Cape Peninsula
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FACTORS THAT IMPACT PROJECT QUALITY AT A NUCLEAR POWER PLANT IN SOUTH AFRICA

by

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DECLARATION

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

Signed **Date**

ABSTRACT

The nuclear industry has established stringent controls to ensure that electricity is produced in a safe and reliable manner. It is expected that a nuclear power plant should be operated safely, adheres to processes and procedures that govern those safe operations, and implements projects or modifications that are of a high quality; and this would be considered as ‘business as usual’. This is crucial for an industry that is under constant scrutiny, since every project or modification, which is implemented, is critically judged.

One important contributing factor to the successful operation of any nuclear power plant is the implementation of projects and modifications in accordance with respective nuclear codes and standards, specifications, processes and procedures. The industry demands that this should be a norm, as quality is synonymous with safety and reliability; factors that cannot be compromised or divorced from each other on a nuclear power plant. Recently, however, there has been great concern relating to non-conformances experienced throughout the project lifecycle, which ultimately affects the quality of modifications and projects, which are implemented at the plant.

The research project investigates factors that affect project quality at a nuclear power plant in South Africa. Against the above backdrop, the research problem was “the delivery of poor quality projects have an adverse effect on modifications and projects, which are implemented at the nuclear power plant in South Africa”.

The primary research objectives of this study are the following:

- To investigate the root cause and impact of inconsistent project quality practices on the project lifecycle; and
- To recommend measures that should be established to improve the way in which project quality is conducted throughout the project lifecycle.

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DEDICATION

The author dedicates this dissertation to all mothers who dare to dream on behalf of their children, and to the children who make a mother's dream come true. To all parents who wish to see the goodness of God in the land of the living and actually live to see their own do them proud. To all factory workers, domestics, tea ladies, and garden workers who toil tirelessly so that their own children can have an even better life. This dissertation is for you, from the daughter of a factory worker; we are of the same cloth.

GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
IAEA	The IAEA is the world's nuclear inspectorate, with more than four decades of verification experience. Inspectors work to verify that safeguarded nuclear material and activities are not used for military purposes.
IMS	An Integrated Management System is a single integrated system used by an organisation to manage the totality of its processes, in order to meet the organisation's objectives and equitably satisfy the stakeholders.
INPO	International Nuclear Power Operators
ISO	International Organisation for Standardisation: ISO, a voluntary, non-treaty federation of standards setting bodies of 130 countries. Founded in 1946-47 in Geneva as a UN agency, it promotes development of standardisation and related activities to facilitate international trade in goods and services, and cooperation on economic, intellectual, scientific, and technological aspects.
KNPS	KNPS Nuclear Power Station
Modification	The equivalent of a project in nuclear terms
NNR	The National Nuclear Regulator
NNRA	National Nuclear Regulation Act
NRC	National Regulation Commission
NPM	Nuclear Project Management
NPP	Nuclear Power Plant

NTP	Nuclear Technical Plan
OSART	Operational Safety Review Teams
PLCM	Project Life Cycle Model
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PQE	Procurement Quality Engineering
PN	A problem notification is a tool that is used to highlight issues/problems with the aim of putting corrective action in place to deal with such problems
Process	A set of interrelated or interacting activities which transforms inputs into output. ISO 9000: (2005:7)
QA	Quality assurance, or QA for short, refers to planned and systematic production processes that provide confidence in a product's suitability for its intended purpose.
QADP	Quality Assurance Data Package
QAP	Quality Assurance Programme
QMS	Quality Management System : Collective policies, plans, practices, and the supporting infrastructure by which an organisation aims to reduce and eventually eliminate non-conformance to specifications, standards, and customer expectations in the most cost effective and efficient manner.
RD0034	Quality and Safety Management Requirements for Nuclear Installations. This Requirements Document was developed by the NNR to address Nuclear Safety and Quality Management.
RFP	Request for Proposal
WANO	World Association of Nuclear Operators

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CHAPTER ONE

PROJECT QUALITY: SCOPE OF THE RESEARCH

1.1. Introduction

South Africa is the only African country that uses nuclear energy to generate electricity. The Koeberg Nuclear Power Station (KNPS) ensures a dependable supply of electricity to the Western Cape, and has operated safely for more than 25 years. It also has a further active life of 30 - 40 years. The station's reactors supply 1 800MW of South Africa's electricity; which translates into 5% of electricity that is produced of the total electricity grid.

The nuclear industry is one where stringent controls are established to ensure that electricity is produced in a safe and reliable manner. It is expected that a nuclear power plant is operated safely; adheres to processes and procedures that govern those safe operations; and implements projects or modifications that are of a high quality, which is all considered as business as usual. This is crucial for an industry that is under constant scrutiny, since every project or modification that is implemented is critically judged. It, therefore, leads to the industry to be viewed as an unforgiving one. Devastating past nuclear events have forced the rules to become even more rigorous, and with South Africa embarking on nuclear new build, KNPS has to prove that it can implement modifications and projects of a high quality for nuclear to remain a viable option in South Africa. KNPS should, therefore, be leaping and not limping into the nuclear future as the country, public and economy depends on it.

One important contributing factor to the successful operation of this plant is the implementation of projects and modifications in accordance with respective nuclear codes and standards, specifications, processes and procedures. The industry demands that this should be a norm as quality is synonymous with safety and reliability; factors that cannot be compromised or divorced from each other on a nuclear power plant (NPP). Recently, however, there has been great concern relating to non-conformances experienced throughout the project lifecycle which ultimately affect the quality of modifications and projects that are implemented at the plant.

Project quality is one aspect for which trade-offs are constantly made, which makes adherence to project quality a continuing concern. It has been observed that poor quality projects can have far reaching consequences, especially when quality is treated like a stepchild of project success, where project managers adhere more to time and cost rather than quality. Literature suggests that there is never time to do the right thing the first time, but there is always time to do it over.

The NPM performs various duties in the management of modifications at the plant. These include the execution of projects to the plant asset creation process, plant related modifications motivated predominantly for operational needs, and in accordance with international standards required to operate plants and the NNR. These are implemented in accordance with the Project Lifecycle Model (PLCM) **(Appendix B)**.

Information, which determine factors that influence project quality and what in the project environment allows these to persist, was collected from the NPM, external departments with staff seconded to the NPM (Nuclear Engineering and Nuclear Project Sourcing), external departments with direct influence on NPM processes and procedures [(Quality Assurance (QA), Project Quality Engineering (PQE)] and contractors. While information was obtained via a survey, historical data that relate to project quality and its influence on the project lifecycle was gleaned from databases and archives.

The Nuclear Project Management Department (NPM) has been tasked with implementing modifications and projects at KNPS; hence it is the subject of this research. To this end, the mandate of NPM is to develop, manage, execute and monitor projects on behalf of KNPS in accordance with its management processes regarding time, budget, scope, quality, safety, health and environment. They are also the custodian of the Nuclear Technical Plan/Business Plan (NTP). NPM has the responsibilities to:

- Provide project management services for the projects and modifications;
- Develop and maintain standards for nuclear projects;
- Minimise outage duration through optimised project plans and production planning, which include close interfaces with Plant Management and, in particular, Outage Management;
- Develop and manage operational, strategic engineering, safety and long term asset management projects for KNPS. The term “develop” implies that the client/project requestor has a clear problem statement or need (acceptance criteria), and participates through the assignment of key staff in the development of this need into a project concept and scope. The term “manage” implies that on receipt or approval of an approved technical requirement specification, NPM is the responsible lead for implementation;
- Manage the medium term NTP (inputs complied by Nuclear and Plant Engineering, moderation and acceptance by KNPS, integration with the Life of Plant Plan (LOPP) is included;

- Manage project engineering and specialist services or subject matter experts who are seconded from Engineering or other departments;
- Provide the function of strategic and detailed planning, scheduling and control of all modifications and projects within the department as well as interfacing with KNPS, Finance and Commercial departments, to agreed milestones;
- Provide the function of project management, quality control and quality assurance of the project lifecycle;
- Manage the training and development of project managers for nuclear projects;
- Support the Nuclear Centre of Excellence (CoE) to develop the project execution plan for the client office. This includes scoping, planning, costing and execution of the owner's scope;
- Monitor and report on configuration control for project document changes;
- Establish links with Eskom's CoE for Project Management; and
- Conduct project review readiness assessments for nuclear projects.

The Nuclear Project Management Integrated policy is summarised as:
Meet the National Nuclear Regulator (NNR) and customer requirements by ensuring the competency of staff through continual improvement of personnel and processes while ensuring the safety of man and environment. **Figure 1.1** below is the Nuclear House and what NPM represents.

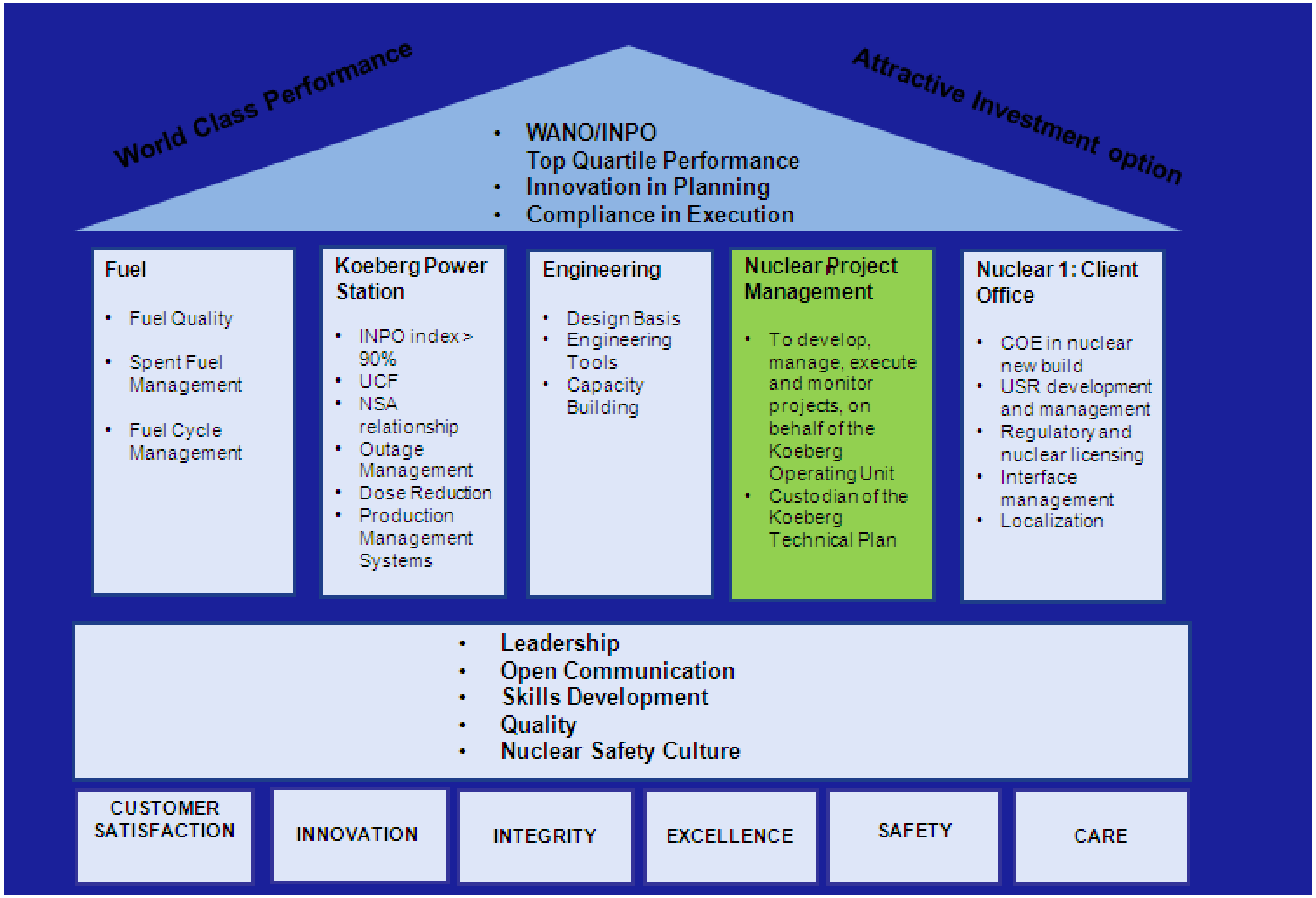


Figure 1.1: The Nuclear House of NPM

The research addressed the benefits of consistently implementing quality in modifications and projects at KNPS, and the detriments of a lack thereof. NPM will benefit from the research in the following ways:

- Areas for improvement, as it relates to project quality throughout the project lifecycle, will be identified;
- Effective areas in the project lifecycle will be highlighted;
- The importance of effectively and consistently using clearly defined processes in the implementation of quality in projects will be highlighted; and
- The research will highlight ways in which confidence from the plant, stakeholders, sponsors and regulatory bodies can be reinforced and maintained.

1.2. Statement of the research problem

Against the above backdrop, the research problem was “the delivery of poor quality projects have an adverse effect on modifications and projects, which are implemented at the nuclear power plant in South Africa”.

1.3. Background of the research problem

Like many other nuclear power plants around the world, the KNPS has confidently demonstrated, to the satisfaction of the NNR, that it can be operated safely and efficiently for a much longer period than was envisioned when it was first designed. From plant life extension studies, which are currently being performed, KNPS’s life can be extended from 40 to 60 years. This of course means that major components should be replaced (some of which will be world firsts) rather than be maintained, and hence extra care should be taken when introducing these major changes to the plant with the implementation of quality modifications and projects.

The KNPS, while demonstrating its ability to operate safely and efficiently is, however, struggling with project quality and this is evident with the projects, which have been introduced at the plant, in recent years. There has been a decline in the quality of modifications and projects implemented on the plant and contributing factors are evident throughout the project lifecycle. These quality issues result in re-work, longer outages, and undue pressure on the national grid, which in turn, leads to a loss of power to customers and a loss of revenue to the organisation. Evidence of this quality decline is recent findings where the plant achieved an unhealthy appraisal with regard to the quality of projects, which have been implemented. This pattern cannot be entertained if KNPS is to meet organisations’ and stakeholders’ goals and objectives of implementing high quality modifications.

The purpose of this research is to investigate factors that impact project quality throughout the project lifecycle; making recommendations on how negative factors can be eliminated, while positive ones can be reinforced in support of better performance of the NPM organisation. The research was conducted within NPM as well as other departments that have an input into its processes and outputs. NPM consists of the following sections: (refer to **Appendix A**: NPM Organisation Structure)

1. Project development;
2. Project execution (operational);
3. Construction management;
4. Programmes management;
5. Monitoring and support (planning and quality assurance / quality control);
6. Contracts Management
7. External departments with seconded staff during this research, which form part of project teams and have a direct impact on NPM include:
    a. Nuclear engineering;
    b. Nuclear project sourcing; and
    c. Nuclear project finance;
8. External departments with a direct influence on NPM processes in terms of the research topic include:
    a. Quality assurance
    b. Project quality engineering; and
9. Suppliers/contractors/vendors.

1.4. Research question

The question that drove this research may be succinctly stated as follows:

"What factors affect project quality, either negatively or positively, and what allows these to persist within the nuclear project management environment"?

1.4.1. Investigative sub- questions

The investigative sub-questions that were researched in support of the research question are as follows:

- How well do management and project teams understand their role in order to ensure project quality in modifications on a nuclear power plant is South Africa?
- To what extent are stakeholders actively involved in projects and project quality on the nuclear power plant in South Africa?
- How well are processes and procedures applied to ensure project quality on the nuclear power plant in South Africa?

- How well do suppliers interpret project quality requirements specific to the nuclear industry?
- Is the nuclear power plant of South Africa in a healthier state once modifications have been introduced to it?
- Which gaps should be bridged so that project quality is continually implemented in the nuclear industry in South Africa?

1.5. Objectives of the research

The following research objectives that were considered in this research are to:

- Investigate the root cause and impact of poor project quality practices on the project lifecycle; and
- Recommend measures to improve the way in which project quality is conducted throughout the project lifecycle.

It is anticipated that the research will lead to an improvement in the way that project quality is viewed and conducted throughout the project life cycle, and not only during the execution phase; this should improve the overall service or project quality, which is delivered by the Nuclear Project Management Department.

1.6. Delineation of the research

Research constraints (limitations or de-limitations) relate to any inhibiting factor, which would constrain the researcher's ability to conduct research. According to Collis and Hussey (2003: 128-129), 'limitations' identify weaknesses in the research, while 'de-limitations' explain how the scope of the study was focused on a particular area, as opposed to a wider or holistic approach. The research constraints are as follows:

- **Limitations:** The focus of the research was on project quality at a nuclear power plant (NPP) with a specific focus on the project lifecycle; and
- **De-limitations:** The research was confined to the NPM and questionnaires were specific to relevant stakeholders who are involved in the project lifecycle.

The constraints that had an impact on this research are:

- Availability of participants, as the survey was conducted during a Short Duration Outage (SDO). These were overcome by targeting respondents via e-mail and giving them an opportunity to complete the questionnaires in their free time;
- Accessibility to information / database - sensitivity of information of an NPP. The researcher was granted permission by Senior Management to conduct the research. Furthermore, only information that was not classified was utilised; and

- Low response from suppliers to participation in the SDO. Those targeted had very few projects in the SDO and were therefore available to complete the questionnaire.

1.7. Significance of the research

All modifications and projects have a significant impact on the plant and its performance, hence careful consideration should be given to project quality. The research compels NPM to view project quality through fresh eyes, and hence improve its service to the plant, relationships with internal and external stakeholders, and honour its mandate by consistently implementing quality modifications and projects; perhaps become a benchmark for the nuclear fraternity. The departments that have a direct impact on outputs can ascertain where they are able to improve the way in which they do business with NPM relative to project quality and suppliers can better understand the vital role that they play in deliverables, and feel valued as partners by ensuring project quality at KNPS.

1.8. Expected outcomes, results and contribution of the research

It is anticipated that the research will lead to an improvement in the way that project quality is viewed and conducted throughout the project life cycle, and not only during the execution phase; this should improve the overall service or project quality, which is delivered by the Nuclear Project Management Department.

For the purpose of this research, the following outcomes are envisaged:

- All involved in the project lifecycle will apply themselves to ensure that proactive and effective project quality is pivotal to the delivery of projects at the plant;
- Ensured continuity and consistence in attaining project quality at all times;
- Increased confidence from stakeholders, sponsors, and regulatory bodies; and
- The researcher will benefit by obtaining a degree as a result of the research.

1.9. Summary

The chapter and content analysis as it applies to this dissertation, read as follows:

- **Chapter 1: Scope of the research**

  This chapter provided a brief introduction, as well as a background of the research. The research process was explained, followed by formulation of the research problem, the research question and supporting investigative questions. The research assumptions and constraints were listed, feeding into the overall research design and methodology, including the research assumptions and key research objectives.

- **Chapter 2: Project quality: A literature review**

  Factors that affect project quality at an NPP were researched by using various media, textbooks and articles, which were reviewed and studied. Guidelines, standards, processes and procedures that are applicable to projects at an NPP were also consulted, as well as the KNPS Library.

- **Chapter 3: Research design and methodology**

  This chapter includes the chosen method of research design and methodology. It also includes how participants were selected, how the research instrument was developed, and how it was administered during this research.

- **Chapter 4: Data analysis and interpretation of results**

  This chapter discusses how the collected data was analysed and how results were interpreted. It also describes and analyses information that was gleaned from databases in further support of the research.

- **Chapter 5: Recommendations and conclusions**

  This chapter concludes the research and provides some recommendations, which are based on the research study's findings.

CHAPTER TWO

PROJECT QUALITY: A LITERATURE REVIEW

2.1 Introduction

As part of the literature review media such as journal articles, books and the Internet were consulted, as well as processes and procedures, which are unique to nuclear power plants. This was done to gain an understanding of how project quality should be properly integrated into the business.

In this literature review factors that affect project quality at an NPP are discussed, and the following topics are covered:

2.1.1 What is a project?
2.1.2 What is a modification?
2.1.3 What is project management?
2.1.4 What is project quality?
2.1.5 Quality and the triple constraint;
2.1.6 What is quality management? and
2.1.7 Factors that influence project quality at an NPP.

2.2 What is a project?

The Project Management Book of Knowledge (PMBOK, 2008:5) and Meredith and Mantel (2012:10) define a project as a temporary endeavour, which is undertaken to create a unique product or service. Temporary: project has a definite beginning and a definite end; and unique: product or service is different in some distinguishing way from all similar products or services. Pinkerton (2003:4-7), whose definition is closest to nuclear, explains that a project is a plan, scheme, and an organised undertaking with the following eight elements:

- Project origination and definition;
- Pre-project planning and organisation;
- Design, procurement and pretesting;
- Construction and installation;
- Training;
- Preoperational testing;
- Start-up (commissioning) and initial operations; and
- Closeout and good analysis.

Kerzner (2006:53), in citing the NASA/Air Force definition, states that "a project is within a program as an undertaking that has a scheduled beginning and end and that normally involves some primary purpose". According to Young (2007:9-10), the project is something special by its nature and may be defined as a collection of linked activities, which are carried out in an organised manner with a clearly defined start point and finish point in order to achieve some specific results that satisfy the needs of an organisation, as derived from the organisation's current business plans. It is, therefore, a temporary endeavour to achieve certain specific objectives in a defined time.

Burke (2009:17) illustrates that the distinctive features of a project include:

- A start and finish;
- A lifecycle;
- A budget with an associated cash flow;
- Activities that are essentially unique and non-repetitive;
- Use of resources from different departments, which need coordinating;
- A single point of responsibility (i.e. the project manager);
- Fast tracking; and
- Team roles and relationships that are subject to change and need to be developed, defined and established (team building).

Campagna *et al.* (2006:8) illustrates in **Figure 2.1** below that the integration of all the elements that are required to make a project successful can pose a challenge.

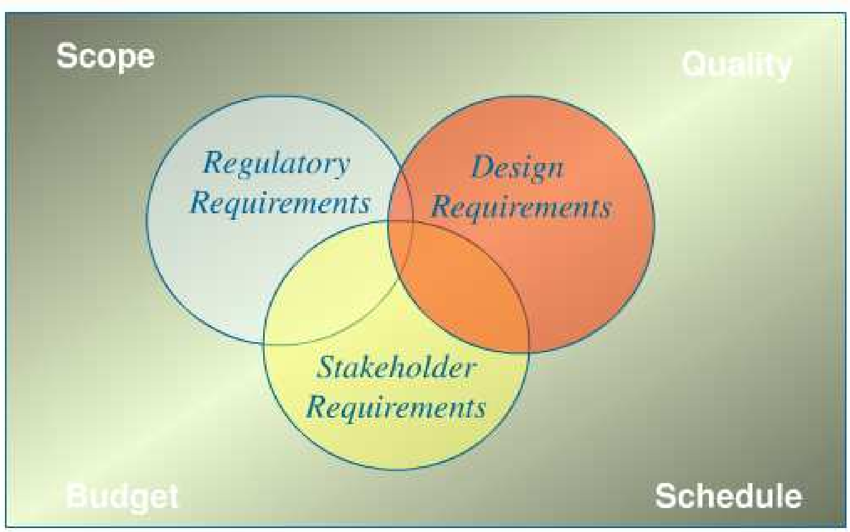


Figure 2.1: Project challenge-integration. Source: Campagna, Lenyk and Hess (2006:8)

2.3 What is a modification?

In the nuclear industry the term modification is widely used to define a project, which is undertaken at an NPP. Marcos and Taylor (1988:235-242) explain that a nuclear plant modification or back fit usually refers to a change in an operating nuclear plant's systems. This can be hardware or procedures, which are intended to meet new regulations, change or improvement of performance, repair of troublesome components, reduction of personnel's exposure to radiation, and/or the reduction or simplification of maintenance. Furthermore, modifications have become an important investment for the power industry, since the number and complexity of rules applied to such work, as well as the extent of modifications and the amount of regulatory scrutiny received, have rapidly escalated. An outage, for example, is considered successful if the units are returned to service on schedule and measured on the timely completion of related modifications. The success of quality modifications, therefore, depends on meticulous pre-outage planning, adherence to quality provisions in the design, procurement, construction, testing and operation of the modified systems. This also includes the detailed review of the impact of the modification on the plant and its licensing commitments.

The International Atomic Energy Agency (IAEA) (2001:1-6) states that while new regulatory requirements, ageing of the plant or obsolescence of equipment deem some modifications necessary, the benefits of regularly updating the plant design can be placed at risk if modifications are not kept under rigorous control throughout the lifetime of the plant. Modifications should affect the plant’s ability to be operated safely in accordance with the assumptions and intent of the design. According to the IAEA, reasons for carrying out modifications to nuclear power plants are:

- maintaining or strengthening existing safety provisions and thus maintaining consistency with or improving on the current design;
- recovering from plant faults;
- improving the thermal performance or increasing the power rating of the plant;
- increasing the maintainability of the plant, reducing the radiation exposure of personnel or reducing the costs of plant maintenance; and
- extending the design intended to improve on the design or to improve operational performance and flexibility.

The NEA/CSNI/R (2005/10:15-16) supports the view that modifications may be generated by internally or externally driven initiatives owing to either operational experience or new regulatory requirements to improve safety or economic performance, or to replace obsolete equipment. They do, however, also have the potential to introduce new challenges to safe and economic performance on the plant. It is further stated that the need for plant modifications arises from:

- the physical ageing of plant systems, structures and components;
- obsolescence in hardware and software;
- feedback from operating experience within the station;
- lessons learned from events and incidents at other plants in the world;
- research that reveals problems with old solutions or presents new opportunities;
- changes in engineering methods and standards;
- opportunities for improvements in plant safety;
- changes in expected performance of the plant;
- changes in organisational and operational practices; and
- changes in regulatory requirements.

2.4 What is project management?

The IAEA (1988:18-25) defines project management as the function of defining, steering, controlling and correcting a project or major parts of it. The guide lists project management tasks and functions as one of the following:

The main functions of project management can be grouped into two categories:

- Getting the job done; and
- Controlling the project work.

Getting the job done usually involves:

- Defining the project's requirements and regulatory and quality assurance requirements;
- Setting aims and milestones, defining, sequencing and initiating the tasks of the project in agreement with the sections and departments involved; ensuring the availability of funds and manpower;
- Dealing with problems, which hinder the progress of the project or threaten its quality; and
- Co-ordinating the project's activities.

Controlling the project work involves:

- Conducting regular meetings with project staff, line organisations and project partners to monitor progress, take necessary corrective actions and communicate essential project information;
- Controlling expenses and project performance against the contracts, budget and schedule, and obtaining proper authorisation for major changes; and
- Monitoring the technical progress of the project in terms of analyses, specifications and drawings by ensuring high quality and compliance with requirements, and authorising equipment specifications for manufacturing and construction.

The IAEA (1988:74) states that a successful nuclear power project is one where the plant is designed, constructed and put on line within the schedule, budget and technical parameters that are established. Project management's primary focus should, therefore, be on the effective use of project resources to produce a high quality plant. The guide states that in order to gain maximum benefit, scheduling must be much more than merely setting target dates and monitoring accomplishments.

According to PMBOK (2008:6), project management is the application of knowledge, skills, tools and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. It explains how meeting or exceeding stakeholder needs and expectations invariably involve balancing competing demands among:

- Scope, time, cost and quality;
- Stakeholders with differing needs and expectations; and
- Identified requirements (needs) and unidentified requirements (expectations).

Conversely, Kerzner (2009:2-4) defines project management as "the art of planning, organising, monitoring, controlling, and reporting of all aspects of a project and the motivation of all those involved in it to achieve the project's objectives", and further believes that it is the planning, organising, directing, and controlling of company resources for a relatively short-term objective that has been established to achieve a specific goal. Project management must achieve the following objectives:

- Within time;
- Within cost;
- At the desired performance/technology level;
- While utilising the assigned resources effectively and efficiently; and
- Accepted by the customer.

Figure 2.2 illustrates an overview of project management as a triangle of time, cost and performance/technology, which all requires resources to be realised and are ultimately links to good customer relations.

Figure 2.2: Overview of project management. Source: Kerzner (2009:4)

The IAEA (1988:18), in crafting a definition for the nuclear industry, states that "project management is the function of defining, steering, controlling and correcting a project or major parts of it. It can further be defined as a technique for the efficient expenditure of resources to achieve a desired result. It defines work to be done, estimates resources that will be required to accomplish the work, controls the quality of the work, monitors the expenditure of the resources, monitors the progress towards the final objectives, and makes corrections in all the foregoing, as may be required to achieve the ultimate goal".

Meredith and Mantel (2012:16-17) believe that the reason for initiating a project is to accomplish specific goals with the responsibility and authority for the attainment of goals on an individual or small group. This has an added advantage of a sharper orientation towards results, better interdepartmental coordination and higher worker morale.

Project management is therefore all applicable tools that ensure project success being used in such a way that success is guaranteed

2.5 What is quality

Ireland (1991:I-4-5) states that “quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.” Hawkins and Pieroni (1991:29-33) assert that in the broadest sense, quality is the degree of excellence that an item or service possesses based on the user's needs. It is achieved by consistently meeting defined requirements. According to Juran (1999:2.1-2.2), “quality means those features of products, which meet customer needs and thereby provide customer satisfaction. It also means freedom from deficiencies. The ISO 9000 (2005:7) defines quality as the “degree to which a set of inherent characteristics fulfils requirements with the term “quality” being used along with adjectives such as poor, good or excellent. “Inherent”, as opposed to “assigned”, means existing in something, especially as a permanent characteristic and requirement, which means the need or expectation that is stated, generally implied or obligatory.” While Rose (2005:3-7) agrees with this definition, he warns that if customers or stakeholders’ requirements are ignored, it will be to the detriment of project success.

Furthermore, much misunderstanding around quality still exists in spite of the various definitions in circulation with quality being many things to many people. The author advances the argument that one important aspect of quality that is not included in any of the popular definitions is that quality is “counter entropic”; it is not the natural order of things. Irrespective of its definition, the author concludes that quality is not a naturally occurring event, it is hard work that begins with planning, includes consideration of contributing elements applies disciplined processes and tools and never, ever ends.”

Jha and Iyer (2006:1155-1156) concede that the world’s oldest documented profession has many definitions, but explains that quality in its simplest form can be defined as: ‘meeting the customer’s expectations,’ or ‘compliance with a customer’s specification’ becoming complex when we try to put it into actual practice. Kerzner (2006:833-834) believes that mature organisations readily admit that they cannot accurately define quality and are fully aware that it is defined by the customer. Baily *et al.* (2008:132) espouses that quality has quite a few meanings and connotations, hence they lean towards the idea of quality being whatever the customer says it is.

Kerzner's (2009:875) take on quality is quite fitting for the nuclear industry, focusing it more on:

- Operability: the degree to which a product can be operated safely;
- Reliability: the probability of the product performing without failure under given conditions and for a set period of time;
- Different pioneers over the years have had their own views as to what quality is. **Table 2.1** below lists the changing views of quality.

Table 2.1: The changing views of quality. Source: Kerzner (2009:874)

Past	Present
Quality is the responsibility of blue-collar workers and direct labour employees on the floor	Quality is everyone's responsibility, including white-collar workers, the indirect labour force and the overhead staff
Quality defects should be hidden from the customers (and possibly management)	Defects should be highlighted and brought to the surface for corrective action
Quality problems lead to blame, faulty justification and excuses	Quality problems lead to cooperative solutions
Corrections to quality problems should be accomplished with minimum documentation	Documentation is essential for "lessons learned" so that mistakes are not repeated
Increased quality will increase costs	Improved quality saves money and increases business
Quality is internally focused	Quality is customer focused
Quality will not occur without close supervision	People want to produce quality products
Quality occurs during project execution	Quality occurs at project initiation and must be planned for within the project

2.6 What is project quality?

Ireland (1991:VII-1) argues that infusing quality into projects is achievable through a dedicated effort of setting standards for the work, understanding the customer's requirements and implementing those requirements in all documentation and actions. The author also states that project quality is achieved through planning; directing and implementing actions that are consistent with the concept of "*do the right thing right the first time"* with the foundation for project quality being the use of tools of modern quality management to monitor, evaluate and assess the processes while conducting continuous improvement. Ireland (1991:VII-1) infers that initial efforts should be focused on understanding customer requirements and achieving a mutual understanding of the technical approach to meeting them, preparing well-structured plans, which are based on those requirements, and anticipating the course of work and the degree of difficulty involved in implementing each part of the project. The author, therefore, concludes that quality is a combination of meeting customer requirements, keeping the customer informed of progress, and being able to change the course of work to meet emerging requirements.

Goff (2008:1-5) agrees with Ireland (1991:I-4-5) and states that many presume that project quality demands more and hence resulting in implied needs bias of stakeholders and team members' preferences about project results. This is owing to an inability to measure project quality in clear terms until it is too late to correct a defective project process or product. Revuelta (2004:67-71) analysed meaningful trends in significant events and identified those, which can also be interpreted as the risk of not fostering quality culture. Revuelta (2004:67-71) raises the warning flags of potentially declining plant performance, leading to extended shutdown periods:

- overconfidence: living on past successes;
- isolationism: few interactions/benchmarking, lagging behind and not knowing it;
- weak relationships: defensive relations with regulator, reporting problems not valued by the management;
- production priorities: important equipment problems not fixed;
- operations and engineering: weak standards and discipline, operations focus overshadowed;
- managing changes: organisational changes not well managed;
- plant events: not correctly addressed, organisational causes not explored;
- nuclear leaders: senior managers without the right experience or not involved in operations; and
- weak self-critical attitude: assessment of problems not critical enough, as they do not find or correct problems.

Rose (2005:11-12) explains the benefits of quality in project performance as how a quality project or product yields customer satisfaction; the greater value that is recognised by a satisfied customer than originally anticipated; leading to something more than customer satisfaction; customer delight; and the last benefit being that of reduced costs. The author construes that implementation of quality processes, therefore, reduces waste, improves efficiency, improves supplies and remains one of the key elements of any organisation, as it perpetually points out the most important aspect of success, namely that of customer satisfaction.

2.7 What is project quality management?

"Project quality management processes include all the activities of the performing organisation that determine quality policies, objectives and responsibilities so that the project will satisfy the needs for which it was undertaken. It implements the quality management system through the policy, procedures and processes of quality planning, quality assurance and quality control with continuous improvement activities conducted throughout as appropriate" (PMBOK Guide, 2008:189).

According to Juran and Godfrey (1999:194), the expected results of quality management are better organisational performance, increased productivity, more effective and efficient processes, and more competitive products (PMBOK Guide 2008:189). Furthermore, project quality management addresses the management of the project and the product of the project; implying that it applies to all projects, regardless of the nature of their product. Project quality management approaches apply to both project and product quality. In either case, failure to meet product or project quality requirements can have serious negative consequences for any or all of the project stakeholders.

The identified eight principles of quality management are:

- Customer focus;
- Leadership;
- People involvement;
- Process approach;
- Systemic management approach;
- Continuous improvement;
- Information-based decisions; and
- Mutual benefits in relationships with suppliers.

Rose (2005:41-42) and Burke (2009:255), in citing the PMBOK Guide, describes three elements of quality management: quality planning (identify quality standards, which are relevant to the project and determine how to satisfy them); quality assurance (evaluate the overall project performance on a regular basis to provide confidence that the project will satisfy the applicable quality standards); and quality control (monitor specific project results and determine if they satisfy quality requirements), which is in contrast to Juran and Godfrey (1999:2.5) who describe them as quality planning, quality control and quality improvement. Rose's (2005:3-7) approach combines these views to include quality planning, quality assurance, quality control and quality improvement. Kerzner (2006:845) highlights the six quality management concepts that should exist to support each project and are ideally embedded within the corporate culture as:

- Quality policy;
- Quality objectives;
- Quality assurance;
- Quality control;
- Quality audit; and
- Quality programme plan.

2.8 Quality assurance

In the nuclear industry, when referring to the quality of projects and programmes, the term quality assurance is widely used. The IAEA (1988:4/19) stresses that the establishment and implementation of a Quality Assurance Programme (QAP) for an NPP is an integral part of plant design, which should provide for a disciplined approach to all activities that affect quality, including verification that each task has been performed to acceptable levels and providing documented evidence which demonstrates the achievement of the required quality. To this end, the following should be in a QAP, “procedures, necessary instructions and drawings, periodical management reviews, organisation responsibility, authority, communication, organisational interfaces, staffing and training, document control, document preparation, review and approval, document release and distribution, document change control, design control, design interface control, design verifications, design changes, procurement control, supplier evaluation and selection, control of purchased items and services, identification and control of materials, parts, components, handling, storage and shipping, maintenance, process control, inspection and test control, programme of inspection, test programme, calibration and control of measuring and testing equipment, indication of inspection, test and operating status, non-conformance control, non-conformance review and disposition, corrective actions, records, preparation of QA records, collection, storage and preservation of QA records, audits, and scheduling of audits”.

According to the IAEA (1988:84-87), quality assurance is "…all those planned and systematic actions necessary to provide adequate confidence that an item or facility will perform satisfactorily in service". It, therefore, represents a management control system that must be established and used in the realisation of the quality objectives. An effective methodology for detecting, correcting and preventing failures is the implementation of an adequate quality assurance programme.

According to the IAEA’s (1998:94-95) recommendations, when participating in activities, which affect the quality of the NPP, shall establish a documented organisational structure where the functional responsibilities, levels of authority and lines of internal and external communication are clearly defined. The organisational structure shall recognise that execution of the QAP involves both performers and verifiers and is not the responsibility of a single group. It should also recognise sufficiently well in advance commencement of the work to ensure its effective implementation. Furthermore, the QAP based on the IAEA recommendations, establishes an effective management tool that can be used by the utility, as well as by the regulatory body, to obtain confidence that the plant will perform satisfactorily in service. The regulatory inspections must correlate with the established QA requirements, and make use of results, which are obtained by the plant owner. They should serve as an effective way of corroborating that the QA programme is being performed correctly. However, this corroboration does not relieve the utility project management of the primary responsibility for effectiveness of the QAP.

Hawkins and Pieroni (1991:29-33) argue that a QAP is often misinterpreted as only a regulatory demand and/or paperwork with no effective impact on the overall performance of the nuclear project. The authors agree that an effectively implemented QAP, which govern all aspects of a nuclear power project, is an essential management tool, which works when management, those who perform work and those who assess work, all contribute to quality in a concerted and cost effective manner. Furthermore, by implementing a QAP, the quality of performance is achieved in a more effective, timely and productive manner when it is built into day-to-day operations, rather than rely on inspection by another organisational unit after-the-fact.

The IAEA Code of Practice in Safety Series No. 50-C-QA - Safety Series No. 50-C/SG-Q (1996:8, 31-35) and IAEA-TECDOC-1305 (2002:1-13) prescribe that a QAP includes details of how work should be managed, performed, and assessed; the organisational structure; functional responsibilities; levels of authority and interfaces for those managing; performing and assessing the adequacy of work, while addressing management measures including planning, scheduling and resource consideration. The code further dictates that the QAP, however, should not be regarded as the sole speciality of any single group, and should, therefore, provide an interdisciplinary approach that involves many organisational components and demonstrate integration of the following principles:

- Managers provide planning, direction, resources and support to achieve the organisation's objectives;
- Staff perform the work to achieve quality; and
- Staff perform assessments, and evaluates the effectiveness of management processes and work performance. The QAP shall be binding on everybody.

The code further prescribes that since management has the unique responsibility of determining how to achieve the vision/mission of the organisation during each stage of plant life by providing the vision and inspiration to motivate the organisation to higher levels of performance, they should develop, implement and maintain a QAP, which includes, amongst others, the following in its description:

- Management's quality policy statement;
- The mission and objective of the organisation;
- The organisational structure and outline of the management procedures;
- The level of authority, responsibilities and accountabilities of persons and organisational units;
- The lines of internal and external communications and interface arrangements;
- The responsibilities of each organisation involved in the work;
- Requirements for the development of detailed working documents for the performance and assessment of work; and
- Arrangements to measure effectiveness and to manage self-assessment of the quality assurance programme.

The Safety Series No. 50-C/SG-Q (1996:31-32) further advocates that since the success of an organisation's QAP is determined by management support and actions, it is imperative that management expresses, in issued policy statements, their commitment to quality and safety, and to the implementation of the QAP as a vehicle to achieve. The guide inculcates that the quality policy should be reviewed periodically to ensure that it accurately reflects current organisational objectives and priorities. "Management must demonstrate its commitment to quality policy through its actions and provide firm and unambiguous support for its implementation. The actions should foster a corresponding commitment to high levels of performance by all personnel, who in turn, should be expected to demonstrate their commitment to the policy" Safety Series No. 50-C/SG-Q, 1996:31-32).

"All planned and systematic actions necessary to provide adequate confidence that an item or service will satisfy given requirements for quality" (Petrangeli, 2006:93).

2.9 Quality and the triple constraint

Rose (2005:6) explains that the project "triple constraint" includes time, cost and scope with all three elements being of equal importance to project success, and project managers typically attempt to balance the three when meeting project objectives, but inevitably make trade-offs among them during project implementation in order to meet objectives and satisfy customers. The author, therefore, introduces a new model and throws in quality as a fourth among equals by explaining that quality may be most closely associated with scope, as they are both based on customer requirements. This linkage is believed to address the quality of the project. The author then explains the disagreement with the school of thought that suggests that quality is part of a quadruple constraint which comprises time, cost, scope and quality, and firmly believes that project managers should routinely make trade-offs among the triple constraint to meet project objectives, whilst believing that a project manager should never trade off quality during project implementation.

Jha and Iyer (2006:1155-1156) explain that in the realm of project management, schedule, cost and quality achievement is also referred to as the iron triangle with the achievement of schedule and cost compliances being attended to most of the time, and project quality sometimes being overlooked, resulting in a half-hearted attempt to achieve quality. The authors believe that although many studies have recognised the importance of maintaining and embarking on quality projects, these aspects are sacrificed in lieu of achieving short-term objectives such as the handover of some critical structures, or those that fall in the critical path.

The IAEA Guidebook (2007:68-11,3/8p) ascribes success of a nuclear controls project (for example of an NPP project) to the following:

- **Meet minimum quality standards**

  Quality standards are defined by a project's documented technical objectives. which are approved by stakeholders, without which, systems cannot operate. When systems do not work as planned, the project fails to meet minimum quality standards.

- **Complete within budget**

  Installation cost is the largest part of a project's total cost and is susceptible to escalation. This is the area that should be analysed early in the process to allow cost to be managed effectively with the two cost management techniques, namely:

  - "Design to cost," which requires developing a target cost during a project's conceptual stage, and then checking and validating the feasibility of meeting that cost several times during the design phase; and
  - Focusing on installation costs during the design phase in order to minimise total project cost. Installation costs can be reduced by providing more design details, but providing more details for costs that are incurred, which make trade-offs necessary.

- **Complete on time**

  Adhering to project schedules, especially those to complete installation and testing within the duration of the planned refuelling outage, is critical. Both cost and quality of a project are adversely impacted by slippages so schedules must account for unforeseen delays and the time, which is required to resolve issues that are inevitably raised by factory acceptance and post-installation tests.

2.10 Planning for quality in projects

Ireland (1991:III-1) believes that planning a project requires an understanding of the needs of individuals, elements of a project plan, supporting plans, test requirements and the project as a success and, therefore, viewing and planning a project as a process gives new insight into techniques to achieve a quality orientation during the early stage of a project, and ultimately project success. The author further states that planning implies the ability to anticipate situations and prepare actions that will bring out the desired outcome, as well as communicating the correct actions in a form, which is understandable and complete.

The author also highlights that since the requirements for quality must be integrated into the project plan, it is necessary to examine the project as it is defined and the product which it should deliver; therefore, both planning knowledge and planning skills are essential to the development of a comprehensive project plan that ensures that the customer is satisfied with the end result.

Kloppenborg and Petrick (2002:3-8) believe that successful projects are those that come in on time, within budget and perform as expected by conforming to design specifications and satisfy customers. Hence, in finding common ground between the project and quality management, the authors reinforce their convergence and believe that the quality context, processes and tools are essential to project management success. It is equally important to manage quality processes within the project stages and to manage the project's impact on its external context, so while there are a variety of generic project lifecycle models, the authors have developed a new five-stage project quality process model, which is presented in **Figure 2.3.** The first and last are not currently in the PMBOK ® Guide, but are crucial to project quality success and parallel to other PMBOK ® *Guide* recommendations. The five stages are: project quality initiation; project quality planning; project quality assurance; project quality control; and project quality closure.

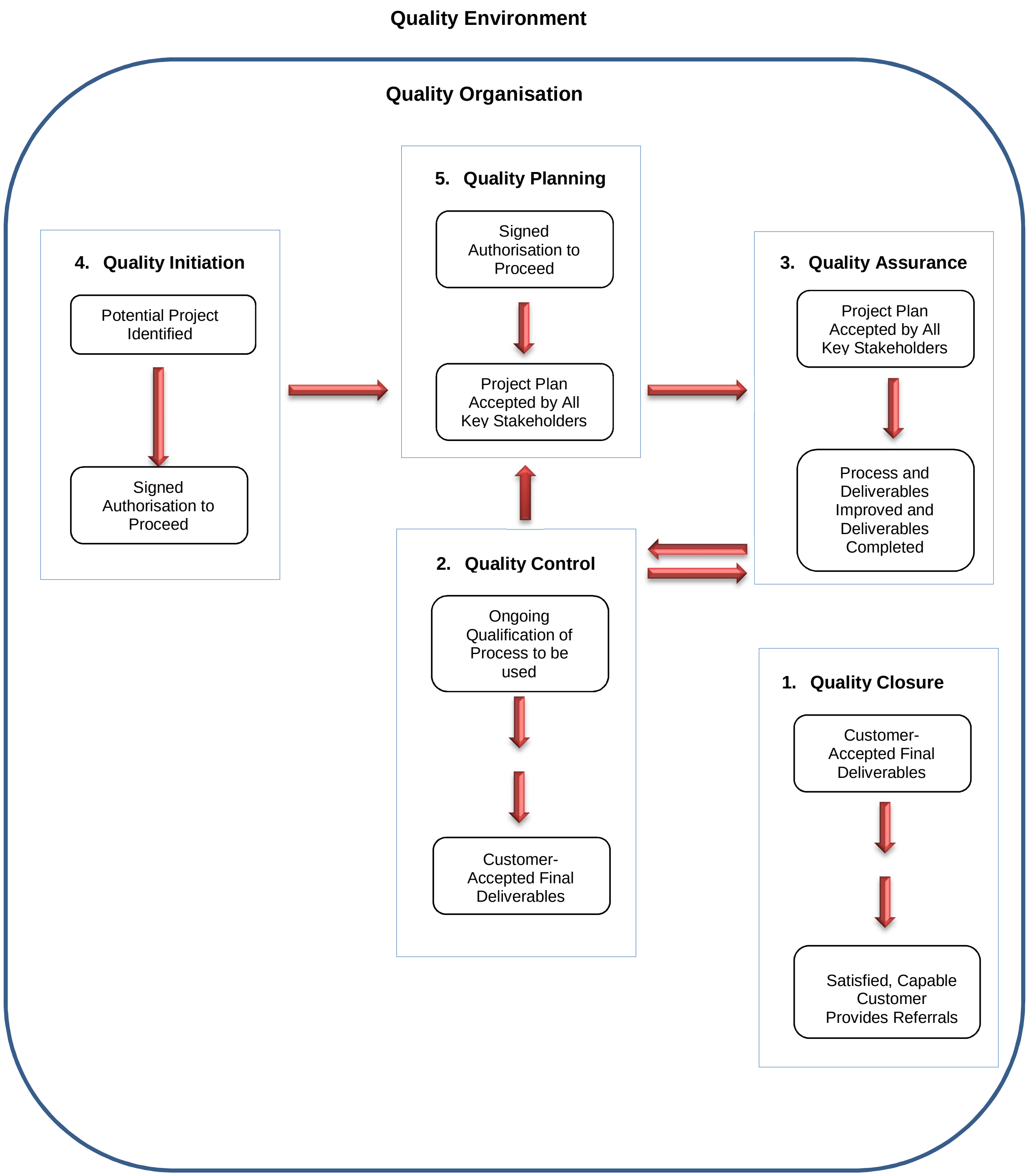


Figure 2.3: **Five-stage project quality process model. Source: Kloppenborg and Petrick (2002:3-8)**

2.11 Cost of quality

Ireland (1991:IV-1) explains that the cost of quality is the total price of all efforts to achieve product or service quality, and that it includes all work to build a product or service that conforms to the requirements, as well as all work resulting from non-conformance to the requirements. Furthermore, according to Ireland (1991:IV-1), the cost of non-quality, conversely, is all expenditure that waste time, material or other valuable resources; a point of contention is that the wastes are often assumed to be given part of the process. “The cost of quality is an investment in the future where the project manager anticipates the actions and resources, which are required to successfully meet customer satisfaction. These actions include planning a project to a level of detail that is necessary for efficient implementation and operation; training the project team with the proper skills and indoctrination to perform the work; establishing a process whereby all engineering design is performed well in advance; and ensuring that materials going into the process are of the proper grade. Costs associated with producing a quality product are much less than those associated with producing a non-quality product that must be repaired” (Ireland, 1991: IV-1).

PMBOK (2008:191-195) states that the cost of quality includes all costs incurred over the life of the product by investment in preventing non-conformance to requirements, appraising the product or service for conformance to requirements, and failing to meet requirements (rework). Failure costs are often categorised into internal (found by the project) and external (found by the customer). Failure costs are also called cost of poor quality. **Figure 2.4** below illustrates the cost of quality.

Cost of conformance Prevention costs (build a quality product) • Training • Document processes • Equipment Time to do it right Appraisal costs • Testing • Destructive testing loss • Inspections	Cost of non-conformance Internal failure costs (failures found by the project) • Scrap • Rework External failure costs • Liabilities • Warranty work • Lost business
Money spent during the project to avoid failures	Money spent during and after the project because of failures

Figure 2.4: Cost of quality. Source: PMBOK (2008:191)

2.12 Root causes of poor quality

Pinkerton (2003:110) states that "…the bitter taste of poor quality lingers long after the sweet fragrance of low price has faded". Rose (2005:3) emphasises that given its importance to project outcomes, quality should be a resolved problem, however, the author observes that projects continue to be plagued by imprecise quality goals and mysterious quality methods, and this condemns the project to less-than-satisfactory results or worse. "Quality tools and techniques have been developed and refined over the past 100 years to the level that they are now a matter of science, not art. Applying these proven ways to project management should be a simple matter of transference, but that seems to be the problem" (Rose, 2005:3).

2.13 Factors that affect project quality at a Nuclear Power Plant Project

Factors that influence project quality at an NPP include the plant, people, processes and procedures. In order for a project to be successful, these aspects and their interfaces should be well integrated and managed. The IAEA (2001:5-6) states that modifications should be managed in accordance with established procedures at all times.

The NEA/CSNI/R(2005/10:15-16) warn that modifications, in spite of their necessity, always carry the risk of introducing new problems owing to unexpected impacts, introduce additional burdens in the retraining of plant personnel and always carry additional costs. It is, therefore, necessary to compare the costs and benefits of not modifying the plant with the costs and benefits of modifying it.

Wahlström (2009:65) explains that NPPs have a long operational life and were initially designed for 30-40 years, but this has recently changed with plans to run for at least 60 years, placing many challenges on the plant, of which the major is said to be technical development, which will inevitably force plants to modernise owing to a combination of more stringent safety requirements, opportunities for power upgrades and difficulties to obtain spares. Another great challenge, according to the author, is maintaining skills and competence over two or more generations of staff.

2.13.1 People

2.13.1.1 Customers

Ireland (1991: II-1-4) believes that understanding customers is an ability to define and appreciate their needs, and that there are generally two types of customers that are served in the project environment who have to be catered for to ensure project success. The first type are those that have an economic interest (stakeholders) and the second (invisible customers) have no interest in the project meeting goals, but rather try to shape the project to meet their individual interests, for example, environmentalists, trade unions, government agencies, and so on. The author also stresses that while the customer is key to the quality function of a project, the set requirements however, must be achievable, stable and unambiguous and mutually understood by all who are involved in the project. The customer, therefore, plays a key role in project quality during design reviews, progress reviews and key milestones as the progress of planning and working on the project may require decisions from the customer when unexpected events occur. The author, therefore, believes that customer satisfaction is directly linked to the customer's feelings about a product or service because when these are met, the product or service has economic value.

Petrangeli (2006:93-94) maintains that quality remains one of the key elements of any organisation, as it perpetually points to the most important aspect of company success, namely that of customer satisfaction. Kerzner (2006:832) concurs that the push for higher levels of quality appears to be customer driven with customers now having more demands than in the past.

Goff (2008:1-5) argues that all too often project teams exceed customer needs in areas where they feel they have control with the misconception that this can make up for the many occurrences where they have no control. The author believes that this is mainly owing to the fact that it is difficult to know all the needs and how to measure the quality of the project delivery until it is too late, which then leads to the notion of *"If you can't measure it, you can't manage it"*. The author therefore concedes that project quality is difficult to measure, as key stakeholders cannot rigorously evaluate the true quality of the results until the benefit realisation point. By this time it is too late to resolve quality gaps and, since projects produce something new, there are few standards against which to evaluate "good" results. Project sponsors and customers, according to the author, are ultimately the "judges and jury" of the quality of project results and hence, they must "buy in" to the project results early and often, should they achieve the intended project benefits.

2.13.1.2 Regulatory authorities

Ireland (1991:VI-6) believes that regulatory authorities interpret and implement the laws in the form of directives and impose detailed requirements on projects depending on their and the affected environment. These regulatory requirements should be anticipated and included in the planning phase of the project and when these requirements are not met, they negatively affect projects in the following ways:

- delays in approvals to proceed;
- re-work to meet minimum requirements; or
- cancellation of the project;

owing to not being able to meet requirements within schedule and budget constraints.

The Safety Series No. 50-C/SG-Q (1996:7) stipulates that the responsible organisation should demonstrate the effective fulfilment of quality assurance requirements to the satisfaction of the regulatory body. Wahlström (2009:66) states that "…international practice places the sole responsibility for safety on the operator of a nuclear power plant. This is a straightforward requirement, but it also carries a subtle contradiction in the assumption that the regulator should not manage the plants, but still influence what they do. Nuclear power is a political technology, which stirs emotional reactions from politicians, media and the general public. This means that the nuclear industry's words and deeds are watched closely. Decision power is also is exercised in political processes when power companies apply for building and operation permits. If something unexpected happens during plant construction or operation, scrutiny is started immediately and efforts to restore public confidence and trust may be considerable".

KNPS, like all other nuclear power utilities, should conduct themselves in terms of quality requirements, as prescribed by regulatory and other related bodies. In this case, the regulatory body is the NNR and they have derived a Requirements Document 0034 (RD0034) to which KNPS must comply. RD0034 is used by the NNR as a guide to meet nuclear requirements and it details the requirement of the NNR for quality and safety management for licenses, those involved in the design, manufacturing, construction, commissioning, operation, modification, and so on for a nuclear installation in South Africa under the National Nuclear Regulation Act (NNRA), Act No. 47 of 1999. The objectives of RD0034 are, among others, to define the relevant quality and safety management requirements to ensure that safety is appropriately taken into account in all activities and decisions by licensees and suppliers that are involved in the lifecycle of a nuclear installation. **Figure 2.5** below illustrates the structure of the Integrated Management System (IMS), as dictated by RD0034.

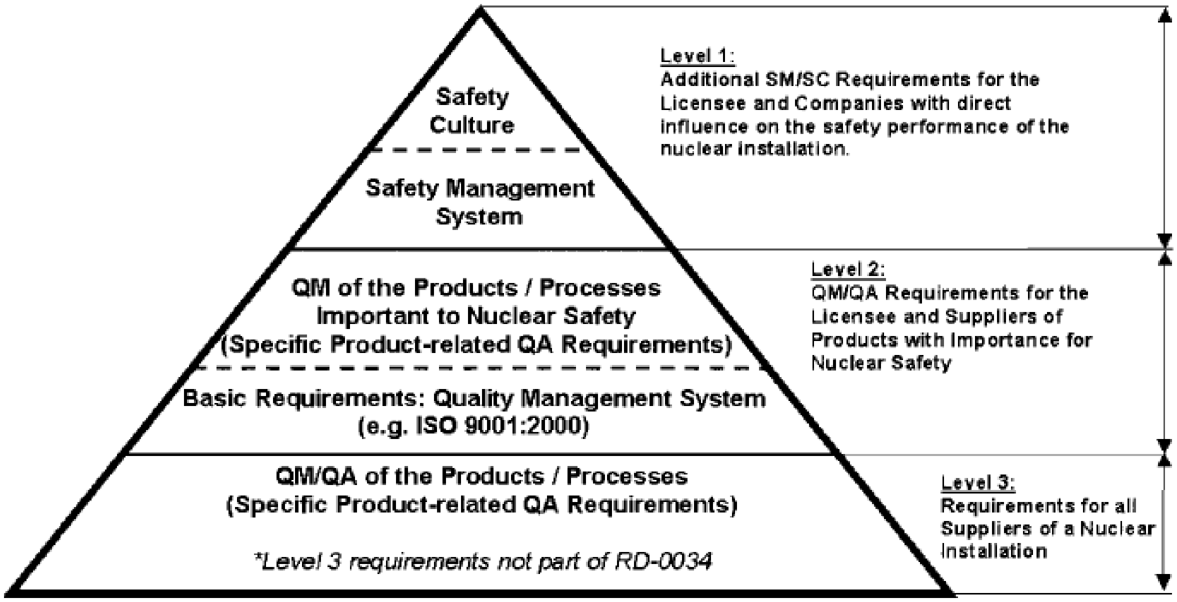


Figure 2.5: Structure of the Integrated Management System. (Source: RD0034, 2008:12)

2.13.1.3 Peer reviewers

The IAEA TECDOC-1305 (2002:6-13) observes that many organisations perform internal assessments and have external assessments by agencies such as the IAEA performing Operational Safety Review Teams (OSART), World Association of Nuclear Operators (WANO) performing peer reviews, Institute of Nuclear Power Operations (INPO) performing evaluations and other assessments, which are performed through the CANDU Owners Group. This is in an effort to comply with standards to maintain and improve overall business performance. The IAEA TECDOC-1305 (2002:6-13) states that the IAEA is supportive of the acceptance of external inputs as a basis for growth, which is required for continuous improvement, as this attitude makes people self-critical; thus creating an organisation that is receptive to the challenges and motivated to improve. Furthermore, for any plant, valuable experience can be collected from other plants to focus and anticipate difficulties and to identify potential improvements for the plant’s lifecycle granting them the status of a learning organisation, supported by exchanging information and practices both internally and externally to the organisation.

Revuelta (2004: 67-71) describes WANO as having a mission to, amongst others, maximise safety and reliability of the operation by exchanging information and encouraging communication. NPPs are expected to demonstrate the following attributes in order to be considered a learning organisation, which is imperative for this high-risk industry:

- focused leadership;
- performance assessments;
- operating experience feedback;
- benchmarking and technical exchange; and
- training and development striving for excellence and continuous improvement.

2.13.2 Project people

Ireland (1991:VI-1) is convinced that more than any other resource, people make the difference in quality for a project with the combination and diversity of knowledge, their skills and abilities, which affect the planning, implementation and operation thereof. The author, therefore, states that management of people is the totality of actions that clearly define what, how and when tasks should be performed and the standards expected in the final product or service; something that goes beyond the day-to-day direction of individuals to perform tasks. The author thus has confidence that in order for project people to be capable of doing what is required, a clear policy statement from senior management, as well as easily understood requirements and standards should be in place, with people understanding why tasks are done, and not only be able, but also display willingness to meet the standards.

Hawkins and Pieroni (1991:29-33) construe that the nuclear industry is reaching beyond traditional quality assurance methods, and is taking a broader perception of quality with management, people performing and assessing the work, which all contributes to quality in a concerted and cost-effective manner. This integration, according to the authors, can only be successful when those who perform work are provided with proper information, tools, support and encouragement to properly carry out tasks. The authors thus accept as true that it is mandatory for management to define requirements, properly train, motivate and empower personnel, provide appropriate resources and assess performance, as these place greater emphasis on being "right the first time", rather than finding and correcting mistakes later.

2.13.2.1 Senior management

The National Regulation Commission (NRC) conducted an audit of six nuclear power plants in the United States in 1982 in relation to quality related problems. They found that an essential factor was a management commitment to quality to facilitate activities that support quality of construction. "*All management claims to support quality, but verbal support is not sufficient. An understanding is required of why quality is important, (e.g., as an important adjunct to achieve an acceptable level of safety, reliability, or scheduled completion) and how to obtain it. That understanding must be disseminated through the entire project team by training, personal contact, audit appraisals, support of QA/QC staff, incentives and other means".* (NRC: 1982).

Ireland (1991:VI-3-5) believes that training and indoctrination of senior managers in the principles of quality, coupled with the need for continuous improvement, is imperative for the future survival of a company with managers required to understand the reason for quality programmes, and to support these through actions. The author also supposes that quality standards should be established for management to use as rateable measures of progress with special attention given to customer requirements and how these translate to the company or project. Quality management, at project level, only works when it is an extension of corporate policy and procedures. To this end, the author stresses that senior management must establish and maintain an active quality program that extends to projects, as they are planned and implemented. The author also indicates that senior management should provide the base for the project's quality program, which is tailored to the unique aspects of individual projects, while playing an important role in supporting the project manager's request for critical and qualified resources to perform work. Senior management should, therefore, provide these resources by setting priorities and directing activities that support the project.

Hawkins and Pieroni (1991:29-33) argue that management's most important and challenging responsibility is to establish and cultivate principles that integrate quality requirements into daily work activities. Only in this way can they demonstrate the necessary commitment and leadership to achieve quality. Pieroni (1996:4/19) believes that the quality responsibility of successful organisations is shared and accepted by every individual that is involved where such organisations cultivate an environment that integrates people who are qualified and motivated for accepting and accomplishing responsibilities; systems and procedures tailored to the particular work; and hardware and installations, which operate in accordance with established specifications. These organisations, as described by Pieroni (1996:4/19), are characterised by an effective quality culture, which manifests itself by consistently being involved in plant activities, promotes staff accountability and sets high expectations for performance. The author goes on to explain that performance objectives are included in the organisation's policy documents and procedures, integrated into staff training and work programmes, communicated to contractors prior to work commencement and reinforced by management staff in daily communications and meetings with management who dedicate permanent attention to performance. The responsibility to achieve quality and verify its achievements is assigned to those who perform the task and their associated line management, and who in all of their activities make safety precede production objectives. The author concludes that in accomplishing their policy and objectives, organisations with vigorous quality-raising initiatives have evolved beyond the fulfilment of requirements that have been established in safety and industrial quality assurance standards. This type of culture is progressively less dependent on the fulfilment of requirements that have been established in quality assurance standards because these requirements are automatically accomplished by the normal way of work performance.

As suggested by Zilbershtein (2004:39), top management must be committed to a quality culture, and must demonstrate this commitment to quality through a shared vision. However, this commitment to quality must be transparent and infectious.

The IAEA (2006:7-8) advocates that management, at all levels, must demonstrate its commitment in the establishment, implementation, assessment and continual improvement of the management system, and must allocate adequate resources to carry out these activities. They must do this by developing individual and institutional values, as well as behavioural expectations for the organisation, which support the implementation of the management system, and also act as role models in the declaration of these values and expectations. In performing the required duties, senior management must consider the expectations of interested parties in activities and interactions in the processes of the management system. This should be achieved with the aim of enhancing satisfaction of interested parties, whilst ensuring that safety is not compromised.

The RD0034 (2008:17) requires management to ensure that management systems are established, implemented, assessed and continually improved, and must demonstrate its commitment to do so. Such commitment in terms of safety and quality of the products must be clearly defined, documented and communicated to staff.

2.13.2.2 Project manager

According to the IAEA (1988:18), the project manager is responsible, above all, for the satisfactory completion of a high quality product. He/she uses the contract, specifications, budget and schedule as control instruments and employs numerous administrative and technical procedures, as well as his/her personal contacts, knowledge and authority.

Ireland (1991: VI-4-5) professes that the project manager is the focal point to ensure that all quality functions are established and implemented during the life of the project and must, therefore, translate customer requirements into specifications and statements of work to ensure that these requirements will be met.

Rose (2005:24) argues that while management is responsible for the quality system, project managers have the ultimate responsibility for project and product quality, as they select the procedures and policies for the project, which means that they control the quality. Hence, the project manager should create an environment that fosters trust and cooperation among all team members.

Kerzner (2006:846) asserts that the project manager should establish administrative processes and procedures, which are necessary to ensure and prove that the scope statement conforms to the actual requirements of the customer by working with his or her team to determine, which processes will be used to ensure that all stakeholders are confident that the quality activities will be properly performed, and that all relevant legal and regulatory requirements are also met.

Young (2007:8-9) clarifies that projects are undertaken by creating and managing change in an organised and structured manner. A successful project is, therefore, a direct measure of the project manager's ability as an effective change agent with the project manager demonstrating enthusiasm and excitement at the prospect of achieving advances in the way that the organisation operates in the current and future business environment. This, in turn, demands a wide range of people skills besides those that are traditionally associated with managing projects, including the ability to:

- select the right team members with appropriate skills;
- recognise and understand the different types of personalities to be managed;
- set clear objectives and align people's personal goals;
- create a real sense of responsibility and obligation in the project team;
- manage a team as an interactive unit;

- create a sense of commitment in the team members, some of whom may have little interest in the results expected;
- coach, guide and actively support the individual team members;
- explain decisions and keep everyone informed of progress;
- establish a sustaining environment for effective dialogue and feedback in the team and with other teams and their management;
- manage upwards to influence senior management and other line managers;
- manage third parties: contractors, suppliers, consultants;
- understand the real needs of the end users of the results; and
- satisfy the internal customer.

Goff (2008:1-5) espouses that effective project managers establish the prerequisites of quality and monitor their success in maintaining those prerequisites from individual assignments to overall project results. Meredith and Mantel (2012:16&105) concede that the project manager's responsibility is ultimately to the project and client, which is ensured by maintaining the integrity of the project in spite of conflicting demands from parties that have legitimate interests in the project. The project manager's responsibilities can be primarily categorised into three separate areas, namely:

- responsibility to the parent organisation;
- responsibility to the project and the client; and
- responsibility to members of the project team.

Meredith and Mantel (2012:16&105) stress that it is important to keep senior management fully informed about project status, cost, timing and prospects, and in spite of the project manager not having authority equal to their responsibility, they are however, expected to coordinate and integrate all activities, which are required to reach the project's goals. In particular, the authors are certain that the project allows the manager to be responsive to:

- the client and the environment;
- identify and correct problems at an early date;
- make timely decisions about trade-offs between conflicting project goals and
- ensure that managers of the separate tasks that comprise the project do not optimise the performance of their individual tasks at the expense of the total project.

2.13.2.3 Project quality team

The IAEA (1988:18) advocate that from the standpoint of resources, time span and complexity, the execution of a nuclear power project is a major undertaking, which cannot be comprehended, directed and controlled by a single person. The necessary team effort and the highly professional approach, which is necessary for engineering and manufacturing, require specialised direction in many different disciplines under delegation from top management. Furthermore, the project manager should reach agreements with technical and administrative disciplines and departments that are involved, having ultimate authority, courage and knowledge to slow down or speed up activities, where necessary, in given circumstances. This means that since the project manager is often the exclusive communication channel, it is, therefore, apparent that people who have communication skills and problem solving are sought as project managers.

Ireland (1991:VI-3-4) believes that the project quality team includes senior management, the project manager, project staff, customers, vendors and suppliers, as well as sub-contractors and the public who are represented by the regulatory authorities. Each plays a vital role in project quality at various stages during the planning, implementation, operation and maintenance, or close-out of a project. This, therefore, makes their relationship more of a partnership than a team effort, as they have a vested interest that will result in a return on investment based on their contributions. **Figure 2.6** below depicts the integration of all project quality partners and how they are intrinsically linked to the project and **Table 2.2's** project lifecycle accountability matrix. The Safety Series No. 50-C/SG-Q (1996:7) states that personnel should be trained and qualified so that they are competent to perform their assigned work, and hence understand the safety consequences of their activities.

According to Bowen, Cattel, Hall, Edwards and Pear (2002:49), the integration of the project team assists the team to have a common objective. Also, a customer focused team will ensure that the provision of products and services meets customer needs. Rose (2005:24) believes that project teams are responsible for the quality aspects of their part of the project, and that individual team members are responsible for quality in everything that they do to contribute to project completion. The author further believes that the days when quality was the responsibility of the quality department are long gone, and in fact leans towards the notion that quality departments have been greatly reduced with their functions transferred to the performing level or being eliminated entirely. Rose (2005:24) states that this is the norm because in today's projects it is well known that quality is everyone's responsibility; this includes management on all levels, supervisors, line and staff, maintenance personnel and all others. This also implies that no one has the luxury of divesting quality responsibility to someone else or to some other function, as everyone who is associated with a project is responsible in some way, with the project manager bearing the burden of ensuring quality in everything that the project does.

Goff (2008:1-5) accentuates that persons who perform work also need to feel a sense of pride, ownership and accomplishment for their efforts, as this ultimately affects the perception of quality measures, concluding that effective teams have just as much difficulty in measuring and managing project quality as do ineffective ones. The author believes that the difference is that effective teams identify factors that they can influence to ensure results and the perception of quality, while ineffective teams trade off quality for easier-to-measure project success factors.

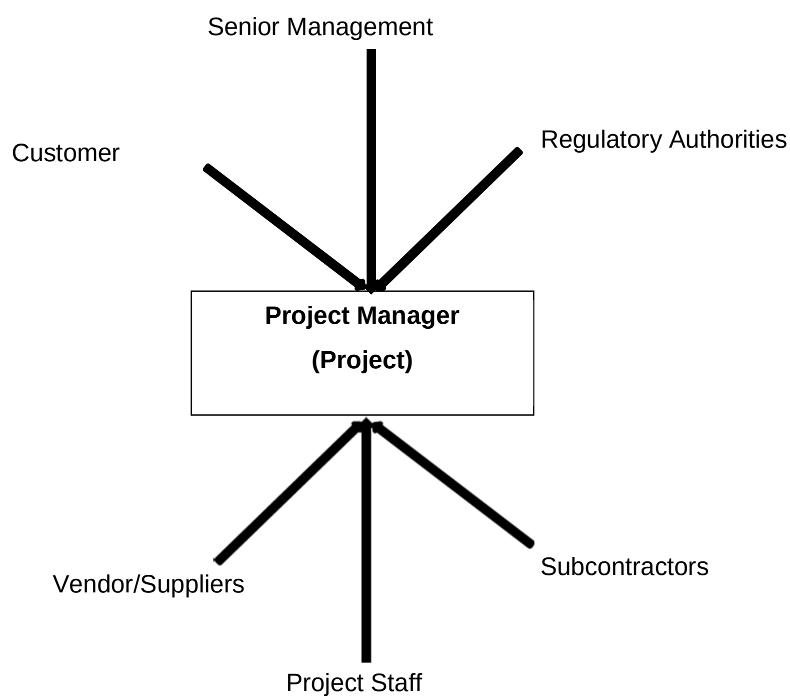


Figure 2.6: Integration of quality participants. Source: Ireland (1991:VI-3-4)

Table 2.2: Project Lifecycle Accountability Matrix. Source: Evans, J.R and Lindsay, W.M (2008:256)

Role / Stage	Project Quality Initiation	Project Quality Planning	Project Quality Assurance	Project Quality Control	Project Quality Closure
Champion	Select project manager, align and select project, commit to charter	Determine decision-making authority, commit to plant, allocate resources needed for project success	Conduct external customer communications, mentor project manager clear obstacles as needed	Conduct external customer communications mentor project manager approve or reject process improvements, clear obstacles as needed	Sign off on project, recognise and reward participants, assess project to improve system
External Customer (Process Owner)	Identify and prioritise expectations, commit to charter	Contribute process knowledge, identify customer satisfaction standards and trade-off values, commit to plan	Participate in on-going communications, assist in obtaining approvals for changes in process	Confirm on-going satisfaction level, accept deliverables	Verify when usage training and support are completed, assess project to improve system, ensure that new processes are implemented, sign-off
Master Black Belt (Technical Consultant)	Assist in strategic project selection, promote six sigma vision, tools and processes	Assist in identifying data collection and analysis needs, provide training resources, ensure that processes are satisfactorily sound	Participate in on-going communications, mentor project manager, facilitate cross-project sharing and learning	Provide expertise in design of process improvements, support project manager (SSBB and/or SSGB)	Assist in deve-lopment of management presentations, do project sign-offs, ensure that project results are publicised, disseminate best practice and lessons learned
Project Manager (SSBB and/or SSGB)	Select core team, identify risks, empower performance, commit to charter	Identify customer satisfaction standards and trade-off values, Plan for short-term training, develop quality and communication plans, commit to plan	Conduct customer/ management communications, select tools, confirm qualified processes used, oversee data gathering and analysis, manage quality audits and planning	Track progress, critical success factors, and cost versus plan, implement mid-course corrections, measure customer satisfaction, manage process improvements	Notify champion of project completion, recognise and reward participants, assess project to improve system
Core Team	Determine team operating principles, flowchart project, identify lessons learned, commit to charter	Plan project, contribute special expertise, identify suppliers, qualify the process, identify data to collect, commit to plan	Use qualified processes, gather data, find root causes, conduct quality audits, plan future work	Measure customer satisfaction, test deliverables, correct defects, endorse deliverables	Provide customer support and training, assess project to improve system

2.13.3 Processes and procedures

2.13.3.1 Performance objectives

The NRC, in their 1982 audit of six nuclear power plants, concluded that maintaining and documenting adequate quality required appropriate procedures for all aspects of the project (such as construction, design, procurement, and so on.) was important, since these procedures needed to be understood, rigorously applied and adhered to at all levels of the project.

Hawkins and Pieroni (1991:29-33) acknowledge that quality of performance concerns all areas in the nuclear project with safety, reliability and economics being positively influenced with the overriding principle being that safety shall not be compromised for reasons of production, economics, and so on. The author believes that when performance objectives are properly defined and controlled, processes provide the assurance that they will be met, while the nature of the innate interrelationship between performance objectives and processes to achieve them, defines how successful an organisation will be. The authors further argue that when there is no balance between performance objectives and processes with an increased focus on processes rather than performance objectives; this vital relationship is destroyed and the ability of the organisation to achieve its performance objectives is lost. The authors then deduce that this has been a problem for the nuclear industry, as it tends to separate performance objectives from processes. "…Traditional quality assurance programmes sometimes focus on the fine-grained details of activities, not stressing performance strongly enough. Hence, the credibility of the industry is called into question by a public that does not understand, and often fears, its objectives" (Hawkins and Pieroni, 1991:29-33).

Kloppenborg and Petrick (2002:13), in describing quality pillars, mention the second project quality pillar as the continual improvement of work processes to efficiently and effectively achieve the strategic goal of customer satisfaction. A set of processes may together form a quality system. which, in turn, provides the organisational operational context for team projects and individual task performances. Different process qualification levels are outlined below.

Level 1: Spontaneous: Few or no process standards are used:

- Lack of documentation;
- Skills and knowledge uneven;
- Inadequate tracking;
- Very little use of systems or technical tools; and
- Process success depends on experience and skills of managers and team.

Level 2: Initialised: Process awareness is widespread but adhoc:

- Non-standard methods and approaches widely used, everyone performs differently;
- Some documented procedures (what needs to be done, but not how to do it);
- Some data collection and documentation;
- Technical tools used, but not always in a full or correct manner; and
- All processes attempt to follow some basic functionality.

Level 3: Formalised: Basic processes are standardised and institutionalised:

- Company-wide standards developed and documented for all basic processes to maintain an existing system;
- Audited and enforced use of standard processes;
- Consistent data collection and reporting across organisation;
- Lessons learned are shared throughout the organisation; and
- Widespread and adequate process specific training to keep current system functioning.

Level 4: Optimised: Processes are systematically measured, continually improved and cross-functionally integrated with business operations:

- Data consistently collected and stored in a database and extensive evaluation performed for all processes;
- Database integrated with company systems to ensure on-going improvement;
- Mechanisms established for continuous process improvement;
- Innovative ideas pursued and organised to improve processes and documentation; and
- Goes beyond process success, emphasises success of people and systems.

Rose (2005:6) explains the difference between product and project quality as: "quality processes attuned to the scope specifications will ensure a quality product. Quality processes that maintain cost and schedule constraints will ensure a quality project."

The RD0034 (2008:16-29) advocates that organisations must ensure that procedures, specifications, instructions or drawings include quantitative and/or qualitative acceptance criteria where appropriate with all organisations involved being informed of any revisions of procedures, specifications, instructions or drawings without delay. Moreover, the involved organisations must ensure that tasks are performed in accordance with valid documents; procedures that ensure that adverse quality conditions such as failures, deficiencies, defective material, system deviations and equipment non-conformity are promptly identified and corrected, are established. Where these conditions adversely affect quality significantly, procedures of the organisations must ensure that the root cause is determined and that appropriate corrective action is introduced to prevent recurrence.

2.13.3.2 Designs and engineering

The IAEA (1988:97) warns that since, in a nuclear power plant, engineers tend to sometimes act as project managers owing to the nature of the work, such cross-overs should be watched constantly and should be minimised in order to avoid conflicts. The guide explains that the main concern of project management with regard to engineering is to make sure that the work is done on time, since delays in engineering have proved to be a common problem in nuclear projects.

Design, including subsequent changes, should be carried out in accordance with established engineering codes and standards and should incorporate applicable requirements and design bases. Design interfaces should be identified and controlled. The adequacy of design, including design tools and design inputs and outputs should be verified or validated by individuals or groups other than those who originally performed the work. Verification, validation and approval should be completed before implementation of the design (Safety Series No. 50-C/SG-Q, 1996:11).

The IAEA (2001:13-14) states that proposals for modifications that are submitted for independent assessment should comply with specified criteria, and in accordance with quality assurance requirements. Submissions must include, amongst others, the following:

- Description of the design and justification of the proposed modification;
- Sketches, drawings and list of materials;
- Specifications for parts and materials;
- Applicable codes, standards;
- Description of methods of fabrication, installation and testing;
- Specification of the operational state of the plant, or parts thereof, necessary to implement the modification;
- Statement of requirements for quality assurance and quality control; and
- Description of the qualification test programme to be performed after implementation.

The IAEA (2001:13-14) further prescribes that the following design conditions are considered:

- When modifications are identified, their compatibility with the design intent and characteristics should be assessed;
- The modifications should, whenever possible, minimise the deviations from the characteristics and intent of the design;
- The detailed design of modifications should specify requirements for construction, installation, commissioning, equipment qualification, testing, test acceptance criteria, and maintenance during operation; and
- Modifications relating to plant configuration should conform to the provisions set forth in the safety requirements for design and associated Safety Guides.

Pinkerton (2003:165) states that when design specifications and inquiries to potential suppliers are being developed, the desired quality levels and inspection and test requirements must be included. These requirements must be unambiguous so that bidders and suppliers clearly understand what is required of them. To this end, it would be in the interest of the project team to have the necessary input from someone with this quality type background, and by so doing, reduce misunderstanding by suppliers and fabricators later as they respond to the Request for Proposal (RFP).

2.13.3.3 Project controls and documentation

The art of a well-developed schedule in the hands of a competent manager pays for itself when used to highlight problems and analyse various ways of solving them.

According to the IAEA (1988:74-77), in a nuclear project, scheduling acts as the catalyst for project co-ordination and control because it:

- helps to define the project scope of work;
- identifies areas of responsibility for the work;
- establishes goals and targets;
- identifies potential problem areas;
- identifies when decisions should be made; and
- becomes the focus for project communications.

According to IAEA (1988:74-77), the schedule should provide the following:

- What has to be done (the task);
- How the task relates to other tasks (the sequence);
- When it must be done (target or milestone dates);
- How long it will take (the duration);
- Who will do it (the function, discipline, organisation);
- The resources needed (manpower, skills, equipment); and
- A unique designation (numbering) for computer handling and sorting.

The IAEA (1988:74-77) summarises that controlling through the project schedule means that the project manager receives up to date, accurate, relevant and foresighted reports on the project performance, as seen against the target schedule. By means of this reporting system, deviations from the target schedule should be noted or automatically listed and reviewed by the project manager (magnitude of the deviation, consequences, and so on). This allows the setting of priorities. They state that "with any management control system, QA requires an organisational structure with defined responsibilities and functions, a documented programme with established goals and objectives, and prescribed procedures for performance evaluation. Feedback of information on performance monitoring should exist to allow corrective action to be taken and to ensure that the organisation is pursuing its established objectives".

The Safety Series No. 50-C/SG-Q (1996:9) states the following:

- Documents such as procedures, instructions, specifications and drawings or other media, which describe processes, specify requirements or establish design, shall be prepared, reviewed, approved, issued, distributed, authorised, revised, and as required, validated. All personnel preparing, revising, reviewing or approving documents shall be specifically assigned to this work and be given access to appropriate information upon, which to base their input. Personnel using documents shall be aware of and use appropriate and correct documents; and
- Records relating to personnel and records that describe the status, configuration and characteristics of items and services, describe the performance of processes and represent objective evidence of quality shall be specified, prepared, reviewed, approved and maintained. All records shall be legible, complete and identifiable. A records system shall be established to provide for the identification, collection, indexing, filing, storing, maintenance, retrieval and disposal of records.

The IAEA (2001:5-26) states that plant modifications should be performed in accordance with established procedures, with due consideration given to quality assurance. Additionally, before being placed in service, plant modifications should be tested to demonstrate that the design intent is met with all relevant documents necessary for the operation of the modified plant updated and personnel trained, as appropriate. The following should be ensured by means of the document management system:

- That all relevant documents affected by the modification are identified and updated, and remain consistent with the plant specific design requirements, and that they accurately reflect the modified plant configuration;
- That all changes to the design over the lifetime of the plant are based on the actual status of the plant, as reflected in the current plant documentation;
- That the modified plant configuration conforms fully with the documentation and conditions of the operating licence;
- All relevant plant documents, which have been revised or developed during the modification process, should be subject to configuration management. Changes to these documents should be traceable to the modification and should be submitted for approval prior to formal revision;
- Documents relating to modifications, in particular, to installation and testing, should be updated as soon as practicable. Responsibility should be clearly assigned for the revision of all documents such as all drawings, including computer representations, specifications, procedures, safety reports, operational limits and conditions, descriptions of equipment and/or plant and systems, training material, including simulator aspects, vendor equipment manuals and spare parts lists;
- Modified operational limits and conditions, and other operational documentation, should be included in plant documentation by means of approved processes and should be subject to review and approval at the same level as for the original operational documentation;
- Expired documents should be marked as ‘invalid’ in an unambiguous manner; and
- Documents and records relating to modifications and to the revised plant configuration should be stored appropriately in order to preserve access to them throughout the lifetime of the plant.

Pinkerton (2003:143) prefers that project controls should be placed on all facets of the project, while the following project elements are tightly controlled:

- Document transmittals and revision hierarchy method;
- Design changes and change approval method;
- Receiving inspection and change approval of materials and equipment;
- Drawing changes and redlines;
- Project monitoring and cost containment reviews;
- Vendor and contractor quality of work;
- Procurement;
- Environmental issues, including permitting requirements and checks
- Safety of personnel.

The RD0034 (2008:16) stipulates that control measures must be established to ensure that all documents are complete and consider relevant requirements before they released with all involved in preparing, revising, reviewing or approving documents that are assigned specific work, while being competent to carry it out and given the necessary access to appropriate information on which to base their input on decisions. Documents must be unambiguously marked for identification and records must be retained (retention times of records must be defined) to provide evidence of activities, which affect quality and safety. These records must be readable, complete, identifiable, classified, stored and easily retrievable.

According to the IAEA (1988:102-106) documents, namely drawings, specifications, procedures, and so on are a powerful communication tool, hence errors, inconsistencies or wrong versions of documents can be extremely costly and would violate licensing and quality assurance requirements with the completeness of the scope of all documents and the correctness and clarity of each document being a major concern for project management. Furthermore, documentation is also the primary tool for quality assurance and control hence well organised record keeping and document security (redundant sets in different locations) should be required by project management and should be set up for the lifetime of the plant. Since the volume of documentation on nuclear power plants is substantial, space is required and computerised methods for document distribution, record keeping and retrieval have become important. A successful document control system will include the following major features:

- Identification. The documents that are produced must be identified at the outset, with the identification including, as a minimum, the type of document that should be produced, the document title, the document identification number taken from the overall project identification system (work breakdown structure and task orders), and the organisational unit and/or person responsible for its production;
- Scheduling. The production of each document must be scheduled for key steps such as the start of the draft, input from other groups, completion of the first draft, review by other groups, final editing, internal approvals, regulatory approval, printing and issue. The project manager and the task engineer and/or the section head must select a manageable number of key steps for the schedule and for the monitoring of progress;
- Lists and schedules. The key dates of the production of documents will be included in the integrated project schedule. It is important that the data should be made available in the most easily usable format for the responsible section and individuals. Usually this is in the form of lists of documents, which indicate the responsibility and the key dates that should be met for each document;
- Reports. Status reports on document production are usually compiled by computer and form part of the overall schedule updating procedure, but can be a separate or collateral effort and may be carried out more frequently than the updating, if desired. Reports will go to the engineering sections involved, to project management and to the licensing and quality assurance departments.
- A reporting system must accomplish three things:
  - It must provide quick turnaround of the information so that the information is up to date and so that corrective action can be taken before any problems become serious;
  - It must clearly identify deviations from the project plan so that management attention can be given to the problems rather than to those documents, which are on schedule; and
  - It must transmit the information to relevant individuals so that they can take appropriate corrective action to get the document back on schedule or to minimise the deviation. It must also alert the appropriate section head and project management assistant so that they can take whatever other corrective actions may be necessary to minimise the impact on the overall project.

2.13.3.4 Procurement

The Safety Series No. 50-C/SG-Q (1996:11-12) states that:

- Procured items and services shall meet established requirements and perform as specified. Suppliers shall be evaluated and selected on the basis of specified criteria;
- Requirements that are necessary to ensure the quality of items and services shall be developed and specified in the procurement documents. Evidence that purchased items and services meet procurement requirements shall be available before they are used;
- Requirements for reporting deviations from procurement requirements shall be specified in the procurement documents;
- Inspection and testing of specified items, services and processes shall be conducted by using established acceptance and performance criteria. The level of inspection and testing and the degree of independence of personnel shall be established; and
- Administrative controls, such as hold points and status indicators, shall be used to preclude the bypassing of required inspections and tests. Any inadvertent use, installation or operation of items, services and processes, which have not passed the required inspections and tests, shall be prevented.

The Safety Series No. 50-C/SG-Q (1996:140&141) further states that:

- The responsible organisation shall ensure that procured items and services meet established requirements and perform as specified, and that selected suppliers continue to provide acceptable items and services during the fulfilment of their procurement obligations;
- Procurement activities shall conform to the regulatory requirements of the member state and as applicable to the provisions of recognised codes standards and specifications, which are used in the design, manufacture, installation and operation of items and services;
- The responsible organisation shall establish a procurement process within its QAP that meets the requirements of the code. The procurement process should require personnel carrying out procurement activities to:
  - Ensure that the information provided to suppliers is clear, concise and unambiguous, fully describes the items and services required, and includes the technical and quality assurance requirements;
  - Ensure, as a basis, for selection, that the supplier is capable of supplying the items and services as specified, including the continuation of any follow-on spare parts;

- Monitor suppliers to confirm that they continue to perform satisfactorily;
- Ensure that the items and services conform to the requirements of procurement documents and perform as expected;
- Ensure that, when required, documentary evidence of conformance is available at the NPP site before items and processes are installed or used;
- Specify the contact person for all procurement communications with the supplier; and
- Ensure that interfaces between the responsible organisation and suppliers and between suppliers are defined to ensure that key dates are met.

Additionally, it is paramount that nuclear safety should be the fundamental consideration in the identification of the items, services and processes to which the QAP applies. A graded approach should be applied throughout the supply chain as follows:

- The requirements for supplier assessment, evaluation and qualification;
- The scope and level of detail of the procurement specification;
- The need and scope of supplier quality plans;
- The extent of responsible organisation inspection, surveillance, audit activities;
- The scope of documents to be submitted and approved and the records to be provided; and
- The extent of records to be provided or stored and preserved.

The Safety Series No. 50-C/SG-Q (1996:140&141) also states that management should consider the potential benefits of establishing partnerships with suppliers to the organisation in order to create value for both parties. A partnership should be based on a joint strategy, sharing knowledge, as well as gains and losses and should be established as follows:

- identify key suppliers, and other organisations as potential partners;
- jointly establish a clear understanding of customers' needs and expectations;
- jointly establish a clear understanding of partners' needs and expectations; and
- set goals to secure opportunities for continuing partnerships (ISO 9004:2000, 2000:8).

According to Kerzner (2006:804-826), the processes to acquire goods and services to attain project scope from outside the performing organisation, consist of:

- Procurement planning: determine what to procure and by when;
- Solicitation planning: document product requirements and identify potential sources;
- Solicitation: obtain quotations, bids, offers or proposals as appropriate;
- Source selection: choose from among potential sellers;
- Contract administration: manage the relationship with the seller or supplier; and
- Contract closeout: completion and settlement of the contract, including resolution of any open item.

The RD0034 (2008:23) recommends that the licensee must establish a supplier qualification process, which is based on and graded according to an accepted safety and quality classification system of the product that should be delivered by the supplier. It is also adamant that NNR involvement must be considered during the supplier qualification process for suppliers of nuclear safety important products with the licensee implementing processes to ensure that the following information is made available to the NNR as a minimum:

- Structures Systems and Components (SSC) that should be delivered or scope of work that should be performed;
- Quality management documentation, facilities and production processes;
- Contractual agreements and interface arrangements; and
- Product related deliverables already provided by the supplier to the licensee and a list of those scheduled for future delivery shall be submitted.

In terms of the RD0034 (2008:23-24):

- All suppliers of products that are important to nuclear safety must have a current quality management system, which is appropriate to the scope of supply and must submit a product related Quality Manual (QM), which is issued by a certification or conformity assessment organisation, which is accepted by the NNR and the South African legal framework. The certificate/confirmation must contain a statement of the scope of application, which must be appropriate to the scope of supply and must be within its stated period of validity. Accreditation must be provided by a relevant organisation where it is required by selected codes and standards;
- suppliers must implement procedures to ensure that product specific requirements and any other requirements, which affect the achievement of quality, are clearly defined;

- the licensee must ensure that the qualification process for suppliers must include an evaluation of their ability to comply with the requirements of RD0034 and to perform the required tasks. The criteria to evaluate of a supplier must be based on product related requirements and, as a minimum, the following aspects must be evaluated:
  - Technical equipment;
  - Qualification of personnel;
  - QMS and certification;
  - Internal and external surveillance; and
  - References and product related experience;
- the licensee must ensure that procedures are established within their own organisation or at the suppliers to ensure that purchased material, equipment and services, were purchased. These procedures must include appropriate provisions for source evaluation and selection. Objective evidence of quality must be available covering inspections at the supplier and at the supplier's sources for accessory parts and examinations of materials, parts and equipment up to delivery;
- it must be ensured by the licensee and its suppliers that materials, parts and equipment must not be used until documentary evidence is available confirming that they conform to the procurement documents;
- it must be ensured by the licensee and its suppliers that materials, parts and equipment are inspected before use to identify any damage occurred during transport, and to determine whether the delivered products conform to the procurement documents;
- the licensee and its suppliers must ensure that documentary evidence is retained confirming that products conform to design requirements that are specified in the procurement documents; and
- procurement documents for material, equipment and services must include or reference the procedures and/or standards, which are required to be applied by the supplier.

2.13.4 Contractor and vendor / supplier management

Ireland (1991:VI-3-6) states that contractual relationships (formal documents, purchase orders, informal agreements) must be established between participants to ensure a mutual understanding of customers' requirements, and the ability to meet them. These contractual commitments should be enforced by the project manager and project team during implementation. Vendors and suppliers of parts, components, systems and materials are an integral part of the quality team.

IAEA (2001:8) clarifies that when contractors are involved in modifications, the professional competence, experience and qualifications of all personnel involved should be confirmed, and it should be ensured that the quality assurance system complies with standards that are in effect at the plant. Pinkerton (2003:116-165) argues that vendor qualification begins during the pre-project planning stage and continues until the project team has determined which vendors will be selected to receive RFPs. Also, during the qualification phase, the project team determines, among other things, the type of vendor organisation (s) that best suits the scope of requirements of the project. Quality issues should be defined in the bid specification as a part of the project's scope. This requires that the project team should determine and communicate quality standards and the kind of programme that the contractor must have in place to ensure that these standards are achieved. Like all other project activities, procurement of equipment, materials and services must be planned in detail and executed with precision, not only to ensure that quality standards for procurement are accomplished, but also to ensure that late-arriving shipments do not impact the start-up date. Prospective vendors must identify their quality organisation and how they will maintain specified quality standards for engineering, purchasing, equipment fabrication, materials, receiving and storage, erecting, testing and site installing. This specification should also contain provisions for quality hold points, third party inspections and release for shipment, shop field testing and non-destructive testing. Prospective vendors must demonstrate that they have the capability within their organisation to police and enforce a quality program. These programs should be carefully scrutinised, especially where the main contractor employs the services of sub-contractors to deliver certain aspects of the project. This can be achieved by carefully reviewing the supplier's quality document, reading the supplier's procedures, surveying the supplier's entire quality program and observing the supplier's personnel list to see exactly who will actually monitor the quality of workmanship at each level.

Baily *et al.* (2008:419, 420, 421) define contract management as: "the activities of a buyer during a contract period to ensure that all parties to the contract fulfil their contractual obligations" An important aspect of this is managing the relationship between all parties in the most effective way to ensure that the contract meets the optimum combination of cost, time and quality. The authors further demonstrate this by quoting The London Fire and Emergency Planning: "*Once you sign a contract, you have three to five years to reap the benefits. If you don't have continuity from procurement, then you don't get those benefits…Potential savings, benefits and efficiencies are worked out and presented with satisfaction. But these are only really meaningful once the contract starts and the 'real' value is achieved.* Contract management is important, but is not always given the full attention that it deserves. The simple solution is that:

- buyers should push suppliers for continuous improvement, which is something that managers who are chiefly concerned with the day to day running of the business, fail to do;
- Companies should ask themselves what they are doing to build up trust with the supplier, and how they can build communication between all parties in the absence of effective contract management;
- Penalising contractors for minor slippages will result in poor relationships - it is better to help to manage and improve the performance of the contract throughout its life; and
- Procurement should be involved in contract management to a greater or lesser extent, depending on their organisational model and culture.

2.13.5 Summary

"If we allow our imagination to project into an ideal future, where such a culture would be universally implemented, the need for quality assurance standards would be minimised. The successive revisions of present standards would be consistently streamlining the contents, because fewer and fewer requirements would need to be established. The final goal in this ideal picture would be a future standard making all quality assurance requirements converge into just one single and unmistakable item. This could, for example, be plainly stated as "doing things right the first time and improving thereafter". This vision does not intend to suggest that quality assurance standards will cease to be needed, particularly in the field of nuclear safety. It only invites us to look ahead, with the intention of progressing towards the creation of a quality culture that integrates quality assurance requirements as an indivisible component of every work performance. This will allow simpler standards and will contribute to an improvement of the present situation where sometimes proliferating,

overlapping and contradictory requirements, methods, and terminology impair the understanding and achievement of the quality objectives" (Pieroni, 1996:4/19).

Ireland (1991:VII-1) advances the arguments that quality only appeared to be significant when it is missing with gaps in quality as a consequence that causes projects to fail to meet the business need. The result of not delivering a quality project, even with meeting time, cost and other easy-to-measure factors, is a failed project. The author therefore, concludes that while using benefits realisation as a primary success measure, the ultimate test of a quality project is when the right quality for the right scope was implemented successfully, and this is far more important than easier to measure indicators.

Rose (2005:3-8) asserts that failure can have devastating immediate and long-term consequences for both the project manager and the project organisation and, in citing the book entitled "Q*uality is free",* Crosby makes the point that quality does not cost, it pays. In improving the quality of a process, defects, which result from this process is reduced. So while the 'new' process turns out to be more expensive, it may also be less expensive, as the reduction in defects pays back a thousand times over. Therefore he concludes that if payback is more than cost, then quality is actually free.

Jha and Iyer (2006:1169) believe that the project manager's competence, top management's support and competence; interaction between project participants, owners' competence, and monitoring and feedback by project participants are factors, which have positive contributions to achieve the desired quality level. Conversely, factors that have an adverse effect on the quality performance of projects include, amongst others, conflict among project participants, ignorance and a lack of knowledge. Certain project specific factors and aggressive competition at the tender stage adversely affect the quality performances of projects. A project manager's competence is observed as the most significant factor at almost all levels of the quality performance rating.

The value and significance of this research is nested in the fact that modifications and projects that undertaken by the NPM should ultimately culminate in 'customer satisfaction' as opposed to 'customer dissatisfaction' with the main customer being the plant itself. That, which the plant dictates should be modified and implemented. The value in delivering a quality project, which leads to customer satisfaction, has immeasurable value for the client, KNPS. As long as the plant is healthy and taken care of, it will also take care of those who operate and modify it.

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the research paradigm, design and methodology that were used in this study, including sampling, population, establishing rigour during and after data collection and how data was derived from primary and secondary sources, validity and reliability, as well as ethical considerations. The fundamental aim of this chapter is to place key factors that affect project quality at KNPS within a research paradigm. The ultimate objective is to find an answer to the research question, which was defined in Chapter 1, Paragraph 1.2, which reads “the delivery of poor quality projects have an adverse effect on modifications and projects, which are implemented at the nuclear power plant in South Africa”.

3.2 The survey environment

The NPM performs various duties in the management of modifications at the plant. These include the execution of projects to the plant asset creation process, plant related modifications motivated predominantly for operational needs, and in accordance with international standards required to operate plants and the NNR. These are implemented in accordance with the Project Lifecycle Model (PLCM) **(Appendix B)**.

Information, which determine factors that influence project quality and what in the project environment allows these to persist, was collected from the NPM, external departments with staff seconded to the NPM (Nuclear Engineering and Nuclear Project Sourcing), external departments with direct influence on NPM processes and procedures [(Quality Assurance (QA), Project Quality Engineering (PQE)] and contractors. While information was obtained via a survey, historical data that relate to project quality and its influence on the project lifecycle was gleaned from databases and archives.

3.3 Research paradigm

Researchers have varying beliefs and different ways of viewing and interacting within their surroundings, hence the way, in which research is conducted, will differ. However, there are certain standards and rules that guide a researcher’s actions and beliefs, and these are referred to as a paradigm. The researcher briefly discusses the chosen methodological approach for this study and, which paradigm best fits the focus of this research. Following a discussion about the research paradigm, the research design and methodology that were utilised in this study are illustrated.

Denzin and Lincoln (2011:91) assert that a paradigm encompasses four terms: ethics (axiology), epistemology, ontology and methodology. Ethics relate to "how will I be as a moral person in the world?. Epistemology asks "how do I know the world?"; and what is the relationship between the inquirer and the known?" Ontology raises basic questions about the nature of reality and the nature of the human being in the world; while methodology focuses on the best means to gain knowledge about the world.

Joubish *et al.* (2011: 2083-2084) state that the design of a research study begins with the selection of a topic and a paradigm with a paradigm essentially being a worldview, a whole framework of beliefs, values and methods within which research takes place. It is this worldview within which research operates. **Table 3.1** below illustrates the philosophical grounding of paradigms in research.

This research falls within the constructivism/interpretive paradigm where qualitative measures are used to conduct such research. The qualitative methodology shares its philosophical grounding with the constructivism/interpretive paradigm, which supports the view that there are many truths and multiple constructive realities. There is also the interactive link between researcher and participants, while judgement is based on consensus of participants and the researcher.

Table 3.1: Philosophical grounding of paradigms in research – adapted "freely". Source: Mortens (1998), Kmitta (2000) and Guifoyle (2005)

	Positivism/Post-Positivism	Constructivism	Emancipatory
Ontology (Nature of reality)	• One reality • Reality knowable within probability	• Multiple constructed realities	• Multiple realities, which include the social, political, cultural, class, economical, gender, and so on.
Epistemology (Nature of knowledge, relationship between knower and what can be known)	• One "body of knowledge" • Objective is important • Researcher controls and observes in an objective dispassionate manner	• Knowledge individually or socially constructed • Framework/values of researcher acknowledged/made viable/explicit • Interactive link between researcher and participants	• Knowledge is socially, historically, politically, culturally situated • Interactive/activist link between researcher and participants/context
Methodology (Purpose)	• Predict • Test • Measure • Prove • Disprove	• Understand • Describe • Construct meaning • Understand from participants' perspectives	• Promote social change • Liberate • Emancipate • Critique • Take political action
Methodology (Purpose)	• Quantitative • Interventionist • Deductive • Design ▪ Single group; ▪ Experimental; ▪ Quasi-Experimental, and so on	• Qualitative • Inductive (discovery of patterns) • Hermeneutical (Interpretive) • Dialectical • Contextual features important	• Qualitative (primarily) • Quantitative (can be used) • Contextual/historical features important as they relate to oppression
Axiology (Value and Judgement)	• Value free/theoretically influenced • Suspend judgement until statistical tests prove/disprove	• Judgement is based upon consensus of participants and researcher • Varies upon theoretical framework/values held by researcher	• Judgement is based on experienced oppression by participants • Framed by beliefs/values of all participants • Can be theory driven

3.4 Qualitative research

Patton (2002:10) explains that since the researcher is the instrument, the credibility of qualitative research methods hinges on the skill, competence and rigour of the person doing the field work as well as the things going on in a person's life that might prove the fruit of qualitative inquiry.

Creswell (2003:182) argues that qualitative research is fundamentally interpretive with the researcher making interpretations of the data and then drawing conclusions about their meaning, both personally and theoretically. Leedy and Ormrod (2005:134-135) believe that qualitative research comprises the following characteristics, namely: description; interpretation; verification and evaluation. Furthermore, the qualitative researcher collects data by using an instrument or gathers information by using a behavioural checklist (Creswell, 2003:17).

While the researcher acknowledges that a number of strategies can be applied to similar research projects, the well-known concepts of objectivity, reliability, and so on inherited from the empirical analytical paradigm, are suggested for business research in more or less the traditional way. The researcher used qualitative methods of research to unearth factors that affect project quality at the KNPS.

3.5 Research design and methodology

According to De Vaus (2001:9-16), the function of a research design is to ensure that the evidence that is obtained enables answering the initial question as unambiguously as possible. The author further writes that research design is the structure of an enquiry; a logical rather than a logistical matter where the type of evidence answers the research question convincingly so that it is not only consistent with a particular theory, but must be found to have the potential to disprove preferred explanations.

Crotty (2003:3) states that research methodology is the strategy, plan of action, process or design lying behind the choice and use of particular methods, whilst linking them to the desired outcomes. Collis and Hussey (2003:55) state that research methodology refers to the overall approach to the research process, from the theoretical underpinning to collection and analysis of data.

Saunders *et al.* (2007:147-152) believe that research design has to do with the credibility of research findings, while Watkins (2008:42) defines it as "…the logical sequence that connects the empirical data to study's initial research question and ultimately, to its conclusion".

In this research the researcher believes that all components (plant, people, processes and procedures, the project lifecycle, project quality, survey environment and respondents) should fit together in such a way that meaningful information and answers can be obtained. To achieve this goal, the researcher compiled a design strategy (as discussed from Paragraph 3.6 onwards) that sought to obtain answers to the research questions that were raised in Chapter 1, paragraph 1.4.1. The adopted strategy shaped the choice and use of particular methods and linked them to the desired outcomes. This approach provided insight into factors that affect project quality at the KNPS.

3.6 Methods of data collection

The construction of a research instrument or tool for data collection is vital, since it determines the nature and quality of the information. Findings or conclusions are based on the type of information, and the data that is collected is entirely dependent on questions that are asked of respondents. According to Kumar (2011:138), when conducting a research study, there are two major approaches to gathering information:

- Primary - data collected for the first time; and
- Secondary - data that has already been collected and analysed by someone else.

As part of the primary data collecting exercise, the researcher used three types of data collection methods, namely:

- Personal interviewing;
- Telephone interviewing; and
- Self-administered questionnaires/surveys (Kumar, 2011:44).

In this research, the researcher employed all three primary data collection methods with self-administered questionnaires serving as the primary data collection method. An indirect approach was used with personal and telephone interviews (contracts manager, quality manager and construction manager, project quality engineering lead auditor), which gave the researcher insight regarding factors that the researcher was not consciously aware of, as it relates to project quality. Personal interviews allowed for the identification of key issues within the target environment, which were not readily identifiable by using a survey questionnaire. This allowed the researcher to interpret responses immediately and allow the respondent to elaborate on significant information. Telephone interviews, while there were few, were also used as a quick method, which also allowed the researcher to explain questions that were not understood by the respondent.

In addition to personal and telephone interviews, the study used self-administered questionnaires. Since there are many ways to ask a question, the questionnaire was flexible and attempted to cover crucial aspects of project quality throughout the project lifecycle. This allowed the researcher to probe deeply round factors that affect project quality, and to secure accurate and inclusive accounts that are based on the personal experiences of those in the employ of NPM, whether permanent, temporary, seconded or contracted. Refer to **Appendix C** for a sample of the questionnaire.

3.7 Questionnaire design and development

The researcher chose the questionnaire as it has several advantages in order to extract information (Kumar 2011:148):

- **It is less expensive**. A lot of time was saved as the researcher did not have to interview too many respondents. The use of a questionnaire was comparatively convenient and inexpensive; and
- **It offers greater anonymity**. As there was no face-to-face interaction between respondents and the interviewer, greater anonymity was ensured, which is something that was apt considering that the survey took place within the nuclear environment. In some situations there were sensitive questions that were posed, so this helped to increase the likelihood of obtaining accurate information.

De Vaus (1996:108) and Kumar (2011:149) agree that self-administered questionnaires, however, are also subject to a number of disadvantages:

- There was no control over who responded to the questionnaire. Evidence of this was that the survey took place during an SDO, which decreased the number of respondents who could have been reached. It was also not evident whether or not a respondent consulted with colleagues while completing it;
- The response rate may be low, giving rise to bias;
- Misunderstandings cannot be cleared up; and
- Sampling is subject to error.

3.8 Administering the questionnaire

For this research study, the researcher designed questions, which covered the most crucial aspects of project quality throughout the project lifecycle. This ensured that questions had a direct link to the objective of the research study. The questionnaire was constructed after a thorough review of the available published literature, consultation with nuclear professionals, and cognisance of similar research that was performed by other colleagues (during the same period as this study), and a reflection on the researcher’s knowledge and professional experience. The questions were also based on the requirements for project quality for an NPP as well as the requirements of RD0034. The questions were, in most cases, a direct demand or instruction by which project/modification success is measured. Such a questionnaire had not previously been tested and, therefore, had to be developed, while its relevance to current project quality practices had to be validated before use.

Questions and statements were formulated in such a manner that respondents could respond to the questions and they ranged from strongly agree to strongly disagree; and to determine factors that affect project quality at an NPP from various perspectives. Respondents had to indicate the level of agreement to a particular statement with the final question giving them an opportunity to provide general comment or to critically express their overall view. Questions were specifically designed to extract responses that would relate and unearth factors that affect project quality, either negatively or positively. Statements within the survey were designed with the following principles in mind:

- Avoidance of double-barrelled statements;
- Avoidance of double-negative statements;
- Avoidance of prestige bias;
- Avoidance of leading statements; and
- Avoidance of the assumption of prior knowledge (Watkins, 2008:143).

The researcher decided to have two separate questionnaires; one for employees at NPM and the seconded and external staff, as explained in paragraph 3.2, and another for its contractors. The reason for the split is that these are project people who provide a different perspective, as relates to project quality. This was purposely done so that it could be ascertained, from both sides, that which needed to be altered and what could be retained so that the partnerships could be geared towards improving the delivery of project quality on the plant.

The researcher was confronted with two major issues when developing the questionnaires. Firstly, the researcher needed to develop a tool that would accurately assess whether there was a continuing trend (good or bad) as it related to project quality, especially when considering the rules in accordance with nuclear standards and RD-0034. Secondly, the researcher needed the tool to be consistent when used on multiple occasions with different categories of participants.

In order for the questionnaire to be effective, the researcher had it reviewed by a few peers in project management, current students who conducted research, the research supervisor, while the service of a statistician was also employed. All were e-mailed copies of the questionnaire and this included an information sheet, which explained the purpose of the study and they were asked to comment. Comments on questions/statements and their relevance to the study and NPM, specifically, were clarified and modified according to the comments from the reviewers. Minor modifications to the layout and wording were made prior to administering the questionnaire. Where suggestions were made about the wording and structure of some of the questions, these were altered accordingly. Expert advice was given in terms of how to extract relevant information from respondents. The supervisor and statistician highlighted the presence of language inconsistencies, ambiguities, and provided guidance to ensure that every question was examined carefully so that the participants would not be confused by the content of the questions. Such professional feedback subjected the questionnaire to further scrutiny prior to its distribution and use in the research study. The purpose of this exercise was for the researcher to overcome or minimise the disadvantages of self-administered questionnaires. The questionnaire was then pre-tested with colleagues who conducted research to identify problems in order to avoid confusion in terms of the wording or layout.

3.9 Ethical consideration

According to Saunders *et al.* (2000:103),"… ethics refers to the appropriateness of your behaviour in relation to the rights of those who become the subject of your work, or are affected by it". The following was the researcher's behaviour and conduct guide during the research:

- **Informed consent:** participants were given the choice to participant or not to participate and were informed in advance about the nature of the study;
- **Right to privacy:** the nature and quality of participants' performance were kept strictly confidential;
- **Honesty with professional colleagues:** data was not fabricated to support a particular conclusion; and
- **Confidentiality / anonymity:** confidentiality or anonymity was offered to respondents (Saunders et al., 2000:103).

In accordance with Kumar (2011: 150-151), the following were included in the covering letter:

- The researcher introduced herself and the institution that she represented;
- The main objectives of the study were described;
- The relevance of the study was explained;
- General instructions were conveyed;
- The letter indicated that participation in the study is voluntary, and that if a respondent did not want to respond to the questionnaire, they had the right not to;
- Respondents were assured of anonymity in terms of information provided by them; and
- The researcher provided a contact number and return address for any further queries.

To this end the researcher obtained a letter of consent from the Senior Manager of NPM granting permission for such a study to be conducted in this business area. The researcher further issued an informed consent letter making all respondents adequately aware of the type of information that is required of them: why it is being sought; what purpose it will be used for; how they are expected to participate in the study; and how it will directly or indirectly affect them. The consent was voluntary and without pressure of any kind. Confidentiality and anonymity was guaranteed, which allowed respondents to be more open and honest with their responses. Refer to **Appendix E** for an example of the informed consent letter that accompanied each questionnaire.

3.10 Determining sample design and choice of the sampling method

Researchers habitually draw conclusions about large groups by taking a sample. A sample is a part of the population, which is selected to represent the population as a whole. Ideally, the sample should be representative and allow the researcher to make accurate estimates of the thoughts and behaviour of the larger population. The survey design asks:

- Sample - who will be surveyed?
- Sample size - how many people will be surveyed?
- Sampling - how should the sample be chosen?

Kumar (2011:192) explains that the selection of a sample in qualitative research is designed either to gain in-depth knowledge about a situation, or to know as much as possible about different aspects of an individual on the assumption that the individual is typical of the group, and will hence provide insight into the group. Similarly, in qualitative research there is no predetermined sample size, but during data collection the point of saturation has to be reached (when no new information is received). Since the sample size does not play any significant role as the purpose is to study only one of a few cases in order to identify the spread of diversity and not its magnitude, data saturation stage during data collection determines the sample size.

Hussey and Hussey (1997:148) assert that there is no ideal of prescribed sample size, as it depends on the discipline, level of confidence expected in the answers and the anticipated response rate. In order that each identifiable stratum of the population is taken into consideration (Collis and Hussey, 2003:157, Easterby-Smith, Thorpe and Lowe, 1996:48), respondents were randomly selected from each stratum.

There are three types of probability samples:

- Simple random sample: every member of the population has an equal chance of being selected;
- Stratified random sample: population is divided into mutually exclusive groups and random samples are drawn from each group; and
- Cluster sample: the population is divided into mutually exclusive groups and the researcher draws a sample of the group that should be interviewed.

The researcher chose the stratified sampling technique, since according to Kumar (2011:192), for a sample to be called a random sample, each element in the study population must have an equal and independent chance of selection. Three random designs were discussed: simple random sampling, stratified random sampling, and clustered sampling. This type of sampling was chosen in order to provide the researcher with the most useful information on which to evaluate factors that affect project quality. Such a sampling technique was appropriate and advantageous for this study because the researcher required specific NPM staff, who practised in specific fields at the plant, are experts and had speciality knowledge in the implementation of modifications and projects at the plant. Some of the staff members within NPM were previously employed by other departments on the plant and could provide a different point of view as well.

Corbetta (2003:210-218) believes that the accuracy of sampling estimates depends on, among other things, sample size and the degree of variability in the distribution of the phenomenon that is studied within the reference population.

The various functional areas, which are listed in paragraph 3.2, served as the individual strata for the research survey and ensured that all identifiable strata of the population were taken into account. Respondents were divided into categories (status) in terms of the project lifecycle model and into the department in which they worked. This served as the individual strata for the survey. The PLCM for Eskom is:

- Concept Release Approval (CRA);
- Definition Release Approval (DRA);
- Execution Release Approval (ERA);
- Finalisation Release Approval (FRA); and
- Benefits Realisation (BR).

The sampling method, which was utilised by the researcher allowed for stratified sampling of the participants. The sample design was organised into three phases, as per Corbetta (2003:210-218):

- The reference population of NPM, which currently has 166 employees (both technical and non-technical), was subdivided into sub-populations called strata (paragraph 3.2), which are homogeneous as possible to be studied. A total of 127 of the total compliment are considered technical and were targeted for this survey;
- A sample was selected from each stratum by means of random procedure; and
- The sample that was drawn from each stratum was pooled in order to produce an overall sample.

The sample breakdown is, therefore, as follows:

Table 3.2: The target population and sample size

Eligible sample	Target population	Sample size
Senior manager	1	1
Middle managers	7	7
Line managers	6	6
Project development	8	8
Project execution (operational)	18	18
Construction management	18	18
Programmes management	4	4
Monitoring and support		
- Planning	8	8
- Quality assurance	3	3
- Quality control	2	2
- Administration staff	23	0
Contracts management	1	1
Strategic projects		
External departments (seconded)		
- Nuclear engineering	18	18
- Nuclear project sourcing	7	0
- Nuclear project finance	9	0
External departments (other)		
- Quality assurance	13	13
- Project quality engineering	8	8
- Quality control	6	6
- Quality management - process support	1	1
- Licensing	2	2
Other	3	3
Total	**166**	**127**

3.11 Target population

For this survey, the researcher selected a random sample of respondents within the entire NPM population who fitted the profile and represented the sampling frame. As it was not necessary to sample the entire population of 166 employees; 127 employees, who comprised project managers, project leaders, project supervisors, contracts managers, design engineers, project engineers, and quality assurers formed the sample size. It should be noted that while external departments have a huge and separate staff compliment, only those staff members that were seconded to NPM as part of the project team formed part of the target population. They were, therefore, considered as part of NPM for purposes of this research. The QA department and PQE were included as they have a direct influence on the business.

The sample also included five contractors who are business partners to ensure that Eskom meet their objectives of keeping the lights burning. The contractors that were targeted are those who have the most influence and impact on project quality. This transposed into a different number of respondents from different functional areas who were randomly selected from the identified research strata in order to ensure representativeness, as the sample across various departments, within NPM, which influences project quality at KNPS. This target population was specifically chosen to validate the practicality of the concepts, as presented within this research. This sample is, therefore, considered as representative of the target population.

The risk of bias, which cannot be statistically eliminated, was recognised by the researcher based on the definition of the target population, as well as the limitations introduced by the number of respondents that was selected in each category. To this end, the researcher took the necessary steps to not deliberately conceal or highlight something that could be seen as the researcher introducing a vested interest, thereby not drawing conclusions to the best of the researcher's ability.

3.12 Measurement scales

According to Kumar (2005:146-151), attitudinal scales measure attitudes towards an issue and their strength lies in their ability to combine attitudes towards different aspects of an issue and to provide an indicator that is reflective of an overall attitude. There are three types of scale that measure attitude: the Likert, Thurstone and Guttman scales. The Likert scale is the most common because it is easy to construct. The author further explains that the Likert Scale does not measure attitude per se, but it does help to place different respondents in relation to each other in terms of the intensity of their attitude towards an issue; it shows the strength of one respondent's view in relation to that of another.

During the survey respondents were asked to respond to statements based on the Likert scale with responses ranging from strongly agree to strongly disagree (1-5). The reason for choosing the Likert scale is that it can be used in both respondent and stimulus centred studies. It was most appropriate to gather data in support of the research problem, and best to extract respondents' views concerning factors that influence project quality at KNPS. It was also structured so that respondents had to personalise and think of these factors when they implemented a project. Advantages in using the Likert scale, according to Watkins (2008:140) citing Emory and Cooper (1995), are that they are easy and quick to construct; and that each item meets an empirical test for discriminating ability.

3.13 Survey sensitivity

There were particular challenges to the researcher, especially in research that was conducted in areas of a sensitive nature such as a nuclear power plant. This survey, as well as the empirical data gleaned by interrogating various databases, speaks to factors that affect project quality at a nuclear power plant. This survey is, therefore, sensitive in nature and the following guidelines from various academics serve to illustrate the mitigation process, which can be deployed in an instance where research is conducted in areas of a sensitive nature.

3.14 Validity and reliability

To tackle the issues of content validity, the researcher approached the technical plan coordinator and other subject matter experts (SME) to examine the questionnaire's content. The researcher wanted to ensure that the tool focused on fundamental and essential nuclear project quality concepts.

Emory and Cooper (1995:156) state that a strategy of empirical analysis of data that is collected and is used in business research, will deliver results that are:

Practical: results will be economical, convenient, and interpretable;

Valid: the extent to which the test measures which, we actually wish to measure, represents the real situation. There are three subsets to the concept of validity. These are construct validity, internal validity and external validity (Yin, 2003:34); and

Reliable: the accuracy and precision of the measurement procedure.

Leedy and Ormrod (2005:28) believe that the validity and reliability of measurement instruments influence the extent to which something can be learned about the phenomenon that is studied, while the probability that statistical significance in data analysis will be obtained, as well as the extent the extent to which meaningful conclusions can be drawn.

Davies (2007:241) states that the concept of reliability is related to the rigour with which the researcher has approached the tasks of data collection and analysis, while reliability is equated with methodological 'accuracy'.

According to Kumar (2011:186), the concept of validity refers to a situation where the findings of a study are in accordance with what it was designed to find out, and with respect to measurement procedures, whether a research instrument measures what it set out to measure. The author believes that the reliability of an instrument refers to its ability to produce consistent measurements each time, which means that when an instrument is administered under the same or similar conditions to the same or similar population and obtain similar results, it is said that the instrument is reliable.

According to Creswell and Miller (2000:126), reliability, validity and triangulation, if they should be relevant research concepts, particularly from a qualitative point of view, should be redefined in order to reflect the multiple ways of establishing truth. The researcher ensured validity and reliability by using the triangulation method in order to have an understanding of how to test or maximise the validity, and hence the reliability of this study.

Patton (2002:247) advocates the use of triangulation by stating that "triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches". Furthermore triangulation may include multiple methods of data collection and data analysis, but does not suggest a fix method for all the researches. The methods chosen in triangulation to test the validity and reliability of a study depend on the criterion of the research.

Since validity and reliability of measurement instruments influence the extent to which something can be learned about the phenomenon that is studied, the probability is that statistical significance will be obtained in data analysis, as well as the extent to which meaningful conclusions can be drawn from collected data (gleaned databases). For this survey the researcher developed two separate survey questionnaires, which contain statements that require a response that has been designed to measure the attitude towards and experience of respondents within NPM who have direct influence on project quality. One questionnaire focused on the NPM project staff, while the other was designed for the contractors. These questionnaires were issued to project managers, project leaders/supervisors, contract managers, quality assurers, buyers and contractors within NPM. These respondents influence project quality in different ways hence it will accurately measure factors that affect project quality at a nuclear power plant from the NPM and contractors' perspective.

3.15 Data analysis

In accordance with Leedy and Ormrod (2010:17), data analysis was conducted in the following manner:

- Organisational: The researcher used software to assemble, categorise, code, integrate and search potentially huge data sets (for example, survey open-ended responses and qualitative interview data). Data was organised and coded by marking the segments of data with symbols, descriptive words, or category names. The researcher continued this process until all data was segmented and initial coding was completed. A master was kept (a list of all the codes that were developed and used in the research study). Then the codes were reapplied to new segments of data each time that an appropriate segment was encountered. Once completed, the data was integrated.
- Conceptual: The researcher used the software to write and store on-going reflections about data and construct theories that integrate research findings. Here the researchers will transcribe data from questionnaires, interviews, observational notes, memos, etc. into word processing documents.
- Statistical assistance: The researcher utilised SPSS, the statistical and spread sheet software package, which was used to categorise and analyse various types of data sets
- Graphic production: The researcher used SPSS to depict data in graphic form to facilitate interpretation. These graphical images illustrated how project quality is meant to work and clarify the relationship between project quality and factors that affect project quality at KNPS.
- Corroborating and validating of results: This is an essential component of data analysis and the qualitative research process and should be done throughout the qualitative data collection, analysis, and write-up process. This is essential because in presenting trustworthy results, otherwise, there is no reason to conduct a research study.

3.16 Summary

When one undertakes research study to find answers to a question, one implies that the process:

- is undertaken within a framework of a set of philosophies (approaches);
- uses procedures, methods and techniques that have been tested for their validity and reliability; and
- is designed to be unbiased and objective.

The researcher ensured that the research is effective in the following ways:

- **Rigorous**: the researcher ensured that procedures were followed to find answers to questions that were relevant, appropriate and justified;
- **Systematic**: the researcher adopted a procedure that followed a certain logical sequence;
- **Valid and verifiable**: the researcher ensured that whatever conclusions were made on the basis that findings were correct, valid and could be verified;
- **Empirical**: the researcher ensured that conclusions that were drawn were based on hard evidence, which was gathered from information that was collected from real life experiences, observations and relevant databases and archives; and
- **Critical**: the researcher critically scrutinised the methods that were employed to ensure that they are sound and able to withstand critical scrutiny.

In this chapter the 'knowledge management' survey design and methodology was addressed and the researcher believes that the above was covered in order to ensure that this research is effective.

Chapter 4 presents results from the survey which are analysed in detail, while conclusions are also drawn in the next chapter.

CHAPTER FOUR
DATA ANALYSIS AND INTEPRETATION OF RESULTS

4.1 Introduction

De Vos (2002: 339) defines data analysis as “the process of bringing order, structure and meaning to the mass of collected data”.

This chapter describes methods of data analysis, which were used by the researcher for the purpose of finding out factors that affect project quality at a nuclear power plant in South Africa. The purpose was not only to explore how NPM perceived them in the execution of project quality in the project lifecycle, but also gauged how external departments, with which NPM have direct interfaces, viewed the implementation of project quality during the project lifecycle.

Walliman (2005:301) strongly believes that an essential part of research is data analysis, hence such analysis and the decision regarding appropriateness of analytical methods must be made in relation to the nature of the research problem, which, as stated in Chapter 1 paragraph 1.3, reads: “the delivery of poor quality projects have an adverse effect on modifications and projects, which are implemented at the nuclear power plant in South Africa”. To this end, the researcher decided to make use of software, called SPSS, to conduct statistical analysis of the data.

The methodology that was described in the preceding chapter provided the baseline for data gathering. In this chapter data, which was obtained from the completed questionnaires are presented and analysed, including data that was gleaned for databases. The presentation of data was systematically linked to the format of the self-developed questionnaire, which is attached in **Appendix C and Appendix D**. Data was analysed as follows: description of the sample, data format, and methods of data analysis, main results, discussion, presentation and interpretation of the results. This was then followed by a discussion of the research findings. The findings related to the research questions that guided the study. Data was analysed to identify, describe and explore the factors that affect project quality at a nuclear power plant in South Africa.

4.2 Sample

The target population was obtained from self-administered questionnaires, as shown in **Table 4.1** below. The administration, finance, project sourcing and internal quality control department, while targeted, did not complete questionnaires and are, therefore, excluded from this survey.

Table 4.1: Target population vs. completed questionnaires

Eligible sample	Target population	Completed questionnaires
Senior manager	1	0
Middle managers	7	1
Line managers	6	4
Project development	8	8
Project execution (operational)	18	10
Construction management	18	9
Programmes management	4	3
Monitoring and support		
- Planning	8	5
- Quality assurance	3	3
- Quality control	2	0
- Administration staff	23	0
Contracts management	1	1
Strategic projects		
External departments (seconded)		
- Nuclear engineering	18	12
- Nuclear project sourcing	7	0
- Nuclear project finance	9	0
External departments (other)		
- Quality assurance	13	4
- Project quality engineering	8	7
- Quality control	6	3
- Quality management - process support	1	1
- Licensing	2	2
Other	3	3
Total	**166**	**76**

4.3 Data format

The questionnaire comprised of two sections and data that was generated was presented as follows:

- This first section of the questionnaire sought to identify the respondents and their characteristics in order to distinguish amongst them in terms of their gender, work experience, stakeholder status, work department and the project life cycle phase on which they based their responses.

- Factors that affect project quality include people, standards, processes and procedures, the plant itself, the contractor and quality overall. The questionnaires were, therefore, designed to emulate this view and were each provided with a code, hence the second section comprises of the following:
  - Section A: people involvement in project quality and how they affect the project lifecycle;
  - Section B: Standards, processes and procedures that should be applied and adhered to in order for project quality to be realised;
  - Section C: The plant and how project quality affects its performance once modifications or projects have been implemented;
  - Section D: Contractor/supplier/vendor management and how these factors affect project quality; and
  - Section E: Quality and how it is implemented and monitored during the project lifecycle.

The contractor questionnaire **(Appendix D)** comprised of two sections and generated data was presented as follows:

- Contractor's work experience at KNPS;
- Section A: Processes and procedures; how they were communicated by the project team and how the contract understood and interpreted those so that project quality was achieved at all times; and
- Section B: Project execution / implementation / delivery in relation to project quality.

The data was received from questionnaires that were coded and captured on a database, which was developed by SPSS. Once captured, information was verified by the statistician who reviewed all data. This information, which had been double-checked for correctness, was then analysed by the custodian of this document and anomalies were fixed by the researcher before any data analysis occurred. The questionnaire was based on the Likert Scale, which set boundaries for the different variables (questions). However, in order for the analysis to be meaningful, the researchers decided to group and recode the data. Hence, the following materialised:

- Q1, 38, 39 and 40 were distributed with the first two sections missing owing to a printing error; however, the researcher chose not to discard them as they were from a crucial external department and the information that was completed was usable;
- Q19, 42, 43, 58,79,80,81 were included in NPM by virtue of the status being that of Project Manager, according to the PLCM;

- Q27, 64 and 72 were discarded as the data was not usable;
- Stakeholder status changes accordingly, Q33 to 9, 55 to 11, 54 to 11 and 56 to 5;
- Q78 department was changed to NPM by virtue of the stakeholder status; and
- The questionnaires that were completed by maintenance (1), document controllers (3) and a buyer (1), did not meet the inclusion criteria and were therefore, not used.

4.4 Methods of data analysis

Walliman (2005:304) explains that there are the two classes of parametric statistics, namely descriptive and inferential statistics with descriptive statistics providing a method of quantifying the characteristics of the data, where their centre is, how broadly they spread and how one aspect of the data relates to another aspect of the same data. Describing information that was collected is called descriptive statistics, while inferential statistics is the testing of assumptions that are made through hypothesis and modelling.

Descriptive statistical analysis was used to identify frequencies and percentages to answer all the questions in the questionnaire. Not all respondents answered all the questions; therefore, percentages correspond with the total number of respondents who answered individual questions. Descriptive statistics were given for each variable and only the respondents who completed the entire questionnaire were used in the inferential statistics.

The SPSS statistical analysis programme was used to analyse the data. The researcher also noted that where it was expected that the respondent (by way of stakeholder status) should either have agreed or disagreed with a statement, they indicated that they were neutral. This would also have an effect on the accuracy of determining where the problem lies, as it relates to project quality in projects.

4.5 Assistance to researcher

The conclusions made by the researcher were validated by the statistical report. Help was given to interpret the outcome of the data. The final report, which was written by the researcher was validated and checked by the statistician in order to exclude any misleading interpretations.

4.6 Interpretation of results

4.6.1 Analysis of questionnaires

A total of 166 questionnaires were distributed and 82 questionnaires were returned, however, only 76 questionnaires were used for this study, as they met the required inclusion criteria which was those employees who were in the employ of NPM during the research, whether permanent or seconded project management staff. It should also to be noted that of the 166, only 134 were NPM staff with 18 being those who were seconded from the Nuclear Engineering Department; 7 from Project Sourcing and 9 from Project Finance. Since Project Sourcing, Project Finance and administration staff did not complete any questionnaires; they are excluded from this sample/survey. The target population is, therefore, [(=166(-7-9-23) 127]. This represents [(76/127) = 59.84%] of the expected population.

4.6.2 Descriptive statistics

A total of 76 questionnaires were used to interpret the results. Data that was gathered through the questionnaires was subject to frequency counts. In other words, the respondents' responses for each individual statement were added together to find the highest frequency of occurrence (the number of times that a particular response occurs). These responses to the statements, which are quantified, were then presented in percentage forms. This analysis is presented in tabular format, while the researcher used variables in different tables.

4.6.2.1 Questionnaire - Frequencies

Gender		Frequency	%	Valid %	Cumulative %
Valid	Male	49	64.5%	72.1%	72.1%
	Female	19	25.0%	27.9%	100.0%
	Total	68	89.5%	100.0%	
Missing	System	8	10.5%		
Total		76	100.0%		

The above table shows that of the 68 respondents, 72.1% are male, while 27.9% are female. It also indicates that there is more than twice the number of males than females, which is something that is common in the male dominated nuclear industry.

Experience (in years)		Frequency	%	Valid %	Cumulative %
Valid	0 - 5	5	6.6	7.4	7.4
	5 - 10	15	19.7	22.1	29.4
	10 - 15	17	22.4	25.0	54.4
	15 - 20	7	9.2	10.3	64.7
	20 - 25	5	6.6	7.4	72.1
	> 25	19	25.0	27.9	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

The above table shows that experience in years reads as follows: 7.4% = 0-5 years; 22.1% = 5-10 years; 25% = 10-15 years; 10.3% = 15-20 years; 7.4% = 20-25 years; and 27.9% have more than 25 years' experience. This depicts that NPM has a fair mix of different levels of experience, and that most of the staff have worked there for more than 25 years.

Stakeholder status		Frequency	%	Valid %	Cumulative %
Valid	Programme manager	4	5.3	5.5	5.5
	Project manager	30	39.5	41.1	46.6
	Project engineer	8	10.5	11.0	57.5
	Design engineer	4	5.3	5.5	63.0
	Project scheduler	5	6.6	6.8	69.9
	Quality	18	23.7	24.7	94.5
	Other	4	5.3	5.5	100.0
	Total	73	96.1	100.0	
Missing	System	3	3.9		
	Total	76	100.0		

Stakeholder status (other)		Frequency	%	Valid %	Cumulative %
Valid	Regulatory/licensing	1	1.3	33.3	33.3
	Quality management	1	1.3	33.3	66.7
	Senior licensing physicist	1	1.3	33.3	100.0
	Total	3	3.9	100.0	
Missing		73	96.1		
Total		76	100.0		

The above tables show respondents' stakeholder status. A majority of respondents are project managers (41.1%), which was expected considering that the study was conducted within NPM. They are closely followed by quality (24.7%), which means that meaningful data can be extracted based on the views of those who monitor the quality of projects both inside and outside NPM. Engineers (11.0%+5.5%=16.5%) also comprised a meaningful number and would, therefore comment fairly, and can provide their perspectives of project quality involvement. The external departments are quality management and licensing, and while their percentage is low (5.5%), their views provide insight into dealings with the NNR, which is crucial to the study.

Department		Frequency	%	Valid %	Cumulative %
Valid	Nuclear project management	49	64.5	66.2	66.2
	Nuclear engineering	8	10.5	10.8	77.0
	procurement	7	9.2	9.5	86.5
	Quality assurance	4	5.3	5.4	91.9
	Quality control	3	3.9	4.1	95.9
	Other	3	3.9	4.1	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	76	100.0	

Department (Other)		Frequency	%	Valid %	Cumulative %
Valid	KNPS nuclear licensing department	1	1.3	33.3	33.3
	Process support	1	1.3	33.3	66.7
	Outage Department	1	1.3	33.3	100.0
	Total	3	3.9	100.0	
Missing		73	96.1		
Total		76	100.0		

The above tables show departments in which respondents work; both internal and external to NPM. The highest number of respondents was NPM (66.2%); followed by Nuclear Engineering (10.8%); and Procurement (9.5%). It should be noted that the Procurement Department (9.5%) is represented here by the Project Quality Engineering Section (PQE). This section is responsible for grading suppliers, conducting supplier capability assessments, and compliance audits once the contract is placed. This is a function, which is performed with and on behalf of the project manager.

Project Phase		Frequency	%	Valid %	Cumulative %
Valid	1	9	11.2	100.0	100.0
DRA - Definition Phase		Frequency	%	Valid %	Cumulative %
Valid	1	15	18.8	100.0	100.0
ERA - Execution Phase		Frequency	%	Valid %	Cumulative %
Valid	1	48	60.0	100.0	100.0
FRA - Finalisation Phase		Frequency	%	Valid %	Cumulative %
Valid	1	8	10.0	100.0	100.0
Total		**80**	**100.0**		

The above table shows the project phase on which respondents based their responses. It was expected that most of the responses would be based on the execution phase as concept phase (11.2%) and definition phase (18.8%), while coordinated by NPM, fall more within the domain of the engineering departments. Furthermore, quality issues are experienced more in the execution phase of the project and this is where quality issues are visible. The finalisation phase (10%) is low and is the one area where lessons that are learnt should be captured. It is also an indication that project managers are not around long enough to complete a project, or that they fail to close out projects effectively. A reason for the increase in the number of responses is owing to the fact that some respondents indicated that they based their responses on more than one phase.

Appendix F shows the rest of the descriptive statistics for all the categorical variables with the frequencies in each category and the percentage from the total number of questionnaires, while **Appendix G** shows the minimum, maximum, median, standard deviation and standard error of deviation. It should be noted that the descriptive statistics are based on the total sample. Due to the voluminous nature of **Tables 4.2 and 4.3**; the tables are contained within the ambit of **Appendix F and Appendix G**.

The data was then cross-tabulated in order to ascertain how the different stakeholders and departments responded to each question. This showed how crucial external stakeholders and departments viewed the implementation of project quality in modifications and projects. It also shed some light on how project managers and the project management department are viewed by crucial stakeholders who have a direct influence on processes, as they relate to project quality. Due to the voluminous nature of **Table 4.4,** the table is contained within the ambit of **Appendix H.**

4.6.3 Uni-variate graphs

Figure 4.1 below illustrates the distribution of the responses for each statement in the survey.

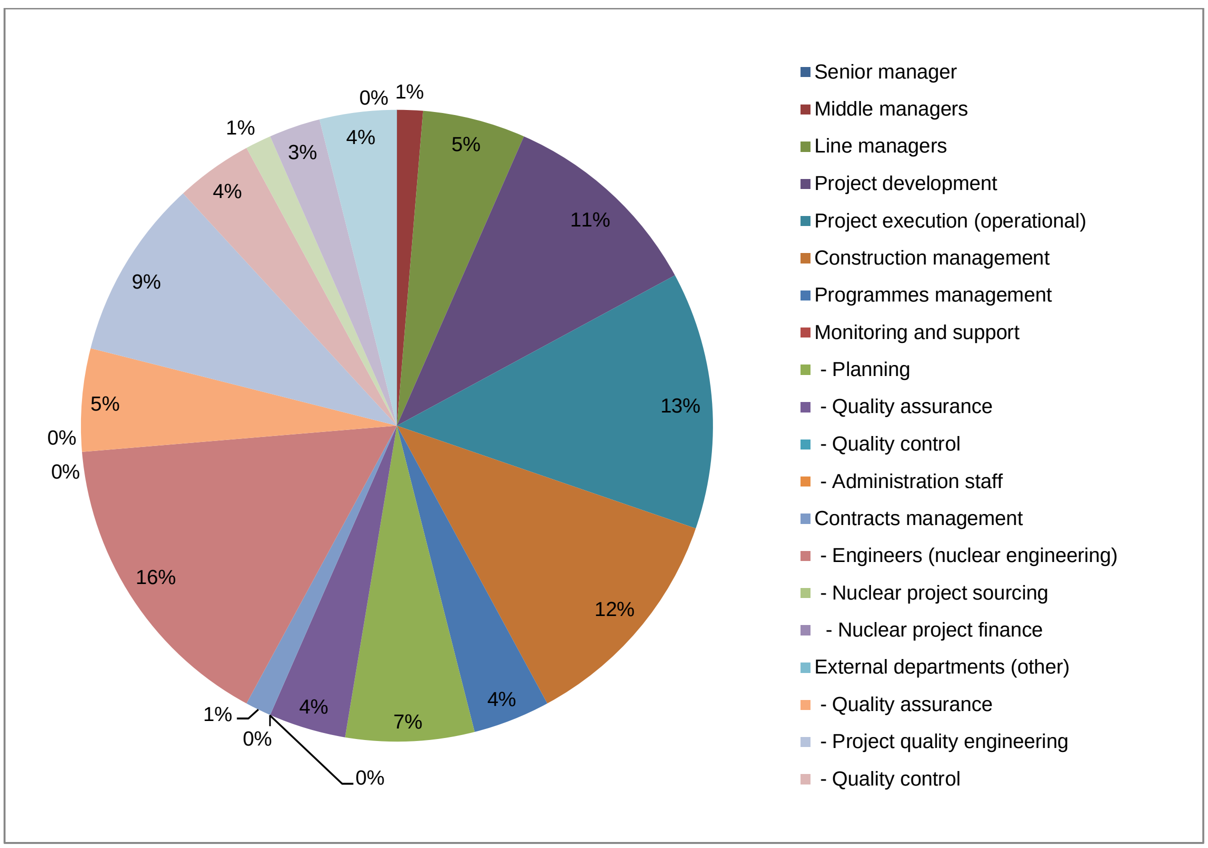


Figure 4.1: Distribution of responses

As part of the study, the researcher found it necessary to check, which statements respondents mostly agreed with, and with which they mostly disagreed. This would pave the way to discover what it is that should be addressed to either enhance or change project quality practises within NPM. **Table 4.5** depicts those respondents who mostly agreed with statements with a ranking from highest to lowest, while **Table 4.6** shows those who mostly disagreed. **Tables 4.5 and 4.6** show a summary of the cases, but owing to the voluminous nature of the detail, **Tables 4.7 and 4.8** are contained within the ambit of **Appendix I**. **Figures 4.2, 4.3, 4.4, 4.5 and 4.6** below depict a graphical representation of respondents who mostly agreed and mostly disagreed with the statements in all sections of the questionnaire.

Table 4.5: Multiple response - statements that were mostly agreed with

Statements that were mostly agreed with	Responses		Percent of Cases
	N	Percent	
Compliance was ensured by using the following: hold/witness points.	60	2.60%	78.90%
Design specifications were prepared.	59	2.60%	77.60%
Design specifications were approved.	58	2.50%	76.30%
Design specifications were prepared by independent reviewers.	56	2.40%	73.70%
Design specifications were authorised.	56	2.40%	73.70%
Processes and procedures were conveniently available.	54	2.30%	71.10%
When the project/ modification was identified, its compatibility with the design intent was assessed.	53	2.30%	69.70%
Design specifications were issued to the suppliers.	53	2.30%	69.70%
The project team demonstrated commitment to achieve project quality.	51	2.20%	67.10%
The project was planned to a level of detail that ensured efficient implementation of project quality.	51	2.20%	67.10%
Design specifications were validated as required (before implementing the design).	51	2.20%	67.10%
The project manager was knowledgeable about the plant.	50	2.20%	65.80%
The project team demonstrated sufficient knowledge and experience to guide contractors on project quality.	50	2.20%	65.80%
Where there were deviations, non-conformances were raised (reported).	50	2.20%	65.80%
Design specifications were revised.	49	2.10%	64.50%
The following was enforced to ensure that a quality project was implemented: the supplier's quality documents were reviewed.	49	2.10%	64.50%
Compliance to project quality was visible during execution.	49	2.10%	64.50%
Senior management demonstrated commitment to project quality.	48	2.10%	63.20%
The modification was performed in accordance with established procedures, whilst taking project quality into account.	48	2.10%	63.20%

Statements that were mostly agreed with	Responses		Percent of Cases
Where there were deviations, non-conformances were issued (recorded).	48	2.10%	63.20%
Compliance was ensured by using the following: third party inspections.	47	2.00%	61.80%
Customer requirements were clear.	46	2.00%	60.50%
It was ensured that documentary evidence of conformance is available before items and processes were installed or used.	46	2.00%	60.50%
The plant was in a better/healthier state once the modification was done /handed over to the client.	45	2.00%	59.20%
Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests.	44	1.90%	57.90%
The following was enforced to ensure that a quality project was implemented: the supplier's procedures were read.	44	1.90%	57.90%
Where there were deviations, non-conformances were resolved (followed up).	44	1.90%	57.90%
Supplier evaluation criteria were based on project quality requirements.	43	1.90%	56.60%
Compliance was ensured by using the following: status indicators; and	43	1.90%	56.60%
Project was audited at various phases before approval to next phase.	43	1.90%	56.60%
All relevant documentation affected by the modification accurately reflected the modified plant configuration.	42	1.80%	55.30%
Accountability was promoted by setting high expectations for project quality performance.	41	1.80%	53.90%
Configuration management was rigorously applied.	41	1.80%	53.90%
Contractor performance (periodic inspection) was constantly monitored to confirm that they continue to perform satisfactorily.	41	1.80%	53.90%
The NNR was engaged in time, where applicable.	40	1.70%	52.60%
Project status was reported on a regular basis; hence project quality issues were identified upfront.	40	1.70%	52.60%
When the modification was tested, it demonstrated that the design intent was met before being placed in service.	39	1.70%	51.30%
The supplier interpreted project quality requirements correctly.	39	1.70%	51.30%
Where applicable, benchmarking was performed to ensure that engineering standards and practices did not lag behind.	38	1.70%	50.00%
The supplier's personnel list was observed to see exactly who will monitor the quality of workmanship at each level.	37	1.60%	48.70%
The client was happy and accepted the project that you delivered.	36	1.60%	47.40%
Processes and procedures were rigorously applied at all levels of the project.	36	1.60%	47.40%
The following was enforced to ensure a quality project was implemented: the supplier's entire quality program was surveyed.	35	1.50%	46.10%
Documents were updated as soon as practicable.	33	1.40%	43.40%
Processes and procedures were cumbersome and hindered progress.	31	1.30%	40.80%
Stakeholders were constantly involved throughout the project lifecycle.	30	1.30%	39.50%
The project schedule was adhered to throughout the project lifecycle.	27	1.20%	35.50%

Statements that were mostly agreed with	Responses		Percent of Cases
The project team wrote a wash-up report that recorded lessons that were learnt, and for distribution throughout the organisation.	27	1.20%	35.50%
Production priorities took preference over project quality in your project.	26	1.10%	34.20%
The project handover certificate was signed off immediately following completion of the project.	25	1.10%	32.90%
Where applicable, the supplier understood the requirements of RD0034.	20	0.90%	26.30%
Where applicable, NNR was involved in the supplier qualification process.	19	0.80%	25.00%
An effectiveness review was conducted as per the required timelines.	15	0.70%	19.70%
Supplier Development and Localisation (SD&L) aided project quality.	14	0.60%	18.40%
FRA closure was done as per the required timelines.	13	0.60%	17.10%
QADP closure was done as per the required timelines.	12	0.50%	15.80%
The project was completed in time and within budget, but lacked quality.	11	0.50%	14.50%
The project was closed on time.	2	0.10%	2.60%

Table 4.6: Multiple response - statements that were mostly disagreed with

Statements that were mostly disagreed with	Responses		Percent of Cases
	N	Percent	
The project schedule was adhered to throughout the project lifecycle.	32	5.40%	48.50%
Production priorities took preference over project quality in your project.	29	4.90%	43.90%
FRA closure was done as per the required timelines.	29	4.90%	43.90%
The project was completed in time and within budget but lacked the quality.	29	4.90%	43.90%
QADP closure was done as per the required timelines.	25	4.20%	37.90%
An effectiveness review was conducted as per the required timelines.	25	4.20%	37.90%
Stakeholders were constantly involved throughout the project lifecycle.	22	3.70%	33.30%
Documents were updated as soon as practicable.	21	3.50%	31.80%
The project handover certificate was signed off immediately following completion of the project.	18	3.00%	27.30%
Processes and procedures were cumbersome and hindered progress.	17	2.90%	25.80%
The project team wrote a wash-up report that recorded lessons that were learnt, and for distribution throughout the organisation.	17	2.90%	25.80%
Where applicable, the supplier understood the requirements of RD0034.	16	2.70%	24.20%
Where applicable, NNR was involved in the supplier qualification process.	14	2.40%	21.20%

Statements that were mostly disagreed with	Responses		Percent of Cases
	N	Percent	
Supplier Development and Localisation (SD&L) aided project quality.	14	2.40%	21.20%
Customer requirements were clear.	13	2.20%	19.70%
Project status was reported on a regular basis; hence project quality issues were identified upfront.	13	2.20%	19.70%
The project was audited at various phases before approval to the next phase	13	2.20%	19.70%
Accountability was promoted by setting high expectations for project quality performance.	12	2.00%	18.20%
Configuration management was rigorously applied.	12	2.00%	18.20%
Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests.	11	1.90%	16.70%
Senior management demonstrated commitment to project quality.	10	1.70%	15.20%
All relevant documentation that was affected by the modification accurately reflected the modified plant configuration.	10	1.70%	15.20%
Compliance to project quality was visible during execution.	10	1.70%	15.20%
The following was enforced to ensure that a quality project was implemented: The supplier's entire quality program surveyed.	9	1.50%	13.60%
The supplier's personnel list was observed to see exactly who will monitor the quality of workmanship at each level.	9	1.50%	13.60%
Contractor performance (periodic inspection) was constantly monitored to confirm that they continue to perform satisfactorily.	9	1.50%	13.60%
The project team demonstrated sufficient knowledge and experience to guide contractors on project quality.	9	1.50%	13.60%
It was ensured that documentary evidence of conformance is available before items and processes were installed or used.	9	1.50%	13.60%
The NNR was engaged in time, where applicable.	8	1.30%	12.10%
The project manager was knowledgeable about the plant.	8	1.30%	12.10%
The project was planned to a level of detail that ensured efficient implementation of project quality.	8	1.30%	12.10%
Processes and procedures were conveniently available.	8	1.30%	12.10%
Processes and procedures were rigorously applied at all levels of the project.	8	1.30%	12.10%
Where applicable, benchmarking was performed to ensure the engineering standards and practices did not lag behind.	8	1.30%	12.10%
The supplier interpreted project quality requirements correctly.	8	1.30%	12.10%
The client was happy and accepted the project that you delivered.	7	1.20%	10.60%
When the modification was tested, it demonstrated that the design intent was met before being placed in service.	7	1.20%	10.60%

Statements that were mostly disagreed with	Responses		Percent of Cases
	N	Percent	
Where there were deviations, non-conformances were resolved (followed up).	7	1.20%	10.60%
The project team demonstrated commitment to achieve project quality.	6	1.00%	9.10%
Supplier evaluation criteria was based on project quality requirements.	5	0.80%	7.60%
The following was enforced to ensure that a quality project was implemented: the supplier's procedures were read.	5	0.80%	7.60%
Compliance was ensured by using the following: status indicators; and	5	0.80%	7.60%
Where there were deviations, non-conformances were raised (reported).	5	0.80%	7.60%
Where there were deviations, non-conformances were issued (recorded).	5	0.80%	7.60%
The plant was in a better/healthier state once the modification was done /handed over to the client.	5	0.80%	7.60%
The project was closed on time.	5	0.80%	7.60%
The following was enforced to ensure that a quality project was implemented: the supplier’s quality documents were reviewed.	4	0.70%	6.10%
Design specifications were revised.	3	0.50%	4.50%
Design specifications were prepared by independent reviewers.	2	0.30%	3.00%
Design specifications were validated as required (before implementing the design).	2	0.30%	3.00%
The modification was performed in accordance with established procedures, whilst taking project quality into account.	2	0.30%	3.00%
Compliance was ensured by using the following: third party inspections.	2	0.30%	3.00%
When the project/ modification was identified, its compatibility with the design intent was assessed.	1	0.20%	1.50%
Design specifications were approved.	1	0.20%	1.50%
Design specifications were issued to the suppliers.	1	0.20%	1.50%
Design specifications were authorised.	1	0.20%	1.50%
Design specifications were prepared.	0	0	0
Compliance was ensured by using the following: hold/witness points.	0	0	0

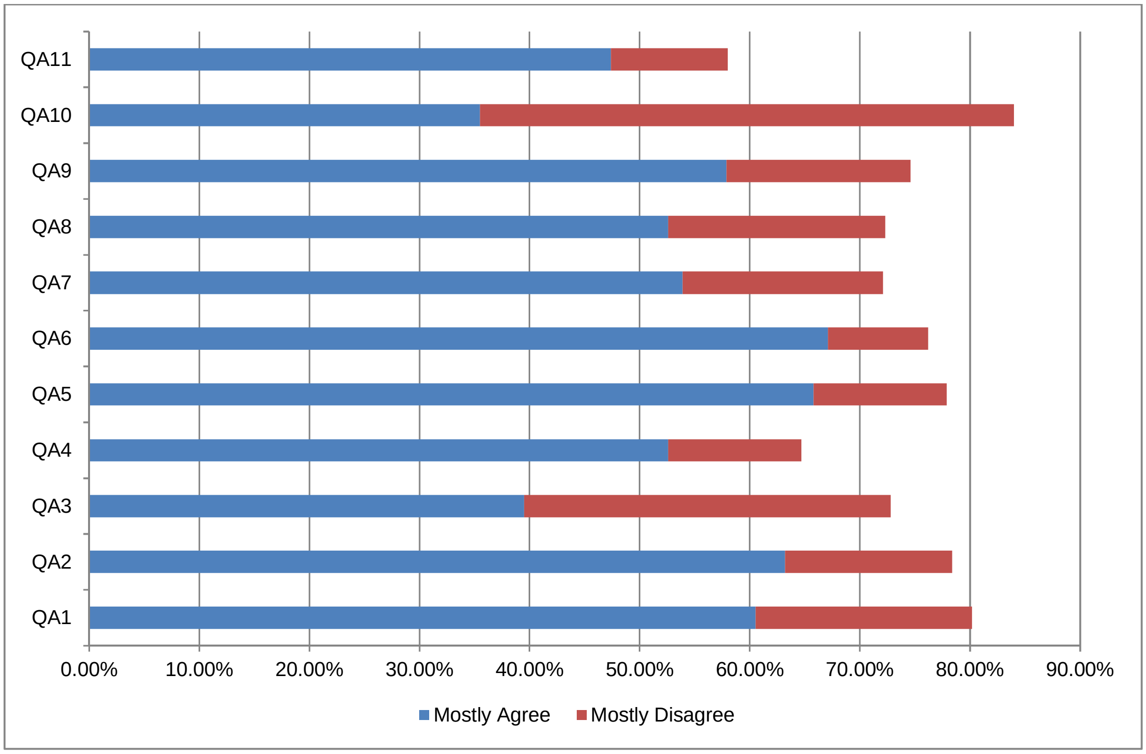


Figure 4.2: Questionnaire A: People - Mostly agree and mostly disagree

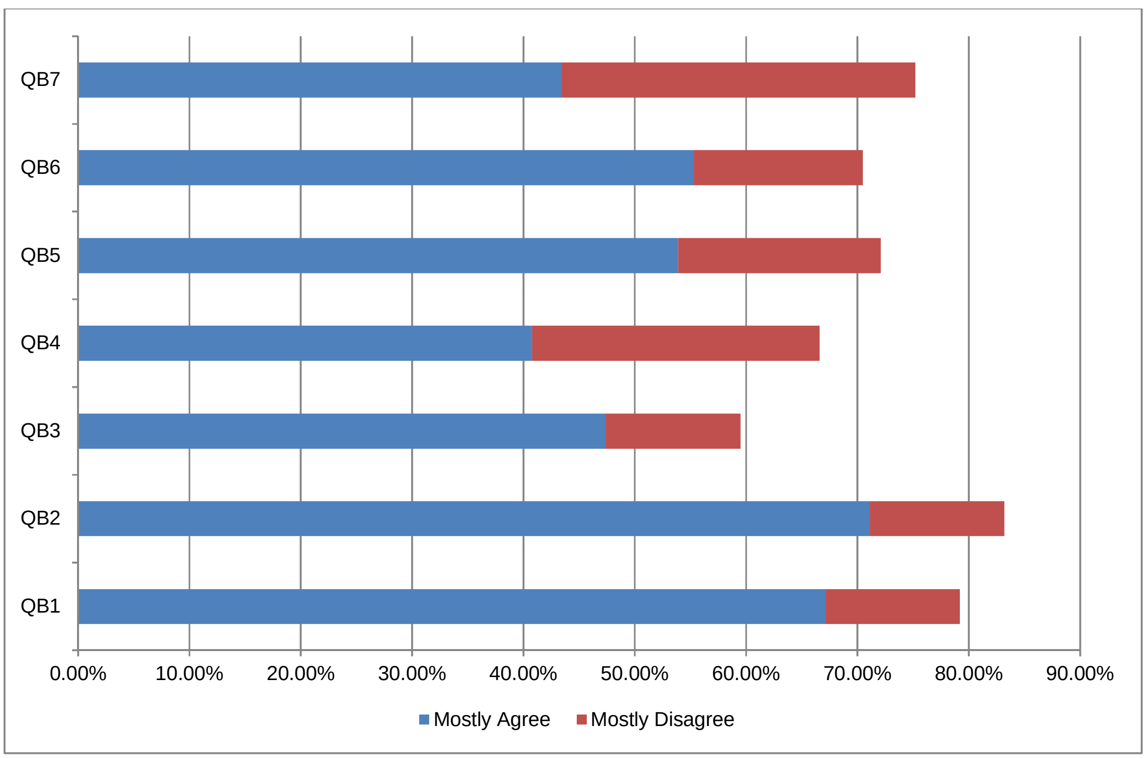


Figure 4.3: Questionnaire B: Standards, Processes and Procedures - Mostly agree and mostly disagree

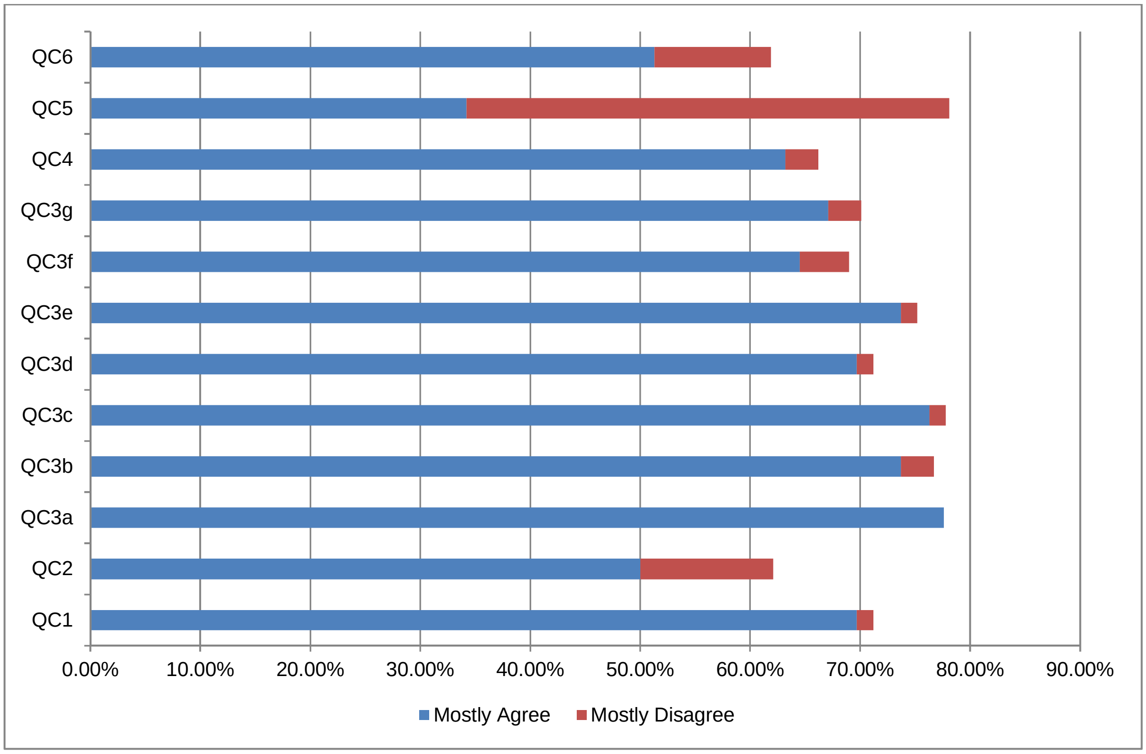


Figure 4.4: Questionnaire C: Plant - Mostly agree and mostly disagree

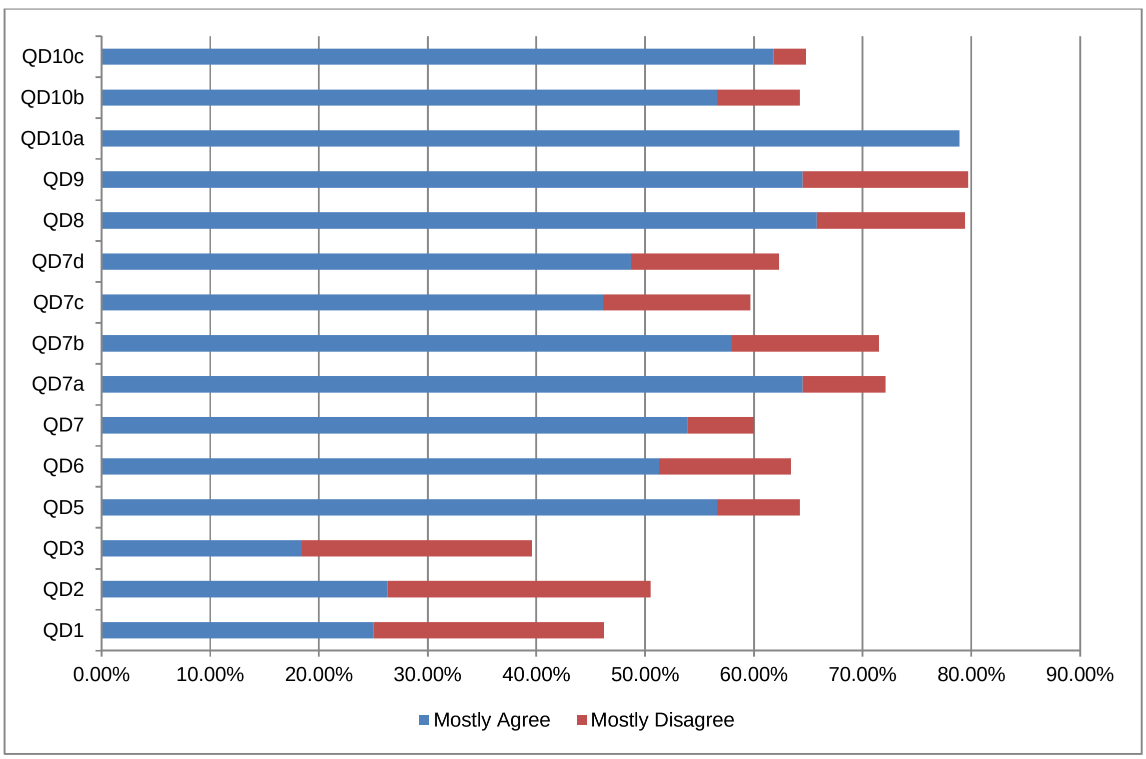


Figure 4.5: Questionnaire D: Contractor/Supplier/Vendor Management - Mostly agree and mostly disagree

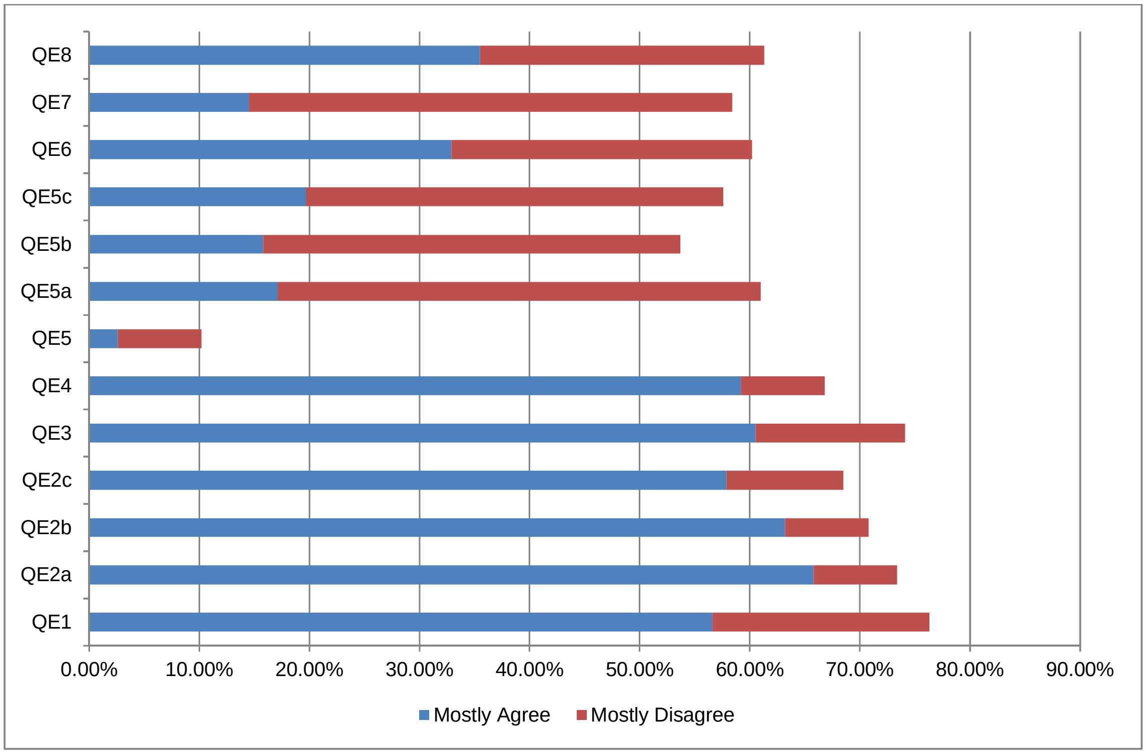


Figure 4.6: Questionnaire E: Quality - Mostly agree and mostly disagree

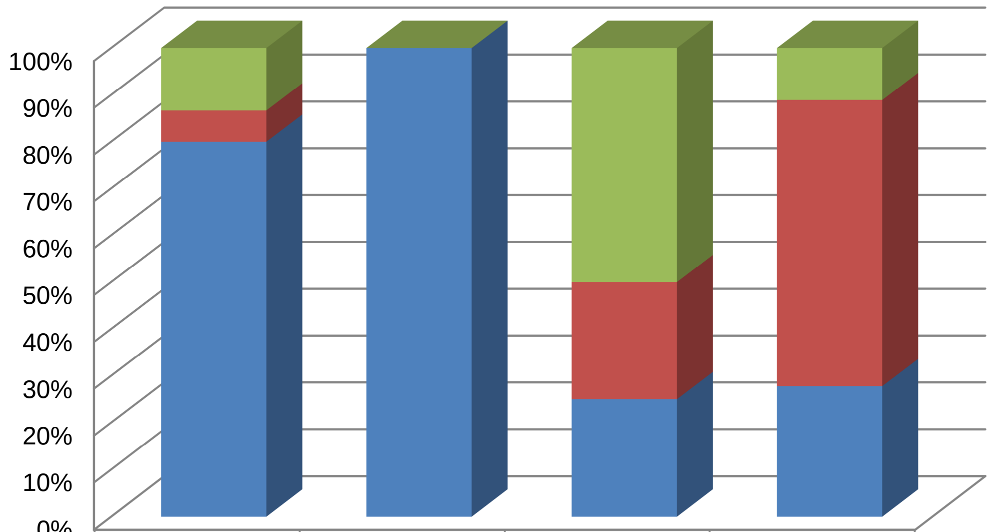
4.6.4 Inferential statistics

The following inferential statistics reflected on the survey data:

- For all the statements in the survey, a comparison was made between the number of respondents who agreed (strongly agreed to agreed), and the number of respondents who disagreed (disagree to strongly disagree) with the statements. The purpose was for the data to serve as statistical evidence when the results are discussed.
- A comparison was made among respondents in accordance with their stakeholder status to see whether there is a difference in their perceptions with respect to the statements (project manager vs. engineers vs. quality).

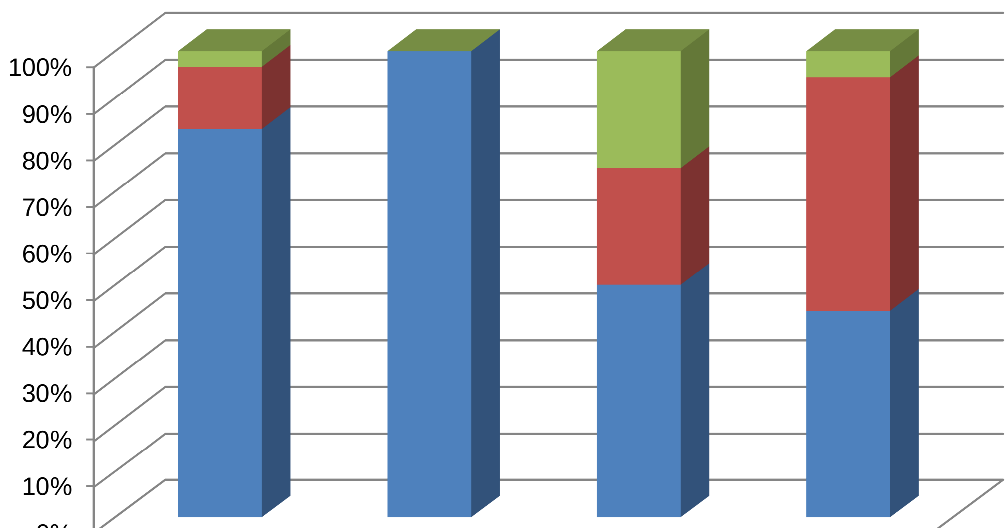
4.6.4.1 Comparison with regard to the difference in proportions of agree and disagree

Table 4.9 details the Pearson Chi-Square test, which was used to test whether there is a significant difference in responses to the statement between the various stakeholders. If the EXACT p-value < 0.05 then we conclude that there is a significant difference amongst stakeholders in their responses to a particular statement. Since the expected cell count was small, the researcher used the exact method to calculate Pearson Chi-Square to prove the significant difference. The results for only the statistically significant differences are illustrated in **Figures 4.7 to 4.26** below, while detailed results are shown in **Table 4.9,** which is within the ambit of **Appendix J**, as they are too voluminous to display here. **Figures 4.7 to 4.26** show statistically significant differences between the proportions of respondents who agree, those who are undecided and those who disagree with the statements listed.



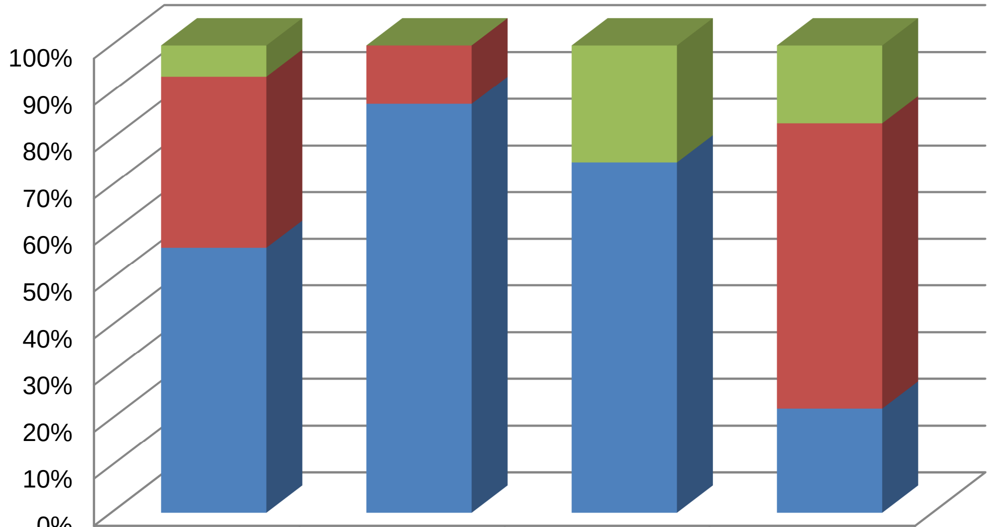
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	4	0	2	2
Neutral	2	0	1	11
Agree	24	8	1	5

Figure 4.7: QA7: Chi-Square Test



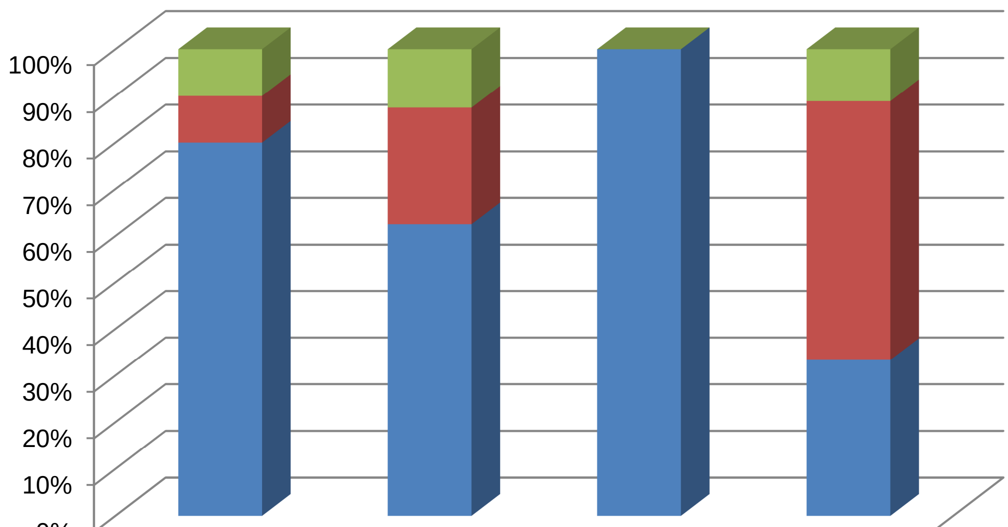
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	1	0	1	1
Neutral	4	0	1	9
Agree	25	8	2	8

Figure 4.8: QB1: Chi-Square Test



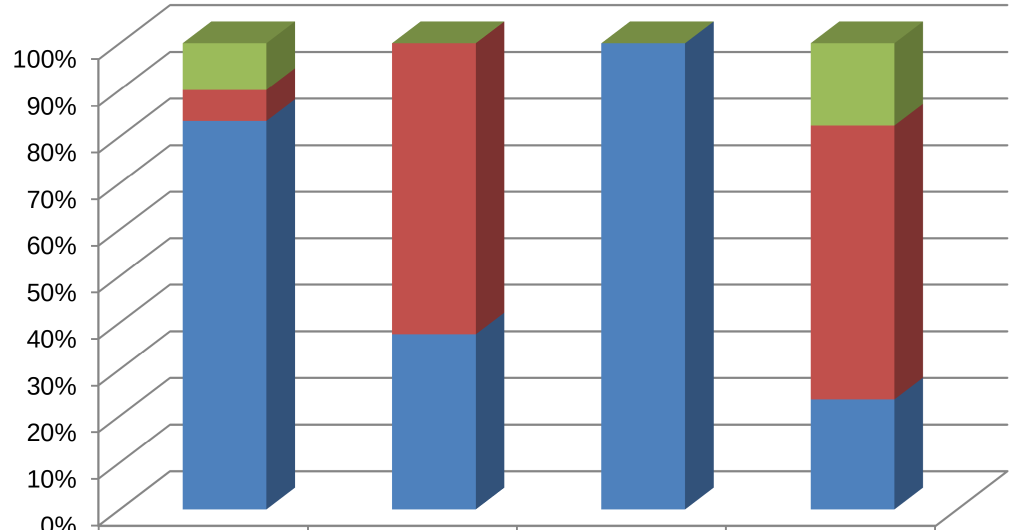
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	2	0	1	3
Neutral	11	1	0	11
Agree	17	7	3	4

Figure 4.9: QB3: Chi-Square Test



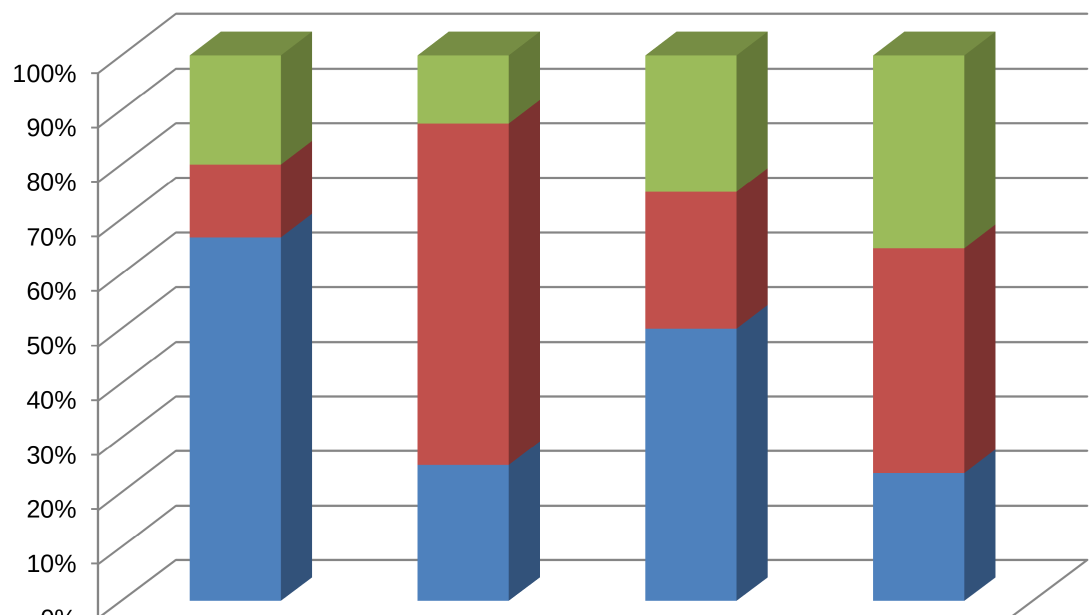
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	3	1	0	2
Neutral	3	2	0	10
Agree	24	5	4	6

Figure 4.10: QB5: Chi-Square Test



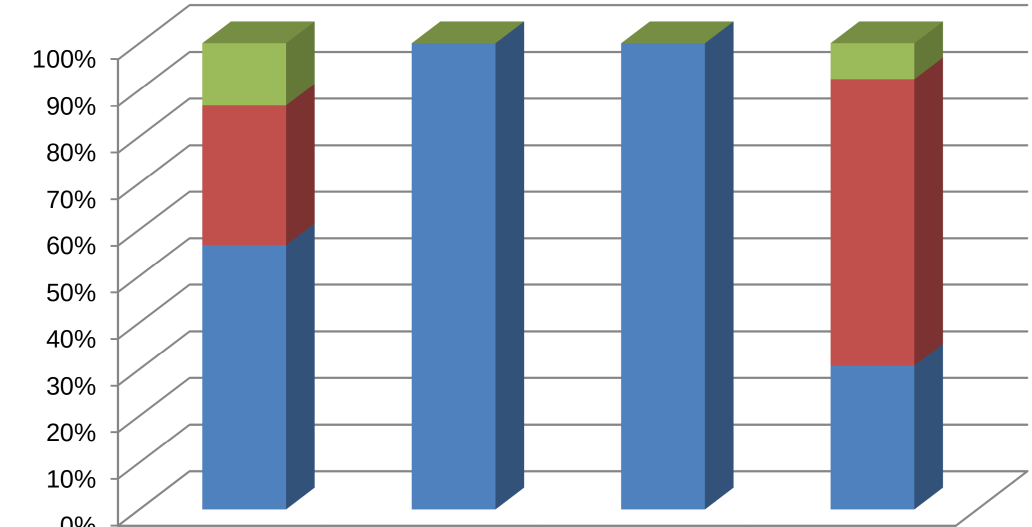
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	3	0	0	3
Neutral	2	5	0	10
Agree	25	3	4	4

Figure 4.11: QB6: Chi-Square Test



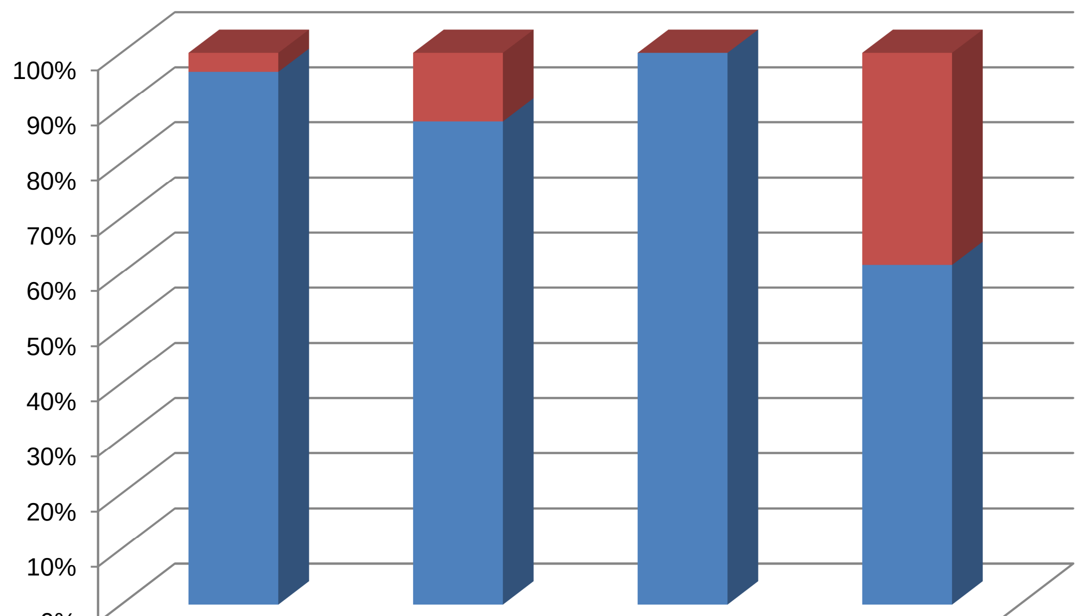
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	6	1	1	6
Neutral	4	5	1	7
Agree	20	2	2	4

Figure 4.12: QB7: Chi-Square Test



	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	4	0	0	1
Neutral	9	0	0	8
Agree	17	8	4	4

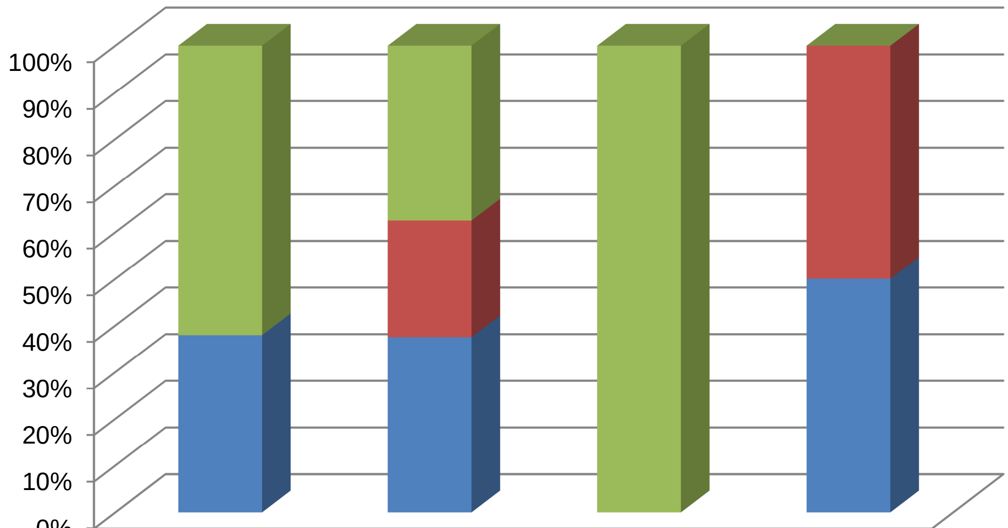
Figure 4.13: QC2: Chi-Square Test



	Project Manager	Project Engineer	Design Engineer	Quality
Neutral	1	1	0	5
Agree	28	7	4	8

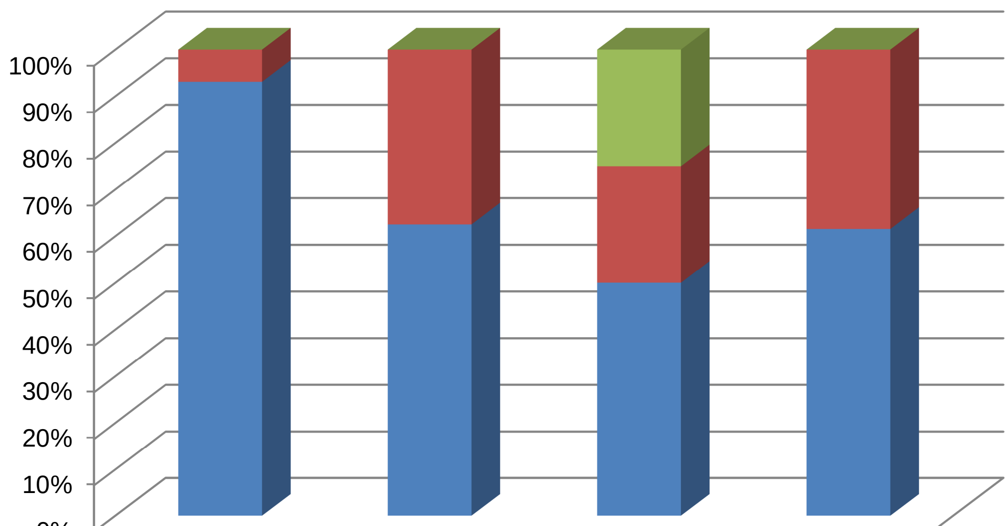
Figure 4.14: QC3a: Chi-Square Test

It can be seen from **Figure 4.13** that for the statements for the above question there were statistically significantly more respondents who agreed than respondents who were undecided. None of the respondents disagreed with this statement.



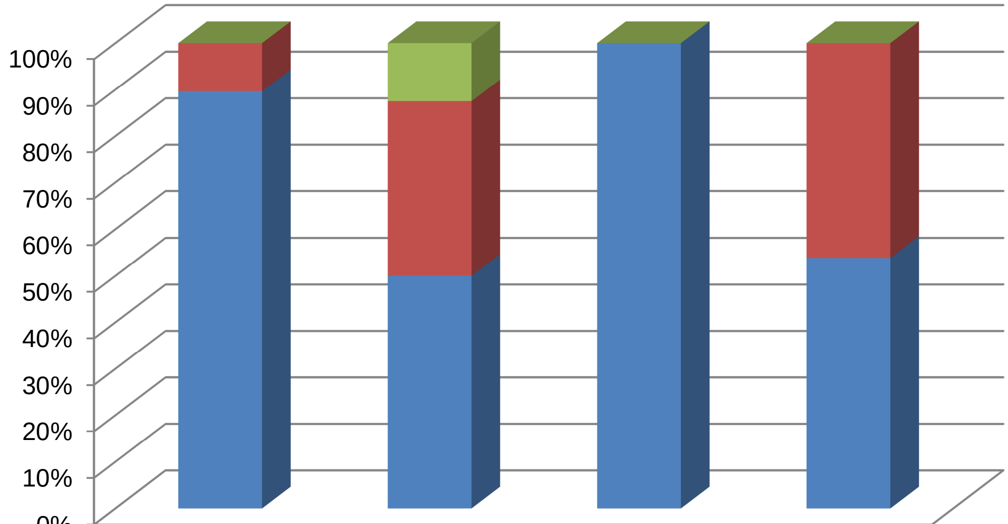
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	18	3	4	0
Neutral	0	2	0	6
Agree	11	3	0	6

Figure 4.15: QC3a: Chi-Square Test



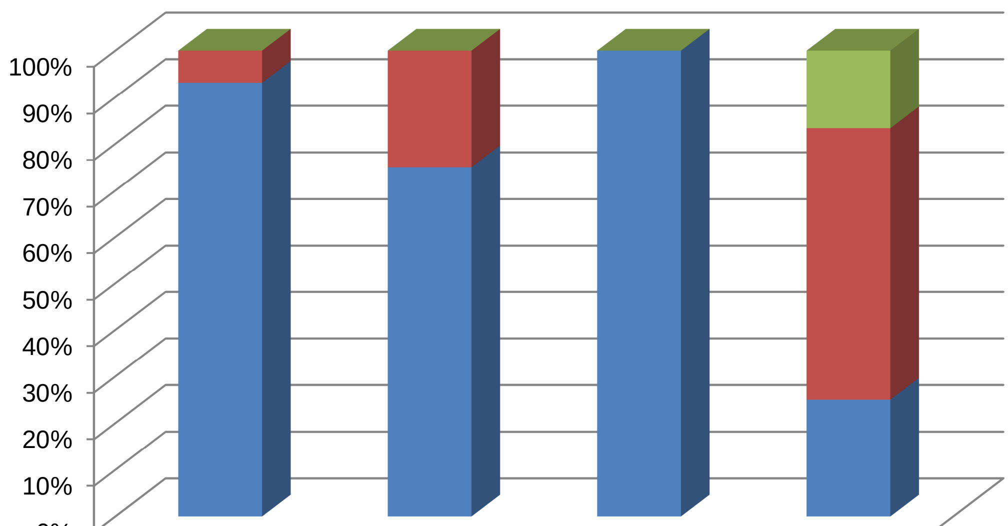
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	0	0	1	0
Neutral	2	3	1	5
Agree	27	5	2	8

Figure 4.16: QC3d: Chi-Square Test



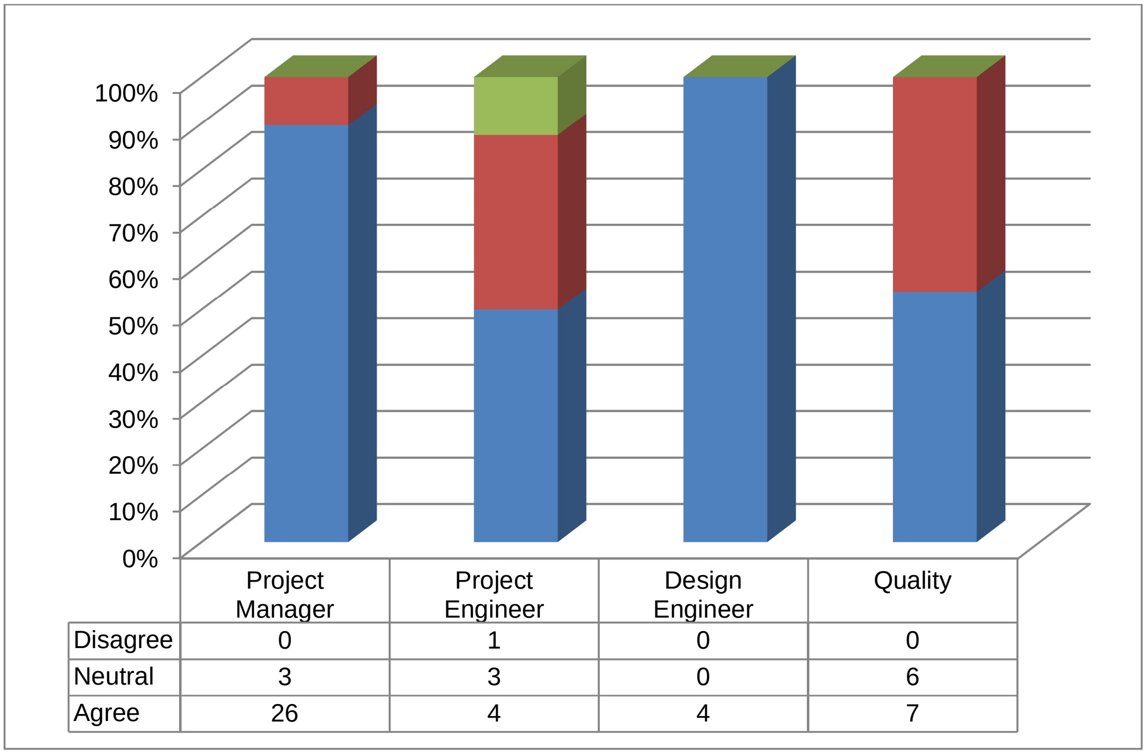
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	0	1	0	0
Neutral	3	3	0	6
Agree	26	4	4	7

Figure 4.17: QC3g: Chi-Square Test



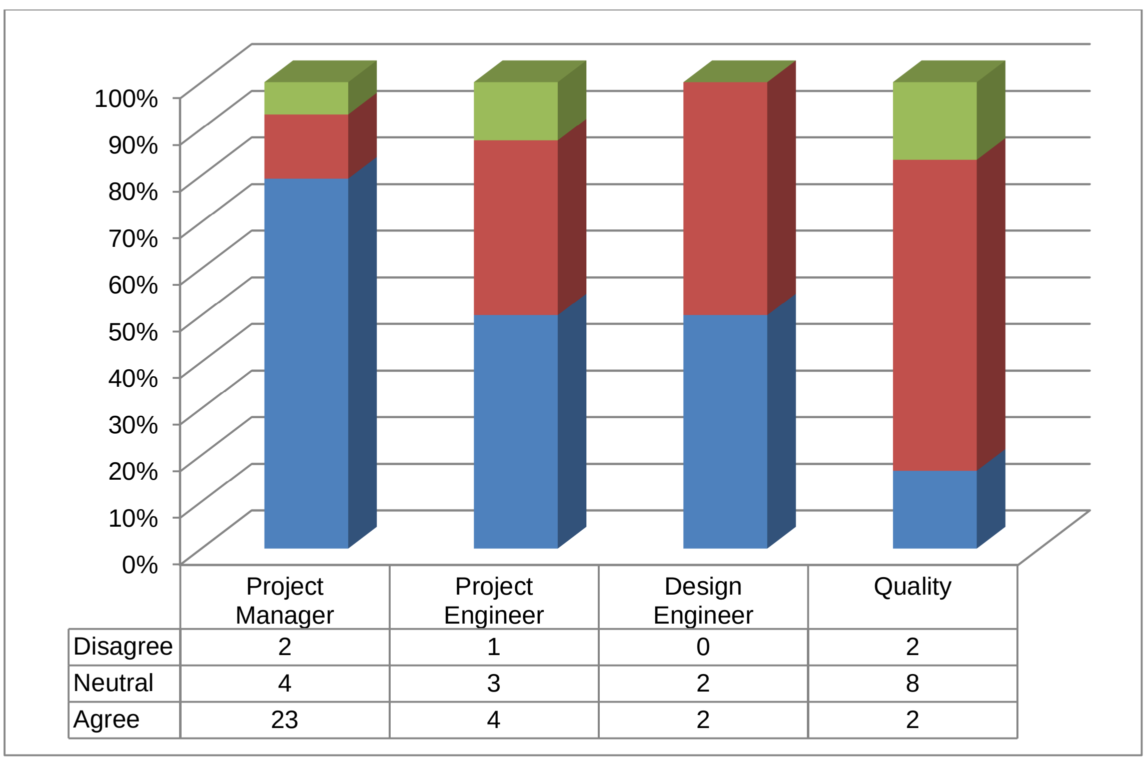
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	0	0	0	2
Neutral	2	2	0	7
Agree	27	6	4	3

Figure 4.18: QC4: Chi-Square Test



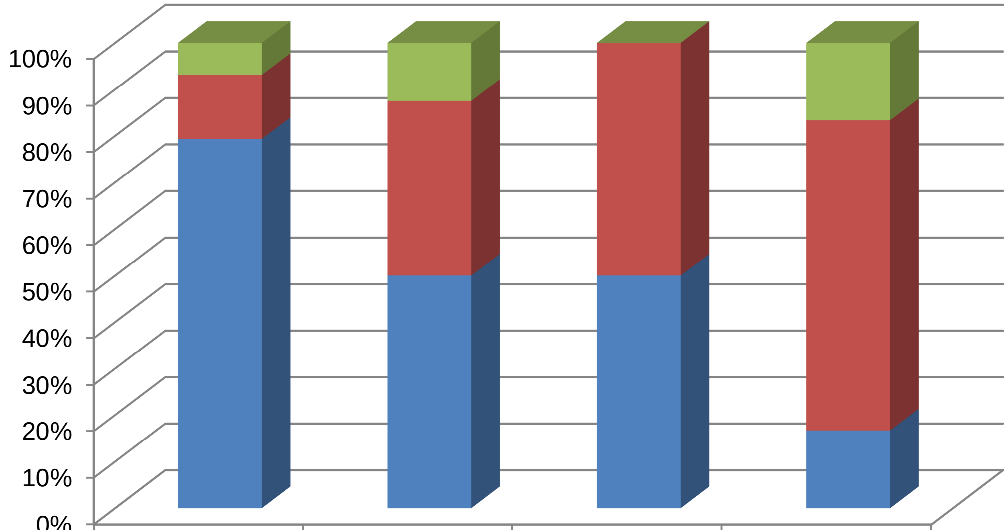
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	0	1	0	0
Neutral	3	3	0	6
Agree	26	4	4	7

Figure 4.19: QC5: Chi-Square Test



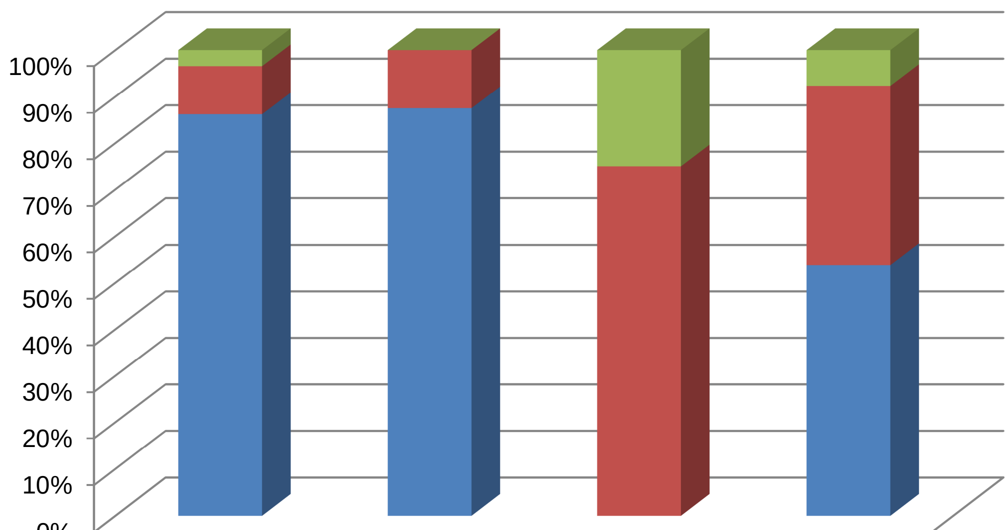
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	2	1	0	2
Neutral	4	3	2	8
Agree	23	4	2	2

Figure 4.20: QC6: Chi-Square Test



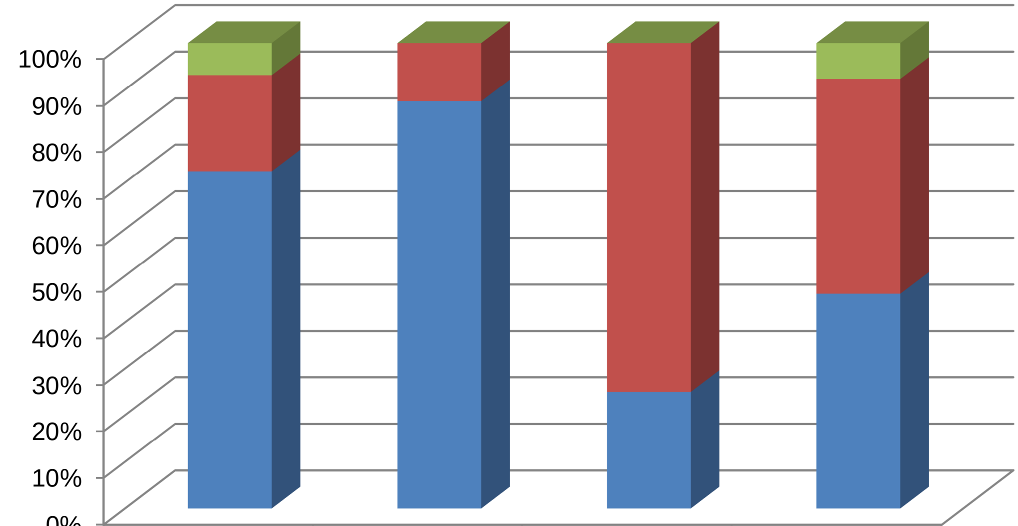
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	2	1	0	2
Neutral	4	3	2	8
Agree	23	4	2	2

Figure 4.21: QD5: Chi-Square Test



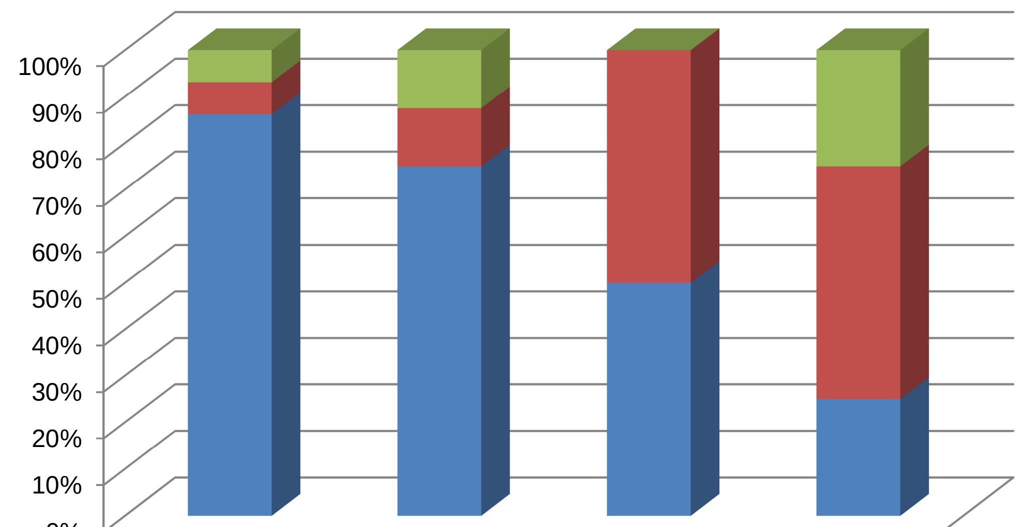
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	1	0	1	1
Neutral	3	1	3	5
Agree	25	7	0	7

Figure 4.22: QD7a: Chi-Square Test



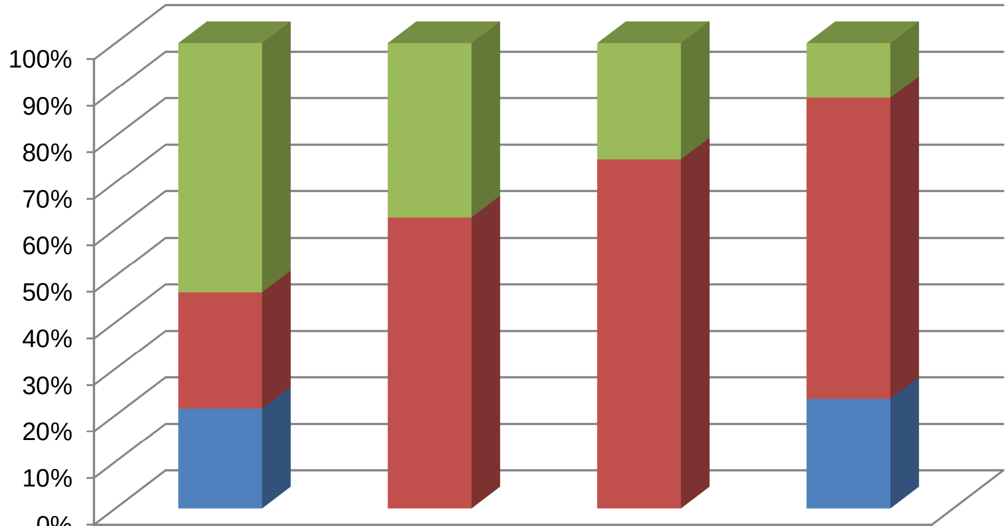
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	2	0	0	1
Neutral	6	1	3	6
Agree	21	7	1	6

Figure 4.23: QD7b: Chi-Square Test



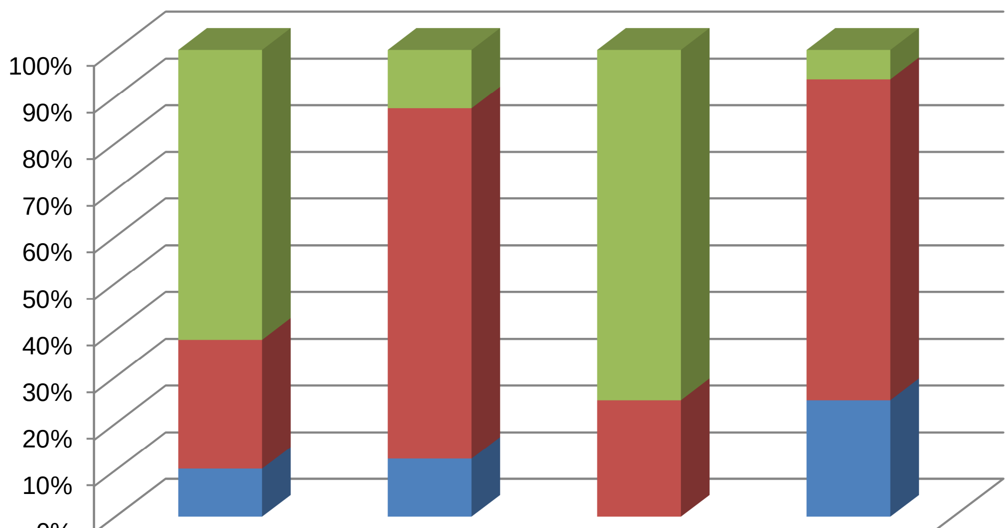
	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	2	1	0	3
Neutral	2	1	2	6
Agree	25	6	2	3

Figure 4.24: QD7: Chi-Square Test



	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	15	3	1	2
Neutral	7	5	3	11
Agree	6	0	0	4

Figure 4.25: QE5a: Chi-Square Test



	Project Manager	Project Engineer	Design Engineer	Quality
Disagree	18	1	3	1
Neutral	8	6	1	11
Agree	3	1	0	4

Figure 4.26: QE7: Chi-Square Test

4.6.5 Nonparametric Tests

Nonparametric tests were used to test whether responses to various categories were the same (equal in number). If the p-value is less than 0.05, then one may conclude that the responses are not equally distributed amongst the categories. Refer to **Appendix K** for detailed results.

4.6.6 Additional comments obtained from questionnaires

The comments below were obtained from the questionnaires, and were copied verbatim. The aim was to provide additional insight round factors that affect project quality, as viewed by some of the respondents. It is listed as the coded questionnaire and indicated by stakeholder status, as well as the department from which the comment came.

- Q3 - (PM, NPM)

  The project department should employ a dedicated, experienced quality team to oversee quality throughout the project life cycle. Stakeholders must be involved throughout the project, not during handover certificate. The project team must not be changed as the new team will not be able to meet the customer's quality requirements if the customer constantly changes his/her quality requirements
- Q17 - (DE, DEG)

  In general, a number of projects are rushed through without proper planning. In particular projects for the conventional plant often suffer due to the plant being committed to a large piece of equipment or technical decision that is made prior to approval of a comprehensive technical specification or thorough design review
- Q30 - (Scheduler, NPM)

  Project managers are pressed for time in the execution phase; they don't always have their eye on every aspect of the project in this phase, that's where document control and quality is compromised. No project can be completed if you don't have all your documentation.
- Q31 - (PM, NPM)

  More time could have been spent on planning and also getting the project organised earlier.
- Q42 - (PM, NPM)

  It is difficult to control the quality within nuclear environment especially the projects that are initiated by Eskom corporate/other Eskom divisions. Nuclear division has its own quality requirements irrespective of the other quality standards. It is better to perform an audit upfront on the contract before placing a contract.

- Q44 - (Programme Manager, NPM)

  1) RD0034 details the requirements of the NNR for quality and safety management systems (QMS,SMS) for licensees, applicants of a nuclear licence, as well as for designers and suppliers involved in the design, manufacturing, construction, commissioning, operation, modification and potential decommissioning for a nuclear installation in South Africa under the National Nuclear Regulator Act of 1999 (NNRA). Currently, there are few vendors (especially local) who comply with the requirements.

  2) The IMS requirements defined in RD0034 directly relate to Quality and Safety Management. Aspects such as security, economics, and environmental or health management are outside the scope of RD0034, but form part of the management system of an organisation. The integration of these issues should be handled.

  3) Currently, within the nuclear industry, skilled resources that can effectively manage large complex projects are limited. One of the contributors to this challenge is an exodus of experienced staff owing to them reaching retirement age. With these older staff goes a wealth of knowledge and experience.

  4) There are no initiatives are in place to determine the effectiveness of training programs.

  5) Even though procedures are reviewed regularly, the staff levels are not sufficient to allow for time to be trained or re-trained on all procedures regularly enough.

  6) Well-thought-out problem statements still problematic, so that resources may be focused on the right areas. A contract specification is a statement of needs and its purpose is to present to potential vendors a clear, accurate and comprehensive statement of Eskom Holdings SOC Ltd's needs so that they can propose solutions to those needs.

  7) The Eskom Holdings SOC Ltd.'s Nuclear Operating Unit, Project Management Department, is often criticised owing to stakeholders claiming insufficient or incorrect flow of information during the management of projects.

- Q45 - (PM, NPM)

  Insufficient suitable storage of project components on site prior to implementation, insufficient attention regarding processes to dispose of redundant equipment.

- Q47 - (PM, NPM)

  Certain quality refinements have been established since the implementation of the above project, i.e. Project QC, which as stipulated in NEC, is the responsibility of the project supervisor. This function was fulfilled accordingly and problems were resolved by due procedure.

- Q49 - (Q, QC)

  Despite their integral role during CSC, there is no feedback or requirement to provide feedback to QC regarding the resolution of quality reservations noted during the CSC. The addition of a QC group within project engineering (NPM) has had a profoundly positive effect on the overall quality of projects.

- Q55 - (Licensing)

  Specific causes of project close out failure have been an area of much debate in project management literature. So the focus should be on close out phase

- Q60 - (PM, NPM)

  Until today, ownership of the project is still in dispute amongst clients; hence the QAPD is not signed off 4 years after completion. South African law for certification of equipment operating in a hazardous atmosphere (HAZLOC) changed during the design approval stage and start of implementation period, hence local conformance is still an issue. The design was corporately dictated, hence a black box approach was assumed, resulting in numerous field changes, as built changes, etc. Good point; (installation and system were declared "excellent" by the Original Equipment Manufacturer - OEM).

- Q65 - (QA, NPM)

  Modifications are rarely completed (i.e.: paper modification QADP's, FRA, etc.) timeously because of incomplete processes. PM's should be aware that for every physical action a record is produced, which must be retained as evidence. This in turn would prove a more positive view of the overall project. In essence, if the evidence is not there, the modification was not implemented. Secondly, QA is involved in the projects, but appears too late in the process. Early QA involvement would eliminate areas of concern.

- Q67 - (PM, NPM)

  When speaking of the project team I think that it is necessary to differentiate in this instance between employer and contractor, as this would provide a more dynamic view of each other's culture in this regard.

- Q75 - (Licensing)

  The impact of early engagement with the NNR and agreement on the regulatory requirements is seldom factored into the project scheduling and resourcing. The capability of Eskom to comply with NNR requirements and the ability of the NNR to meet the expected review and acceptance stage is often under estimated. Licensing is an activity, which the project manager has limited control over.

4.6.7 Analysis of contractor questionnaires

1. Work experience at KNPS (in years)

0-5	5-10	10-15	15-20	20-25	> 25
3	0	1	0	0	1

A. PROCESSES AND PROCEDURES

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	You understood the customer requirements related to project quality.	2	2	0	1	0
2	You were familiar with the KNPS processes and procedures related to the service that you had to provide.	1	3	0	1	0
3	Your processes and procedures were in line with those of KNPS project quality requirement for that service.	1	2	1	1	0
4	KNPS processes and procedures were conveniently available	1	2	1	1	0
5	KNPS clearly communicated the project quality standards for your project / service.	0	4	0	1	0
6	KNPS clearly communicated the kind of quality programme that you had to have in place to ensure that project quality was achieved.	0	3	0	2	0
7	You identified how your organisation would maintain specified quality standards for your service.	3	2	0	0	0
8	You established control measures to ensure that all documentation complied with quality requirements.	3	2	0	0	0
9	Supplier Development and Localisation (SD&L) is a good tool.	2	2	1		
10	You understand the requirements of RD0034.	0	1	2	1	1

B. PROJECT EXECUTION / IMPLEMENTATION / DELIVERY

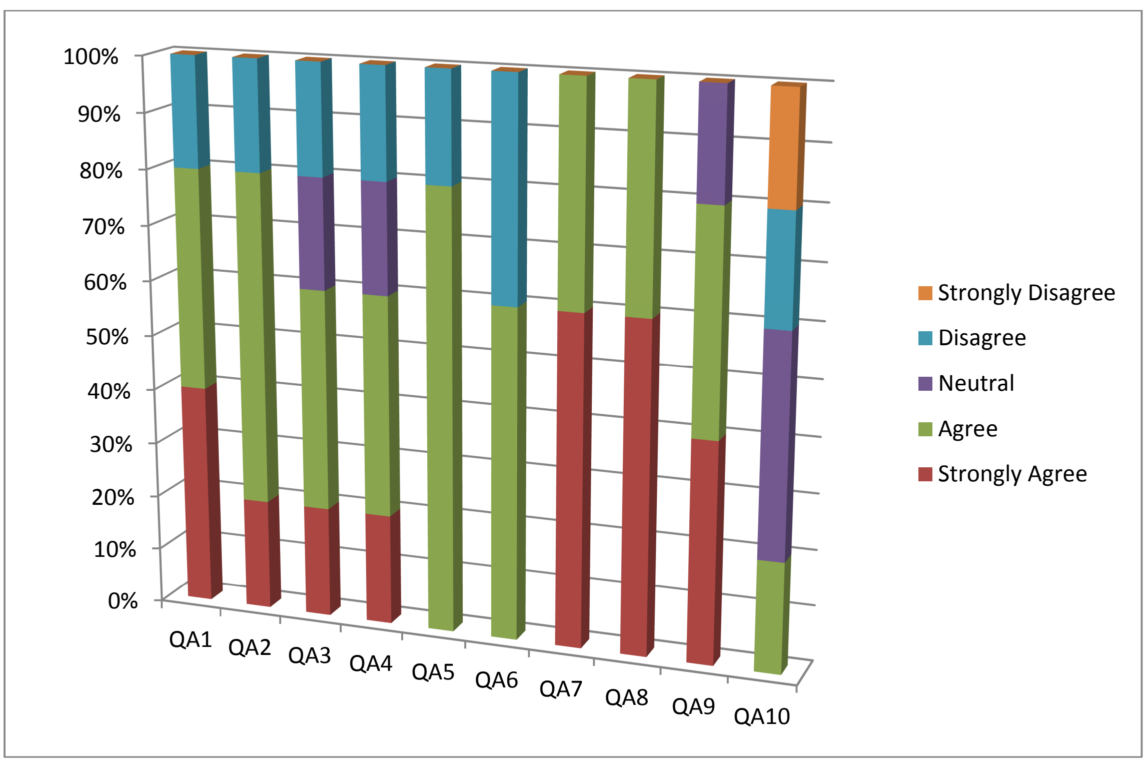
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Information that was received from the customer described the service and was:					
a	• Clear;	1	2	1	1	0
b	• Concise; and	1	2	0	2	0
c	• Unambiguous.	1	1	2	1	0
2	You had a clear understanding of customers' expectations.	1	2	1	1	0
3	You had the capability within your organisation to monitor /enforce a quality program.	3	2	0	0	0
4	You planned projects to a level of detail, which is necessary for project quality to be realised.	3	2	0	0	0
5	You understood your role in the execution of quality projects.	3	2	0	0	0
6	KNPS interventions provided value in supplier development.	2	0	0	2	1
7	KNPS processes and procedures were too cumbersome and hindered progress.	1	2	0	2	0
8	People who did the work were authorised to do so.	2	3	0	0	0
9	People who did the work were adequately trained to do so.	1	3	1	0	0

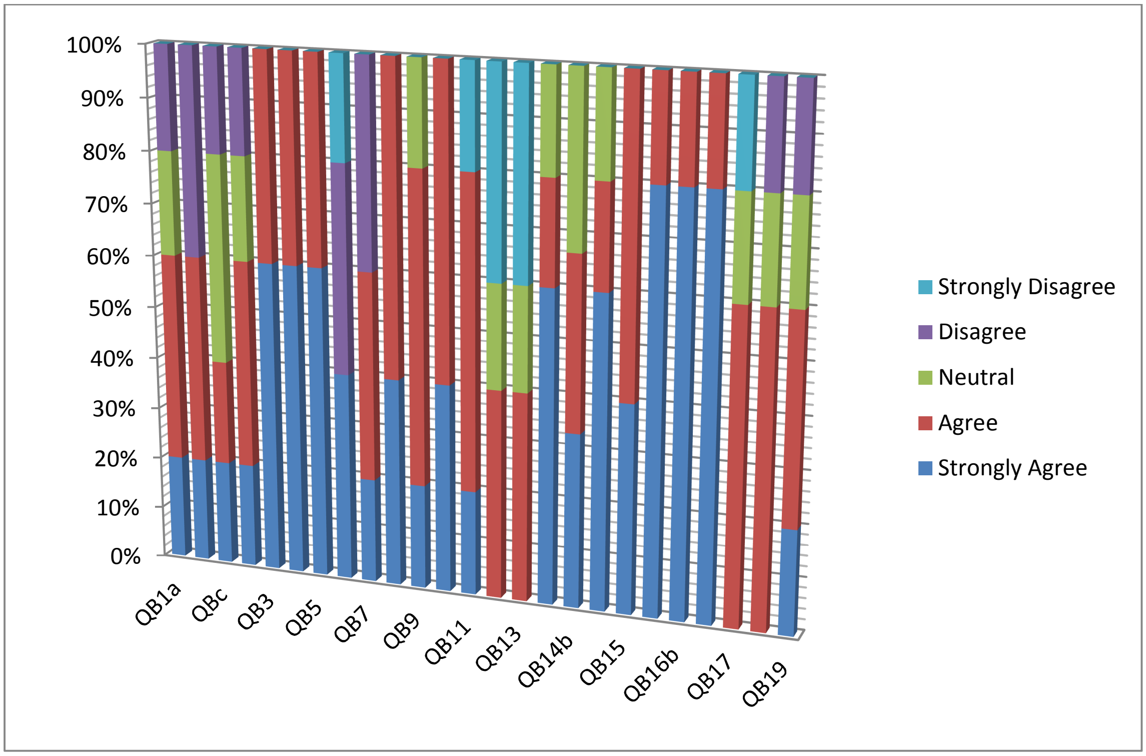
10	Your project supervisors had sufficient experience to monitor and guide sub-contractors on project quality.	2	3	0	0	0
11	Your project supervisors carried out periodic inspections of work in terms of the project quality requirements.	1	3	0	0	1
12	KNPS project supervisors were always helpful on site.	0	2	1	0	2
13	KNPS monitored your progress to confirm continued, satisfactory performance (quality of workmanship).	0	2	1	0	2
14	Where there were deviations, non-conformances were:					
a	• Raised (reported);	3	1	1	0	0
b	• Issued (recorded);	1	1	1	0	0
c	• Resolved (followed up).	3	1	1	0	0
15	You reported on factors that affected the way in which you delivered a quality service.	2	3	0	0	0
16	You ensured compliance for project quality by using the following:					
a	• Hold/witness points;	4	1	0	0	0
b	• Status indicators; and	4	1	0	0	0
c	• Third party inspections.	4	1	0	0	0
17	KNPS pushed/encouraged you for continuous improvement.	0	3	1	0	1
18	You were given sufficient time to comply with project quality.	0	3	1	1	0
19	You conducted a customer satisfaction survey at the end of the project to ensure continuous improvement.	1	2	1	1	0

What, in your opinion can be done to ensure better quality results from projects?

Visibility and involvement of senior management where such is integrated into the overall outcome. Look at the Phillips quality system for introspection.

Constant on job coaching, adherence to quality plans, 100% supervision of all work at all times, training of artisans and creating a quality awareness





4.6.8 Analysis of information gleaned from the database

The KNPS uses an Electronic Problem Management System (EPMS) to raise and track problems, investigations, corrective actions and recommendations until completion. This computer programme also allows KNPS to track issues until all actions have been closed to prevent a recurrence of events, to perform trending of events and to provide OE for activities on the plant. It forms part of the continuous improvement programme.

For the purpose of this survey, a sample was pulled where these issues were raised against a project / modification for NPM. The following tables are an indication of the trend of such incidents as it relates to project quality, including the number raised over the past seven (7) years. These were analysed in order to comment on the trend with regard to identifying and closing out of the same.

Figure 4.1: Mod 0_Plant Modification / Work Processes

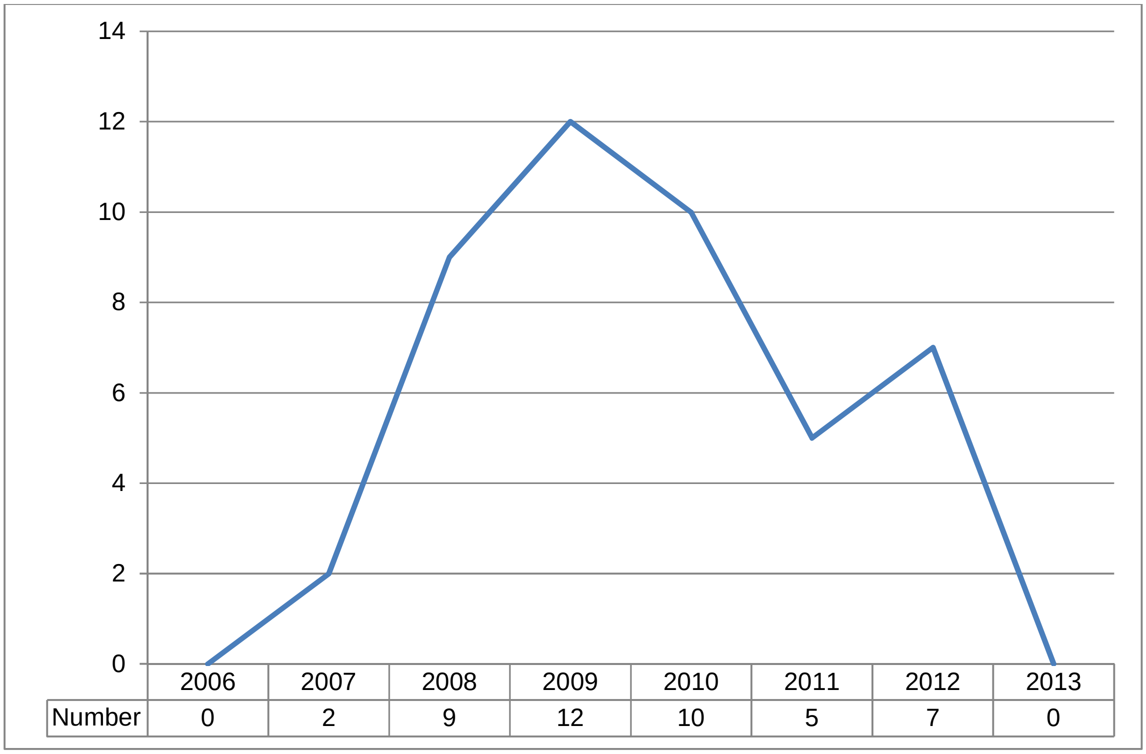


Figure 4.1 above depicts the problem notifications (PNs) for raised for plant modification work processes that were not adhered to. The graph shows how this number increased from 0 on 2006, peaking at 12 in 2009 and dropping to 5 in 2010, but picking up again in 2012. Hence, there was a decline, but the trend seems to be increasing again.

Figure 4.2: Mod1_Design Inadequate

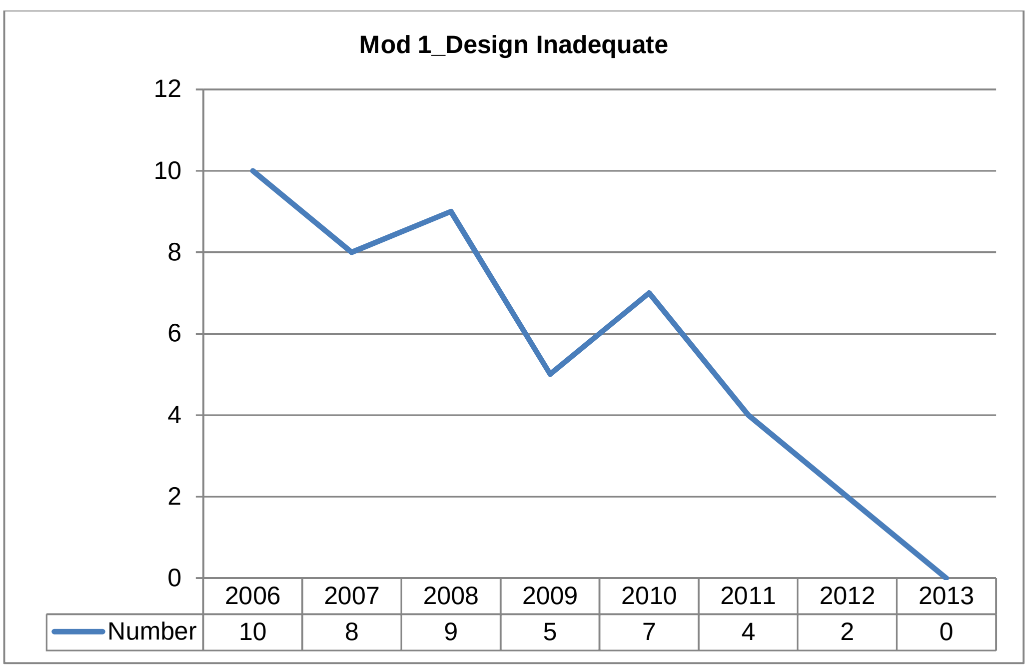
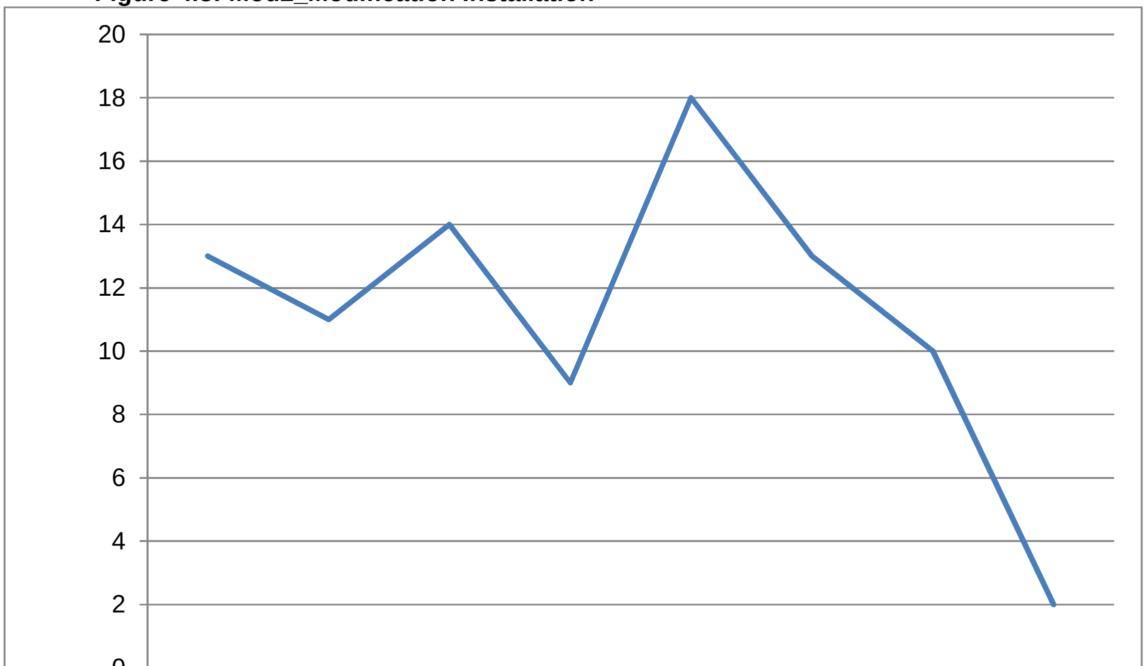


Figure 4.2 above shows that there has been a decline in the inadequacy of designs, which moved from 10 in 2006 to 0 in 2013 with the exception of 2010 where they increased from 5 in 2009 to 7 in 2010. This is in line with the data analysis as far as design is concerned.

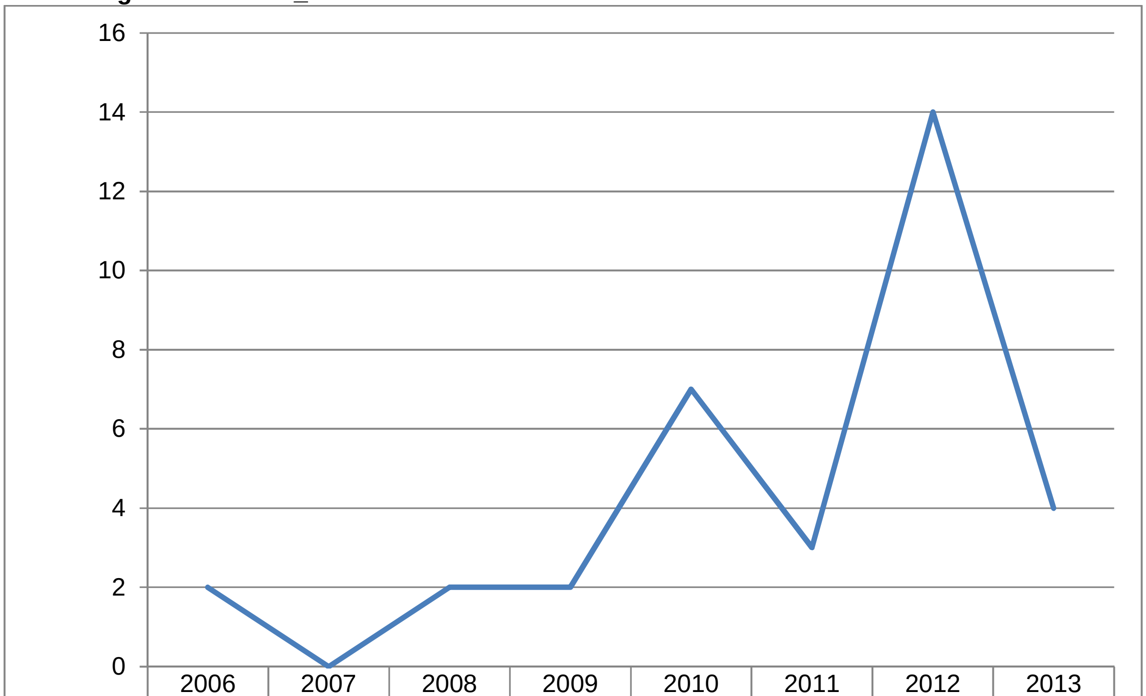
Figure 4.3: Mod2_Modification Installation



	2006	2007	2008	2009	2010	2011	2012	2013
Number	13	11	14	9	18	13	10	2

Figure 4.3 above shows that in 2006 there were only 13 reported incidents, which relate to deficiencies in the modification installation process. This number remained between the range of 13 and 9 from 2006 to 2009, but a sudden sharp increase was experienced in 2010 with 18 PNs raised in that year. The number then returned to 13 in 2011, which is the same as when it began in 2006, and 10 in 2012. This means that installation of modifications remains an area of concern, while project quality should be checked for future projects. This is in line with the data analysis as far as design is concerned.

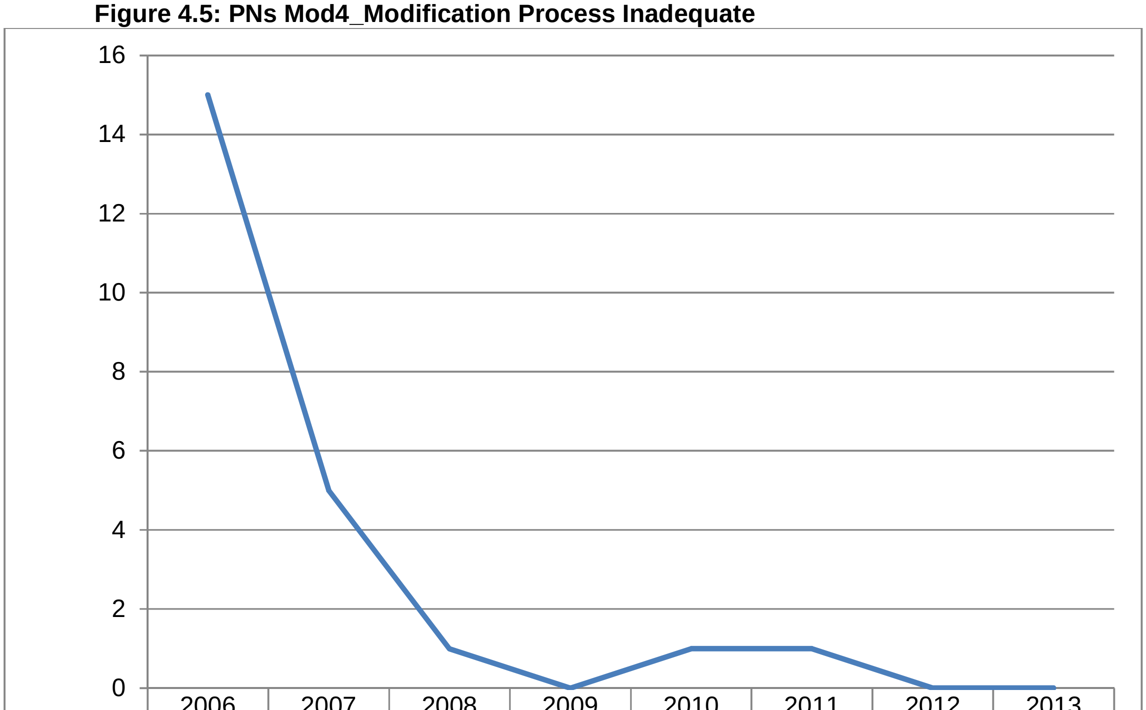
Figure 4.4: Mod3_Modification Documentation



	2006	2007	2008	2009	2010	2011	2012	2013
Number	2	0	2	2	7	3	14	4

Figure 4.4 shows that there has been a consistent trend from 2006 to 2009. Somehow it spiked in 2010 (7) and doubled in 2012 (14). It would appear that the documentation issue is a recurring one and in line with the survey results around the completion of documentation during the modification process.

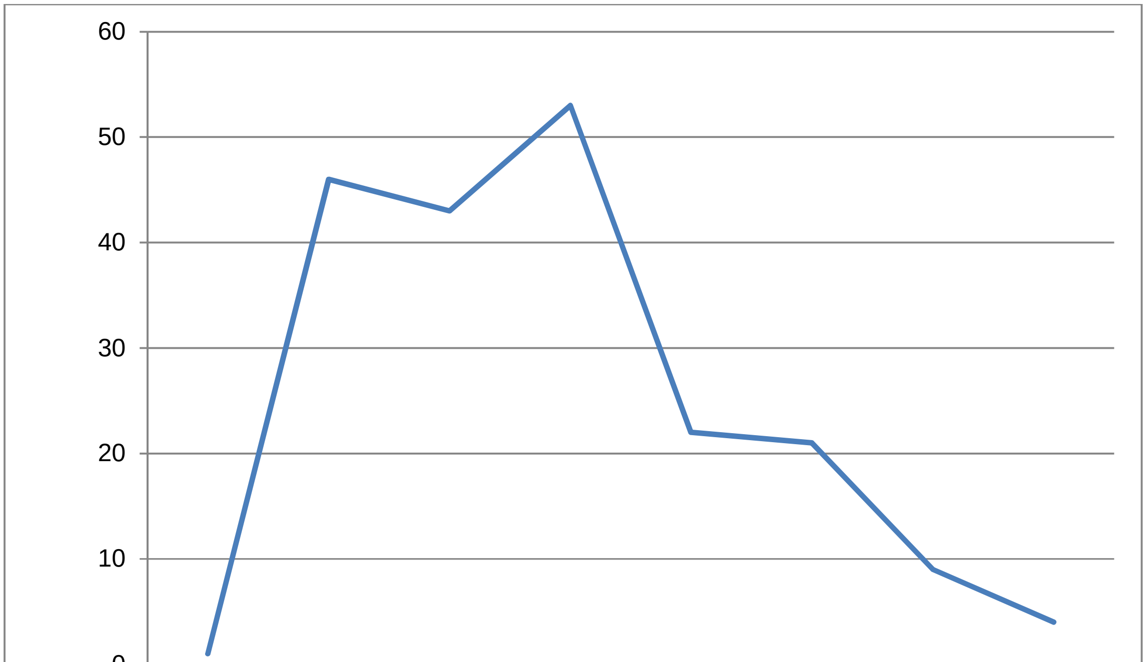
Figure 4.5: PNs Mod4_Modification Process Inadequate



	2006	2007	2008	2009	2010	2011	2012	2013
Number	15	5	1	0	1	1	0	0

Figure 4.5 above shows the “Modification Process Inadequate” PNs, which started out at 15 in 2006; however, there has been a steady decline with 2012 having 0. This would suggest that the organisation is learning from this type of non-conformance and applying lessons that were learnt accordingly.

Figure 4.6: Mod7_ Modification Process not followed



	2006	2007	2008	2009	2010	2011	2012	2013
Number	1	46	43	53	22	21	9	4

Figure 4.6 above depicts that since 2006, where 0 was recorded; these PNs went as high as 46, 43 and 53 in the following three years. The years2010 (22) and 2011 (21) saw a sharp decline with the same trend continuing in 2012 with only 9, and 2013 with only 4 incidents. This would imply that some mind shift had to have happened, as well as fundamental change in 2010, for this to be realised.

4.7 Presentation of data and discussion of findings

In order to suitably complete this study, collected data had to be analysed in order to answer the research question as stated in Chapter 1.4, paragraph which read: “What factors affect project quality either negatively or positively, and what in the project environment allows these to persist?” As already indicated in the preceding chapter, data was interpreted in a descriptive format.

Questionnaire A: People

		Agree	Neutral	Disagree
1	Customer requirements were clear.	61.3	21.3	17.3
2	Senior management demonstrated commitment to project quality.	64.0	22.7	13.3
3	Stakeholders were constantly involved throughout the project lifecycle.	40.5	29.7	29.7
4	The NNR was engaged in time, where applicable.	57.1	31.4	11.4
5	The project manager was knowledgeable about the plant.	65.8	23.7	10.5
6	The project team demonstrated commitment to achieve project quality.	68.0	24.0	8.0
7	Accountability was promoted by setting high expectations for project quality performance.	53.9	30.3	15.8
8	Project status was reported on a regular basis, hence project quality issues were identified upfront.	53.3	29.3	17.3
9	Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties that had legitimate interests.	58.7	26.7	14.7
10	The project schedule was adhered to throughout the project lifecycle.	36.5	18.9	43.2
11	The client was happy and accepted the project that you delivered.	48.6	41.9	9.5

The above table indicates that, of the respondents who were asked whether customer requirements were clear, those in agreement totalled 61.3% of the total number of respondents Also, while senior management demonstrated commitment to project quality (64.0%), the project manager was knowledgeable about the plant (65.8%) and the project team demonstrated commitment to achieve project quality (68.0%). This paints a picture that internal stakeholders (senior management, project managers, project team) involvement in projects is quite high compared to that of external stakeholders in relation to being constantly involved throughout the project as they achieved a low result of 40.5%. There is, however an equal number of those who are neutral and those who disagree (29.7%). A total of 57.1% of respondents agree that the NNR was engaged in time, while 31.4% were neutral, and 11.4% disagreed. It is interesting to note that on the quality side, whether internal or external, no one agreed with this statement. This would allude to the fact that there is misalignment in the response around NNR engagement.

Hence stakeholder involvement in projects is not as desired. A total of 65.8% of respondents indicated that project managers were knowledgeable about the plant, 23.7% were neutral and 10.5% disagreed. This is consistent with the experience of those who work in NPM. This is also an important quality when working on a nuclear power plant.

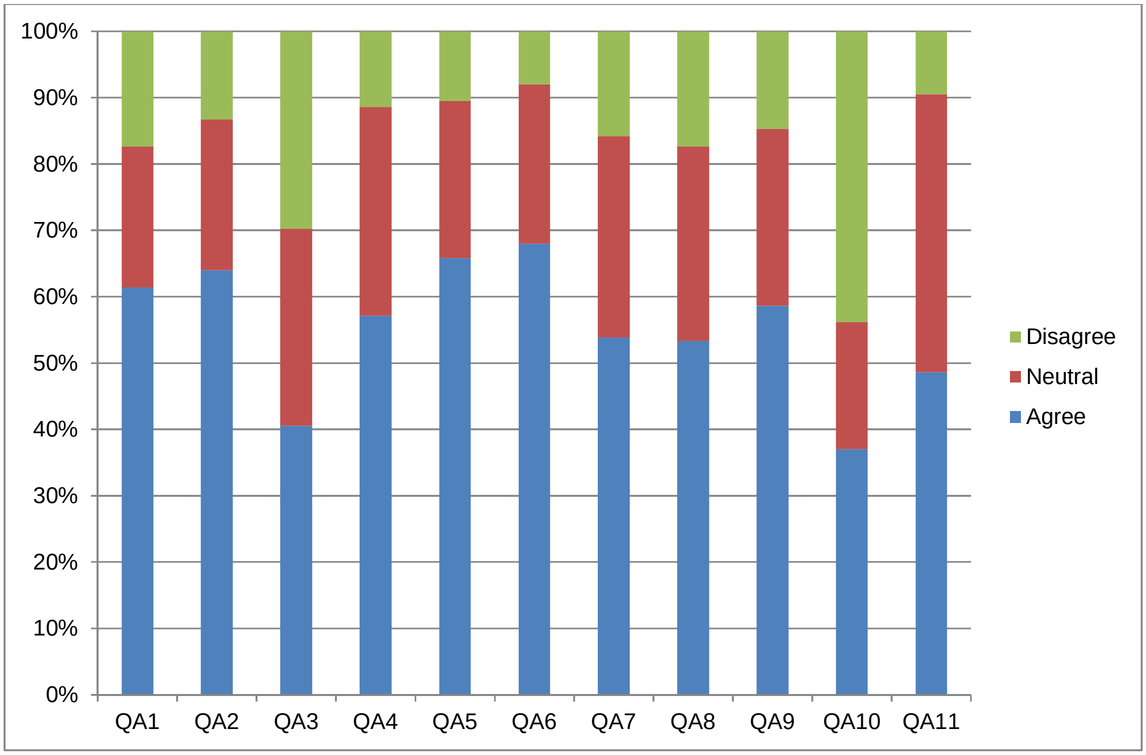
A total of 53.9% of respondents agreed that accountability was promoted by setting high expectations for project quality performance, while 30.3% were neutral and 15.8% disagreed. The 30.3% that were neutral and the fact that of those 50% are quality personnel would imply that more effort should go into the setting of quality performance goals for projects. The fact that the project team demonstrated commitment (68.4%), means that project quality is not only the responsibility of the project manager, but also that of the project team.

The total number of external departments (34.7%) attest to this. This is important, as it demonstrates that project quality is not only the responsibility of the project manager, but also that of the project team. A total of 53.3% of respondents agreed that project status was reported on a regular basis; hence project quality issues were identified upfront. Almost one third (29.3%) were undecided, while 19.3% disagreed. This means that the practice of project reporting is not being addressed consistently. A total of 58.7% of respondents agreed that integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties that have legitimate interests. A total number of 26.7% and 14.7% were neutral disagreed, respectively. A total number of 70% of project managers did not feel that undue pressure was placed on the project, which allowed them to maintain the integrity of the project, implying that they have the ability to defend the project and its objectives. The quality control group does not agree with this statement, which means that project integrity is always compromised. Another area of concern is the project schedule that is not adhered to throughout the project life cycle with just over a third of the respondents (36.5%) agreeing. Project managers who agree are equal to those who disagree, which could be an indication that the sentiment is shared both ways. A total of 72% (NPM) disagreed with this statement, which is a cause for concern.

The fact that the client was not happy with the project that was delivered, 46.5% is considered a high percentage considering that this is the pivotal point of project quality, namely customer satisfaction; and if the customer is not happy, the plant cannot be healthy. It is, however, noteworthy that those who agree with the statement are almost equal to those who are neutral (41.9%), while only 9.5% disagreed.

If NPM should move to the perception of customer delight, then it has some way to go. Work should be done to improve this picture. On average, for the “People” section, 55.3% agreed with the statements, while 27.3% were undecided and 17.4% disagreed with the statements.

Figure 4.27: Questionnaire A Analysis



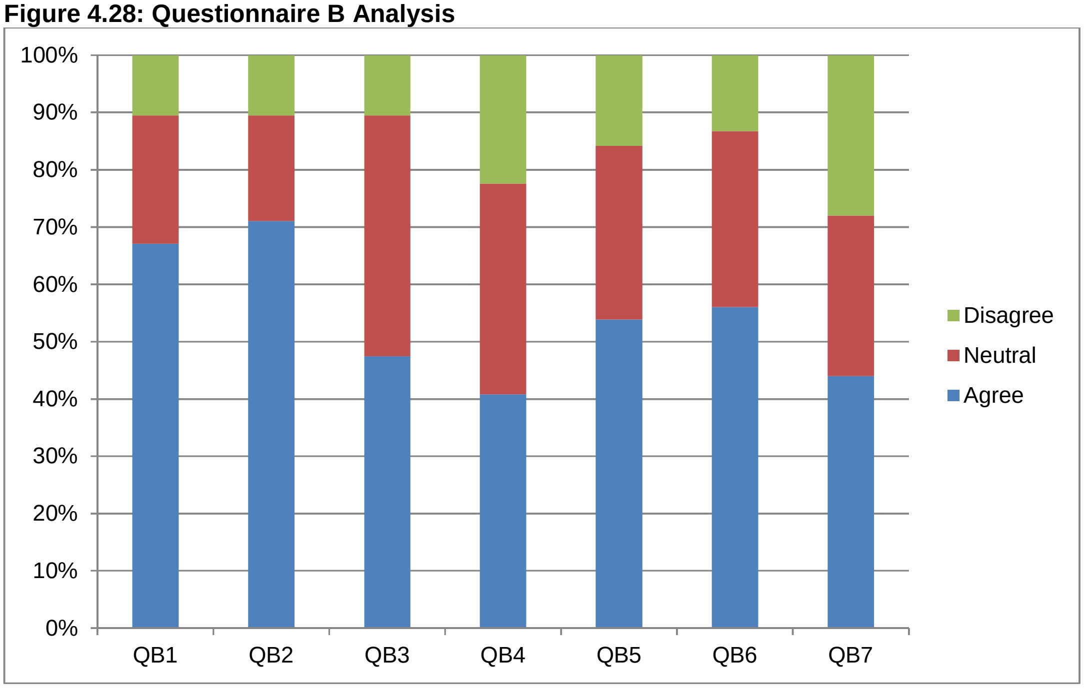
Questionnaire B: Standards, Processes and Procedures

		Agree	Neutral	Disagree
1	The project was planned to a level of detail that ensured efficient implementation of project quality.	67.1	22.4	10.5
2	Processes and procedures were conveniently available.	71.1	18.4	10.5
3	Processes and procedures were rigorously applied at all levels of the project.	47.4	42.1	10.5
4	Processes and procedures were cumbersome and hindered progress.	40.8	36.8	22.4
5	Configuration management was rigorously applied.	53.9	30.3	15.8
6	All relevant documentation, which was affected by the modification accurately, reflected the modified plant configuration.	56.0	30.7	13.3
7	Documents were updated as soon as practicable.	44.0	28.0	28.0

The above table summarised respondents' comments regarding standards, processes and procedures. A total of 40.8% of respondents agreed that the processes and procedures are too cumbersome and that they hindered the project's progress. It is interesting to note that 47.4% believed that processes and procedures were rigorously applied at all levels of the project. This appears to be in line with cumbersome processes and procedures. According to 44.0% of respondents, documents were not updated as soon as practicable. This is a crucial part of operating a plant where the paper plant should reflect the actual plant; hence this is another area that should be addressed if project quality, as far as documentation is concerned, is to be realised as effective.

It is noteworthy that 68.5% of respondents agreed that the project was planned to a level of detail that ensured efficient implementation of project quality, while 71.1% agreed that processes and procedures were conveniently available. This would imply that processes and procedures are available and facilitate a high quality of planning on projects. A total of 47.4% of respondents agreed that processes and procedures were rigorously applied at all levels of the project while 10.5% disagreed and 42.1% remained neutral. Neutrality could mean that those who were involved in projects did not want to disclose the truth about the application of processes and procedures. It is not a good picture if less than half adhere to processes and procedures. Somehow disconnect happens during the application phase of the project and concludes with documents not being updated as required. If less than half of project teams are updating documentation, this could pose a serious problem for future modifications. A total of 56.9% agreed that all relevant documentation affected by the modification accurately reflected the modified plant configuration, while 30.6% remained neutral and 12.5% disagreed. The percentage is low considering that the plant should always reflect the latest (modified) plant configuration. On average, for the "Standards, Processes and Procedures" section, 54.3% agreed with the statements, 29.8% were undecided and 15.9% disagreed with the statements.

Figure 4.28: Questionnaire B Analysis



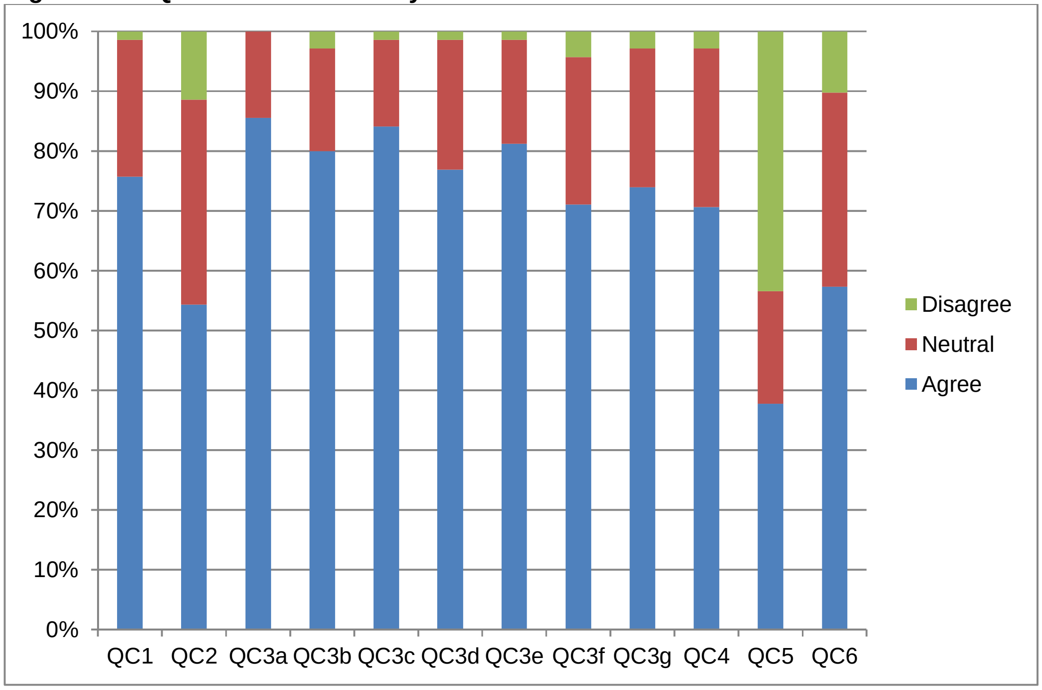
Questionnaire C: Plant

		Agree	Neutral	Disagree
1	When the project/modification was identified, its compatibility with the design intent was assessed.	75.7	22.9	1.4
2	Where applicable, benchmarking was performed to ensure that engineering standards and practices did not lag behind.	54.3	34.3	11.4
3	Design specifications were:			
a	• Prepared;	85.5	14.5	0.0
b	• Reviewed by independent reviewers;	80.0	17.1	2.9
c	• Approved;	84.1	14.5	1.4
d	• Issued to the suppliers;	76.8	21.7	1.4
e	• Authorised;	81.2	17.4	1.4
f	• Revised ;and	71.0	24.6	4.3
g	• Validated as required (before implementing the design).	73.9	23.2	2.9
4	The modification was performed in accordance with established procedures, whilst taking project quality into account.	70.6	26.5	2.9
5	Production priorities took preference over project quality in your project.	37.7	18.8	43.4
6	When the modification was tested, it demonstrated that the design intent was met it was placed in service.	57.4	32.4	10.3

The above table depicts that in the area of design specifications, respondents mostly agreed that the process is followed accordingly. It is a positive to note that all respondents agreed that when the project/modification was identified, its compatibility with the design intent was assessed (75.7%), and that the modification was performed in accordance with established procedures, whilst taking project quality into account (70.6%). A total of 54.3% of all respondents agreed that where applicable, benchmarking was performed to ensure that engineering standards and practices did not lag behind. A total of 34.3% was undecided, and 11% disagreed. It would appear that efforts should to be increased as far as benchmarking (54.3% agreed) is concerned, while employees should remain abreast of new standards and practices in the nuclear world. It also indicates that production priorities did not take preference over project quality (37.7%). The 57.4% of respondents who agreed that the modification was tested demonstrated that the design intent was met before being placed in service. This would suggest that while design specifications are sound and rigorously followed, there is a problem from that point through execution, which leads to the notion that the intent was not met. A total of 76.8% of respondents were confident that design specifications were issued to suppliers before they could work on the plant, while 42.9% of PQE remained neutral, while 57.1% of them disagreed. Once again, there is misalignment with what NPM perceives and what PQE does.

On average, for the "Plant" section, 70.7% agreed with the statements, while 22.3% remained undecided and 7.0% disagreed with the statements.

Figure 4.29: Questionnaire C Analysis

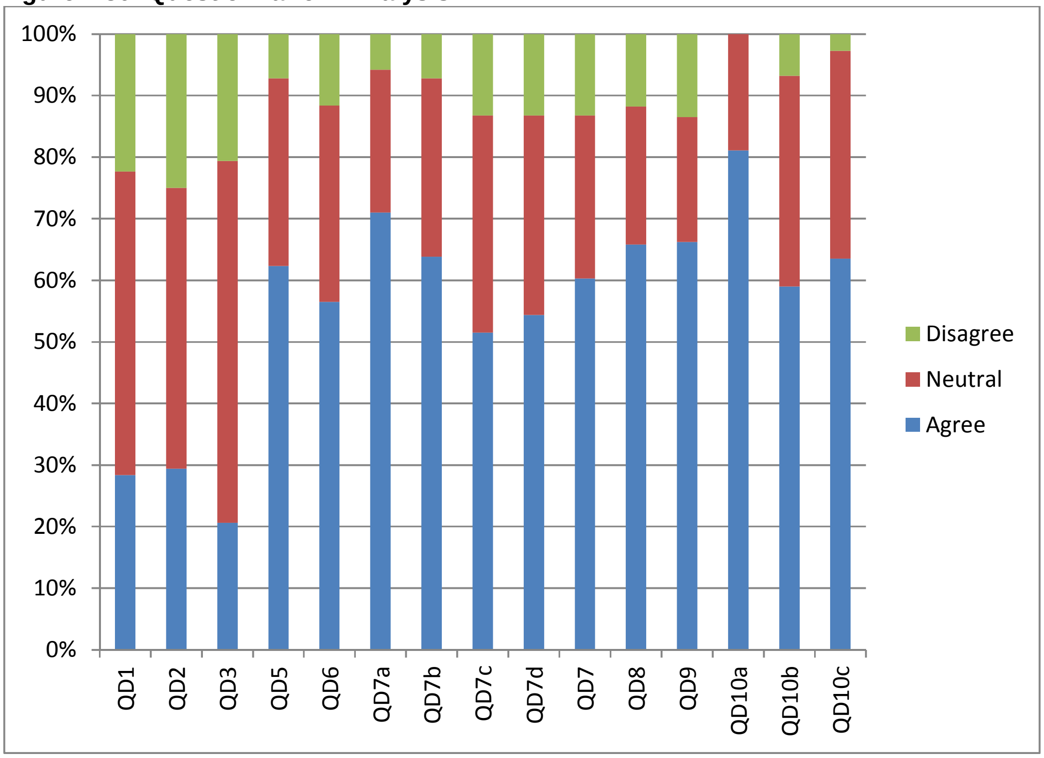


Questionnaire D: Contractor / Supplier / Vendor Management

		Agree	Neutral	Disagree
1	Where applicable, NNR was involved in the supplier qualification process.	28.4	49.3	22.4
2	Where applicable, the supplier understood the requirements of RD0034.	29.4	45.6	25.0
3	Supplier Development and Localisation (SD&L) aided project quality.	20.6	58.8	20.6
5	Supplier evaluation criteria were based on project quality requirements.	62.3	30.4	7.2
6	The supplier interpreted project quality requirements correctly	56.5	31.9	11.6
7	The following was enforced to ensure that a quality project was implemented:			
a	• The supplier's quality documents were reviewed;	71.0	23.2	5.8
b	• The supplier's procedures were read;	63.8	29.0	7.2
c	• The supplier's entire quality program was surveyed; and	51.5	35.3	13.2
d	• The supplier's personnel list was observed to who will monitor the quality of workmanship at each level.	54.4	32.4	13.2
7	Contractor performance (periodic inspection) was constantly monitored to confirm that they continue to perform satisfactorily.	60.3	26.5	13.2
8	The project team demonstrated sufficient knowledge and	65.8	22.4	11.8

	experience to guide contractors on project quality.			
9	Compliance to project quality was visible during execution.	66.2	20.3	13.5
10	Compliance was ensured by using the following:			
a	• Hold/witness points;	81.1	18.9	0.0
b	• Status indicators; and	58.9	34.2	6.8
c	• Third party inspections.	63.5	33.8	2.7

Figure 4.30: Questionnaire D Analysis



The above table shows that respondents agreed that supplier evaluation criteria were based on project quality requirements (62.3%), however; only 56.5% of suppliers interpreted those requirements correctly. This implies that there is a communication link that should be strengthened for both parties, or sometimes the incorrect suppliers are selected to implement the work, especially since contractors should implement changes in accordance with design specifications and quality requirements. There also appears to be a missing link design when considering quality of design specifications (85.5%). A total of 57.4% of the design intent is met before it is placed in service; and now 56.5% of the correct interpretation of requirements by suppliers.

Supplier development and localisation is fairly new in the organisation and not too many project teams have been exposed to it, hence the low response rate of 20.6%, and the high neutrality figure of 58.8%. Similarly, the supplier's understanding of RD0034 (29.4%) is consistent with the fact that RD0034 is not as entrenched in the business, as it is still considered fairly new, and hence the high number of neutral respondents (45.6%). When considering NNR, involvement in the qualification process of suppliers is only applicable when RD0034's is implemented as part of the project, hence it would make sense that these responses are almost identical with that of the RD0034 understanding of suppliers.

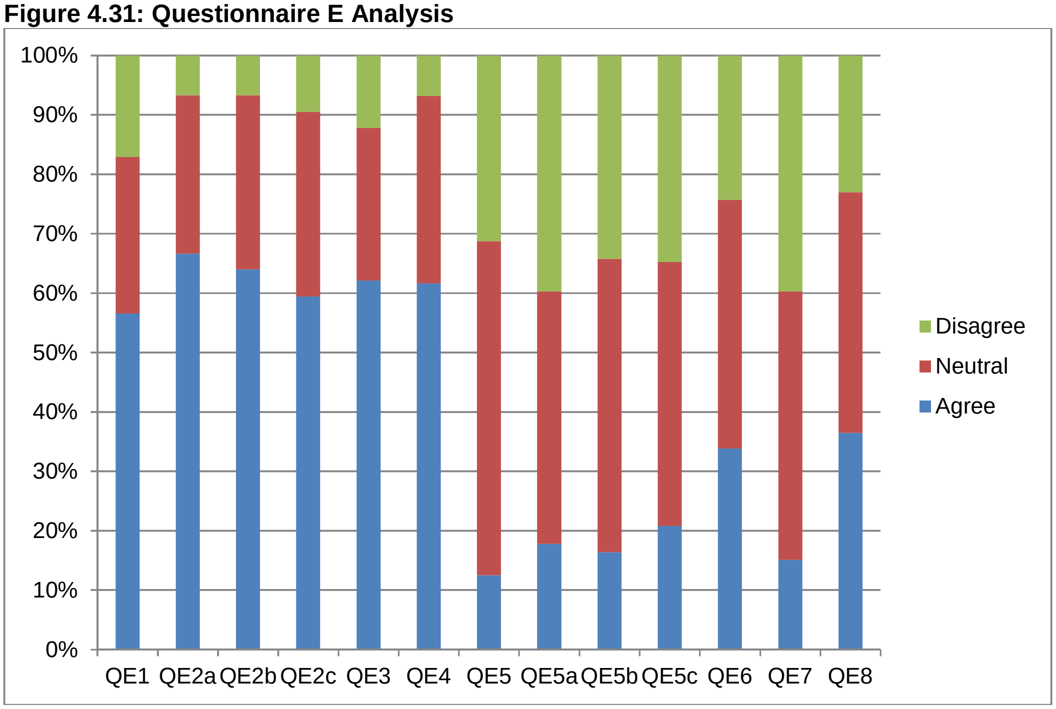
As far as contractor performance is concerned, the percentages of agreement with statements are considered to be average. In order to breach the gap between design specifications and the design intent being met when the project is placed in service, these areas that should be focussed on so that project quality at execution level is realised. Respondents agreed that while supplier quality documents were reviewed (71.0%) and read (63.8%), only 51.5% of the entire program was surveyed. This would imply that their documents were reviewed and once in execution, less effort is made to survey the entire program. A total of 54.4% of respondents agreed that the supplier's personnel list was observed to check who will monitor the quality of workmanship at each level. This is a low percentage when considering that, in accordance with the survey; execution is the area that requires the most focus. A total of 81.1% of respondents agreed that hold and witness points were used as a compliance mechanism, while status indicators (58.9%) and third party inspections (63.5%) are used to a lesser extent. It is interesting to note that procurement and quality control were mostly neutral on this topic, which is their area of responsibility.

In line with the experience that exists within the organisation, the project team demonstrated sufficient knowledge and experience to guide contractors on project quality (65.8%), while compliance to project quality was visible during execution (66.2%). This is expected considering the work experience distribution within the organisation. On average, for the "Vendor Management" section, 55.6% agreed, 32.8% was undecided and 11.6% disagreed with the statements.

Questionnaire E: Quality

		Agree	Neutral	Disagree
1	Project was audited at various phases before approval to next phase.	56.6	26.3	17.1
2	Where there were deviations, non-conformances were:			
a	• Raised (reported);	66.7	26.7	6.7
b	• Issued (recorded); and	64.0	29.3	6.7
c	• Resolved (followed up).	59.5	31.1	9.5
3	It was ensured that documentary evidence of conformance is available before items and processes were installed or used.	62.2	25.7	12.2
4	The plant was in a better/healthier state once the modification was done /handed over to the client.	61.6	31.5	6.8
5	The project was closed on time:	12.5	56.3	31.3
a	• FRA closure was done as per the required timelines;	17.8	42.5	39.7
b	• QADP closure was done as per the required timelines; and	16.4	49.3	34.2
c	• An effectiveness review was done as per the required timelines.	20.8	44.4	34.7
6	The project handover certificate was signed off immediately following completion of the project.	33.8	41.9	24.3
7	The project was completed in time and within budget but lacked quality.	15.1	45.2	39.7
8	The project team wrote a wash-up report that recorded lessons that were learnt and should be distributed throughout the organisation.	36.5	40.5	23.0

Figure 4.31: Questionnaire E Analysis



As far as deviations and non-conformance is concerned, respondents agreed that they were raised (66.7%), issued (64.0%) and resolved (59.5%), which is a sign of sound quality principles during the implementation phase. Documentary evidence of conformance was available before items and processes were installed (62.2%). A total of 61.6% of respondents agreed that the plant was in a better/healthier state once the modification was done/handed over to the client; however, this picture can be improved.

One of the poorest statistics is that only 12.5% agreed that the project was closed on time, while 31.3% disagreed. The closure of QADPs and FRAs had 16.4% and 17.8% respondents agreeing, respectively, while 43.2% and 39.7% disagreed. When considering that if projects are not closed properly the plant cannot be updated effectively, results in cause for concern. Effectiveness reviews are also not conducted as prescribed (20.8% agreed and 34.7% disagreed).

A total of 24.3% of respondents disagreed that project handover certificates were signed off immediately following completion of the project, while only 33.8% agreed, and 41.9% remained undecided. Wash-up reports were only written and lessons learnt were distributed throughout the organisation were only agreed upon by 36.5%, while 23.0% disagreed and 40.5% remained undecided. On average, for the "Quality" section, 40.3% agreed, 37.7% was undecided and 22.0% disagreed with the statements.

4.8 Conclusion

The investigative sub-questions, as stated in Chapter 1.4.1, are as follow:

- How well do management and project teams understand their role to ensure project quality?

  According to the survey, senior management demonstrated a commitment to project quality (64.0%), and the project team demonstrated a commitment to achieve project quality (68%). This leads to the conclusion that the level of understanding amongst senior management and the project team with regard to their role in quality, is acceptable, but can be improved. All good efforts, however, will fall by the way side if the client is not happy (48.6%). This implies that the project team's understanding should be in line with customer requirements, which at this stage is only clear (61.3%) of the time. Another crucial factor in respect of satisfying the customer is to adhere to the schedule (36.5% agreement) at all times, as this should keep the client happy.

- To what extent are stakeholders actively involved in projects and project quality?

  The survey concluded that stakeholders' involvement in the project was not as desired (40.5%). Efforts, therefore, should be made to constantly engage all stakeholders throughout the project. While the NNR's timely engagement was average (57.1%), they are a crucial stakeholder that could stop a project at any time if their involvement was not timely and/or adequate. Relationship management should be enhanced with all stakeholders. To this end, methods that include stakeholder impact analysis should be conducted upfront so that the project team understands how to interact with different stakeholders.
- How well are processes and procedures applied to ensure project quality?

  The survey showed that processes and procedures, while conveniently available (71.1%) and not too cumbersome (40.8%), were not rigorously applied at all levels of the project (are well defined and applied to ensure project quality) (47.4%).
- How well do suppliers interpret project quality requirements?

  The survey revealed that design specifications were issued to suppliers (76.8%) that supplier interpretation of project quality was not as desired (56.5%), and that compliance during execution could be improved (66.2%).
- Was the plant in a healthier state once modifications were introduced to it?

  A total of 61.6% agreed that the plant was in a better/healthier state once the modification was done/handed over to the client, while 6.8% disagreed and 31.5% was undecided.
- Which gaps should be bridged so that project quality is continually implemented?

  The strengths and weaknesses of the way in which project quality is planned, conducted and implemented were highlighted above, while gaps were also identified and discussed.

CHAPTER FIVE
RECOMMENDATIONS

5.1 Introduction

Presently, project quality is more important than ever and even more so in the nuclear industry, where a lack of project quality can have dire consequences. It appears that the need to maintain quality as an integral part of any modification and project that is implemented on the plant is well recognised, however, achieving appropriate results may not be as well deployed throughout the project lifecycle. So while it is generally easier to blame those who are responsible for introducing changes to the plant and certain processes for project quality deficiencies, the research has shown that quality should be considered throughout the project lifecycle in order for it to be realised. Delivering projects of poor quality can have far reaching consequences. It is, therefore, imperative, now more than ever, that modifications should be implemented on the plant and are in line with quality standards, especially when considering new build. Therefore, project quality issues throughout the project life cycle should be addressed so as to ensure that the door is not opened to short-cuts and dodging tactics.

The research thus far indicates that project quality plays a vital role in the project lifecycle and in the delivery of projects on the NPP, especially when considering the future of nuclear technology in South Africa. In this research the areas that can be improved and those where current practices can be enhanced so that the overall impact on project quality is positive, was investigated. Factors that affect project quality (negative and positive) on the plant's performance have been elaborated on.

5.2 Recommendations

From the above results it is evident that whilst there are measures in place to ensure project quality, a more concerted effort should be made so that the entire project life cycle is effective. The following recommendations are made to mitigate and provide answers to the research problem.

- Areas for improvement, as it relates to project quality throughout the project lifecycle, are identified below:
  - According to the survey; closing projects on time is an area that should be improved (12.5%). The FRA should be closed as per the required timelines (17.8%), while the QADP should be completed as per the set timelines (16.4%);
  - In order for NPM to be considered as a learning organisation, effectiveness reviews should also be conducted on time (20.8%) so that lessons are learnt

can be distributed throughout the organisation. This is also where wash-up reports should be completed (36.5%) so that learning is ensured. It is recommended that he project team should write a “lessons learnt” report after each phase of the project for learning purposes, and not only at the end of the project, especially when considering that planning of quality is key, and not only the implementation thereof;

- A system that captures internal project quality non-conformances and lessons learnt can be set up. This will allow the organisation to have a reference system in terms of lessons regarding project quality. Project managers can then access this database and use them as inputs into their projects;
- As it is a tedious job for the project manager and even for the project team to think of and consider all things that should be done to achieve project quality, it is recommended that a cross functional checklist that merges quality, standards across all disciplines (QMS, ISO, RD-0034, and so on) should be introduced and amalgamated into one. This will ensure that all aspects of project quality are addressed and adhered to during the project lifecycle;
- A phase gate approach should be introduced where only those projects that meet requirements are allowed to proceed to the next step. The gatekeepers should be the quality department and independent project quality reviewers before a project can move to the next phase. Internal auditors should be appointed who check on projects and not random selection, but all projects should undergo this phase;

- Effective areas in the project lifecycle were also highlighted by the survey with percentages of 70% and above attained. The effective areas, although not at a comfortable level, include:
  - Processes and procedures were conveniently available (71.1%);
  - When the project/modification was identified, its compatibility with the design intent was assessed (75.7%);
  - Design specifications were:
    - Prepared (85.5%);
    - Reviewed by Independent Reviewers (80.0%);
    - Approved (84.1%);
    - Issued to the suppliers (76.8%);
    - Authorised (81.2%);
    - Revised (71.0%); and
    - Validated as required (before implementing the design) (73.9%);
  - The modification was performed in accordance with established procedures, whilst taking project quality into account (70.6%);

- Hold/Witness points were adhered to during implementation (81.1%); and
- The supplier's quality documents were reviewed (71.0%).

- The importance of effectively and consistently using clearly defined processes in the implementation of quality in projects was highlighted;
  The study has demonstrated that having clearly defined processes is only half the problem solved; implementing them and applying them rigorously throughout the project life cycle, will however, improve project quality; and
- The research highlights ways in which confidence from the plant, stakeholders, sponsors and regulatory bodies can be reinforced and maintained.

The study concluded that in order for project quality to be realised throughout the project life cycle, stakeholders should be constantly engaged. Confidence from the plant will only be attained when the relevant stakeholders are involved at the right time during the project. Relationship management should be enhanced with all stakeholders. To this end, methods that include stakeholder impact analysis should be conducted upfront so that the project team understands how to interact with different stakeholders. It is further recommended that projects (depending on the complexity and magnitude) appoint interface leaders who ensure that information flows correctly to various stakeholders with project quality as the main consideration. The steps below, as adapted from Eskom's Quality Department, should assist NPM to reach the goal of customer delight through effective project quality.

How to make Quality Work?
High motivation **O**bjective listening **W**orkable goals
Timely training **O**btainable standards
Meaningful measurements **A**ttention to causes **K**een spirit **E**rror prevention
Quick detection **U**nwavering commitment **A**greement **L**ifelong process **I**ntegrity **T**eamwork **Y**es we can attitude
Wise leadership **O**bservable results **R**ecognition of achievements **K**nowledge

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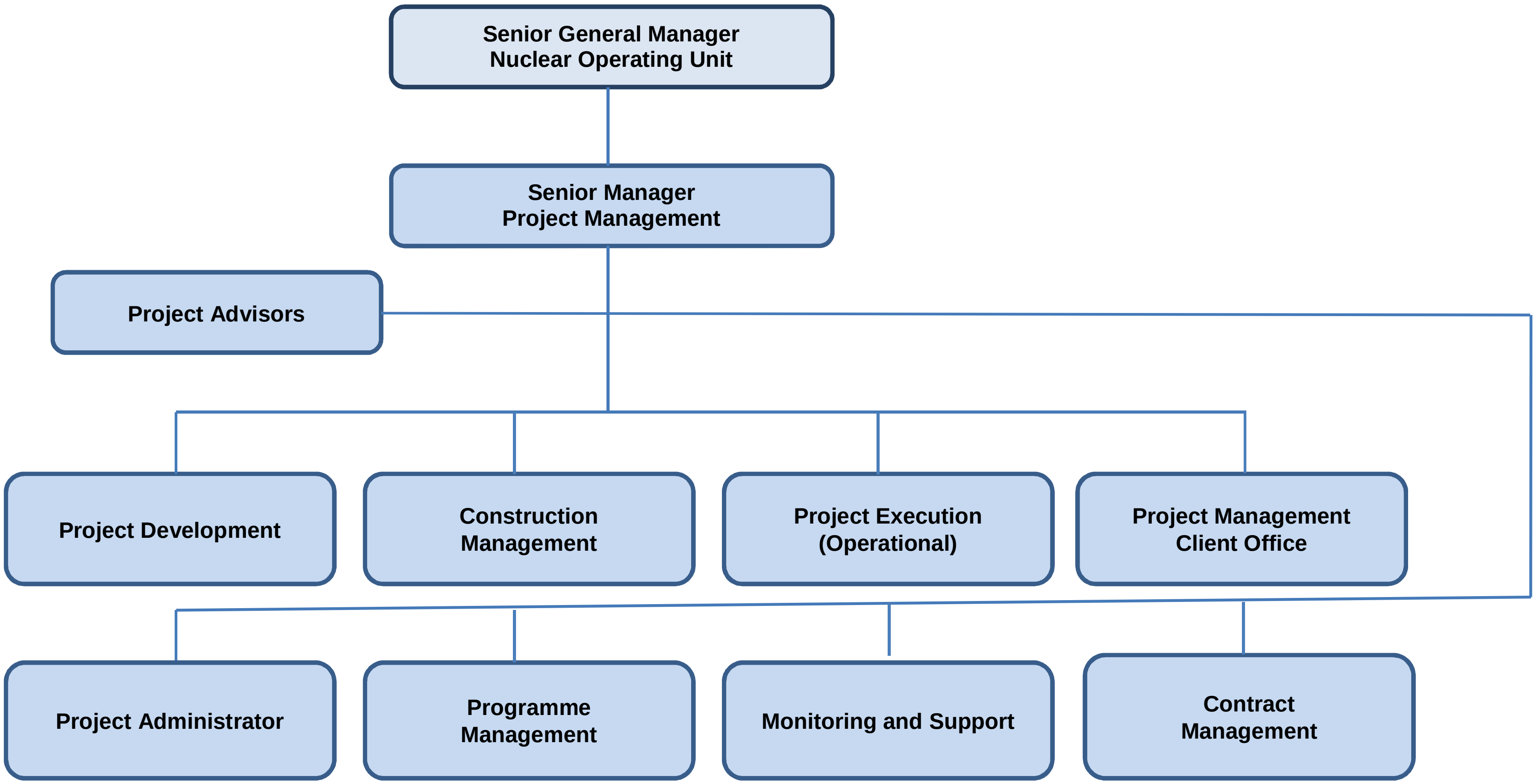
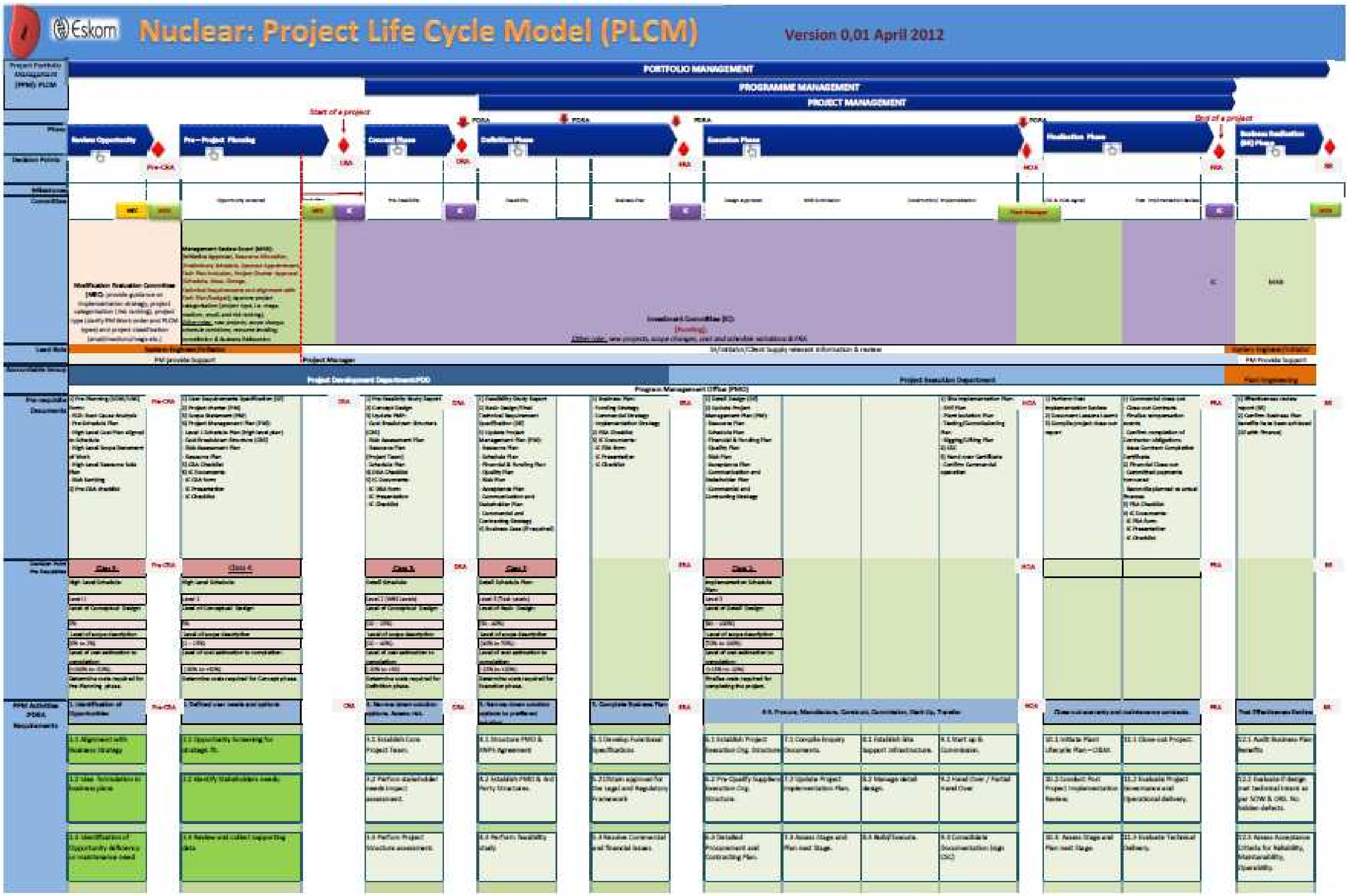
APPENDICES

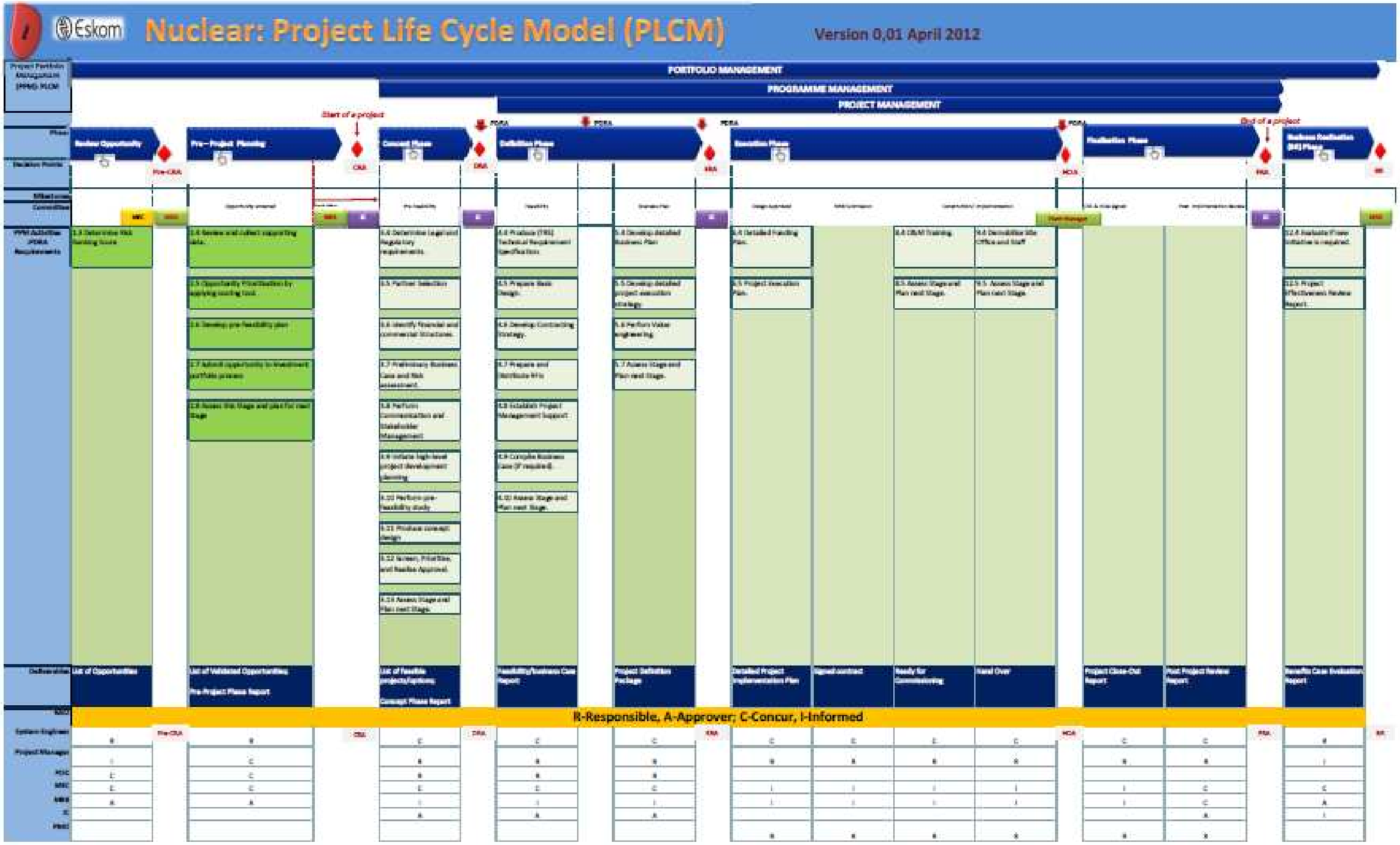
Appendix A: Nuclear Project Management Organisation Structure



Appendix B: Eskom Project Life Cycle Model



Appendix B: Eskom Project Life Cycle Model



Appendix C: Questionnaire

RESPONDENTS' CHARACTERISTICS

2. Gender

Male	Female

3. Work experience (in years)

0-5	5-10	10-15	15-20	20-25	> 25

4. Kindly indicate your Project Life Cycle Model (PLCM) stakeholder status?

Project initiator/System engineer	
Portfolio manager	
Programme manager	
Project manager	
Project engineer	
Design engineer	
Buyer	
Project accountant	
Project controller	
Project scheduler	
Quality (please specify QA or QC)	
Other (please specify)	

5. Please indicate the Department in which you work.

Nuclear project management	
Plant engineering	
Nuclear engineering	
Procurement	
Quality assurance	
Quality control	
Maintenance	
Technical documentation and records management	
Other (please specify)	

6. Please indicate the project phase on which your response is based

CRA	
DRA	
ERA	
FRA	

The researcher would like you to answer the following section based on your personal experience with regard to projects or modifications (your role in the project lifecycle) in order for the results to be a true reflection of the current trend during various stages of the project lifecycle, as it relates to project quality. To this end, think of the last time that you were involved in a project or modification, and respond accordingly.

A. PEOPLE

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Customer requirements were clear.					
2	Senior management demonstrated commitment to project quality.					
3	Stakeholders were constantly involved throughout the project lifecycle.					
4	The NNR was engaged in time, where applicable.					
5	The project manager was knowledgeable about the plant.					
6	The project team demonstrated commitment to achieve project quality.					
7	Accountability was promoted by setting high expectations for project quality performance.					
8	Project status was reported on a regular basis so that project quality issues were identified upfront.					
9	Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests.					
10	The project schedule was adhered to throughout the project lifecycle.					
11	The client was happy and accepted the project that you delivered.					

B. STANDARDS, PROCESSES AND PROCEDURES

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	The project was planned to a level of detail that ensured efficient implementation of project quality.					
2	Processes and procedures were conveniently available.					
3	Processes and procedures were rigorously applied at all levels of the project.					
4	Processes and procedures were cumbersome and hindered progress.					
5	Configuration management was rigorously applied.					
6	All relevant documentation affected by the modification accurately reflected the modified plant configuration.					
7	Documents were updated as soon as practicable.					

C. PLANT

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	When the project/modification was identified, its compatibility with the design intent was assessed.					
2	Where applicable, benchmarking was performed to ensure that engineering standards and practices did not lag behind.					
3	Design specifications were:					
a	• Prepared;					
b	• Reviewed by independent reviewers;					
c	• Approved;					
d	• Issued to suppliers;					
e	• Authorised;					
f	• Revised; and					
g	• Validated as required (before implementing the design).					
4	The modification was performed in accordance with established procedures whilst taking project quality into account.					
5	Production priorities took preference over project quality in your project					
6	When the modification was tested, it demonstrated that the design intent was met before being placed in service.					

D. CONTRACTOR / SUPPLIER / VENDOR MANAGEMENT

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Where applicable, NNR was involved in the supplier qualification process.					
2	Where applicable, the supplier understood the requirements of RD0034.					
3	Supplier Development and Localisation (SD&L) aided project quality.					
5	Supplier evaluation criteria were based on project quality requirements.					
6	The supplier interpreted project quality requirements correctly.					
7	The following was enforced to ensure that a quality project was implemented:					
a	• The supplier's quality documents were reviewed;					
b	• The supplier's procedures were read;					
c	• The supplier's entire quality program was surveyed; and					

d	• The supplier's personnel list was observed check who monitors the quality of workmanship at each level.					
7	Contractor performance (periodic inspection) was constantly monitored to confirm that they continue to perform satisfactorily.					
8	The project team demonstrated sufficient knowledge and experience to guide contractors on project quality.					
9	Compliance to project quality was visible during execution.					
10	Compliance was ensured by using the following:					
a	• Hold/Witness points;					
b	• Status indicators; and					
c	• Third party inspections					

E. QUALITY

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	The project was audited at various phases before approval to the next phase.					
2	Where there were deviations, non-conformances were:					
a	• Raised (reported);					
b	• Issued (recorded); and					
c	• Resolved (followed up).					
3	It was ensured that documentary evidence of conformance is available before items and processes were installed or used.					
4	The plant was in a better/healthier state once the modification was done /handed over to the client.					
5	The project was closed on time:					
a	• FRA closure was done as per the required timelines;					
b	• QADP closure was done as per the required timelines; and					
c	• An effectiveness review was done as per the required timelines.					
6	The project handover certificate was signed off immediately following completion of the project.					
7	The project was completed in time and within budget but lacked the quality.					
8	The project team wrote a wash-up report that recorded lessons that were learnt for distribution throughout the organisation.					

9. Any other comments
……

Appendix D: Contractor Questionnaire

1. Work eExperience at KNPS (in years)

0-5	5-10	10-15	15-20	20-25	> 25

A. PROCESSES AND PROCEDURES

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	You understood the customer requirements related to project quality.					
2	You were familiar with the KNPS processes and procedures related to the service that you had to provide.					
3	Your processes and procedures were in line with those of KNPS project quality requirements for that service.					
4	KNPS processes and procedures were conveniently available.					
5	KNPS clearly communicated project quality standards for your project / service.					
6	KNPS clearly communicated the kind of quality programme that you had to have in place to ensure that project quality was achieved.					
7	You identified how your organisation would maintain specified quality standards for your service.					
8	You established control measures to ensure that all documentation complied with quality requirements.					
9	Supplier Development and Localisation (SD&L) is a good tool.					
10	You understand the requirements of RD0034.					

B. PROJECT EXECUTION / IMPLEMENTATION / DELIVERY

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Information that you received from the customer described the service and was:					
a	• Clear;					
b	• Concise; and					
c	• Unambiguous.					
2	You had a clear understanding of the customers' expectations.					
3	You had the capability within your organisation to monitor a quality program.					
4	You planned projects to a level of detail, which is necessary for project quality to be realised.					
5	You understood your role in the execution of quality projects.					
6	KNPS interventions provided value in supplier development.					
7	KNPS processes and procedures were too cumbersome and hinder progress.					
8	People who did the work were authorised to do so.					
9	People who did the work were adequately trained to do so.					
10	Your project supervisors had sufficient experience to monitor and guide sub-contractors on project quality.					
11	Your project supervisors carried out periodic inspections of work in terms of the project quality requirements.					
12	KNPS project supervisors were always helpful on site.					
13	KNPS monitored your progress to ensure continued, satisfactory performance (quality of workmanship).					
14	Where there were deviations, non-conformances were:					
a	• Raised (reported);					
b	• Issued (recorded); and					
c	• Resolved (followed up).					
15	You reported on factors that affected the way in which you delivered a quality service.					
16	You ensured compliance to project quality by using the following:					
a	• Hold/Witness points;					
b	• Status indicators; and					
c	• Third party inspections.					
17	KNPS pushed/encouraged you for continuous improvement.					
18	You were given sufficient time to comply with project quality.					
19	You conducted customer satisfaction survey at the end of the project to ensure continuous improvement.					

Appendix E: Informed Consent Letter

7 Janey Close
Montana
Cape Town
7490

February 2013

Dear Respondent

FACTORS THAT IMPACT ON PROJECT QUALITY AT A NUCLEAR POWER PLANT IN SA

Project quality is a concern, not only within Nuclear Project Management, but also across the organisation. It is also the one aspect for which trade-offs are most common throughout the project lifecycle.

This study seeks to understand factors that impact on project quality at a Nuclear Power Plant in South Africa. Your kind co-operation as part of a sample survey is, therefore, sought for the completion of the accompanying questionnaire. Also note that by participating in this survey, you will provide vital insight into how problems can be remedied and successes can be enhanced in order for project quality and its benefits to be realised.

Please note that your participation in this research is voluntary and all information will be treated as strictly confidential. The survey is anonymous hence, responses cannot be traced to any individual, so please do not write your name on the survey form. There are no right or wrong answers to any question, as it is your opinion on each that matters, hence feel free to express your opinion, as this will be most helpful. Should you at any time and for any reason become uncomfortable to answer any question, you are welcome to either omit that question or withdraw from the research completely.

The questionnaire has been designed in such a way that it will require the minimum of time to complete, namely 10 minutes. Your willingness to complete the questionnaire will be much appreciated, as the information that is obtained will assist the researcher to complete a Master's Degree, and the Nuclear Project Management (NPM) organisation to provide an even better, quality service to the plant.

Please **place an "X" in the block** that you wish to select. Enquiries about the questionnaire or the research project may be directed to the researcher whose details are presented below.

Wilhelmina Galetta (Researcher)
E-mail: galetta@eskom.co.za
Tel: 021 550 5425
Cell: 076 804 4900

Stanley Fore (Supervisor)
E-mail: ForeS@cput.ac.za
Tel: 021 460 3516

Appendix F: Descriptive Statistics

Table 4.2: Descriptive statistics for all the variables - Frequencies

Customer requirements were clear

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	46	60.5	61.3	61.3
	Neutral	16	21.1	21.3	82.7
	Disagree	13	17.1	17.3	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Senior management demonstrated commitment to project quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	48	63.2	64.0	64.0
	Neutral	17	22.4	22.7	86.7
	Disagree	10	13.2	13.3	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Stakeholders were constantly involved throughout the project lifecycle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	30	39.5	40.5	40.5
	Neutral	22	28.9	29.7	70.3
	Disagree	22	28.9	29.7	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

The NNR was engaged in time, where applicable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	40	52.6	57.1	57.1
	Neutral	22	28.9	31.4	88.6
	Disagree	8	10.5	11.4	100.0
	Total	70	92.1	100.0	
Missing	System	6	7.9		
Total		76	100.0		

The project manager was knowledgeable about the plant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	50	65.8	65.8	65.8
	Neutral	18	23.7	23.7	89.5
	Disagree	8	10.5	10.5	100.0
	Total	76	100.0	100.0	

The project team demonstrated commitment to achieve project quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	51	67.1	68.0	68.0
	Neutral	18	23.7	24.0	92.0
	Disagree	6	7.9	8.0	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Accountability was promoted by setting high expectations for project quality performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	41	53.9	53.9	53.9
	Neutral	23	30.3	30.3	84.2
	Disagree	12	15.8	15.8	100.0
	Total	76	100.0	100.0	

Project status was reported on a regular basis so project quality issues were identified upfront

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	40	52.6	53.3	53.3
	Neutral	22	28.9	29.3	82.7
	Disagree	13	17.1	17.3	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	44	57.9	58.7	58.7
	Neutral	20	26.3	26.7	85.3
	Disagree	11	14.5	14.7	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

The project schedule was adhered to throughout the project lifecycle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	27	35.5	36.5	36.5
	Neutral	14	18.4	18.9	55.4
	Disagree	32	42.1	43.2	98.6
	4	1	1.3	1.4	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

The client was happy and accepted the project that you delivered

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	36	47.4	48.6	48.6
	Neutral	31	40.8	41.9	90.5
	Disagree	7	9.2	9.5	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

The project was planned to the level of detail that ensured efficient implementation of project quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	51	67.1	67.1	67.1
	Neutral	17	22.4	22.4	89.5
	Disagree	8	10.5	10.5	100.0
	Total	76	100.0	100.0	

Processes and procedures were conveniently available

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	54	71.1	71.1	71.1
	Neutral	14	18.4	18.4	89.5
	Disagree	8	10.5	10.5	100.0
	Total	76	100.0	100.0	

Processes and procedures were rigorously applied at all levels of the project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	36	47.4	47.4	47.4
	Neutral	32	42.1	42.1	89.5
	Disagree	8	10.5	10.5	100.0
	Total	76	100.0	100.0	

Processes and procedures were cumbersome and hindered progress

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	31	40.8	40.8	40.8
	Neutral	28	36.8	36.8	77.6
	Disagree	17	22.4	22.4	100.0
	Total	76	100.0	100.0	

Configuration management was rigorously applied

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	41	53.9	53.9	53.9
	Neutral	23	30.3	30.3	84.2
	Disagree	12	15.8	15.8	100.0
	Total	76	100.0	100.0	

All relevant documentation affected by the modification accurately reflected the modified plant configuration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	42	55.3	56.0	56.0
	Neutral	23	30.3	30.7	86.7
	Disagree	10	13.2	13.3	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Documents were updated as soon as practicable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	33	43.4	44.0	44.0
	Neutral	21	27.6	28.0	72.0
	Disagree	21	27.6	28.0	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

When the project/modification was identified, its compatibility with the design intent was assessed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	53	69.7	75.7	75.7
	Neutral	16	21.1	22.9	98.6
	Disagree	1	1.3	1.4	100.0
	Total	70	92.1	100.0	
Missing	System	6	7.9		
Total		76	100.0		

Where applicable, benchmarking was performed to ensure the engineering standards and practices were not lagging behind

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	38	50.0	54.3	54.3
	Neutral	24	31.6	34.3	88.6
	Disagree	8	10.5	11.4	100.0
	Total	70	92.1	100.0	
Missing	System	6	7.9		
Total		76	100.0		

Design specifications were: Prepared

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	59	77.6	85.5	85.5
	Neutral	10	13.2	14.5	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

Design specifications were: Prepared by independent reviewers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	56	73.7	80.0	80.0
	Neutral	12	15.8	17.1	97.1
	Disagree	2	2.6	2.9	100.0
	Total	70	92.1	100.0	
Missing	System	6	7.9		
Total		76	100.0		

Design specifications were: Approved

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	58	76.3	84.1	84.1
	Neutral	10	13.2	14.5	98.6
	Disagree	1	1.3	1.4	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

Design specifications were: Issued to the suppliers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	53	69.7	76.8	76.8
	Neutral	15	19.7	21.7	98.6
	Disagree	1	1.3	1.4	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

Design specifications were: Authorised

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	56	73.7	81.2	81.2
	Neutral	12	15.8	17.4	98.6
	Disagree	1	1.3	1.4	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

Design specifications were: Revised

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	49	64.5	71.0	71.0
	Neutral	17	22.4	24.6	95.7
	Disagree	3	3.9	4.3	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

Design specifications were: Validated as required (before implementing the design)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	51	67.1	73.9	73.9
	Neutral	16	21.1	23.2	97.1
	Disagree	2	2.6	2.9	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

The modification was performed in accordance with established procedures, whilst taking project quality into account

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	48	63.2	70.6	70.6
	Neutral	18	23.7	26.5	97.1
	Disagree	2	2.6	2.9	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

Production priorities took preference over project quality in your project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	26	34.2	37.7	37.7
	Neutral	13	17.1	18.8	56.5
	Disagree	29	38.2	42.0	98.6
	4	1	1.3	1.4	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

When the modification was tested, it demonstrated that the design intent was met before it was placed in service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	39	51.3	57.4	57.4
	Neutral	22	28.9	32.4	89.7
	Disagree	7	9.2	10.3	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

Where applicable, NNR was involved in the supplier qualification process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	19	25.0	28.4	28.4
	Neutral	33	43.4	49.3	77.6
	Disagree	14	18.4	20.9	98.5
	4	1	1.3	1.5	100.0
	Total	67	88.2	100.0	
Missing	System	9	11.8		
Total		76	100.0		

Where applicable, the supplier understood the requirements of RD0034

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	20	26.3	29.4	29.4
	Neutral	31	40.8	45.6	75.0
	Disagree	16	21.1	23.5	98.5
	4	1	1.3	1.5	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

Supplier Development and Localisation (SD&L) aided project quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	14	18.4	20.6	20.6
	Neutral	40	52.6	58.8	79.4
	Disagree	14	18.4	20.6	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

Supplier evaluation criteria was based on project quality requirements

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	43	56.6	62.3	62.3
	Neutral	21	27.6	30.4	92.8
	Disagree	5	6.6	7.2	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

The supplier interpreted project quality requirements correctly

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	39	51.3	56.5	56.5
	Neutral	22	28.9	31.9	88.4
	Disagree	8	10.5	11.6	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

The following was enforced to ensure that a quality project was implemented: The supplier's quality documents were reviewed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	49	64.5	71.0	71.0
	Neutral	16	21.1	23.2	94.2
	Disagree	4	5.3	5.8	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

The following was enforced to ensure that a quality project was implemented: the supplier's procedures were read

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	44	57.9	63.8	63.8
	Neutral	20	26.3	29.0	92.8
	Disagree	5	6.6	7.2	100.0
	Total	69	90.8	100.0	
Missing	System	7	9.2		
Total		76	100.0		

The following was enforced to ensure that a quality project was implemented: supplier's entire quality program was surveyed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	35	46.1	51.5	51.5
	Neutral	24	31.6	35.3	86.8
	Disagree	9	11.8	13.2	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

The supplier's personnel list was observed to see check who will monitor the quality of workmanship at each level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	37	48.7	54.4	54.4
	Neutral	22	28.9	32.4	86.8
	Disagree	9	11.8	13.2	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

Contractor performance (periodic inspection) was constantly monitored to ensure that they continue to perform satisfactorily

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	41	53.9	60.3	60.3
	Neutral	18	23.7	26.5	86.8
	Disagree	9	11.8	13.2	100.0
	Total	68	89.5	100.0	
Missing	System	8	10.5		
Total		76	100.0		

The project team demonstrated sufficient knowledge and experience to guide contractors on project quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	50	65.8	65.8	65.8
	Neutral	17	22.4	22.4	88.2
	Disagree	9	11.8	11.8	100.0
	Total	76	100.0	100.0	

Compliance to project quality was visible during execution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	49	64.5	66.2	66.2
	Neutral	15	19.7	20.3	86.5
	Disagree	10	13.2	13.5	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

Compliance was ensured by using the following: hold/witness points

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	60	78.9	81.1	81.1
	Neutral	14	18.4	18.9	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

Compliance was ensured by using the following: status indicators

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	43	56.6	58.9	58.9
	Neutral	25	32.9	34.2	93.2
	Disagree	5	6.6	6.8	100.0
	Total	73	96.1	100.0	
Missing	System	3	3.9		
Total		76	100.0		

Compliance was ensured by using the following: third party inspections

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	47	61.8	63.5	63.5
	Neutral	25	32.9	33.8	97.3
	Disagree	2	2.6	2.7	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

The project was audited at various phases before approval to the next phase

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	43	56.6	56.6	56.6
	Neutral	20	26.3	26.3	82.9
	Disagree	13	17.1	17.1	100.0
	Total	76	100.0	100.0	

Where there were deviations, non-conformances were raised (reported)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	50	65.8	66.7	66.7
	Neutral	20	26.3	26.7	93.3
	Disagree	5	6.6	6.7	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Where there were deviations, non-conformances were issued (recorded)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	48	63.2	64.0	64.0
	Neutral	22	28.9	29.3	93.3
	Disagree	5	6.6	6.7	100.0
	Total	75	98.7	100.0	
Missing	System	1	1.3		
Total		76	100.0		

Where there were deviations, non-conformances were resolved (followed up)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	44	57.9	59.5	59.5
	Neutral	23	30.3	31.1	90.5
	Disagree	7	9.2	9.5	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

It was ensured that documentary evidence of conformance is available before items and processes were installed or used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	46	60.5	62.2	62.2
	Neutral	19	25.0	25.7	87.8
	Disagree	9	11.8	12.2	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

The plant was in a better/healthier state once the modification was done /handed over to the client

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	45	59.2	61.6	61.6
	Neutral	23	30.3	31.5	93.2
	Disagree	5	6.6	6.8	100.0
	Total	73	96.1	100.0	
Missing	System	3	3.9		
Total		76	100.0		

The project was closed on time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	2	2.6	12.5	12.5
	Neutral	9	11.8	56.3	68.8
	Disagree	5	6.6	31.3	100.0
	Total	16	21.1	100.0	
Missing	System	60	78.9		
Total		76	100.0		

FRA closure was done as per the required timelines

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	13	17.1	17.8	17.8
	Neutral	31	40.8	42.5	60.3
	Disagree	29	38.2	39.7	100.0
	Total	73	96.1	100.0	
Missing	System	3	3.9		
Total		76	100.0		

QADP closure was done as per the required timelines

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	12	15.8	16.4	16.4
	Neutral	36	47.4	49.3	65.8
	Disagree	25	32.9	34.2	100.0
	Total	73	96.1	100.0	
Missing	System	3	3.9		
Total		76	100.0		

An effectiveness review was done as per the required timelines

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	15	19.7	20.8	20.8
	Neutral	32	42.1	44.4	65.3
	Disagree	25	32.9	34.7	100.0
	Total	72	94.7	100.0	
Missing	System	4	5.3		
Total		76	100.0		

The project handover certificate was signed off immediately following completion of the project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	25	32.9	33.8	33.8
	Neutral	31	40.8	41.9	75.7
	Disagree	18	23.7	24.3	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

The project was completed in time and within budget but lacked the quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	11	14.5	15.1	15.1
	Neutral	33	43.4	45.2	60.3
	Disagree	29	38.2	39.7	100.0
	Total	73	96.1	100.0	
Missing	System	3	3.9		
Total		76	100.0		

The project team wrote a wash-up report that recorded lessons that were learnt and distributed throughout the organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	27	35.5	36.5	36.5
	Neutral	30	39.5	40.5	77.0
	Disagree	17	22.4	23.0	100.0
	Total	74	97.4	100.0	
Missing	System	2	2.6		
Total		76	100.0		

Appendix G: Descriptive Statistics

Table 4.3: Descriptive statistics – Minimum, Maximum, Mean, Median, Standard Deviation and Standard Error of Deviation

	N	Minimum	Maximum	Mean	Median	Standard Deviation	Standard Error of Mean
Customer requirements were clear.	79	Strongly Agree	Strongly disagree	2.48	2.00	.918	.103
Senior management demonstrated commitment to project quality.	79	Strongly Agree	Strongly disagree	2.38	2.00	.938	.106
Stakeholders were constantly involved throughout the project lifecycle.	78	Strongly Agree	Strongly disagree	2.81	3.00	.954	.108
The NNR was engaged in time, where applicable.	74	Strongly Agree	Strongly disagree	2.45	2.00	.862	.100
The project manager was knowledgeable about the plant.	79	Strongly Agree	Disagree	2.29	2.00	.819	.092
The project team demonstrated commitment to achieve project quality.	80	Strongly Agree	Disagree	2.28	2.00	.795	.089
Accountability was promoted by setting high expectations for project quality performance.	80	Strongly Agree	Disagree	2.54	2.00	.856	.096
Project status was reported on a regular basis, hence project quality issues were identified upfront.	79	Strongly Agree	Disagree	2.48	2.00	.918	.103
Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests.	79	Strongly Agree	Disagree	2.48	2.00	.875	.098

The project schedule was adhered to throughout the project lifecycle.	78	Strongly Agree	Strongly disagree	3.08	3.00	1.066	.121
The client was happy and accepted the project that you delivered.	78	Strongly Agree	Disagree	2.50	2.00	.769	.087
The project was planned to a level of detail that ensured efficient implementation of project quality.	80	Strongly Agree	Strongly disagree	2.38	2.00	.802	.090
Processes and procedures were conveniently available.	80	Strongly Agree	Disagree	2.29	2.00	.799	.089
Processes and procedures were rigorously applied at all levels of the project.	80	Strongly Agree	Strongly disagree	2.51	2.50	.871	.097
Processes and procedures were cumbersome and hindered progress.	80	Strongly Agree	Strongly disagree	2.73	3.00	.954	.107
Configuration management was rigorously applied.	80	Strongly Agree	Disagree	2.53	2.00	.871	.097
All relevant documentation that was affected by the modification accurately reflected the modified plant configuration.	79	Strongly Agree	Disagree	2.47	2.00	.875	.098
Documents were updated as soon as practicable.	79	Strongly Agree	Strongly disagree	2.80	3.00	.939	.106
When the project/modification was identified, its compatibility with the design intent was assessed.	74	Strongly Agree	Disagree	2.08	2.00	.678	.079
Where applicable, benchmarking was performed to ensure that engineering standards and practices did not lag behind.	74	Strongly Agree	Strongly disagree	2.32	2.00	.967	.112
Design specifications were prepared.	73	Strongly Agree	Neutral	1.92	2.00	.595	.070
Design specifications were prepared by independent reviewers.	74	Strongly Agree	Disagree	1.99	2.00	.749	.087
Design specifications were approved.	73	Strongly Agree	Disagree	1.89	2.00	.657	.077

Design specifications were issued to suppliers.	73	Strongly Agree	Disagree	2.00	2.00	.687	.080
Design specifications were authorised.	72	Strongly Agree	Disagree	1.93	2.00	.678	.080
Design specifications were revised.	72	Strongly Agree	Disagree	2.15	2.00	.725	.085
Design specifications were validated as required (before implementing the design).	73	Strongly Agree	Disagree	2.08	2.00	.702	.082
The modification was performed in accordance with established procedures, whilst taking project quality into account.	72	Strongly Agree	Disagree	2.13	2.00	.711	.084
Production priorities took preference over project quality in your project.	73	Strongly Agree	Strongly disagree	3.00	3.00	1.054	.123
When the modification was tested, it demonstrated that the design intent was met before being placed in service.	72	Strongly Agree	Disagree	2.36	2.00	.844	.100
Where applicable, NNR was involved in the supplier qualification process.	71	Strongly Agree	Strongly disagree	2.89	3.00	.934	.111
Where applicable, the supplier understood the requirements of RD0034	72	Strongly Agree	Strongly disagree	2.94	3.00	.820	.097
Supplier Development and Localisation (SD&L) aided project quality.	72	Strongly Agree	Strongly disagree	2.94	3.00	.767	.090
Supplier evaluation criteria were based on project quality requirements.	73	Strongly Agree	Disagree	2.33	2.00	.800	.094
The supplier interpreted project quality requirements correctly.	73	Strongly Agree	Disagree	2.45	2.00	.765	.089
The following was enforced to ensure that a quality project was implemented: the supplier's quality documents were reviewed.	73	Strongly Agree	Strongly disagree	2.23	2.00	.755	.088
The following was enforced to ensure that a quality project was implemented: the supplier's procedures were read.	73	Strongly Agree	Strongly disagree	2.30	2.00	.811	.095

The following was enforced to ensure that a quality project was implemented: the supplier's entire quality program was surveyed.	72	Strongly Agree	Strongly disagree	2.50	2.00	.872	.103
The supplier's personnel list was observed to check who will monitor the quality of workmanship at each level.	72	Strongly Agree	Strongly disagree	2.56	2.00	.820	.097
Contractor performance (periodic inspection) was constantly monitored to ensure that they continue to perform satisfactorily.	72	Strongly Agree	Strongly disagree	2.47	2.00	.903	.106
The project team demonstrated sufficient knowledge and experience to guide contractors on project quality.	80	Strongly Agree	Disagree	2.34	2.00	.856	.096
Compliance to project quality was visible during execution.	78	Strongly Agree	Disagree	2.41	2.00	.813	.092
Compliance was ensured by using the following: hold/witness points.	78	Strongly Agree	Neutral	1.92	2.00	.660	.075
Compliance was ensured by using the following: status indicators.	76	Strongly Agree	Disagree	2.36	2.00	.828	.095
Compliance was ensured by using the following: third party inspections.	78	Strongly Agree	Disagree	2.18	2.00	.769	.087
The project was audited at various phases before approval to next phase.	80	Strongly Agree	Strongly disagree	2.60	2.00	.989	.111
Where there were deviations, non-conformances were raised (reported).	79	Strongly Agree	Strongly disagree	2.27	2.00	.887	.100
Where there were deviations, non-conformances were issued (recorded).	79	Strongly Agree	Strongly disagree	2.28	2.00	.846	.095
Where there were deviations, non-conformances were resolved (followed up).	79	Strongly Agree	Strongly disagree	2.39	2.00	.912	.103
It was ensured that documentary evidence of conformance is available before items and processes were installed or used.	78	Strongly Agree	Strongly disagree	2.40	2.00	.888	.101
The plant was in a better/healthier state once the modification was done /handed over to the client.	77	Strongly Agree	Strongly disagree	2.29	2.00	.841	.096

The project was closed on time.	37	Strongly Agree	Strongly disagree	3.08	3.00	.983	.162
FRA closure was done as per the required timelines.	76	Strongly Agree	Strongly disagree	3.33	3.00	.929	.107
QADP closure was done as per the required timelines.	76	Strongly Agree	Strongly disagree	3.26	3.00	.900	.103
An effectiveness review was done as per the required timelines	76	Strongly Agree	Strongly disagree	3.25	3.00	.926	.106
The project handover certificate was signed off immediately following completion of the project.	77	Strongly Agree	Strongly disagree	2.84	3.00	1.027	.117
The project was completed in time and within budget but lacked the quality.	76	Strongly Agree	Strongly disagree	3.28	3.00	.858	.098
The project team wrote a wash-up report that recorded lessons that were learnt and distributed throughout the organisation.	74	Strongly Agree	Strongly disagree	2.84	3.00	.980	.114

Appendix H: Descriptive Statistics

Table 4.4: Descriptive statistics - Stakeholder status cross-tabulation

Customer requirements were clear * Stakeholder Status

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Customer requirements were clear	Agree	Count	2	20	6	1	1	11	2	43
		% within Stakeholder Status	50.0%	66.7%	75.0%	25.0%	20.0%	64.7%	50.0 %	59.7%
	Neutral	Count	1	5	1	1	2	4	2	16
		% within Stakeholder Status	25.0%	16.7%	12.5%	25.0%	40.0%	23.5%	50.0 %	22.2%
	Disagree	Count	1	5	1	2	2	2	0	13
		% within Stakeholder Status	25.0%	16.7%	12.5%	50.0%	40.0%	11.8%	0.0%	18.1%
Total		Count	4	30	8	4	5	17	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Senior management demonstrated a commitment to project quality * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Senior management demonstrated commitment to project quality	Agree	Count	2	21	7	4	2	9	1	46
		% within Stakeholder Status	50.0%	70.0%	87.5%	100.0%	40.0%	52.9%	25.0 %	63.9%
	Neutral	Count	1	6	1	0	2	4	2	16
		% within Stakeholder Status	25.0%	20.0%	12.5%	0.0%	40.0%	23.5%	50.0 %	22.2%
	Disagree	Count	1	3	0	0	1	4	1	10
		% within Stakeholder Status	25.0%	10.0%	0.0%	0.0%	20.0%	23.5%	25.0 %	13.9%
Total		Count	4	30	8	4	5	17	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Stakeholders were constantly involved throughout the project lifecycle * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Stakeholders were constantly involved throughout the project lifecycle	Agree	Count	1	14	6	1	2	5	0	29
		% within Stakeholder Status	25.0%	48.3%	75.0%	25.0%	40.0%	29.4%	0.0%	40.8%
	Neutral	Count	0	7	1	0	1	8	3	20
		% within Stakeholder Status	0.0%	24.1%	12.5%	0.0%	20.0%	47.1%	75.0 %	28.2%
	Disagree	Count	3	8	1	3	2	4	1	22
		% within Stakeholder Status	75.0%	27.6%	12.5%	75.0%	40.0%	23.5%	25.0 %	31.0%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The NNR was engaged in time, where applicable * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The NNR was engaged in time, where applicable	Agree	Count	2	16	5	3	2	9	2	39
		% within Stakeholder Status	66.7%	59.3%	62.5%	75.0%	40.0%	52.9%	50.0 %	57.4%
	Neutral	Count	1	8	0	1	2	8	1	21
		% within Stakeholder Status	33.3%	29.6%	0.0%	25.0%	40.0%	47.1%	25.0 %	30.9%
	Disagree	Count	0	3	3	0	1	0	1	8
		% within Stakeholder Status	0.0%	11.1%	37.5%	0.0%	20.0%	0.0%	25.0 %	11.8%
Total		Count	3	27	8	4	5	17	4	68
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project manager was knowledgeable about the plant * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project manager was knowledgeable about the plant	Agree	Count	2	21	7	1	3	13	0	47
		% within Stakeholder Status	50.0%	70.0%	87.5%	25.0%	60.0%	72.2%	0.0%	64.4%
	Neutral	Count	2	6	1	2	2	1	4	18
		% within Stakeholder Status	50.0%	20.0%	12.5%	50.0%	40.0%	5.6%	100.0 %	24.7%
	Disagree	Count	0	3	0	1	0	4	0	8
		% within Stakeholder Status	0.0%	10.0%	0.0%	25.0%	0.0%	22.2%	0.0%	11.0%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project team demonstrated a commitment to achieve project quality * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project team demonstrated commitment to achieve project quality	Agree	Count	2	20	8	3	2	12	1	48
		% within Stakeholder Status	50.0%	69.0%	100.0%	75.0%	40.0%	66.7%	25.0 %	66.7%
	Neutral	Count	2	5	0	1	2	5	3	18
		% within Stakeholder Status	50.0%	17.2%	0.0%	25.0%	40.0%	27.8%	75.0 %	25.0%
	Disagree	Count	0	4	0	0	1	1	0	6
		% within Stakeholder Status	0.0%	13.8%	0.0%	0.0%	20.0%	5.6%	0.0%	8.3%
Total		Count	4	29	8	4	5	18	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Accountability was promoted by setting high expectations for project quality performance * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Accountability was promoted by setting high expectations for project quality performance	Agree	Count	0	24	8	1	1	5	0	39
		% within Stakeholder Status	0.0%	80.0%	100.0%	25.0%	20.0%	27.8%	0.0%	53.4%
	Neutral	Count	3	2	0	1	2	11	3	22
		% within Stakeholder Status	75.0%	6.7%	0.0%	25.0%	40.0%	61.1%	75.0 %	30.1%
	Disagree	Count	1	4	0	2	2	2	1	12
		% within Stakeholder Status	25.0%	13.3%	0.0%	50.0%	40.0%	11.1%	25.0 %	16.4%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Project status was reported on a regular basis so that project quality issues were identified upfront * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Project status was reported on a regular basis so project quality issues were identified upfront	Agree	Count	1	20	5	0	2	10	0	38
		% within Stakeholder Status	25.0%	66.7%	62.5%	0.0%	40.0%	58.8%	0.0%	52.8%
	Neutral	Count	1	6	3	2	1	5	3	21
		% within Stakeholder Status	25.0%	20.0%	37.5%	50.0%	20.0%	29.4%	75.0 %	29.2%
	Disagree	Count	2	4	0	2	2	2	1	13
		% within Stakeholder Status	50.0%	13.3%	0.0%	50.0%	40.0%	11.8%	25.0 %	18.1%
Total		Count	4	30	8	4	5	17	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests	Agree	Count	1	21	7	3	0	9	1	42
		% within Stakeholder Status	25.0%	70.0%	87.5%	75.0%	0.0%	52.9%	25.0 %	58.3%
	Neutral	Count	3	6	1	0	4	3	2	19
		% within Stakeholder Status	75.0%	20.0%	12.5%	0.0%	80.0%	17.6%	50.0 %	26.4%
	Disagree	Count	0	3	0	1	1	5	1	11
		% within Stakeholder Status	0.0%	10.0%	0.0%	25.0%	20.0%	29.4%	25.0 %	15.3%
Total		Count	4	30	8	4	5	17	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project schedule was adhered to throughout the project lifecycle * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project schedule was adhered to throughout the project lifecycle	Agree	Count	0	13	3	1	0	9	0	26
		% within Stakeholder Status	0.0%	43.3%	37.5%	25.0%	0.0%	56.3%	0.0%	36.6%
	Neutral	Count	0	3	1	1	1	3	3	12
		% within Stakeholder Status	0.0%	10.0%	12.5%	25.0%	20.0%	18.8%	75.0 %	16.9%
	Disagree	Count	4	13	4	2	4	4	1	32
		% within Stakeholder Status	100.0%	43.3%	50.0%	50.0%	80.0%	25.0%	25.0 %	45.1%
	4	Count	0	1	0	0	0	0	0	1
		% within Stakeholder Status	0.0%	3.3%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
Total		Count	4	30	8	4	5	16	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The client was happy and accepted the project that you delivered * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The client was happy and accepted the project that you delivered	Agree	Count	2	18	3	2	1	7	0	33
		% within Stakeholder Status	50.0%	62.1%	37.5%	50.0%	20.0%	41.2%	0.0%	46.5%
	Neutral	Count	1	8	4	1	4	10	3	31
		% within Stakeholder Status	25.0%	27.6%	50.0%	25.0%	80.0%	58.8%	75.0 %	43.7%
	Disagree	Count	1	3	1	1	0	0	1	7
		% within Stakeholder Status	25.0%	10.3%	12.5%	25.0%	0.0%	0.0%	25.0 %	9.9%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project was planned to a level of detail that ensured efficient implementation of project quality * Stakeholder Status

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project was planned to the level of detail that ensured efficient implementation of project quality	Agree	Count	2	25	8	2	3	8	2	50
		% within Stakeholder Status	50.0%	83.3%	100.0%	50.0%	60.0%	44.4%	50.0 %	68.5%
	Neutral	Count	1	4	0	1	0	9	1	16
		% within Stakeholder Status	25.0%	13.3%	0.0%	25.0%	0.0%	50.0%	25.0 %	21.9%
	Disagree	Count	1	1	0	1	2	1	1	7
		% within Stakeholder Status	25.0%	3.3%	0.0%	25.0%	40.0%	5.6%	25.0 %	9.6%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Processes and procedures were conveniently available * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Processes and procedures were conveniently available	Agree	Count	4	23	5	4	3	10	3	52
		% within Stakeholder Status	100.0%	76.7%	62.5%	100.0%	60.0%	55.6%	75.0 %	71.2%
	Neutral	Count	0	4	2	0	2	5	0	13
		% within Stakeholder Status	0.0%	13.3%	25.0%	0.0%	40.0%	27.8%	0.0%	17.8%
	Disagree	Count	0	3	1	0	0	3	1	8
		% within Stakeholder Status	0.0%	10.0%	12.5%	0.0%	0.0%	16.7%	25.0 %	11.0%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Processes and procedures were rigorously applied at all levels of the project * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Processes and procedures were rigorously applied at all levels of the project	Agree	Count	2	17	7	3	1	4	1	35
		% within Stakeholder Status	50.0%	56.7%	87.5%	75.0%	20.0%	22.2%	25.0 %	47.9%
	Neutral	Count	2	11	1	0	4	11	2	31
		% within Stakeholder Status	50.0%	36.7%	12.5%	0.0%	80.0%	61.1%	50.0 %	42.5%
	Disagree	Count	0	2	0	1	0	3	1	7
		% within Stakeholder Status	0.0%	6.7%	0.0%	25.0%	0.0%	16.7%	25.0 %	9.6%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Processes and procedures were cumbersome and hindered progress * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Processes and procedures were cumbersome and hindered progress	Agree	Count	1	13	6	1	2	5	2	30
		% within Stakeholder Status	25.0%	43.3%	75.0%	25.0%	40.0%	27.8%	50.0 %	41.1%
	Neutral	Count	2	10	2	1	1	9	2	27
		% within Stakeholder Status	50.0%	33.3%	25.0%	25.0%	20.0%	50.0%	50.0 %	37.0%
	Disagree	Count	1	7	0	2	2	4	0	16
		% within Stakeholder Status	25.0%	23.3%	0.0%	50.0%	40.0%	22.2%	0.0%	21.9%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Configuration management was rigorously applied * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Configuration management was rigorously applied	Agree	Count	0	24	5	4	1	6	1	41
		% within Stakeholder Status	0.0%	80.0%	62.5%	100.0%	20.0%	33.3%	25.0 %	56.2%
	Neutral	Count	2	3	2	0	2	10	2	21
		% within Stakeholder Status	50.0%	10.0%	25.0%	0.0%	40.0%	55.6%	50.0 %	28.8%
	Disagree	Count	2	3	1	0	2	2	1	11
		% within Stakeholder Status	50.0%	10.0%	12.5%	0.0%	40.0%	11.1%	25.0 %	15.1%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

All relevant documentation that was affected by the modification accurately reflected the modified plant configuration * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
All relevant documentation that was affected by the modification accurately reflected the modified plant configuration	Agree	Count	2	25	3	4	1	4	2	41
		% within Stakeholder Status	50.0%	83.3%	37.5%	100.0%	20.0%	23.5%	50.0 %	56.9%
	Neutral	Count	2	2	5	0	2	10	1	22
		% within Stakeholder Status	50.0%	6.7%	62.5%	0.0%	40.0%	58.8%	25.0 %	30.6%
	Disagree	Count	0	3	0	0	2	3	1	9
		% within Stakeholder Status	0.0%	10.0%	0.0%	0.0%	40.0%	17.6%	25.0 %	12.5%
Total		Count	4	30	8	4	5	17	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Documents were updated as soon as practicable * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Documents were updated as soon as practicable	Agree	Count	2	20	2	2	0	4	2	32
		% within Stakeholder Status	50.0%	66.7%	25.0%	50.0%	0.0%	23.5%	50.0 %	44.4%
	Neutral	Count	0	4	5	1	2	7	1	20
		% within Stakeholder Status	0.0%	13.3%	62.5%	25.0%	40.0%	41.2%	25.0 %	27.8%
	Disagree	Count	2	6	1	1	3	6	1	20
		% within Stakeholder Status	50.0%	20.0%	12.5%	25.0%	60.0%	35.3%	25.0 %	27.8%
Total		Count	4	30	8	4	5	17	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

When the project/ modification was identified, its compatibility with the design intent was assessed * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
When the project/ modification was identified, its compatibility with the design intent was assessed	Agree	Count	4	26	8	3	2	8	0	51
		% within Stakeholder Status	100.0%	86.7%	100.0%	75.0%	40.0%	61.5%	0.0%	75.0%
	Neutral	Count	0	4	0	1	3	5	3	16
		% within Stakeholder Status	0.0%	13.3%	0.0%	25.0%	60.0%	38.5%	75.0 %	23.5%
	Disagree	Count	0	0	0	0	0	0	1	1
		% within Stakeholder Status	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0 %	1.5%
Total		Count	4	30	8	4	5	13	4	68
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Where applicable, benchmarking was performed to ensure that engineering standards and practices did not lag behind * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Where applicable, benchmarking was performed to ensure that engineering standards and practices were not lagging behind	Agree	Count	1	17	8	4	1	4	1	36
		% within Stakeholder Status	25.0%	56.7%	100.0%	100.0%	20.0%	30.8%	25.0 %	52.9%
	Neutral	Count	2	9	0	0	3	8	2	24
		% within Stakeholder Status	50.0%	30.0%	0.0%	0.0%	60.0%	61.5%	50.0 %	35.3%
	Disagree	Count	1	4	0	0	1	1	1	8
		% within Stakeholder Status	25.0%	13.3%	0.0%	0.0%	20.0%	7.7%	25.0 %	11.8%
Total		Count	4	30	8	4	5	13	4	68
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Prepared * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Prepared	Agree	Count	4	28	7	4	4	8	2	57
		% within Stakeholder Status	100.0%	96.6%	87.5%	100.0%	80.0%	61.5%	50.0 %	85.1%
	Neutral	Count	0	1	1	0	1	5	2	10
		% within Stakeholder Status	0.0%	3.4%	12.5%	0.0%	20.0%	38.5%	50.0 %	14.9%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Prepared by independent reviewers * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Prepared by independent reviewers	Agree	Count	4	27	7	4	3	8	2	55
		% within Stakeholder Status	100.0%	90.0%	87.5%	100.0%	60.0%	61.5%	50.0 %	80.9%
	Neutral	Count	0	1	1	0	2	5	2	11
		% within Stakeholder Status	0.0%	3.3%	12.5%	0.0%	40.0%	38.5%	50.0 %	16.2%
	Disagree	Count	0	2	0	0	0	0	0	2
		% within Stakeholder Status	0.0%	6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%
Total		Count	4	30	8	4	5	13	4	68
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Approved * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Approved	Agree	Count	4	27	7	4	4	8	2	56
		% within Stakeholder Status	100.0%	93.1%	87.5%	100.0%	80.0%	61.5%	50.0 %	83.6%
	Neutral	Count	0	1	1	0	1	5	2	10
		% within Stakeholder Status	0.0%	3.4%	12.5%	0.0%	20.0%	38.5%	50.0 %	14.9%
	Disagree	Count	0	1	0	0	0	0	0	1
		% within Stakeholder Status	0.0%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Issued to suppliers * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Issued suppliers	Agree	Count	4	27	5	2	3	8	2	51
		% within Stakeholder Status	100.0%	93.1%	62.5%	50.0%	60.0%	61.5%	50.0 %	76.1%
	Neutral	Count	0	2	3	1	2	5	2	15
		% within Stakeholder Status	0.0%	6.9%	37.5%	25.0%	40.0%	38.5%	50.0 %	22.4%
	Disagree	Count	0	0	0	1	0	0	0	1
		% within Stakeholder Status	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	0.0%	1.5%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Authorised * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Authorised	Agree	Count	4	27	7	3	3	8	2	54
		% within Stakeholder Status	100.0%	93.1%	87.5%	75.0%	60.0%	61.5%	50.0 %	80.6%
	Neutral	Count	0	1	1	1	2	5	2	12
		% within Stakeholder Status	0.0%	3.4%	12.5%	25.0%	40.0%	38.5%	50.0 %	17.9%
	Disagree	Count	0	1	0	0	0	0	0	1
		% within Stakeholder Status	0.0%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Revised * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Revised	Agree	Count	2	25	6	2	3	8	2	48
		% within Stakeholder Status	50.0%	86.2%	75.0%	50.0%	60.0%	61.5%	50.0 %	71.6%
	Neutral	Count	1	2	2	2	2	5	2	16
		% within Stakeholder Status	25.0%	6.9%	25.0%	50.0%	40.0%	38.5%	50.0 %	23.9%
	Disagree	Count	1	2	0	0	0	0	0	3
		% within Stakeholder Status	25.0%	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%	4.5%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Design specifications were: Validated as required (before implementing the design) * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Design specifications were: Validated as required (before implementing the design)	Agree	Count	3	26	4	4	3	7	2	49
		% within Stakeholder Status	75.0%	89.7%	50.0%	100.0%	60.0%	53.8%	50.0 %	73.1%
	Neutral	Count	0	3	3	0	2	6	2	16
		% within Stakeholder Status	0.0%	10.3%	37.5%	0.0%	40.0%	46.2%	50.0 %	23.9%
	Disagree	Count	1	0	1	0	0	0	0	2
		% within Stakeholder Status	25.0%	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	3.0%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The modification was performed in accordance with established procedures, whilst taking project quality into account * Stakeholder

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The modification was performed in accordance with established procedures, whilst taking project quality into account	Agree	Count	2	27	6	4	3	3	2	47
		% within Stakeholder Status	50.0%	93.1%	75.0%	100.0%	60.0%	25.0%	50.0 %	71.2%
	Neutral	Count	2	2	2	0	2	7	2	17
		% within Stakeholder Status	50.0%	6.9%	25.0%	0.0%	40.0%	58.3%	50.0 %	25.8%
	Disagree	Count	0	0	0	0	0	2	0	2
		% within Stakeholder Status	0.0%	0.0%	0.0%	0.0%	0.0%	16.7%	0.0%	3.0%
Total		Count	4	29	8	4	5	12	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Production priorities took preference over project quality in your project * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Production priorities took preference over project quality in your project	Agree	Count	1	11	3	0	3	6	1	25
		% within Stakeholder Status	25.0%	36.7%	37.5%	0.0%	60.0%	50.0%	25.0 %	37.3%
	Neutral	Count	2	0	2	0	1	6	2	13
		% within Stakeholder Status	50.0%	0.0%	25.0%	0.0%	20.0%	50.0%	50.0 %	19.4%
	Disagree	Count	1	18	3	4	1	0	1	28
		% within Stakeholder Status	25.0%	60.0%	37.5%	100.0%	20.0%	0.0%	25.0 %	41.8%
Total		Count	4	30	8	4	5	12	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

When the modification was tested, it demonstrated that the design intent was met before it was placed in service * Stakeholder Status

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
When the modification was tested, it demonstrated that the design intent was met before it was placed in service	Agree	Count	2	23	4	2	2	2	2	37
		% within Stakeholder Status	50.0%	79.3%	50.0%	50.0%	40.0%	16.7%	50.0 %	56.1%
	Neutral	Count	1	4	3	2	3	8	1	22
		% within Stakeholder Status	25.0%	13.8%	37.5%	50.0%	60.0%	66.7%	25.0 %	33.3%
	Disagree	Count	1	2	1	0	0	2	1	7
		% within Stakeholder Status	25.0%	6.9%	12.5%	0.0%	0.0%	16.7%	25.0 %	10.6%
Total		Count	4	29	8	4	5	12	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Where applicable, NNR was involved in the supplier qualification process * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Where applicable, NNR was involved in the supplier qualification process	Agree	Count	0	6	5	2	2	1	2	18
		% within Stakeholder Status	0.0%	22.2%	62.5%	50.0%	40.0%	7.7%	50.0 %	27.7%
	Neutral	Count	1	11	3	2	2	11	2	32
		% within Stakeholder Status	25.0%	40.7%	37.5%	50.0%	40.0%	84.6%	50.0 %	49.2%
	Disagree	Count	3	9	0	0	1	1	0	14
		% within Stakeholder Status	75.0%	33.3%	0.0%	0.0%	20.0%	7.7%	0.0%	21.5%
Total		Count	4	27	8	4	5	13	4	65
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Where applicable, the supplier understood the requirements of RD0034 * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Where applicable, the supplier understood the requirements of RD0034	Agree	Count	0	8	2	1	2	4	1	18
		% within Stakeholder Status	0.0%	28.6%	25.0%	25.0%	40.0%	30.8%	25.0 %	27.3%
	Neutral	Count	1	14	5	2	2	5	2	31
		% within Stakeholder Status	25.0%	50.0%	62.5%	50.0%	40.0%	38.5%	50.0 %	47.0%
	Disagree	Count	3	5	1	1	1	4	1	16
		% within Stakeholder Status	75.0%	17.9%	12.5%	25.0%	20.0%	30.8%	25.0 %	24.2%
Total		Count	4	28	8	4	5	13	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Supplier Development and Localisation (SD&L) aided project quality * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Supplier Development and Localisation (SD&L) aided project quality	Agree	Count	0	8	2	0	1	1	1	13
		% within Stakeholder Status	0.0%	28.6%	25.0%	0.0%	20.0%	7.7%	25.0 %	19.7%
	Neutral	Count	3	13	4	4	4	9	2	39
		% within Stakeholder Status	75.0%	46.4%	50.0%	100.0%	80.0%	69.2%	50.0 %	59.1%
	Disagree	Count	1	7	2	0	0	3	1	14
		% within Stakeholder Status	25.0%	25.0%	25.0%	0.0%	0.0%	23.1%	25.0 %	21.2%
Total		Count	4	28	8	4	5	13	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Supplier evaluation criteria was based on project quality requirements * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Supplier evaluation criteria was based on project quality requirements	Agree	Count	0	25	6	0	0	9	1	41
		% within Stakeholder Status	0.0%	86.2%	75.0%	0.0%	0.0%	69.2%	25.0 %	61.2%
	Neutral	Count	2	4	2	3	4	3	3	21
		% within Stakeholder Status	50.0%	13.8%	25.0%	75.0%	80.0%	23.1%	75.0 %	31.3%
	Disagree	Count	2	0	0	1	1	1	0	5
		% within Stakeholder Status	50.0%	0.0%	0.0%	25.0%	20.0%	7.7%	0.0%	7.5%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The supplier interpreted project quality requirements correctly * Stakeholder Status Cross abulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The supplier interpreted project quality requirements correctly	Agree	Count	1	23	4	2	1	5	1	37
		% within Stakeholder Status	25.0%	79.3%	50.0%	50.0%	20.0%	38.5%	25.0 %	55.2%
	Neutral	Count	1	5	3	1	4	6	2	22
		% within Stakeholder Status	25.0%	17.2%	37.5%	25.0%	80.0%	46.2%	50.0 %	32.8%
	Disagree	Count	2	1	1	1	0	2	1	8
		% within Stakeholder Status	50.0%	3.4%	12.5%	25.0%	0.0%	15.4%	25.0 %	11.9%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The following was enforced to ensure that a quality project was implemented: The supplier's quality documents were reviewed * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The following was enforced to ensure that a quality project was implemented: The supplier's quality documents were reviewed	Agree	Count	3	25	7	0	3	7	2	47
		% within Stakeholder Status	75.0%	86.2%	87.5%	0.0%	60.0%	53.8%	50.0 %	70.1%
	Neutral	Count	0	3	1	3	2	5	2	16
		% within Stakeholder Status	0.0%	10.3%	12.5%	75.0%	40.0%	38.5%	50.0 %	23.9%
	Disagree	Count	1	1	0	1	0	1	0	4
		% within Stakeholder Status	25.0%	3.4%	0.0%	25.0%	0.0%	7.7%	0.0%	6.0%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The following was enforced to ensure that a quality project was implemented: The supplier's procedures were read * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The following was enforced to ensure that a quality project was implemented: The supplier's procedures were read	Agree	Count	2	21	7	1	3	6	2	42
		% within Stakeholder Status	50.0%	72.4%	87.5%	25.0%	60.0%	46.2%	50.0%	62.7%
	Neutral	Count	0	6	1	3	2	6	2	20
		% within Stakeholder Status	0.0%	20.7%	12.5%	75.0%	40.0%	46.2%	50.0%	29.9%
	Disagree	Count	2	2	0	0	0	1	0	5
		% within Stakeholder Status	50.0%	6.9%	0.0%	0.0%	0.0%	7.7%	0.0%	7.5%
Total		Count	4	29	8	4	5	13	4	67
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The following was enforced to ensure that a quality project was implemented: The supplier's entire quality program was surveyed * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The following was enforced to ensure a quality project was implemented: The supplier's entire quality program was surveyed	Agree	Count	2	17	6	0	3	3	2	33
		% within Stakeholder Status	50.0%	58.6%	75.0%	0.0%	60.0%	25.0%	50.0%	50.0%
	Neutral	Count	0	9	2	3	1	8	1	24
		% within Stakeholder Status	0.0%	31.0%	25.0%	75.0%	20.0%	66.7%	25.0%	36.4%
	Disagree	Count	2	3	0	1	1	1	1	9
		% within Stakeholder Status	50.0%	10.3%	0.0%	25.0%	20.0%	8.3%	25.0%	13.6%
Total		Count	4	29	8	4	5	12	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The supplier's personnel list was observed to check who will monitor the quality of workmanship at each level * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The supplier's personnel list was observed to see exactly who will actually be policing the quality of workmanship at each level	Agree	Count	1	21	6	0	3	3	1	35
		% within Stakeholder Status	25.0%	72.4%	75.0%	0.0%	60.0%	25.0%	25.0%	53.0%
	Neutral	Count	0	7	1	3	1	8	2	22
		% within Stakeholder Status	0.0%	24.1%	12.5%	75.0%	20.0%	66.7%	50.0%	33.3%
	Disagree	Count	3	1	1	1	1	1	1	9
		% within Stakeholder Status	75.0%	3.4%	12.5%	25.0%	20.0%	8.3%	25.0%	13.6%
Total		Count	4	29	8	4	5	12	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Contractor performance (periodic inspection) was constantly monitored to ensure that they continue to perform satisfactorily *

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Contractor performance (periodic inspection) was constantly monitored to confirm they continue to perform satisfactorily	Agree	Count	0	25	6	2	2	3	1	39
		% within Stakeholder Status	0.0%	86.2%	75.0%	50.0%	40.0%	25.0%	25.0 %	59.1%
	Neutral	Count	2	2	1	2	3	6	2	18
		% within Stakeholder Status	50.0%	6.9%	12.5%	50.0%	60.0%	50.0%	50.0 %	27.3%
	Disagree	Count	2	2	1	0	0	3	1	9
		% within Stakeholder Status	50.0%	6.9%	12.5%	0.0%	0.0%	25.0%	25.0 %	13.6%
Total		Count	4	29	8	4	5	12	4	66
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project team demonstrated sufficient knowledge and experience to guide contractors on project quality * Stakeholder Status

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project team demonstrated sufficient knowledge and experience to guide contractors on project quality	Agree	Count	2	24	8	3	2	8	1	48
		% within Stakeholder Status	50.0%	80.0%	100.0%	75.0%	40.0%	44.4%	25.0 %	65.8%
	Neutral	Count	1	4	0	1	1	8	2	17
		% within Stakeholder Status	25.0%	13.3%	0.0%	25.0%	20.0%	44.4%	50.0 %	23.3%
	Disagree	Count	1	2	0	0	2	2	1	8
		% within Stakeholder Status	25.0%	6.7%	0.0%	0.0%	40.0%	11.1%	25.0 %	11.0%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Compliance to project quality was visible during execution * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Compliance to project quality was visible during execution	Agree	Count	2	24	6	3	2	8	2	47
		% within Stakeholder Status	50.0%	82.8%	75.0%	75.0%	40.0%	47.1%	50.0 %	66.2%
	Neutral	Count	0	4	2	0	3	5	1	15
		% within Stakeholder Status	0.0%	13.8%	25.0%	0.0%	60.0%	29.4%	25.0 %	21.1%
	Disagree	Count	2	1	0	1	0	4	1	9
		% within Stakeholder Status	50.0%	3.4%	0.0%	25.0%	0.0%	23.5%	25.0 %	12.7%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Compliance was ensured by using the following: Hold/Witness points * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Compliance was ensured by using the following: Hold/Witness points	Agree	Count	3	26	5	3	4	14	2	57
		% within Stakeholder Status	75.0%	89.7%	62.5%	75.0%	80.0%	82.4%	50.0 %	80.3%
	Neutral	Count	1	3	3	1	1	3	2	14
		% within Stakeholder Status	25.0%	10.3%	37.5%	25.0%	20.0%	17.6%	50.0 %	19.7%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Compliance was ensured by using the following: status indicators * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Compliance was ensured by using the following: Status indicators and	Agree	Count	1	21	4	3	2	9	1	41
		% within Stakeholder Status	25.0%	72.4%	50.0%	75.0%	40.0%	56.3%	25.0 %	58.6%
	Neutral	Count	2	7	3	1	3	7	2	25
		% within Stakeholder Status	50.0%	24.1%	37.5%	25.0%	60.0%	43.8%	50.0 %	35.7%
	Disagree	Count	1	1	1	0	0	0	1	4
		% within Stakeholder Status	25.0%	3.4%	12.5%	0.0%	0.0%	0.0%	25.0 %	5.7%
Total		Count	4	29	8	4	5	16	4	70
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

Compliance was ensured by using the following: third party inspections * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Compliance was ensured by using the following: Third party inspections	Agree	Count	2	21	3	3	2	11	2	44
		% within Stakeholder Status	50.0%	72.4%	37.5%	75.0%	40.0%	64.7%	50.0 %	62.0%
	Neutral	Count	2	7	5	1	2	6	2	25
		% within Stakeholder Status	50.0%	24.1%	62.5%	25.0%	40.0%	35.3%	50.0 %	35.2%
	Disagree	Count	0	1	0	0	1	0	0	2
		% within Stakeholder Status	0.0%	3.4%	0.0%	0.0%	20.0%	0.0%	0.0%	2.8%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project was audited at various phases before approval to the next phase * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Project was audited at various phases before approval to the next phase	Agree	Count	0	19	7	2	3	8	2	41
		% within Stakeholder Status	0.0%	63.3%	87.5%	50.0%	60.0%	44.4%	50.0%	56.2%
	Neutral	Count	2	8	0	1	1	7	1	20
		% within Stakeholder Status	50.0%	26.7%	0.0%	25.0%	20.0%	38.9%	25.0%	27.4%
	Disagree	Count	2	3	1	1	1	3	1	12
		% within Stakeholder Status	50.0%	10.0%	12.5%	25.0%	20.0%	16.7%	25.0%	16.4%
Total		Count	4	30	8	4	5	18	4	73
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Where there were deviations, non-conformances were: Raised (reported) * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Where there were deviations, non-conformances were: Raised (reported)	Agree	Count	2	22	5	4	3	11	2	49
		% within Stakeholder Status	50.0%	75.9%	62.5%	100.0%	60.0%	61.1%	50.0%	68.1%
	Neutral	Count	2	6	3	0	0	6	2	19
		% within Stakeholder Status	50.0%	20.7%	37.5%	0.0%	0.0%	33.3%	50.0%	26.4%
	Disagree	Count	0	1	0	0	2	1	0	4
		% within Stakeholder Status	0.0%	3.4%	0.0%	0.0%	40.0%	5.6%	0.0%	5.6%
Total		Count	4	29	8	4	5	18	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Where there were deviations, non-conformances were: Issued (recorded) * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Where there were deviations, non-conformances were: Issued (recorded)	Agree	Count	3	21	5	4	3	9	2	47
		% within Stakeholder Status	75.0%	72.4%	62.5%	100.0%	60.0%	50.0%	50.0%	65.3%
	Neutral	Count	1	6	3	0	1	8	2	21
		% within Stakeholder Status	25.0%	20.7%	37.5%	0.0%	20.0%	44.4%	50.0%	29.2%
	Disagree	Count	0	2	0	0	1	1	0	4
		% within Stakeholder Status	0.0%	6.9%	0.0%	0.0%	20.0%	5.6%	0.0%	5.6%
Total		Count	4	29	8	4	5	18	4	72
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Where there were deviations, non-conformances were: Resolved (followed up) * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
Where there were deviations, non-conformances were: Resolved (followed up)	Agree	Count	2	21	5	4	3	7	1	43
		% within Stakeholder Status	50.0%	75.0%	62.5%	100.0%	60.0%	38.9%	25.0 %	60.6%
	Neutral	Count	1	6	3	0	1	9	2	22
		% within Stakeholder Status	25.0%	21.4%	37.5%	0.0%	20.0%	50.0%	50.0 %	31.0%
	Disagree	Count	1	1	0	0	1	2	1	6
		% within Stakeholder Status	25.0%	3.6%	0.0%	0.0%	20.0%	11.1%	25.0 %	8.5%
Total		Count	4	28	8	4	5	18	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

It was ensured that documentary evidence of conformance was available before items and processes were installed or used * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
It was ensured that documentary evidence of conformance was available before items and processes were installed or used	Agree	Count	2	22	5	3	2	8	3	45
		% within Stakeholder Status	50.0%	75.9%	62.5%	75.0%	40.0%	47.1%	75.0 %	63.4%
	Neutral	Count	0	5	2	1	1	8	1	18
		% within Stakeholder Status	0.0%	17.2%	25.0%	25.0%	20.0%	47.1%	25.0 %	25.4%
	Disagree	Count	2	2	1	0	2	1	0	8
		% within Stakeholder Status	50.0%	6.9%	12.5%	0.0%	40.0%	5.9%	0.0%	11.3%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The plant was in a better/healthier state once the modification was done/handed over to the client * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The plant was in a better/healthier state once the modification was don /handed over to the client	Agree	Count	1	23	5	4	0	9	2	44
		% within Stakeholder Status	25.0%	82.1%	62.5%	100.0%	0.0%	52.9%	50.0 %	62.9%
	Neutral	Count	2	4	3	0	3	8	1	21
		% within Stakeholder Status	50.0%	14.3%	37.5%	0.0%	60.0%	47.1%	25.0 %	30.0%
	Disagree	Count	1	1	0	0	2	0	1	5
		% within Stakeholder Status	25.0%	3.6%	0.0%	0.0%	40.0%	0.0%	25.0 %	7.1%
Total		Count	4	28	8	4	5	17	4	70
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project was closed on time * Stakeholder Status Cross tabulation

			Stakeholder Status					Total
			Project Manager	Project Engineer	Project Scheduler	Quality	Other	
The project was closed on time	Agree	Count	1	0	0	1	0	2
		% within Stakeholder Status	16.7%	0.0%	0.0%	16.7%	0.0%	12.5%
	Neutral	Count	2	1	0	5	1	9
		% within Stakeholder Status	33.3%	100.0%	0.0%	83.3%	50.0%	56.3%
	Disagree	Count	3	0	1	0	1	5
		% within Stakeholder Status	50.0%	0.0%	100.0%	0.0%	50.0%	31.3%
Total		Count	6	1	1	6	2	16
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

FRA closure was done as per the required timelines * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
FRA closure was done as per the required timelines	Agree	Count	0	6	0	0	1	4	1	12
		% within Stakeholder Status	0.0%	21.4%	0.0%	0.0%	20.0%	23.5%	25.0 %	17.1%
	Neutral	Count	0	7	5	3	1	11	2	29
		% within Stakeholder Status	0.0%	25.0%	62.5%	75.0%	20.0%	64.7%	50.0 %	41.4%
	Disagree	Count	4	15	3	1	3	2	1	29
		% within Stakeholder Status	100.0%	53.6%	37.5%	25.0%	60.0%	11.8%	25.0 %	41.4%
Total		Count	4	28	8	4	5	17	4	70
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

QADP closure was done as per the required timelines * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
QADP closure was done as per the required timelines	Agree	Count	0	7	0	0	1	4	0	12
		% within Stakeholder Status	0.0%	25.0%	0.0%	0.0%	20.0%	23.5%	0.0%	17.1%
	Neutral	Count	1	12	4	3	0	10	3	33
		% within Stakeholder Status	25.0%	42.9%	50.0%	75.0%	0.0%	58.8%	75.0 %	47.1%
	Disagree	Count	3	9	4	1	4	3	1	25
		% within Stakeholder Status	75.0%	32.1%	50.0%	25.0%	80.0%	17.6%	25.0 %	35.7%
Total		Count	4	28	8	4	5	17	4	70
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

An effectiveness review was done as per the required timelines * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
An effectiveness review was done as per the required timelines	Agree	Count	0	10	1	0	1	3	0	15
		% within Stakeholder Status	0.0%	35.7%	12.5%	0.0%	20.0%	17.6%	0.0%	21.7%
	Neutral	Count	1	8	3	3	0	11	3	29
		% within Stakeholder Status	33.3%	28.6%	37.5%	75.0%	0.0%	64.7%	75.0 %	42.0%
	Disagree	Count	2	10	4	1	4	3	1	25
		% within Stakeholder Status	66.7%	35.7%	50.0%	25.0%	80.0%	17.6%	25.0 %	36.2%
Total		Count	3	28	8	4	5	17	4	69
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project handover certificate was signed off immediately after completion of the project * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project handover certificate was signed off immediately after completion of the project	Agree	Count	0	13	1	3	2	4	0	23
		% within Stakeholder Status	0.0%	44.8%	12.5%	75.0%	40.0%	23.5%	0.0%	32.4%
	Neutral	Count	1	9	4	1	2	9	4	30
		% within Stakeholder Status	25.0%	31.0%	50.0%	25.0%	40.0%	52.9%	100.0 %	42.3%
	Disagree	Count	3	7	3	0	1	4	0	18
		% within Stakeholder Status	75.0%	24.1%	37.5%	0.0%	20.0%	23.5%	0.0%	25.4%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project was completed in time and within budget but lacked the quality * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project was completed in time and within budget but lacked the quality	Agree	Count	0	3	1	0	1	4	1	10
		% within Stakeholder Status	0.0%	10.3%	12.5%	0.0%	20.0%	25.0%	25.0 %	14.3%
	Neutral	Count	2	8	6	1	1	11	3	32
		% within Stakeholder Status	50.0%	27.6%	75.0%	25.0%	20.0%	68.8%	75.0 %	45.7%
	Disagree	Count	2	18	1	3	3	1	0	28
		% within Stakeholder Status	50.0%	62.1%	12.5%	75.0%	60.0%	6.3%	0.0%	40.0%
Total		Count	4	29	8	4	5	16	4	70
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0 %	100.0 %

The project team wrote a wash-up report that recorded lessons that were learnt and was distributed throughout the organisation * Stakeholder Status Cross tabulation

			Stakeholder Status							Total
			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Other	
The project team wrote a wash-up report that recorded lessons that were learnt and distributed throughout the organisation	Agree	Count	2	15	3	0	2	3	0	25
		% within Stakeholder Status	50.0%	51.7%	37.5%	0.0%	40.0%	17.6%	0.0%	35.2%
	Neutral	Count	1	8	3	2	3	11	2	30
		% within Stakeholder Status	25.0%	27.6%	37.5%	50.0%	60.0%	64.7%	50.0%	42.3%
	Disagree	Count	1	6	2	2	0	3	2	16
		% within Stakeholder Status	25.0%	20.7%	25.0%	50.0%	0.0%	17.6%	50.0%	22.5%
Total		Count	4	29	8	4	5	17	4	71
		% within Stakeholder Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix I: Comparison Statistics

Table 4.7: Multiple Response - Statements that were mostly agreed with

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	Customer requirements were clear	Count	2	20	6	1	1	11	41
		% within Status	50.0%	66.7%	75.0%	25.0%	20.0%	61.1%	
	Senior management demonstrated commitment to project quality	Count	2	21	7	4	2	9	45
		% within Status	50.0%	70.0%	87.5%	100.0%	40.0%	50.0%	
	Stakeholders were constantly involved throughout the project lifecycle	Count	1	14	6	1	2	5	29
		% within Status	25.0%	46.7%	75.0%	25.0%	40.0%	27.8%	
	The NNR was engaged in time, where applicable	Count	2	16	5	3	2	9	37
		% within Status	50.0%	53.3%	62.5%	75.0%	40.0%	50.0%	
	The project manager was knowledgeable about the plant	Count	2	21	7	1	3	13	47
		% within Status	50.0%	70.0%	87.5%	25.0%	60.0%	72.2%	
	The project team demonstrated commitment to achieve project quality	Count	2	20	8	3	2	12	47
		% within Status	50.0%	66.7%	100.0%	75.0%	40.0%	66.7%	
	Accountability was promoted by setting high expectations for project quality performance	Count	0	24	8	1	1	5	39
		% within Status	0.0%	80.0%	100.0%	25.0%	20.0%	27.8%	
	Project status was reported on a regular basis so project quality issues were identified upfront	Count	1	20	5	0	2	10	38
		% within Status	25.0%	66.7%	62.5%	0.0%	40.0%	55.6%	
	Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests	Count	1	21	7	3	0	9	41
		% within Status	25.0%	70.0%	87.5%	75.0%	0.0%	50.0%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	The project schedule was adhered to throughout the project lifecycle	Count	0	13	3	1	0	9	26
		% within Status	0.0%	43.3%	37.5%	25.0%	0.0%	50.0%	
	The client was happy and accepted the project that you delivered	Count	2	18	3	2	1	7	33
		% within Status	50.0%	60.0%	37.5%	50.0%	20.0%	38.9%	
	The project was planned to a level of detail that ensured efficient implementation of project quality	Count	2	25	8	2	3	8	48
		% within Status	50.0%	83.3%	100.0%	50.0%	60.0%	44.4%	
	Processes and procedures were conveniently available	Count	4	23	5	4	3	10	49
		% within Status	100.0%	76.7%	62.5%	100.0%	60.0%	55.6%	
	Processes and procedures were rigorously applied at all levels of the project	Count	2	17	7	3	1	4	34
		% within Status	50.0%	56.7%	87.5%	75.0%	20.0%	22.2%	
	Processes and procedures were cumbersome and hindered progress	Count	1	13	6	1	2	5	28
		% within Status	25.0%	43.3%	75.0%	25.0%	40.0%	27.8%	
	Configuration management was rigorously applied	Count	0	24	5	4	1	6	40
		% within Status	0.0%	80.0%	62.5%	100.0%	20.0%	33.3%	
	All relevant documentation that was affected by the modification accurately reflected the modified plant configuration	Count	2	25	3	4	1	4	39
		% within Status	50.0%	83.3%	37.5%	100.0%	20.0%	22.2%	
	Documents were updated as soon as practicable	Count	2	20	2	2	0	4	30
		% within Status	50.0%	66.7%	25.0%	50.0%	0.0%	22.2%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	When the project/ modification was identified, its compatibility with the design intent was assessed	Count	4	26	8	3	2	8	51
		% within Status	100.0%	86.7%	100.0%	75.0%	40.0%	44.4%	
	Where applicable, benchmarking was performed to ensure that the engineering standards and practices did not lag behind	Count	1	17	8	4	1	4	35
		% within Status	25.0%	56.7%	100.0%	100.0%	20.0%	22.2%	
	Design specifications were: Prepared	Count	4	28	7	4	4	8	55
		% within Status	100.0%	93.3%	87.5%	100.0%	80.0%	44.4%	
	Design specifications were: Prepared by independent reviewers	Count	4	27	7	4	3	8	53
		% within Status	100.0%	90.0%	87.5%	100.0%	60.0%	44.4%	
	Design specifications were: Approved	Count	4	27	7	4	4	8	54
		% within Status	100.0%	90.0%	87.5%	100.0%	80.0%	44.4%	
	Design specifications were: Issued to the suppliers	Count	4	27	5	2	3	8	49
		% within Status	100.0%	90.0%	62.5%	50.0%	60.0%	44.4%	
	Design specifications were: Authorised	Count	4	27	7	3	3	8	52
		% within Status	100.0%	90.0%	87.5%	75.0%	60.0%	44.4%	
	Design specifications were: Revised	Count	2	25	6	2	3	8	46
		% within Status	50.0%	83.3%	75.0%	50.0%	60.0%	44.4%	
	Design specifications were: Validated as required (before implementing the design)	Count	3	26	4	4	3	7	47
		% within Status	75.0%	86.7%	50.0%	100.0%	60.0%	38.9%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	The modification was performed in accordance with established procedures, whilst taking project quality into account	Count	2	27	6	4	3	3	45
		% within Status	50.0%	90.0%	75.0%	100.0%	60.0%	16.7%	
	Production priorities took preference over project quality in your project	Count	1	11	3	0	3	6	24
		% within Status	25.0%	36.7%	37.5%	0.0%	60.0%	33.3%	
	When the modification was tested, it demonstrated that the design intent was met before it was placed in service	Count	2	23	4	2	2	2	35
		% within Status	50.0%	76.7%	50.0%	50.0%	40.0%	11.1%	
	Where applicable, NNR was involved in supplier qualification process	Count	0	6	5	2	2	1	16
		% within Status	0.0%	20.0%	62.5%	50.0%	40.0%	5.6%	
	Where applicable, the supplier understood the requirements of RD0034	Count	0	8	2	1	2	4	17
		% within Status	0.0%	26.7%	25.0%	25.0%	40.0%	22.2%	
	Supplier Development and Localisation (SD&L) aided project quality	Count	0	8	2	0	1	1	12
		% within Status	0.0%	26.7%	25.0%	0.0%	20.0%	5.6%	
	Supplier evaluation criteria was based on project quality requirements	Count	0	25	6	0	0	9	40
		% within Status	0.0%	83.3%	75.0%	0.0%	0.0%	50.0%	
	The supplier interpreted project quality requirements correctly	Count	1	23	4	2	1	5	36
		% within Status	25.0%	76.7%	50.0%	50.0%	20.0%	27.8%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	The following was enforced to ensure that a quality project was implemented: the supplier's quality documents were reviewed	Count	3	25	7	0	3	7	45
		% within Status	75.0%	83.3%	87.5%	0.0%	60.0%	38.9%	
	The following was enforced to ensure a quality project was implemented: The supplier's procedures were read	Count	2	21	7	1	3	6	40
		% within Status	50.0%	70.0%	87.5%	25.0%	60.0%	33.3%	
	The following was enforced to ensure that a quality project was implemented: the supplier's entire quality program surveyed	Count	2	17	6	0	3	3	31
		% within Status	50.0%	56.7%	75.0%	0.0%	60.0%	16.7%	
	The supplier's personnel list was observed to check who will monitor the quality of workmanship at each level	Count	1	21	6	0	3	3	34
		% within Status	25.0%	70.0%	75.0%	0.0%	60.0%	16.7%	
	Contractor performance (periodic inspection) was constantly monitored to ensure they continue to perform satisfactorily	Count	0	25	6	2	2	3	38
		% within Status	0.0%	83.3%	75.0%	50.0%	40.0%	16.7%	
	The project team demonstrated sufficient knowledge and experience to guide contractors on project quality	Count	2	24	8	3	2	8	47
		% within Status	50.0%	80.0%	100.0%	75.0%	40.0%	44.4%	
	Compliance to project quality was visible during execution	Count	2	24	6	3	2	8	45
		% within Status	50.0%	80.0%	75.0%	75.0%	40.0%	44.4%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	Compliance was ensured by using the following: Hold/Witness points	Count	3	26	5	3	4	14	55
		% within Status	75.0%	86.7%	62.5%	75.0%	80.0%	77.8%	
	Compliance was ensured by using the following: status indicators	Count	1	21	4	3	2	9	40
		% within Status	25.0%	70.0%	50.0%	75.0%	40.0%	50.0%	
	Compliance was ensured by using the following: third party inspections	Count	2	21	3	3	2	11	42
		% within Status	50.0%	70.0%	37.5%	75.0%	40.0%	61.1%	
	Project was audited at various phases before approval to next phase	Count	0	19	7	2	3	8	39
		% within Status	0.0%	63.3%	87.5%	50.0%	60.0%	44.4%	
	Where there were deviations, non-conformances were raised (reported)	Count	2	22	5	4	3	11	47
		% within Status	50.0%	73.3%	62.5%	100.0%	60.0%	61.1%	
	Where there were deviations, non-conformances were issued (recorded)	Count	3	21	5	4	3	9	45
		% within Status	75.0%	70.0%	62.5%	100.0%	60.0%	50.0%	
	Where there were deviations, non-conformances were resolved (followed up)	Count	2	21	5	4	3	7	42
		% within Status	50.0%	70.0%	62.5%	100.0%	60.0%	38.9%	
	It was ensured that documentary evidence of conformance was available before items and processes were installed or used	Count	2	22	5	3	2	8	42
		% within Status	50.0%	73.3%	62.5%	75.0%	40.0%	44.4%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	The plant was in a better/healthier state once the modification was done /handed over to the client	Count	1	23	5	4	0	9	42
		% within Status	25.0%	76.7%	62.5%	100.0%	0.0%	50.0%	
	The project was closed on time	Count	0	1	0	0	0	1	2
		% within Status	0.0%	3.3%	0.0%	0.0%	0.0%	5.6%	
	FRA closure was done as per the required timelines	Count	0	6	0	0	1	4	11
		% within Status	0.0%	20.0%	0.0%	0.0%	20.0%	22.2%	
	QADP closure was done as per the required timelines	Count	0	7	0	0	1	4	12
		% within Status	0.0%	23.3%	0.0%	0.0%	20.0%	22.2%	
	An effectiveness review was done as per the required timelines	Count	0	10	1	0	1	3	15
		% within Status	0.0%	33.3%	12.5%	0.0%	20.0%	16.7%	
	The project handover certificate was signed off immediately following completion of the project	Count	0	13	1	3	2	4	23
		% within Status	0.0%	43.3%	12.5%	75.0%	40.0%	22.2%	
	The project was completed in time and within budget but lacked the quality	Count	0	3	1	0	1	4	9
		% within Status	0.0%	10.0%	12.5%	0.0%	20.0%	22.2%	
	The project team wrote a wash-up report that recorded lessons that were learnt and distributed throughout the organisation	Count	2	15	3	0	2	3	25
		% within Status	50.0%	50.0%	37.5%	0.0%	40.0%	16.7%	
Total		Count	4	30	8	4	5	18	69
		% within Status							

Table 4.8: Multiple Response - Statements that were mostly disagreed with

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	Customer requirements were clear	Count	1	5	1	2	2	2	13
		% within Status	25.0%	17.2%	14.3%	50.0%	40.0%	15.4%	
	Senior management demonstrated a commitment to project quality	Count	1	3	0	0	1	4	9
		% within Status	25.0%	10.3%	0.0%	0.0%	20.0%	30.8%	
	Stakeholders were constantly involved throughout the project lifecycle	Count	3	8	1	3	2	4	21
		% within Status	75.0%	27.6%	14.3%	75.0%	40.0%	30.8%	
	The NNR was engaged in time, where applicable	Count	0	3	3	0	1	0	7
		% within Status	0.0%	10.3%	42.9%	0.0%	20.0%	0.0%	
	The project manager was knowledgeable about the plant	Count	0	3	0	1	0	4	8
		% within Status	0.0%	10.3%	0.0%	25.0%	0.0%	30.8%	
	The project team demonstrated a commitment to achieve project quality	Count	0	4	0	0	1	1	6
		% within Status	0.0%	13.8%	0.0%	0.0%	20.0%	7.7%	
	Accountability was promoted by setting high expectations for project quality performance	Count	1	4	0	2	2	2	11
		% within Status	25.0%	13.8%	0.0%	50.0%	40.0%	15.4%	
	The project status was reported on a regular basis so project quality issues were identified upfront	Count	2	4	0	2	2	2	12
		% within Status	50.0%	13.8%	0.0%	50.0%	40.0%	15.4%	
	Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests	Count	0	3	0	1	1	5	10
		% within Status	0.0%	10.3%	0.0%	25.0%	20.0%	38.5%	
	The project schedule was adhered to throughout the project lifecycle	Count	4	13	4	2	4	4	31
		% within Status	100.0%	44.8%	57.1%	50.0%	80.0%	30.8%	
	The client was happy and accepted the project that you delivered	Count	1	3	1	1	0	0	6
		% within Status	25.0%	10.3%	14.3%	25.0%	0.0%	0.0%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	The project was planned to the level of detail that ensured efficient implementation of project quality	Count	1	1	0	1	2	1	6
		% within Status	25.0%	3.4%	0.0%	25.0%	40.0%	7.7%	
	Processes and procedures were conveniently available	Count	0	3	1	0	0	3	7
		% within Status	0.0%	10.3%	14.3%	0.0%	0.0%	23.1%	
	Processes and procedures were rigorously applied at all levels of the project	Count	0	2	0	1	0	3	6
		% within Status	0.0%	6.9%	0.0%	25.0%	0.0%	23.1%	
	Processes and procedures were cumbersome and hindered progress	Count	1	7	0	2	2	4	16
		% within Status	25.0%	24.1%	0.0%	50.0%	40.0%	30.8%	
	Configuration management was rigorously applied	Count	2	3	1	0	2	2	10
		% within Status	50.0%	10.3%	14.3%	0.0%	40.0%	15.4%	
	All relevant documentation affected by the modification accurately reflected the modified plant configuration	Count	0	3	0	0	2	3	8
		% within Status	0.0%	10.3%	0.0%	0.0%	40.0%	23.1%	
	Documents were updated as soon as practicable	Count	2	6	1	1	3	6	19
		% within Status	50.0%	20.7%	14.3%	25.0%	60.0%	46.2%	
	When the project/ modification was identified, its compatibility with the design intent was assessed	Count							
		% within Status							
	Where applicable, benchmarking was performed to ensure the engineering standards and practices were not lagging behind	Count	1	4	0	0	1	1	7
		% within Status	25.0%	13.8%	0.0%	0.0%	20.0%	7.7%	
	Design specifications were: Prepared	Count							
		% within Status							
	Design specifications were: Prepared by independent reviewers	Count	0	2	0	0	0	0	2
		% within Status	0.0%	6.9%	0.0%	0.0%	0.0%	0.0%	
	Design specifications were: Approved	Count	0	1	0	0	0	0	1
		% within Status	0.0%	3.4%	0.0%	0.0%	0.0%	0.0%	
	Design specifications were: Issued to the suppliers	Count	0	0	0	1	0	0	1
		% within Status	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	
	Design specifications were: Authorised	Count	0	1	0	0	0	0	1
		% within Status	0.0%	3.4%	0.0%	0.0%	0.0%	0.0%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	Design specifications were: Revised	Count	1	2	0	0	0	0	3
		% within Status	25.0%	6.9%	0.0%	0.0%	0.0%	0.0%	
	Design specifications were: Validated as required (before implementing the design)	Count	1	0	1	0	0	0	2
		% within Status	25.0%	0.0%	14.3%	0.0%	0.0%	0.0%	
	The modification was performed in accordance with established procedures, whilst taking project quality into account	Count	0	0	0	0	0	2	2
		% within Status	0.0%	0.0%	0.0%	0.0%	0.0%	15.4%	
	Production priorities took preference over project quality in your project	Count	1	18	3	4	1	0	27
		% within Status	25.0%	62.1%	42.9%	100.0%	20.0%	0.0%	
	When the modification was tested, it demonstrate that the design intent was met before being placed in service	Count	1	2	1	0	0	2	6
		% within Status	25.0%	6.9%	14.3%	0.0%	0.0%	15.4%	
	Where applicable, NNR was involved in supplier qualification process	Count	3	9	0	0	1	1	14
		% within Status	75.0%	31.0%	0.0%	0.0%	20.0%	7.7%	
	Where applicable, the supplier understood the requirements of RD0034	Count	3	5	1	1	1	4	15
		% within Status	75.0%	17.2%	14.3%	25.0%	20.0%	30.8%	
	Supplier Development and Localisation (SD&L) aided project quality	Count	1	7	2	0	0	3	13
		% within Status	25.0%	24.1%	28.6%	0.0%	0.0%	23.1%	
	Supplier evaluation criteria was based on project quality requirements	Count	2	0	0	1	1	1	5
		% within Status	50.0%	0.0%	0.0%	25.0%	20.0%	7.7%	
	The supplier interpreted project quality requirements correctly	Count	2	1	1	1	0	2	7
		% within Status	50.0%	3.4%	14.3%	25.0%	0.0%	15.4%	
	The following was enforced to ensure a quality project was implemented: The supplier's quality documents were reviewed	Count	1	1	0	1	0	1	4
		% within Status	25.0%	3.4%	0.0%	25.0%	0.0%	7.7%	
	The following was enforced to ensure a quality project was implemented: The supplier's procedures were read	Count	2	2	0	0	0	1	5
		% within Status	50.0%	6.9%	0.0%	0.0%	0.0%	7.7%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	The following was enforced to ensure a quality project was implemented: The supplier's entire quality program surveyed	Count	2	3	0	1	1	1	8
		% within Status	50.0%	10.3%	0.0%	25.0%	20.0%	7.7%	
	The supplier's personnel list was observed to see exactly who will actually be policing the quality of workmanship at each level	Count	3	1	1	1	1	1	8
		% within Status	75.0%	3.4%	14.3%	25.0%	20.0%	7.7%	
	Contractor performance (periodic inspection) was constantly monitored to confirm they continue to perform satisfactorily	Count	2	2	1	0	0	3	8
		% within Status	50.0%	6.9%	14.3%	0.0%	0.0%	23.1%	
	The project team demonstrated sufficient knowledge and experience to guide contractors on project quality	Count	1	2	0	0	2	2	7
		% within Status	25.0%	6.9%	0.0%	0.0%	40.0%	15.4%	
	Compliance to project quality was visible during execution	Count	2	1	0	1	0	4	8
		% within Status	50.0%	3.4%	0.0%	25.0%	0.0%	30.8%	
	Compliance was ensured by using the following: Hold/Witness points	Count							
		% within Status							
	Compliance was ensured by using the following: Status indicators and	Count	1	1	1	0	0	0	3
		% within Status	25.0%	3.4%	14.3%	0.0%	0.0%	0.0%	
	Compliance was ensured by using the following: Third party inspections	Count	0	1	0	0	1	0	2
		% within Status	0.0%	3.4%	0.0%	0.0%	20.0%	0.0%	
	Project was audited at various phases before approval to next phase	Count	2	3	1	1	1	3	11
		% within Status	50.0%	10.3%	14.3%	25.0%	20.0%	23.1%	
	Where there were deviations, non-conformances were: Raised (reported)	Count	0	1	0	0	2	1	4
		% within Status	0.0%	3.4%	0.0%	0.0%	40.0%	7.7%	
	Where there were deviations, non-conformances were: Issued (recorded)	Count	0	2	0	0	1	1	4
		% within Status	0.0%	6.9%	0.0%	0.0%	20.0%	7.7%	

			Programme Manager	Project Manager	Project Engineer	Design Engineer	Project Scheduler	Quality	Total
	Where there were deviations, non-conformances were: Resolved (followed up)	Count	1	1	0	0	1	2	5
		% within Status	25.0%	3.4%	0.0%	0.0%	20.0%	15.4%	
	It was ensured that documentary evidence of conformance is available before items and processes were installed or used	Count	2	2	1	0	2	1	8
		% within Status	50.0%	6.9%	14.3%	0.0%	40.0%	7.7%	
	The plant was in a better/healthier state after the modification was done /handed over to the client	Count	1	1	0	0	2	0	4
		% within Status	25.0%	3.4%	0.0%	0.0%	40.0%	0.0%	
	The project was closed on time	Count	0	3	0	0	1	0	4
		% within Status	0.0%	10.3%	0.0%	0.0%	20.0%	0.0%	
	FRA closure was done as per the required timelines	Count	4	15	3	1	3	2	28
		% within Status	100.0%	51.7%	42.9%	25.0%	60.0%	15.4%	
	QADP closure was done as per the required timelines	Count	3	9	4	1	4	3	24
		% within Status	75.0%	31.0%	57.1%	25.0%	80.0%	23.1%	
	An effectiveness review was done as per the required timelines	Count	2	10	4	1	4	3	24
		% within Status	50.0%	34.5%	57.1%	25.0%	80.0%	23.1%	
	The project handover certificate was signed off immediately after completion of the project	Count	3	7	3	0	1	4	18
		% within Status	75.0%	24.1%	42.9%	0.0%	20.0%	30.8%	
	The project was completed within time and budget but lacked the quality	Count	2	18	1	3	3	1	28
		% within Status	50.0%	62.1%	14.3%	75.0%	60.0%	7.7%	
	The project team wrote a wash-up report that recorded lessons learnt to be distributed throughout the organisation	Count	1	6	2	2	0	3	14
		% within Status	25.0%	20.7%	28.6%	50.0%	0.0%	23.1%	
Total		Count	4	29	7	4	5	13	62
		% within Status							

Appendix J: Statistical Significance

Table 4.9: Statistically significant Pearson Chi-square test for equal proportions

Questionnaire A: People	N of valid cases	Value	df	P -value (2-sided)	Exact p - value (2-sided)
Customer requirements were clear	59	4.599a	6	.596	.630
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .68					
Senior management demonstrated commitment to project quality	59	6.197a	6	.402	.399
8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .47.					
Stakeholders were constantly involved throughout the project lifecycle	58	11.200a	6	.082	.077
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is 1.10.					
The NNR was engaged in time, where applicable	56	11.941a	6	.063	.059
8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .43.					
The project manager was knowledgeable about the plant	60	8.595a	6	.198	.187
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .53.					
The project team demonstrated commitment to achieve project quality	59	5.546a	6	.476	.471
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .34.					
Accountability was promoted by setting high expectations for project quality performance	60	29.154a	6	.000	.000
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .53.					
Project status was reported on a regular basis so project quality issues were identified upfront	59	9.387a	6	.153	.144
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .54.					
	N of valid cases	Value	df	P -value (2-sided)	Exact p - value (2-sided)
Questionnaire A: People					
Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests	59	6.251a	6	.396	.396
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .61.					
The project schedule was adhered to throughout the project lifecycle	58	4.125a	9	.903	.898
12 cells (75.0%) have an expected count of less than 5. The minimum expected count is .07.					
The client was happy and accepted the project that you delivered	58	7.304a	6	.294	.283
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .34.					
Questionnaire B: Standards, Processes and Procedures					
The project was planned to the level of detail that ensured efficient implementation of project quality	60	16.010a	6	.014	.019
8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .20.					
Processes and procedures were conveniently available	60	4.446a	6	.617	.638
8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .47.					
Processes and procedures were rigorously applied at all levels of the project	60	13.793a	6	.032	.028
8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .40.					
Processes and procedures were cumbersome and hindered progress	60	7.919a	6	.244	.250
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .87.					
Configuration management was rigorously applied	60	15.471a	6	.017	.016
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .40.					
All relevant documentation affected by the modification accurately reflected the modified plant configuration	59	24.965a	6	.000	.001

a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .41.					
Documents were updated as soon as practicable	59	13.369a	6	.038	.032
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .95.					
Questionnaire C: Plant					
When the project/ modification was identified, its compatibility with the design intent was assessed	55	5.971a	3	.113	.121
a. 4 cells (50.0%) have an expected count of less than 5. The minimum expected count is .73.					
Where applicable, benchmarking was performed to ensure the engineering standards and practices were not lagging behind	55	14.483a	6	.025	.024
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .36.					
Design specifications were: Prepared	54	10.416a	3	.015	.018
a. 5 cells (62.5%) have an expected count of less than 5. The minimum expected count is .52.					
Design specifications were: Prepared by independent reviewers	55	12.067a	6	.060	.066
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .15.					
Design specifications were: Approved	54	11.102a	6	.085	.119
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .07.					
Design specifications were: Issued to the suppliers	54	20.321a	6	.002	.004
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .07.					
Design specifications were: Authorised	54	9.730a	6	.136	.150
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .07.					
Design specifications were: Revised	54	9.319a	6	.156	.162
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .15.					
	N of valid cases	**Value**	**df**	**P -value (2-sided)**	**Exact p -value (2-sided)**
Design specifications were: Validated as required (before implementing the design)	54	15.239a	6	.018	.043
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .07.					
The modification was performed in accordance with established procedures, whilst taking project quality into account	53	24.145a	6	.000	.005
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .15.					
Production priorities took preference over project quality in your project	54	27.851a	9	.001	.001
a. 13 cells (81.3%) have an expected count of less than 5. The minimum expected count is .07.					
When the modification was tested, it demonstrate that the design intent was met before being placed in service	53	15.179a	6	.019	.017
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .38.					
Questionnaire D: Contractor/Supplier/Vendor Management					
Where applicable, NNR was involved in supplier qualification process	52	17.135a	9	.047	.064
a. 12 cells (75.0%) have an expected count of less than 5. The minimum expected count is .08.					
Where applicable, the supplier understood the requirements of RD0034	53	2.605a	9	.978	.980
a. 12 cells (75.0%) have an expected count of less than 5. The minimum expected count is .08.					
Supplier Development and Localisation (SD&L) aided project quality	53	6.059a	6	.417	.431
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .83.					
Supplier evaluation criteria was based on project quality requirements	54	16.381a	6	.012	.014
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .15.					
The supplier interpreted project quality requirements correctly	54	8.559a	6	.200	.192
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .37.					

The following was enforced to ensure a quality project was implemented: The supplier's quality documents were reviewed	54	16.784a	6	.010	.020
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .22.					
The following was enforced to ensure a quality project was implemented: The supplier's procedures were read	54	8.989a	6	.174	.160
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .22.					
The following was enforced to ensure a quality project was implemented: The supplier's entire quality program surveyed	53	11.042a	6	.087	.088
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .38.					
The supplier's personnel list was observed to see exactly who will actually be policing the quality of workmanship at each level	53	15.886a	6	.014	.016
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .30.					
Contractor performance (periodic inspection) was constantly monitored to confirm they continue to perform satisfactorily	53	17.417a	6	.008	.010
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .45.					
The project team demonstrated sufficient knowledge and experience to guide contractors on project quality	60	11.413a	6	.076	.073
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .27.					
Compliance to project quality was visible during execution	58	10.120a	6	.120	.119
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .41.					
Compliance was ensured by using the following: Hold/Witness points	58	3.438a	3	.329	.354
a. 4 cells (50.0%) have an expected count of less than 5. The minimum expected count is .69.					

	N of valid cases	Value	df	P -value (2-sided)	Exact p -value (2-sided)
Compliance was ensured by using the following: Status indicators and	57	4.721a	6	.580	.576
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .14.					
Compliance was ensured by using the following: Third party inspections	58	5.151a	6	.525	.476
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .07.					
Questionnaire E: Quality					
Project was audited at various phases before approval to next phase	60	5.815a	6	.444	.457
a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .53.					
Where there were deviations, non-conformances were: Raised (reported)	59	3.728a	6	.713	.733
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .14					
Where there were deviations, non-conformances were: Issued (recorded)	59	5.950a	6	.429	.438
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .20.					
Where there were deviations, non-conformances were: Resolved (followed up)	58	9.380a	6	.153	.140
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .21.					
It was ensured that documentary evidence of conformance is available before items and processes were installed or used	58	5.580a	6	.472	.482
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .28.					
The plant was in a better/healthier state after the modification was done /handed over to the client	57	8.583a	6	.198	.206
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .07.					

The project was closed on time	13	5.146a	4	.273	.427
a. 9 cells (100.0%) have an expected count of less than 5. The minimum expected count is .15.					
FRA closure was done as per the required timelines	57	13.100a	6	.041	.037
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .70.					
QADP closure was done as per the required timelines	57	5.988a	6	.425	.445
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .77.					
An effectiveness review was done as per the required timelines	57	9.451a	6	.150	.148
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .98.					
The project handover certificate was signed off immediately after completion of the project	58	7.547a	6	.273	.283
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .97.					
The project was completed within time and budget but lacked the quality	57	18.787a	6	.005	.004
a. 8 cells (66.7%) have an expected count of less than 5. The minimum expected count is .56.					
The project team wrote a wash-up report that recorded lessons learnt to be distributed throughout the organisation	58	10.260a	6	.114	.110
a. 7 cells (58.3%) have an expected count of less than 5. The minimum expected count is .90.					

Appendix K: Inferential Statistics

Table 4.10: Non-Parametric Test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	Customer requirements were clear.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
2	Senior management demonstrated commitment to project quality.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
3	Stakeholders were constantly involved throughout the project lifecycle.	One-Sample Chi-Square Test	.421	Retain the null hypothesis
4	The NNR was engaged in time, where applicable.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
5	The project manager was knowledgeable about the plant.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
6	The project team demonstrated commitment to achieve project quality.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
7	Accountability was promoted by setting high expectations for project quality performance.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
8	Project status was reported on a regular basis so project quality issues were identified upfront.	One-Sample Chi-Square Test	.001	Reject the null hypothesis
9	Integrity (quality) of the project was maintained in spite of conflicting demands (time and cost) from parties with legitimate interests.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
10	The project schedule was adhered to throughout the project lifecycle.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
11	The client was happy and accepted the project that you delivered.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
1	The project was planned to the level of detail that ensured efficient implementation of project quality.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
2	Processes and procedures were conveniently available.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
3	Processes and procedures were rigorously applied at all levels of the project.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
4	Processes and procedures were cumbersome and hindered progress.	One-Sample Chi-Square Test	.117	Retain the null hypothesis
5	Configuration management was rigorously applied.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
6	All relevant documentation affected by the modification accurately reflected the modified plant configuration.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
7	Documents were updated as soon as practicable.	One-Sample Chi-Square Test	.147	Reject the null hypothesis

	Null Hypothesis	Test	Sig.	Decision
1	When the project/ modification was identified, its compatibility with the design intent was assessed.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
2	Where applicable, benchmarking was performed to ensure the engineering standards and practices were not lagging behind.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
3	Design specifications were:			
a	• Prepared;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
b	• Reviewed by independent reviewers;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
c	• Approved;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
d	• Issued to the suppliers;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
e	• Authorised;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
f	• Revised; and	One-Sample Chi-Square Test	.000	Reject the null hypothesis
g	• Validated as required (before implementing the design).	One-Sample Chi-Square Test	.000	Reject the null hypothesis
4	The modification was performed in accordance with established procedures, whilst taking project quality into account.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
5	Production priorities took preference over project quality in your project	One-Sample Chi-Square Test	.000	Reject the null hypothesis
6	When the modification was tested, it demonstrated that the design intent was met before being placed in service.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
1	Where applicable, NNR was involved in supplier qualification process.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
2	Where applicable, the supplier understood the requirements of RD0034.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
3	Supplier Development and Localisation (SD&L) aided project quality.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
5	Supplier evaluation criteria were based on project quality requirements.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
6	The supplier interpreted project quality requirements correctly.	One-Sample Chi-Square Test	.000	Reject the null hypothesis

	Null Hypothesis	Test	Sig.	Decision
7	The following was enforced to ensure a quality project was implemented:			
a	• The supplier's quality docume1nts were reviewed;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
b	• The supplier's procedures were read;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
c	• The supplier's entire quality program surveyed; and	One-Sample Chi-Square Test	.000	Reject the null hypothesis
d	• The supplier's personnel list was observed to see exactly who will actually be policing the quality of workmanship at each level.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
7	Contractor performance (periodic inspection) was constantly monitored to confirm they continue to perform satisfactorily.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
8	The project team demonstrated sufficient knowledge and experience to guide contractors on project quality.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
9	Compliance to project quality was visible during execution.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
10	Compliance was ensured by using the following:			
a	• Hold/Witness points;	One-Sample Chi-Square Test	.000	Reject the null hypothesis
b	• Status indicators; and	One-Sample Chi-Square Test	.000	Reject the null hypothesis
c	• Third party inspections	One-Sample Chi-Square Test	.000	Reject the null hypothesis
1	Project was audited at various phases before approval to the next phase.	One-Sample Chi-Square Test	.000	Reject the null hypothesis
2	Where there were deviations, non-conformances were:			
a	• Raised (reported);	One-Sample Chi-Square Test	.000	Reject the null hypothesis
b	• Issued (recorded); and	One-Sample Chi-Square Test	.000	Reject the null hypothesis
c	• Resolved (followed up).	One-Sample Chi-Square Test	.000	Reject the null hypothesis
3	It was ensured that documentary evidence of conformance is available before items and processes were installed or used..	One-Sample Chi-Square Test	.000	Reject the null hypothesis
4	The plant was in a better/healthier state after the modification was done /handed over to the client.	One-Sample Chi-Square Test	.099	Retain the null hypothesis

	Null Hypothesis	Test	Sig.	Decision
5	The project was closed on time	One-Sample Chi-Square Test	.000	Reject the null hypothesis
a	• FRA closure was done as per the required timelines;	One-Sample Chi-Square Test	.018	Reject the null hypothesis
b	• QADP closure was done as per the required timelines; and	One-Sample Chi-Square Test	.003	Retain the null hypothesis
c	• An effectiveness review was done as per the required timelines.	One-Sample Chi-Square Test	.048	Reject the null hypothesis
6	The project handover certificate was signed off immediately after completion of the project.	One-Sample Chi-Square Test	.180	Retain the null hypothesis
7	The project was completed within time and budget but lacked the quality.	One-Sample Chi-Square Test	.004	Reject the null hypothesis
8	The project team wrote a wash-up report that recorded lessons learnt to be distributed throughout the organisation.	One-Sample Chi-Square Test	.153	Retain the null hypothesis