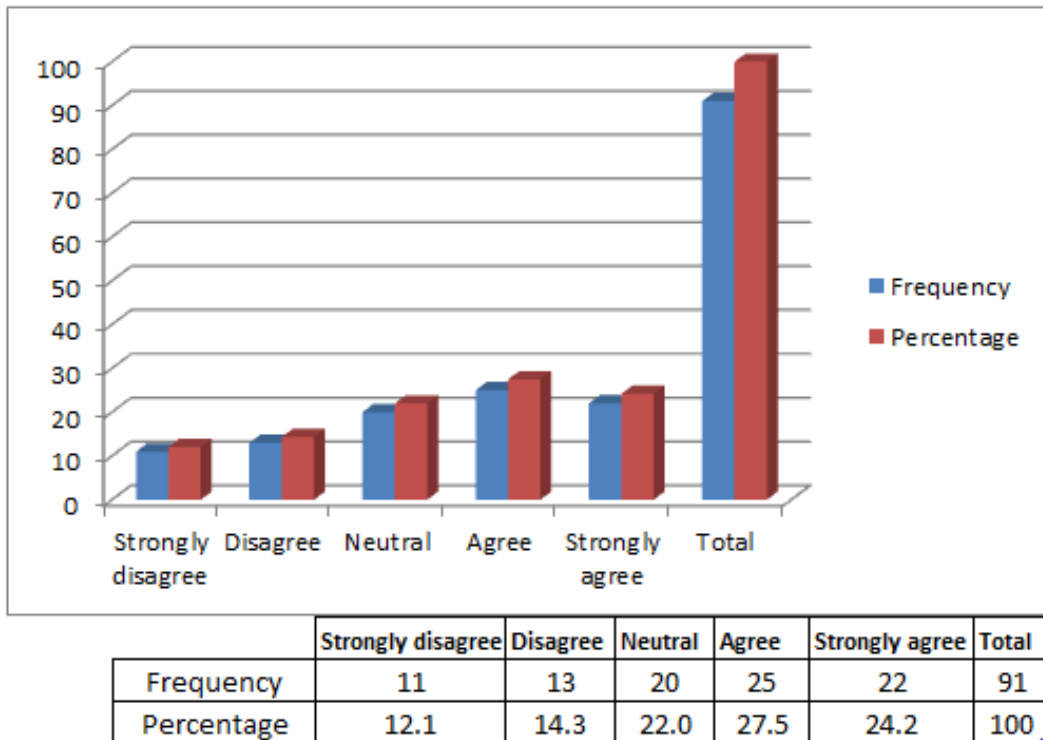
**Source: Author's own construction**

Figure 6.24 above illustrates that a majority which is 57.2% (n=52) agreed with the statement that late payments of contractors can cause project delay, followed by 23.1% (n=21) disagreed, and while 19.8% (n=18) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 57.2% (n=52) in total fully agreed with the statement and can be concluded that the delays in paying the contractors will definitely have an impact on the project.

**Research question: I do get delays due to late approval of designs and samples.**

The delays in approving the designs can delay the entire project; those delays can be caused by design errors. These design errors can have an impact on the available budget and on the scheduled time for the project. The researcher decided to include this statement in the survey because of the weight of this statement and thought this statement will contribute more in assessing project delays. The results of the respondents are presented in figure 6.25 below.

**Figure 6.25 – Delays due to late approval of designs and samples**



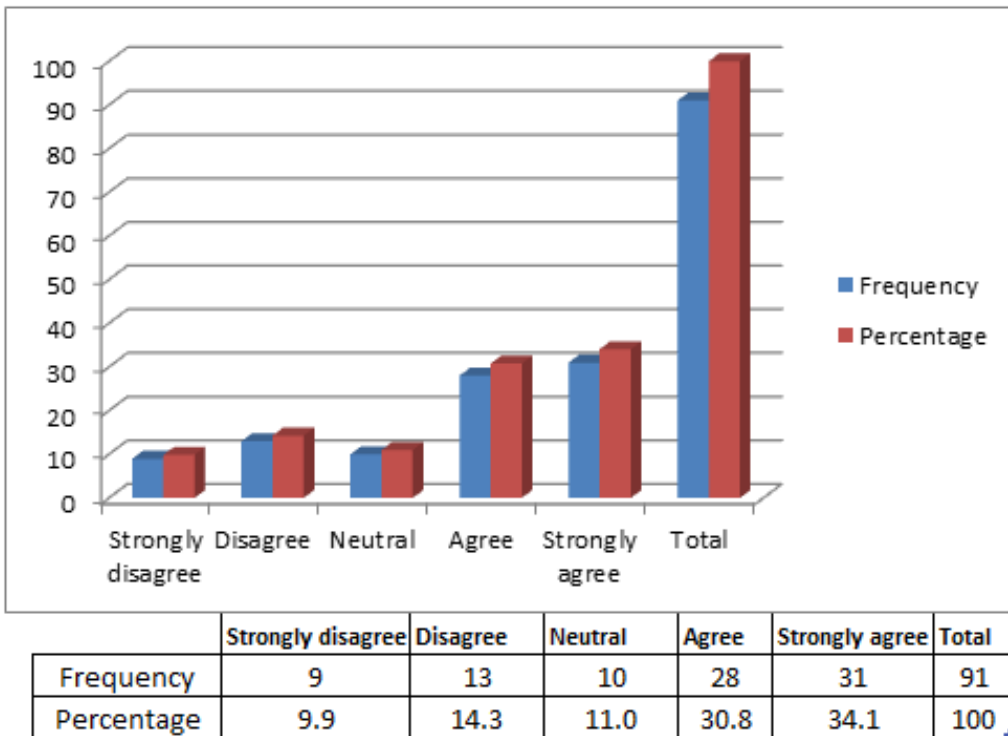
**Source: Author's own construction**

Figure 6.25 above illustrates that a majority which is 51.7% (n=47) agreed with the statement that delayed approval of designs and samples can cause project delay, followed by 26.4% (n=24) disagreed, and while 22% (n=20) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 51.7% (n=47) in total fully agreed with the statement.

**Research question: I manage project budget.**

Monitoring a project budget is one of the important tasks when dealing with projects; budget should be part of regular status report for easy controlling. The researcher decided to include this statement to assess how respondents manage their project budget in the workplace. The results of the respondents are presented in figure 6.26 below.

**Figure 6.26 – Management of Project Budget.**



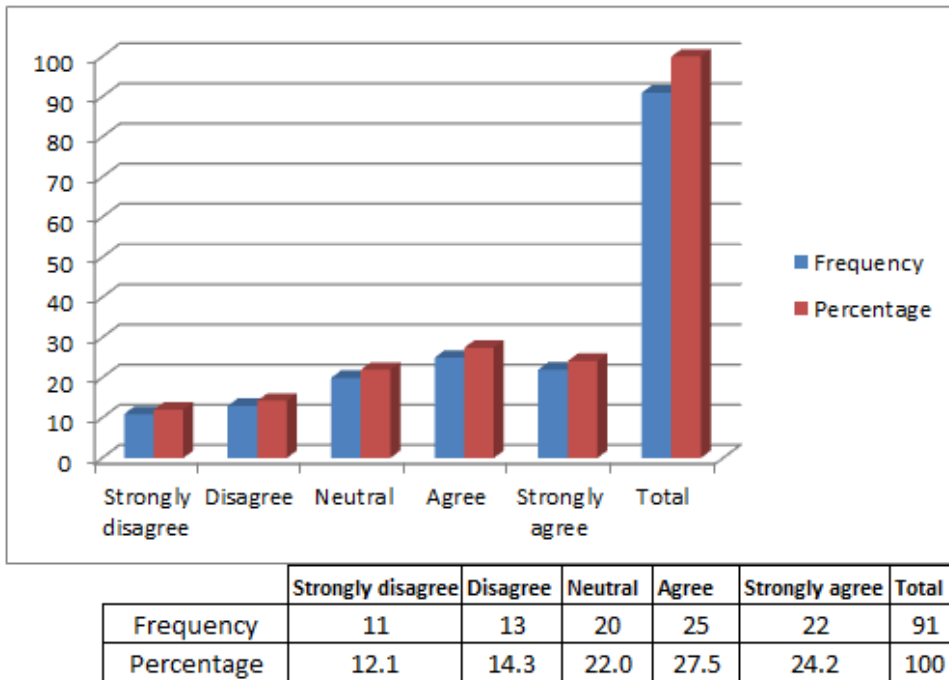
**Source: Author's own construction**

Figure 6.26 above illustrates that a majority which is 64.9% (n=59) agreed with the statement that poor management of project budget can cause project delay, followed by 24.2% (n=22) disagreed, and while 11% (n=10) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 64.9% (n=59) in total fully agreed with the statement. The majority of respondents agreed that project budget can definitely delay the project progress.

**Research question: I do experience the shortage of material**

When the materials are not managed properly for projects can result in project delays and cost blow outs. From the researcher's point of view this statement was more important to evaluate how the poor management of materials can delay the completion of a project. Figure 6.27 below illustrates the results from the respondents.

**Figure 6.27 – Experience the Shortage of Material**



**Source: Author's own construction**

Figure 6.27 above illustrates that a majority which is 51.7% (n=47) agreed with the statement that shortage of material can cause project delay, followed by 26.4% (n=24) disagreed, and while 22% remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 51.7% in total fully agreed with the statement.

### 6.3.2.3 Surrounding Communities Safety

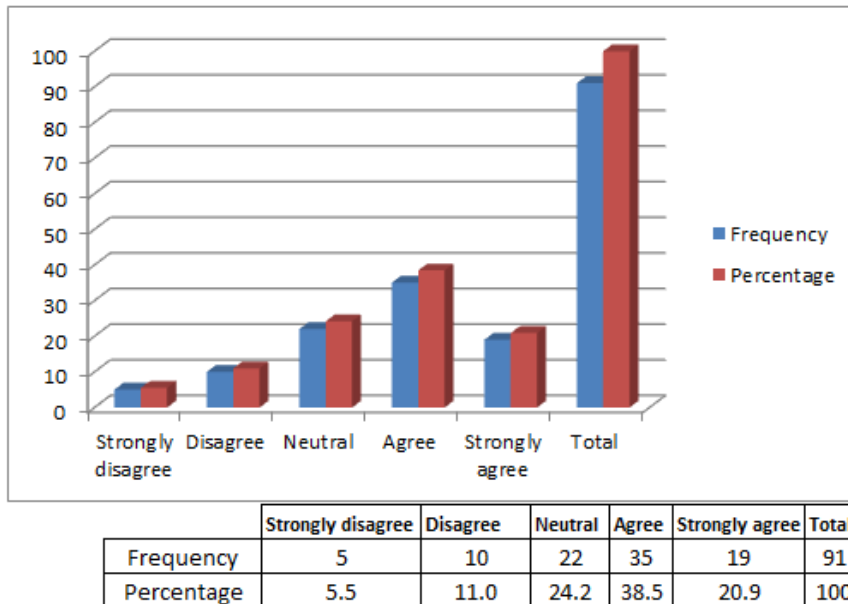
At Transnet Freight Rail (TFR), safety is considered to be one of the most critical aspects of daily operations, not just the safety of employees, but also that of people who reside in communities wherein TFR operates. Employees conduct safety awareness campaigns in the areas with the aim of educating residents of the communities about the importance of acting safely and responsibly around the railways. This subsection analyses and discusses safety of the surrounding communities based on the following statement that were asked to respondents.

**Research question: TFR provides level-crossing awareness to surrounding communities.**

It is the responsibility of the company to educate surrounding communities about level-crossing operations. By doing so, the number of incidents and accidents that are taking place in TFR level-crossings will be reduced. There more information the

surrounding community get from Transnet regarding the awareness of level-crossings the more the community will be safe. Figure 6.28 below shows the results regarding the awareness of level-crossings.

**Figure 6.28 – Level-crossing awareness to surrounding communities is provided**



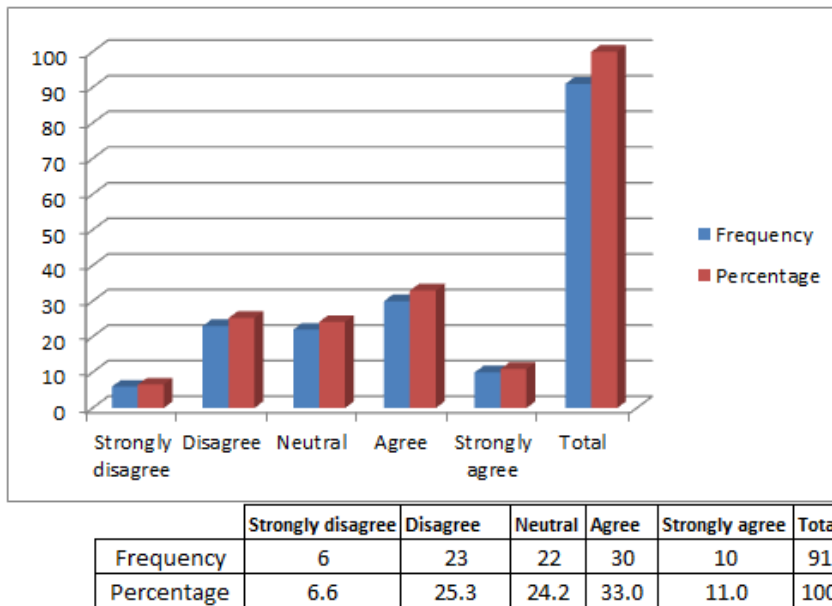
**Source: Author’s own construction**

Figure 6.28 above illustrates that a majority which is 59.4% (n=54) agreed with the statement that level-crossing awareness to surrounding communities is provided, followed by 24.2% (n=22) remained neutral, and 16.5% (n=15) disagreed. From the results it can be seen that the majority of the respondents which is 59.4% in total fully agreed with the statement. This awareness plays a very important role in keeping the record of low rate of incidents and accidents in Iron Ore line.

**Research question: TFR provides information to surrounding communities regarding pollution.**

The intention of this statement was to assess the amount of information that is made available by TFR to the surrounding communities regarding pollution awareness. The results are presented in figure 6.29 below.

**Figure 6.29 – Pollution awareness is done in the surrounding communities**



**Source: Author's own construction**

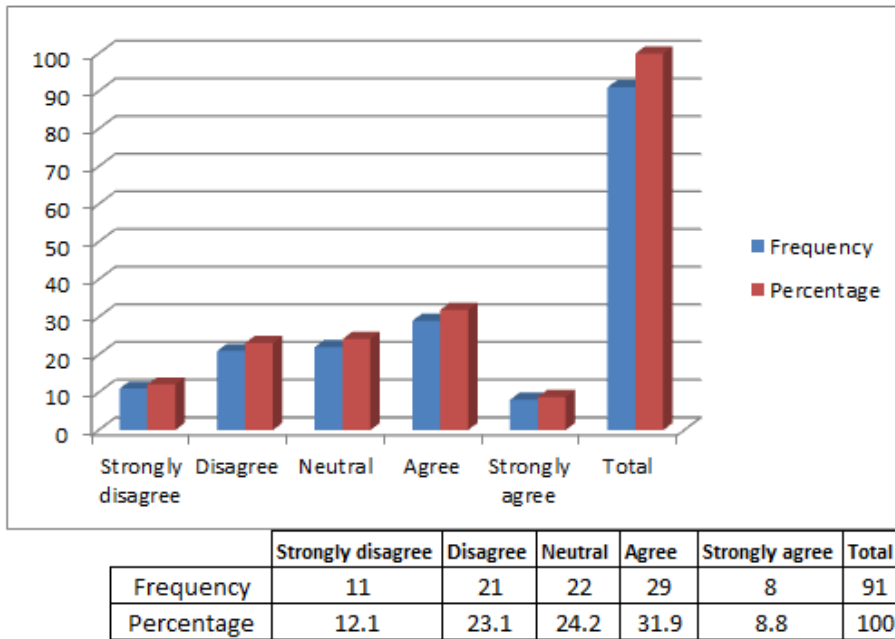
Figure 6.29 above illustrates that a majority which is 44% (n=40) agreed with the statement that pollution awareness is done in the surrounding communities, followed by 31.9% (n=29) disagreed with the statement, and while 24.2% (n=22) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 44% (n=40) in total fully agreed with the statement and 31.9% disagreed. Judging from the results it seems that there is a lot of work that TFR need to do regarding this specific statement of pollution awareness. It means that TFR should come up with another strategy in improving the pollution awareness in surrounding communities.

**Research question: TFR provides safety awareness to surrounding communities regarding the operations of trains.**

This statement asked intentionally to determine the awareness of the surrounding communities regarding train operations. The results for this statement are presented below in figure 6.30.

**Figure 6.30 – Safety awareness regarding train operation is done in the surrounding communities**





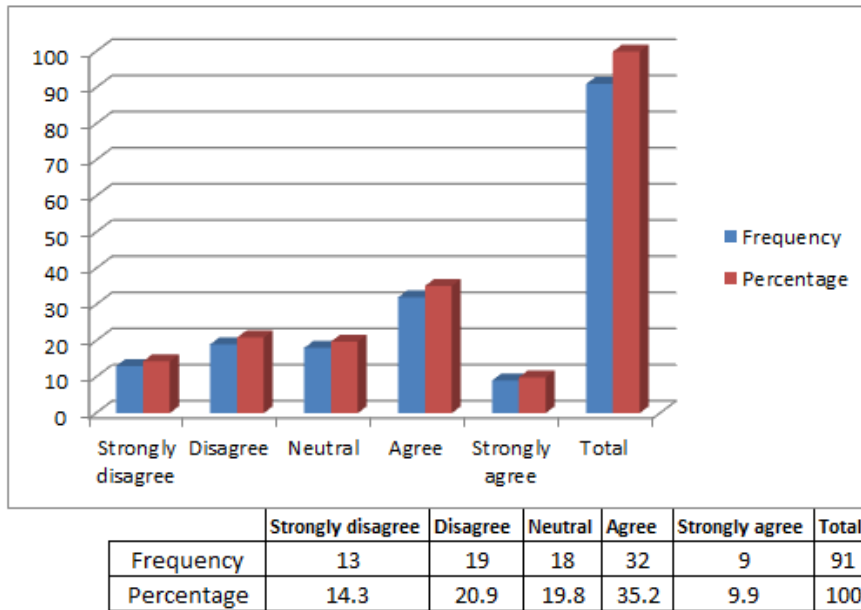
**Source: Author's own construction**

Figure 6.30 above illustrates that a majority which is 40.7% (n=37) agreed with the statement that safety awareness regarding train operation is done in the surrounding communities, followed by 35.2% (n=32) disagreed, and while 24.2% (n=22) remained neutral with the statement. From the results it can be seen that TFR is taking care of the surrounding communities regarding the safety awareness.

**Research question: TFR provides possible health risk information to surrounding communities.**

As the area of this study is dealing strictly with iron ore transportation, there are possible health risks that can be caused by this iron ore to the surrounding communities. So this statement was included to evaluate how TFR is avoiding these possible health risks to the surrounding communities. The results for this specific statement are presented in figure 6.31 below.

**Figure 6.31 – Possible health risk information is provided to surrounding communities.**



**Source: Author's own construction**

Figure 6.31 above illustrates that a majority which is 45.1% (n=41) agreed with the statement that possible health risk information is provided to surrounding communities regarding the danger of the iron ore to residents' health, followed by 35.2% (n=32) disagreed, and while 19.8% (n=18) remained neutral with the statement. From the results it can be seen that the surrounding communities are provided with necessary information regarding the possible health risks.

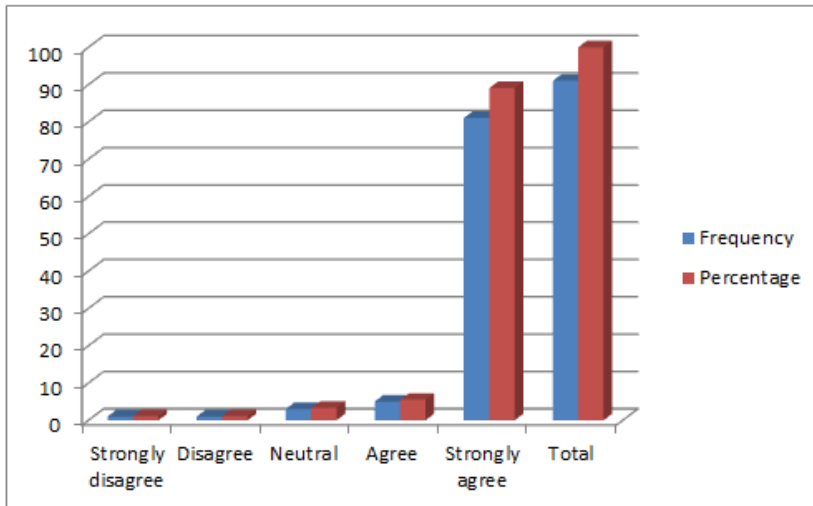
#### **6.3.2.4 Company Safety**

It is the responsibility of a company to ensure that its employees are working on a safe environment with safe tools and personnel protective equipment. Statements and questions that contributed in this survey are listed below with responses from different respondents to achieve research objectives. These statements and questions are based on the current company safety practices.

#### **Research question: I am encouraged to attend a safety symposium monthly.**

The intention of this statement was to collect more information regarding the safety symposium which takes place every month. The aim was to get an understanding that whether or not the employees are being encouraged by the employer to attend. The results for this question are shown below in figure 6.32.

**Figure 6.32 – Encouragement in attending monthly safety symposium**



	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Frequency	1	1	3	5	81	91
Percentage	1.1	1.1	3.3	5.5	89.0	100

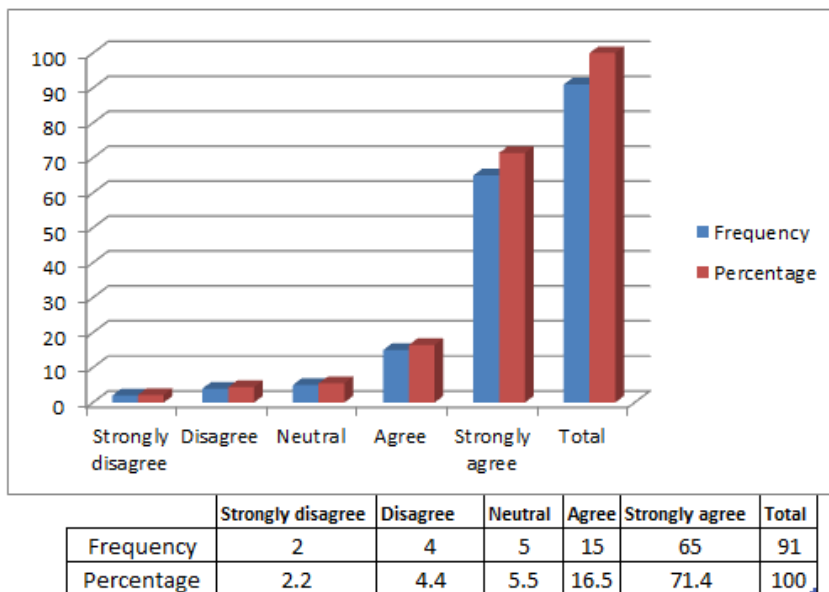
**Source: Author's own construction**

Figure 6.32 above illustrates that a majority which is 94.5% (n=86) agreed with the statement that employees are encouraged to attend safety symposium monthly, followed by 3.3% (n=3) remained neutral, while 2.2% (n=2) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 94.5% (n=86) in total fully agreed with the statement. It is a very important thing that the company does its responsibility by encouraging employees to be part of this safety meeting as the majority of the respondents strongly agreed.

**Research question: I am encouraged to attend first aid course every three years.**

This statement was helpful in assessing the importance of attending first aid training by employees. This statement managed to reveal how the first aid training can assist in the workplace. Figure 6.33 below shows the results of the respondents on the encouragement on attending first aid course.

**Figure 6.33 – Encouragement in attending first aid course every three years**



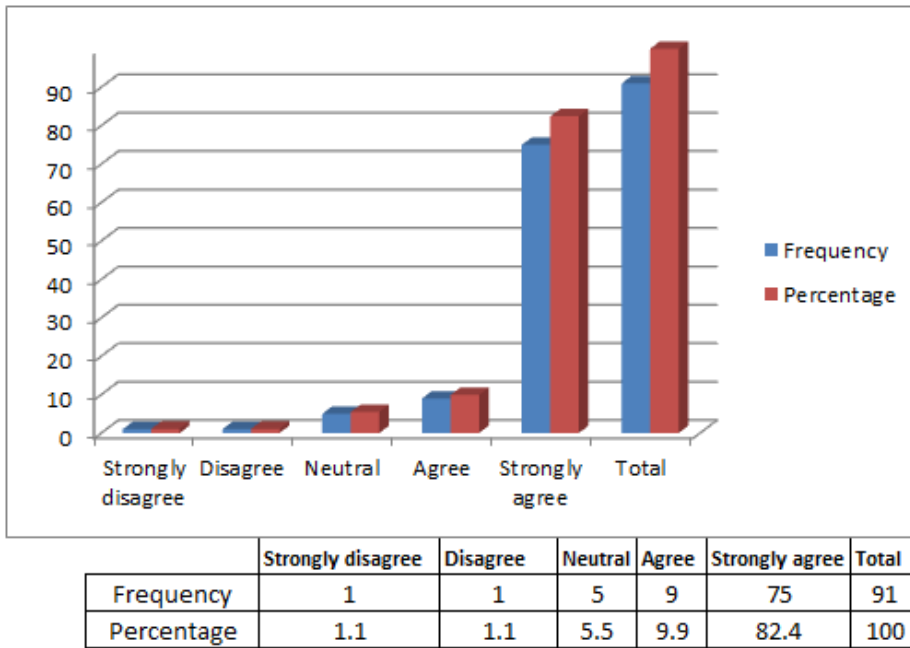
**Source: Author's own construction**

Figure 6.33 above illustrates that a majority which is 87.9% (n=80) agreed with the statement that employees are encouraged to attend first aid every three years, followed by 6.6% (n=6) disagreed, and 5.5% (n=5) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 87.9% (n=80) in total fully agreed with the statement. As the majority agreed with the statement, when the employees attended first aid training they become more safety aware and can spot risks and incidents from occurring. This awareness assists in reducing the number of hazards that may occur in the workplace.

**Research question: I am encouraged to attend SHE training every three years.**

SHE training is one of the important courses in the workplace to maintain a low lost man hours through injuries and to reduce an accident rate. The intention of this statement was to evaluate how often is this training attended and the benefits in the workplace. Figure 6.34 below illustrates the results from the respondents regarding SHE training.

**Figure 6.34 – Encouragement in attending SHE training every three years**



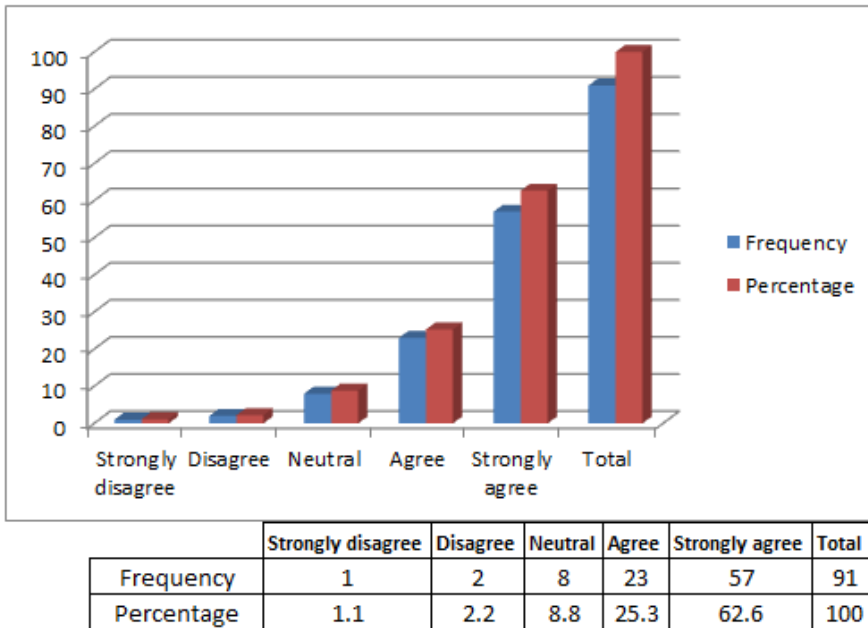
**Source: Author's own construction**

Figure 6.34 above illustrates that a majority which is 92.3% (n=84) agreed with the statement that employees are encouraged to SHE training every three years, followed by 5.5% (n=5) remained neutral, disagreed respondents sit at 2.2% (n=2) . From the results it can be seen that the majority of the respondents which is 92.3% (n=84) in total fully agreed with the statement. Employers have a duty to ensure that all the employees and visitors in their workplace are taken care of. It is the responsibility of the employer to do a detailed risk assessment and record the findings as part of SHE requirements.

**Research question: I am encouraged to attend fire fighting training every three years.**

As we all know that this type of training is very important in the workplace and outside the workplace. This statement was included to assess how often this training is offered to employees. Figure 6.35 shows the results of the respondents regarding employees attending fire fighting course.

**Figure 6.35 – Encouragement in attending fire fighting training every three years**



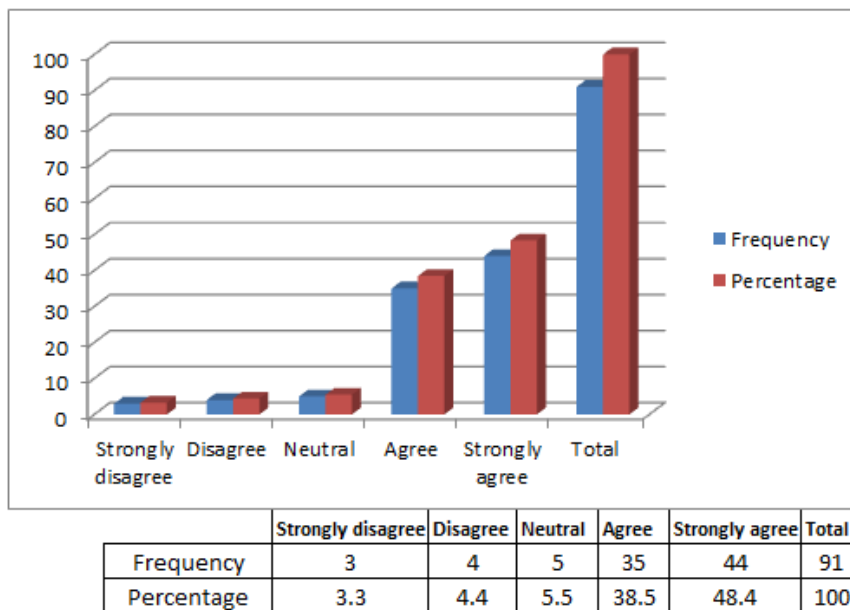
**Source: Author's own construction**

Figure 6.35 above illustrates that a majority which is 87.9% (n=80) agreed with the statement that employees are encouraged to fire fighting training every three years, followed by 8.8% remained neutral, and 3.3% (n=3) disagreed with the statement. From the results it can be seen that the majority of the respondents which is 87.9% (n=80) in total fully agreed with the statement. It is the responsibility of employer for the well-being of employee. Fire fighting training is very vital to ensure that employees know what procedures to follow in the event of fire in the workplace.

**Research question: I am aware of TFR safety policy and procedures.**

This statement was intentionally included to assess the knowledge of safety policy and procedures from the respondents. In order to analyse who is aware of such policy and how is it applied in the workplace. Figure 6.36 below shows the results of this statement.

**Figure 6.36 – Knowledge of TFR safety policy and procedures**



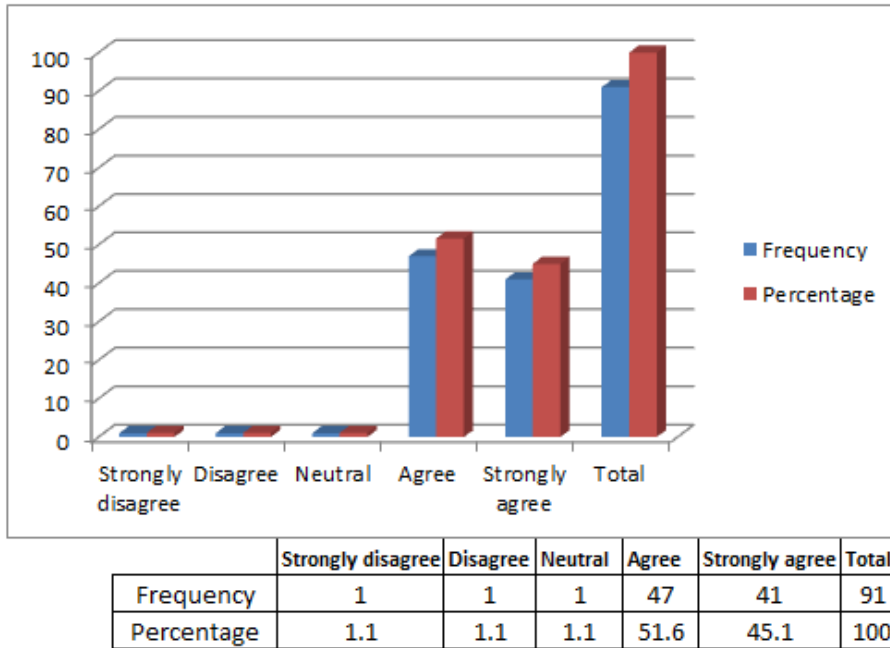
**Source: Author's own construction**

Figure 6.36 above illustrates that a majority which is 86.9% (n=79) agreed with the statement that employees are aware of TFR safety policy and procedures, followed by 7.7% (n=7) disagreed, and 5.5% (n=5) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 86.9% (n=79) in total fully agreed with the statement.

**Research question: Relevant safety documents are compiled by a qualified individual.**

It is the responsibility of an employer to ensure that specific tasks are carried out by qualified individuals for accuracy purpose. There are safety policies and procedures that are in place in the company to guide employees in the workplace. This specific statement was influenced by the need to evaluate how qualified are the individuals who compile these documents. Figure 5.37 below shows the results for this statement.

**Figure 6.37 – Relevant safety documents are compiled by a qualified individual**



**Source: Author's own construction**

Figure 6.37 above illustrates that a majority which is 96.7% (n=88) agreed with the statement that relevant safety documents are compiled by a qualified individual, followed by 2.2% (n=2) disagreed, and 1.1% (n=1) remained neutral with the statement. From the results it can be seen that the majority of the respondents which is 96.7% (n=88) in total fully agreed with the statement.

### **6.3.3 Section C: General Concerns on Quality Management and how it affects the Productivity of the Company.**

This section presents general concerns on quality management as well as how it affects the productivity of the company. Some of respondents managed to answer section C of this questionnaire. The results are discussed below from the respondents.

#### **Research question: List five things you like most about project participation.**

A majority of respondents which is 93% (n=85) managed to answer this specific question, while 7% (n=6) of the respondents did not answer. The results from the respondents for things that they like most about project participation are listed below with no order of importance. Participate in decision making process; being able to be creative; given a chance to show the skills and knowledge; being able to work with different departments; having a good goal and working towards one goal; team work;



gaining more experience; and experiencing different scope of work as projects differ. Those are the answers from the respondents which are in line with the study.

**Research question: List five things that affect you directly in relation to effective project participation.**

The purpose of this question was to assess challenges that are faced by project team members during project execution. A majority of respondents which is 96.7% (n=88) managed to answer this specific question, while 3.3% (n=3) of the respondents did not answer. The answers from the respondents are as following with no order of importance. Shortage of resources; shortage of skills; working under budget; lack of time management; lack of performance management; lack of prioritising; better chances of increase; and not enough manpower.

**Research question: List five things you dislike the most in relation to your decision making processes in project participation in Transnet Freight Rail.**

This question was included to evaluate decision making processes within the respondents which are TFR employees. A majority of respondents which is 98.8% (n=90) managed to answer this specific question, while 1.2% (n=1) of the respondents did not answer. The results for the respondents are as following with no order of importance. Bad decision making can cause damage to the company; sometimes a risky decision can be made causing irreversible costs; and having to discipline the employees for misconduct.

#### **6.4 Chapter Summary**

This chapter analysed and discussed the survey findings as collected from the respondents. All the questions that were asked in the questionnaire and responses from the respondents were presented in the form of graphs for easy readability. The replies that were obtained from the participants were agreed with the literature review of this investigation document. The responses from the respondents strongly agreed that any size of a project needs a quality officer who will be doing quality tasks. The findings also revealed that the absence of a quality management department in Iron Ore line of Transnet's Freight Rail division is really causing a lot of problems in projects.

The next chapter will include the summary of findings, concludes the research, discusses some recommendations influenced by the research findings, and areas for future research.

## **Chapter 7**

### **Findings, Conclusions and Recommendations**

#### **7.1 Introduction**

This chapter summarises the findings of the study as discussed and presented in the previous chapter. Firstly, the summary of previous chapters was discussed to review some important components. Secondly, this chapter focusses on the conclusion of the research findings as well as the views of the author on the findings. The research recommendations will be discussed giving TFR iron ore line business unit some suggests for continuous improvement. Lastly the areas for future research will be identified. Every employee plays an important role in a company to achieve quality management.

#### **7.2 Overview of the Research problem and purpose of the study**

The research problem raised after the researcher noticed the continued delay of goods trains because there are ever increasing accidents of goods trains. The percentage of these derailments are increasing in summer because of the high temperature, causing the rail and the sleepers to lose the shape “kick out” (the bending of the rail and the sleepers in response to heat), and this causes delays and derailments costing the company extensively. There are no quality processes that are currently in place from procurement through to closeout phase for these upgrade construction projects. Consequently many injuries occur and there are constant repairs which could have been prevented. There was a need for a thorough review of the quality system used (if any) by the company to guarantee reduction if not eradication of these incidents that result in risks to both human lives and unbudgeted for repairs costs.

The researches that have been conducted in Transnet Freight Rail did not include the evaluation of quality management in the Iron Ore railway line. This issue has been left out while there is a continuity of derailments that result in risks to both human lives and unbudgeted for repairs costs. In order to prevent risks to both human lives and unbudgeted costs quality management should be evaluated.

### **7.3 Summary of Research findings from Literature Review**

Chapter one introduced the importance and the background of the study. The research problem statement was analysed based on the identification of the study objectives and questions. Research design, research constraints, targeted population, sample size and research ethics were discussed as well as the methods that were adopted to resolve the research problem. The chapter was concluded by classifying all the chapters that will be included in the study.

Chapter two dealt with the general overview of railway engineering, where the history of South African railway was discussed in detail, engineering fields that are involved in railway construction was discussed and the engineering standards was explained as well.

Chapter three dealt with the quality management, where the current quality management practices were revealed from international expert's point of view. This chapter was divided into three sections, namely; first section discussed project quality management processes which include the following: quality planning, quality assurance, and quality control. The second section discussed quality cost in construction which includes the following: quality cost during design phase, quality cost during execution phase, and cost of poor quality.

Chapter four dealt with the overview of study environment which is TFR Iron Ore line. This chapter discussed the previous TFR performances which include the revenue, operating expenses, and safety based on the annual results from 2010 to 2014 financial years. Project management plans which include project quality plan and execution quality plan were discussed. The approval of material, inspection and test plan were also discussed in this chapter.

Chapter five discussed in detail the research design, research strategy and research methodology. The population validity and the sample size were discussed, including the method of data collection. The data analysis, validity and reliability, sampling bias

were also discussed in detail. Assumptions made during the study, scope and limitations were discussed as well.

Chapter six analysed, discussed and presented the findings of the research based on the responses collected from the respondents. The findings were plotted and presented in the form of graphs and interpreted in detail. By concluding the respondents strongly agreed that quality management in TFR projects is needed to improve project delivery.

#### **7.4 Summary of Findings from Empirical Study**

In chapter seven the main points were highlights of the findings as discussed in Chapter six, whereby they were brief discussed and recommendations were given. The conclusions and recommendations were based on the researcher's understanding and analysis of the importance from the data that was gathered.

##### **7.4.1 To evaluate construction quality management practices at a South African freight rail company.**

The following are the research findings:

- Random sampling of errors and record seen defects.
- Full control over sub-contractors.
- Quality monitoring throughout the project life cycle.

The task of random sampling of errors and record seen defects is one of the important tasks in project quality management. This task cannot be left out when executing a project in order to achieve high quality. The findings have revealed that the majority of the respondents which is 82.5% in total fully disagreed with the fact that random sampling of errors and record of seen defects is being done. This is not a good quality image, TFR should introduce quality management department to avoid more problems based on the quality of projects undertakings.

There are projects that are being outsourced based on different reasons, the relationship between the employees and the sub-contractors during this process of outsourcing is very important. The findings have revealed that the majority of the

respondents which is 88% in total fully agreed that the employees have a full control of outsourced projects; therefore they are able to monitor the quality. There are different advantages and disadvantages of outsourcing, so before making any decision employees should educate themselves so that they can make an informed decision.

The quality monitoring process is very important in project execution. The findings have revealed that the majority of the respondents which is 87.9% in total fully disagree with the fact that the quality monitoring is performed during the execution of these construction projects in Iron Ore line as there is no quality management department.

#### **7.4.2 To determine the perceptions of internal stakeholders regarding Total Quality Assurance (TQA) measures that should be used to reduce unbudgeted expenditures as well as occupational accidents at Transnet Freight Rail.**

The following are the research findings:

- Quality audits.
- Quality control routine.
- Unscheduled quality tours.

Quality assurance is one of the project management processes. In order to achieve high quality in any project, quality audits should be performed in different project phases. The findings have reveals that the majority of the respondents which is 96.7% in total fully disagree with the fact that quality audits are being done in TRF projects. These results show that quality audits are not done as required to meet high quality.

Quality control routines contribute more in achieving high quality in project environment, it is very important to perform this task whenever involved in a project. The research has revealed that the majority of the respondents which is 95.6% in total fully disagree with the fact that quality control routines are being performed in TFR construction projects. From the above findings it can be concluded that in TFR Iron Ore line the quality assurance measures are not performed.

The unscheduled quality tours assist in examination of a work area to ensure that standards of operation are acceptable, possible causes of defects or errors are

removed and quality standards are maintained. The research has revealed that the majority of the respondents which is 74.8% in total fully disagree with the fact that unscheduled quality tours are being performed in TFR projects.

#### **7.4.3 To establish the perceptions of stakeholders regarding quality standards that could be used on all project undertakings at Transnet Freight Rail.**

The following are the research findings:

- Knowledge of quality standards.
- Relevant quality documents.
- Knowledge of quality policy.

Quality standards are sets of statements designed to measure quality improvements in a specific environment. It was very important to pose this statement so that the researcher can be able to determine from the responses whether the respondents are aware of quality standards. The findings have revealed that the majority of the respondents which is 93.5% in total fully agree with the fact that they are aware of the required quality standards. The results show that the respondents have a knowledge of quality standards which is a good aspect when involved with projects even though there is an absent of quality department.

It is the responsibility of an employer to ensure that specific tasks are carried out by qualified individuals for accuracy purpose. There is quality policy that is in place in the company to guide employees in the workplace. The findings have revealed that the majority of the respondents which is 39.6% in total fully agreed with the fact that the relevant quality documents are compiled by the qualified individuals.

A quality policy is a very important document that is developed by top management with respect to quality. ISO 9001:2015 requires a well-defined quality policy that is understood within the company. The findings have revealed that the majority of the respondents are aware of a quality policy which means that this knowledge contributes in the improvement of quality management in the entire company. The research has revealed that the majority of the respondents which is 77% in total fully agree with the fact that they are aware of the quality policy.

## **7.5 Conclusions**

The main objectives of this research were to evaluate construction quality management practices at a South African freight rail company, to determine the perceptions of internal stakeholders regarding Total Quality Assurance measures that should be used to reduce unbudgeted expenditures as well as occupational accidents at Transnet Freight Rail. To establish the perceptions of internal stakeholders regarding quality standards that could be used on all project undertakings at Transnet Freight Rail. This study has revealed that the Total Quality Assurance measures are being ignored, such as:

- Lack of unscheduled quality tours.
- Lack of quality audits.
- Lack of quality control routines.
- Lack of random sampling of errors and record seen defects.
- Lack of quality monitoring throughout the project life cycle.

The research has revealed that the majority of the respondents fully agreed with the fact that they are aware of the required quality standards. The results show that the respondents have a knowledge of quality standards which is a good aspect when involved with projects.

## **7.6 Recommendations**

- The design and execution teams should be introduced from the inception of the project so that technical expertise can be exploited and buildability of the execution methods can be adapted where this would enhance the project's deliverables.
- Transnet Freight Rail should provide more training to the employees, because training makes the execution team get things right the first time easily and more frequently, and training reduces the skills shortage within the company.
- Transnet Freight Rail should ensure that more projects are designed and executed by the same company, to encourage continuity and the quality of the project is managed with greater assurance. When the project quality is



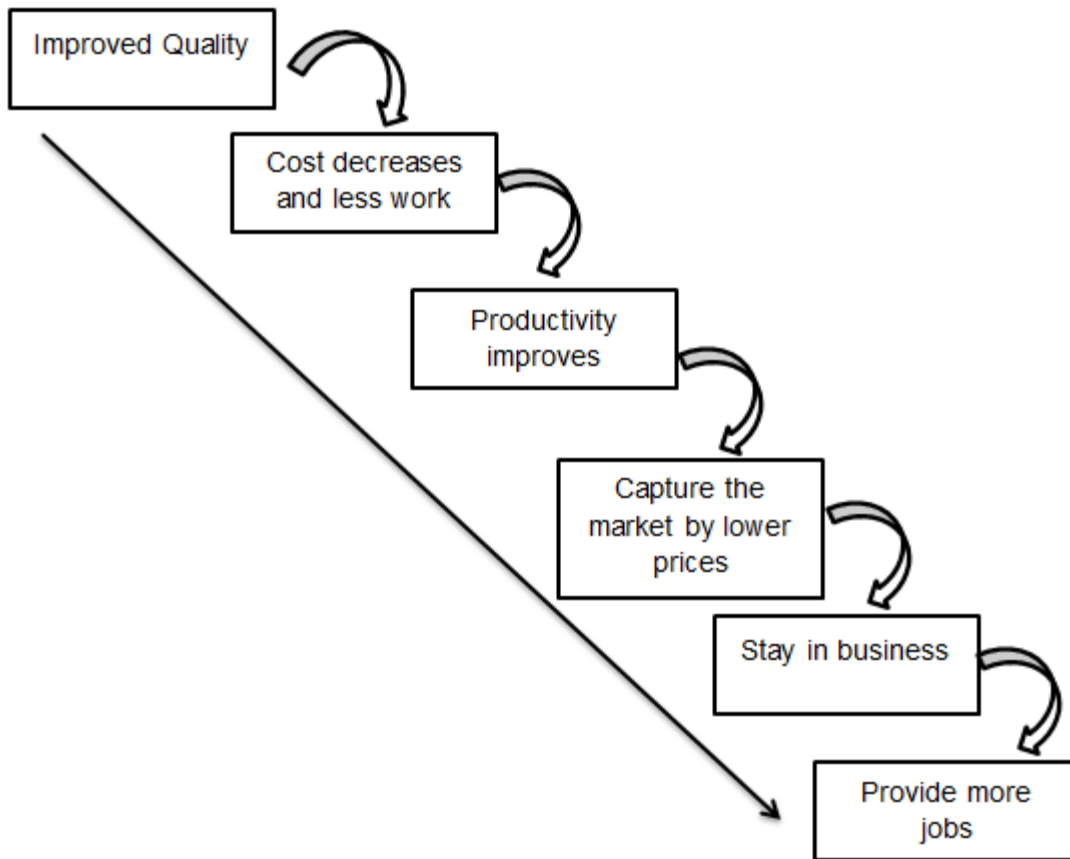
achieved, maintenance costs are minimised, and the life cycle of the project is improved.

- Transnet Freight Rail should ensure that in order to improve the standard of quality, the labour productivity should be improved as well. The literature revealed that this can be achieved by introduction of improved tools and equipment, health and safety conditions of the employees, and improving the company and management of the construction projects.
- It is strongly recommended that Transnet Freight Rail to determine the balance between prevention, evaluation and failure costs for a specified level of quality performance for cost value so that investments in quality is based on cost improvement and profit improvement.

### **7.6.1 Dr. Deming's Chain Reaction Theory**

According to Dale (2004:28), Dr. Edward Deming initiated a "Chain Reaction Theory". This theory states that quality improvements result in lower costs because of less rework, advance mistakes fewer delays and complications, better quality and lower prices, a company can accomplish a higher market share and stay in business, and leading to more and more jobs created. Figure 7.1 below illustrates Dr. Deming's Chain Reaction Model that is highly recommended in companies.

#### **Figure 7.1 – Dr. Edward Deming's Chain Reaction Model**



**Source: Dale (2004:28)**

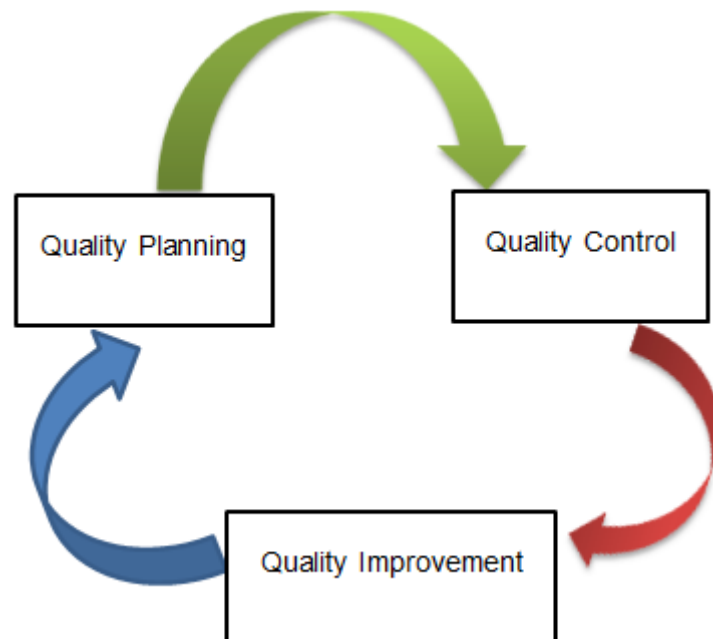
It is strongly recommended that Transnet Freight Rail apply the above mentioned chain reaction theory for employees to take meaningful roles in the work of the company and for a company to find meaning in its work. All the benefits of this chain reaction theory can be achieved by the following steps:

- Improve quality of services – this is the first step that will initiate the pride in employees who contribute to a company’s quality improvement.
- Costs will decrease as a result of this emphasis on quality rather than quantity.
- Productivity will increase as employees see meaning in their efforts.
- Company can expand their market share by increasing productivity.
- This will allow a company to stay in business.
- This will also expand the opportunities for employees by adding jobs and improve training.

### **7.6.2 Dr. Juran’s Quality Trilogy**

According to Kerzner (2009:878), Dr. Juran has felt that dealing with quality needs the same attention as that of other functions. Therefore, he developed the quality trilogy which involves: quality planning, quality control, and quality improvement as illustrated in figure 7.2 below.

**Figure 7.2 - Dr. Joseph Juran's Quality Trilogy**



**Source: Kerzner (2009:878)**

- **Quality planning** – That is where the quality officer identifies the relevant standards for the project and how to fulfil them. The defects are prevented by proper material selection, indoctrinating employees in quality, and plan for a process that ensures the best outcome. The outputs of quality planning process are as following; quality checklists, quality management plan, project management plan updates, quality metrics, process improvement plan, and quality baseline (Plura, 2010:257). Plura (2010:258) further stated the main reason for focusing on quality planning as summarised below:
  - Quality planning on principle encouragements customer satisfaction in the company.
  - Quality planning is the important aspect of company's competitiveness.
  - The way to prevent non-conformities is to implement quality planning during realisation and use of the product.

- In pre-production phases its where the most of non-conformities arise, as well as quality planning activities are realised too.
  - The elimination of non-conformities requires the shortest time and the lowest cost in the pre-production phases.
  - By implementing procedures of quality planning the organization proves that it used all means to achieve customer satisfaction and to prevent non-conformities.
  - The results of quality planning increases customer confidence on the products of the organization.
- **Quality control** – Quality officer monitors the results of the projects to ensure that they meet the requirements of the relevant standards. The outputs of quality control are as following; quality control measurements, suggested preventive and corrective actions, validated deliverable, quality baseline updates, validated and suggested defect repair, and acceptance decisions.

Wang (2011:4) recommended that when a company is quality-oriented, the same company should understand clearly that whether the cost on quality is in excess or not that can result in quality cost increase. For that reason, the total quality management should be employed as following:

- In the early stages of each sub-project, in depth technical explanation must be given.
  - The quality must be measured strictly according to the construction standards, In order to prevent quality accidents that can occur which will lead to cost increase.
  - Each construction process must be aligned with the correct quality standard to meet specified requirements.
  - The higher the quality of construction the lower the project cost will be.
- **Quality improvement** – Emphases on long term goal pursuing to achieve quality break through that change a company to a new level of performance.

## **7.7 Limitations of the Study**

The study focused on Transnet Freight Rail Iron Ore line, which is from Saldanha to Sishen railway line. The data were collected in the area of the study. The study was limited to approximately 100 people, and any findings may not be generalized to the whole of Transnet. More rigorous statistical analysis could be conducted to obtain a more robust set of results.

## **7.8 Suggestions for Future Research**

This specific study focussed on one Transnet Freight Rail line only. Firstly, the future research should cover the entire Transnet with the aim of quality improvement. Secondly, should evaluate the competence of women who are involved in construction projects nationally, as we all know that there are few women in engineering field. Lastly the effectiveness of female project managers in construction projects and the success of the projects they managed. Future research could use more robust statistical tests such as exploratory factor analysis, correlation and regression analysis to explore cause and affect issues within the same area.

## **7.9 Summary**

During the course of this study, it was discovered that TFR needs to send its employees to relevant training. This training ranges from the basic skills of the general workers, professionals and management levels. This indicates the amount of attention that should be put to training to achieve better quality management in projects and to reduce cost related errors. Good and clear communication should be defined in the quality management document to reduce cost related delays, for clear responsibilities of all the employees from top management to employees who are on site, and to ensure the design, workmanship and materials meet specified requirements.

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## APPENDICES

## Annexure A: Consent letter



Department of Project Management &  
Management  
Faculty of Business & Management  
Sciences  
Cape Peninsula University of Technology  
PO Box 652  
Cape Town  
8000

04 January 2016

### **M-TECH: QUALITY MANAGEMENT RESEARCH CONSENT LETTER**

**Principal investigator: Gcobani Mhlekwa (Cell 073 125 9304)**

**Co-investigator: Dr. L.E Jowah, Research supervisor (Tel. 021 460 4293)**

Dear Sir/Madam

I am currently completing Master's degree in Project Management at the Cape Peninsula University of Technology, Cape Town campus. My research title is, **“Evaluating quality management on selected South African freight rail construction projects.”** The reason of this letter is to request authority to collect data at your company. A structured questionnaire will be used as a method of data collection. This letter serves to notify you that all the participants and company information will be given the right of confidentiality and anonymity in this study.

Your cooperation will be highly appreciated in order for me to present my research findings.

If you require any further information, please do not hesitate to contact me as following, email address: [mhlekwag@gmail.com](mailto:mhlekwag@gmail.com) or alternatively contact me on 073 125 9304.

Yours Sincerely,

Gcobani Mhlekwa (Mr)



To Whom It May Concern

N. Malamele  
Human Capital Practitioner  
Rail Network  
Saldanha

Tel.: 022 703 3724  
nokukhanya.malamele@transnet.net

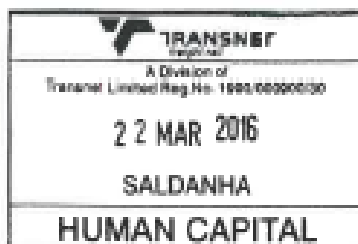
Date: 23 March 2016

**CONFIRMATION OF PERMISSION – MASTER'S DEGREE RESEARCH**

This is to confirm that Gcobani Mhlekwu (Sap No. 145417) has been given permission to do his research for his Master's degree. His research will be based on Quality Management of our projects for the Iron Ore Business Unit of Transnet's Freight Rail Division. The permission has been granted by MR Gilbert Nortier, Depot Engineer, Iron Ore Line, Rail Network.

Yours sincerely

  
Nokukhanya Malamele  
Human Capital Practitioner



## Annexure B: Questionnaire



Department of Project Management &  
Management  
Faculty of Business & Management  
Sciences  
Cape Peninsula University of Technology  
PO Box 652  
Cape Town  
8000

### To whom it may concern

Dear Sir/Madam

I am currently completing Master's degree in Project Management at the Cape Peninsula University of Technology, Cape Town campus. My research title is, **“Evaluating quality management on selected South African Freight Rail construction projects.”** Dr. L.E Jowah is my research supervisor. The dissertation will be submitted to the department of Project Management and Management in partial fulfilment of the requirements for the Master's Degree in Project Management at the Cape Peninsula University of Technology

Transnet Freight Rail Iron Ore experiences a high rate of accidents and injuries that happen on daily basis which affect the company's operations and profits. The absence of quality management department at Transnet Freight Rail Saldanha Depot can be the main causes of these experienced project delays and high rate of incidents. The need to pursue this study arises influenced by the need for change in the performance of Transnet Freight Rail projects and to minimise the rate of accidents and injuries. Thus, the purpose of this investigation is to gather data from employees and management who are involved in projects.

Your cooperation will be highly appreciated, If you require any further information about this questionnaire, please do not hesitate to contact me as following, email address: [mhlekwag@gmail.com](mailto:mhlekwag@gmail.com) or alternatively contact me on 073 125 9304.

Yours Sincerely,

Gcobani Mhlekwana (Mr)



**Evaluating quality management on selected South African Freight Rail construction projects.**

This is purely an academic exercise; do not write your name. No information will be passed on to any authorities, you are safe and protected.

**SECTION A. BIOGRAPHY**

Please cross the applicable boxes

**1. What is your position in the company?**

Project manager	Quality Officer	Project Coordinator	Part of project team
-----------------	-----------------	---------------------	----------------------

**2. How long have you been involved in projects at this level?**

0 - 5 years	6 – 10 years	11 – 15 years	16 – more years
-------------	--------------	---------------	-----------------

**3. How often are you involved in project team meetings?**

Daily	Weekly	Fortnightly	Monthly
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**4. How regular are your project team meetings?**

No meetings	For problems only	No stipulated times	Regular times
-------------	-------------------	---------------------	---------------

**5. Who calls for the meetings?**

Any team member	Project manager	Depot Engineer	Scheduled dates
-----------------	-----------------	----------------	-----------------

**6. Are there managers responsible for the daily basis operations?**

No one	One involved daily	Many involved	The team only
--------	--------------------	---------------	---------------

**7. What department are you involved in? Please indicate in the boxes below.**

Perway	Electrical	Technical Support	Other
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**SECTION B;**

**FUNCTIONS OF THE PROJECT TEAM AND QUALITY OFFICERS.**

Please rank the following by crossing the most applicable. The weightings are; 1 to 5 on an increasing scale (1- least up to 5 - critical / always)

	<b>Quality Management</b>	
--	---------------------------	--

1	I do unscheduled quality tours fortnightly.	1	2	3	4	5
2	I do random sampling of errors and record seen defects weekly.	1	2	3	4	5
3	I do quality survey weekly.	1	2	3	4	5
4	I am aware of the quality policy.	1	2	3	4	5
5	I am aware of the required quality standard.	1	2	3	4	5
6	I do quality audits monthly.	1	2	3	4	5
7	I perform quality control routine weekly.	1	2	3	4	5
8	I perform irregular quality control on weekly basis.	1	2	3	4	5
9	I perform quality monitoring throughout the project life cycle.	1	2	3	4	5
10	Relevant quality documents are compiled by a qualified individual.	1	2	3	4	5
	<b>Project Delays</b>					
11	I always give realistic time schedule in contract.	1	2	3	4	5
12	I do have a full control over sub-contractors.	1	2	3	4	5
13	I do get material delivery delays from vendors.	1	2	3	4	5
14	I do experience rework due to errors in project execution.	1	2	3	4	5
15	I do experience conflict between employer and other stakeholders.	1	2	3	4	5
16	I do experience rework due to change of project scope.	1	2	3	4	5
17	I do get delays due to late payments of contractors.	1	2	3	4	5
18	I do get delays due to late approval of designs and samples.	1	2	3	4	5
19	I manage project budget.	1	2	3	4	5
20	I do experience the shortage of material.	1	2	3	4	5
	<b>Surrounding Communities Safety</b>					

21	TFR provides level-crossing awareness to surrounding communities.	1	2	3	4	5
22	TFR provides information to surrounding communities regarding pollution.	1	2	3	4	5
23	TFR provides safety awareness to surrounding communities regarding the operations of trains.	1	2	3	4	5
24	TFR provides possible health risk information to surrounding communities.	1	2	3	4	5
<b>Company Safety</b>						
25	I am encouraged to attend a safety symposium monthly.	1	2	3	4	5
26	I am encouraged to attend a first aid course every three years.	1	2	3	4	5
27	I am encouraged to attend a SHE training every three years.	1	2	3	4	5
28	I am encouraged to attend a fire fighting training every three years.	1	2	3	4	5
29	I am aware of TFR safety policy and procedures.	1	2	3	4	5
30	Relevant safety documents are compiled by a qualified individual.	1	2	3	4	5

**SECTION C;**

**GENERAL CONCERNS ON QUALITY MANAGEMENT AND HOW IT AFFECTS THE PRODUCTIVITY OF THE COMPANY.**

**Open ended questions,**

**Please state clearly your concerns, likes and dislikes and indicate problems that make you uncomfortable in your role.**

**1. List five things you like most about project participation.**

- .....
- .....

- .....
- .....
- .....

**2. List five things that affect you directly in relation to effective project participation.**

- .....
- .....
- .....
- .....
- .....

**3. List five things you dislike the most in relation to your decision making processes in project participation in Transnet Freight Rail.**

- .....
- .....
- .....
- .....
- .....

**Thank you for your cooperation; please scan and e-mail to [Mhlekwag@gmail.com](mailto:Mhlekwag@gmail.com)**

## **Annexure C: Grammarian certificate**