

**Development of a Quality Management System for a Civil Engineering and Project
Management Consultancy**

by

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Executive Summary

The Afri-Infra Group (Pty) Ltd is a South African civil engineering company, specialising in project management, civil and municipal services, structural engineering, transportation engineering and asset management.

Recently there have been various arguments amongst regulatory authorities that an accredited Quality Management System should be a standard requirement in the civil and consulting industry. The abovementioned company requested that an analysis be done to determine an appropriate and beneficial Quality Management System to be developed and implemented in all four regional offices.

A literature review was conducted to review and compare currently available Quality Management Systems. The ISO 9001:2008 was determined to be the most appropriate and recommended system to implement in the civil engineering and project management industry.

A Gap Analysis compared the current system to the requirements of the international standard and revealed that the implementation of ISO 9001:2008 will improve the compliance of the company with 82.04% overall.

A Quality Manual consisting of an introduction, policies, procedures and standard documentation, was developed in accordance with the requirements of international standards.

The implementation of the Quality Manual and its contents is highly recommended. The effective management of the system and implementation of the documents developed will increase the quality of service provided as well as the probability of international accreditation.

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List of Acronyms and Abbreviations

| | |
|---------------|--|
| AIG | Afri-Infra Group |
| BOQ | Bill of Quantities |
| CC | Creditor's Clerk |
| CESA | Consulting Engineers of South Africa |
| CIDB | Construction Industry Development Board |
| COLTO | Committee of Land Transport Officials |
| CPA | Contract Price Adjustment |
| CPC | Contractor's Payment Certificate |
| CSIM | Compulsory Site Inspection Meeting |
| DC | Debtors Clerk |
| DMS | Design Management System |
| ECSA | Engineering Council of South Africa |
| EIA ROD | Environmental Impact Assessment Record of Decision |
| GCOC 2004 | General Conditions of Contract for Construction Work |
| HO | Head Office |
| ISO | International Organization for Standardization |
| ISO 9001:2008 | ISO Quality Management System Requirement |
| MD | Managing Director |
| MPR | Monthly Progress Report |
| PF | Professional Fee |
| PM | Project Manager |
| QM | Quality Manual |
| QMS | Quality Management System |
| RM | Regional Manager |
| SABS | South African Bureau of Standards |
| SANS | South African National Standards |
| SCS | Sub-Contractor's Services |
| SCSI | Sub-Consultant's Sales Invoice |
| SOW | Scope of Work |
| WBS | Work Breakdown Structure |

1 Introduction and Background

1.1 Background on the Company

The Afri-Infra Group (Pty) Ltd is a dynamic, South African civil engineering company, committed to providing innovative solutions for engineering design and project management services to national, provincial and local governments, as well as commercial and industrial markets.

The company's core disciplines are: project management, civil and municipal engineering, structural engineering, transportation engineering and asset management. The company inter alia focuses on the provision and development of water, sewers, roads, storm water drainage, and infrastructure projects that impact directly on the living standard of South Africans who were previously excluded from it.

Afri-Infra Group is a member of Consulting Engineers South Africa, most commonly known as CESA. A statement was released by the organisation during the November 2002 AGM which proposed, and collectively agreed, that the concept of quality management should be included in the CESA Code of Conduct, with a requirement that member firms implement and maintain such a system within their practice as a condition of membership. (CESA, Consulting Engineers South Africa)

1.2 Problem Definition

Afri-Infra Group is merely one of many civil engineering companies tendering for specific projects as a professional service provider in the construction industry, and the probability of their successful appointment depends greatly on factors such as cost, resources availability, Black Economic Empowerment for Equity (BEEE), quality and good customer relations.

Recently there have been various arguments among regulatory authorities that an accredited Quality Management System should be a standard requirement in the civil and consulting industry. Afri-Infra Group concluded that the system may benefit them, not only in improving the quality of their service, but also increasing the probability of successfully tendered appointments.

The company requested an analysis in order to determine an appropriate and beneficial Quality Management System to be developed for the company to:

- effectively manage project and safety risks;
- increase customer relations;
- increase the probability of being successful in tendered appointments;
- ensure control over their core and support processes;
- continually improve and manage defects;
- step up to the standards of benchmark civil engineering companies;
- adhere to the requirements as stated by CESA; and
- submit the system for accreditation by a recognised organisation.

2 Project Aim

The aim of the project is to specify and develop a Quality Management System to be implemented in the company that is appropriate for the Civil Engineering and Project Management Industry and will be suitable for accreditation by a recognised organisation, such as the South African National Accreditation System (SANAS).

3 Project Scope

The project analyses whether a Quality Management System is appropriate to the problem definition and determine which Quality Management Systems are available to be implemented in all four regional offices of the company.

Research was done on the available Quality Management Systems to determine the best and most appropriate system to develop.

A industry-related survey has been conducted to determine which Quality Management System is currently preferred in the Civil Engineering and Project Management Industry and what difficulties other companies have experienced with the development and implementation of such a system.

Based upon the research and the survey, an appropriate Quality Management System is recommended. Further research has been done to determine the requirements for such a system.

A detailed gap analysis of current practices and the proposed system requirements was done. An implementation plan has been developed to attend to the shortcomings identified, however, the actual implementation of the ISO system falls out of the scope of this project.

4 Project Deliverables

The project intends to deliver a Quality Management System that includes the following:

- a Quality Manual consisting of the required documentation needed for implementation, as well as the policies and procedures;
- sub-systems needed to comply with the requirements of the proposed system standards;
- a risk management system;
- a final detailed project report; and
- a final project presentation.

5 Project Plan

5.1 Activities and tasks

Table 1 provides a detailed list of the activities, tasks, and milestones set to ensure that the project is successfully completed.

| PROJECT ACTIVITIES AND TASKS | MILESTONE |
|---|-----------------------------------|
| 1. Project Brief and Induction | |
| 1.1. Brief | |
| 1.2. Induction as New Employee | |
| 2. Project Planning and Proposal | |
| 2.1. Research and Literature Review | |
| 2.2. Training in MS Projects | |
| 2.3. Project Proposal | Project Proposal due 1 March 2011 |
| 3. Project Development | |
| 3.1. Training: Implementation of QMS (CESA) | |
| 3.2. Business Analysis | |
| 3.2.1. Business Analysis | |
| 3.2.2. Business Model | |
| 3.2.3. Quality Policy and Objectives | |
| 3.2.4. Quality Manual Introduction | |
| 4. Policies, Procedures and Standard Documents. | |
| 4.1. Human Resources | |
| 4.1.1. HR Management Meeting | |
| 4.1.2. Documentation | |
| 4.1.3. Review | |
| 4.2. Training: Internal Auditing (CESA) | |
| 4.3. Tender Process | |
| 4.3.1. Tender Management Meeting | |
| 4.3.2. Documentation | |
| 4.3.3. Review | |
| 4.4. Strategic Planning | |

| PROJECT ACTIVITIES AND TASKS | MILESTONE |
|---|--|
| 4.4.1. Strategic Planning Meeting | |
| 4.4.2. Documentation | |
| 4.4.3. Review | |
| 5. Professional Services | |
| 5.1. Professional Services Meeting | |
| 5.2. Documentation | |
| 5.3. Review | |
| 6. Finance | |
| 6.1. Finance Management Meeting | |
| 6.2. Documentation | |
| 6.3. Review | |
| 7. Legal and Risk | |
| 7.1. Legal and Risk Management Meeting | |
| 7.2. Develop Risk Management System | |
| 7.3. Implement OH&S | |
| 7.4. Documentation | |
| 7.5. Review | |
| 8. Performance Management | |
| 8.1. Performance Management Meeting | |
| 8.2. Documentation | |
| 8.3. Review | |
| 9. IT, Systems and Processes | |
| 9.1. IT, Systems and Processes Meeting | |
| 9.2. Documentation | |
| 9.3. Review | |
| 10. Administration | |
| 10.1. Administration Meeting | |
| 10.2. Documentation | |
| 10.3. Review | |
| 11. General Management | |
| 11.1. Documentation | |
| 11.2. Review | |
| 12. Produce Quality Manual | |
| 13. Documentation Control and review | |
| 14. Printing of Contents of Manual | |
| 15. Graphic Design and Printing | |
| 15.1. Graphic Design | |
| 15.2. File Printing | Project End 11 August 2011 |
| 16. UP Project Proposal | UP Project Proposal due 11 August 2011 |
| 17. Project Documentation | |
| 18. Interim Project Report Documentation | UP Interim Project due 13 September 2011 |
| 19. Final Project Report Documentation | UP Final Project due 11 October 2011 |
| 20. Final Project Presentation and Poster | UP Presentation due by 7 November 2011 |

Table 1 - Project Activities, Tasks and Milestones

5.2 Project Resources

The project has been subject to various resources, as provided in Table 2 below. Due to the locations of the various regional offices, the management input for the development of the Quality Management System, was restricted to the Pretoria and Middelburg Offices.

| RESOURCE | TASKS |
|--|--|
| 1. Company Intellectual Resources | |
| 1.1. MD (BCL) | Business Analysis, Strategic Planning, Finance, Legal and Risk, Performance Management and General Management. |
| 1.2. Regional Manager (FB,ADW,EJ) | Professional Services, IT, Systems and Processes and Tender. |
| 1.3. Design Manager | Professional Services |
| 1.4. Financial Clerks (ZG, MdL) | Finance |
| 1.5. Human Resource Management (MvZ) | Human Resources and Performance Management |
| 1.6. Senior Secretary (AC) | Administration, Quality Manual Documentation. |
| 1.7. Student (ZvN) | Entire Project |
| 2. Other Intellectual Resources | |
| 2.1. Graphical Designer | Graphical Design and Printing |
| 2.2. CESA | Training |
| 3. Software | |
| 3.1. Microsoft Project | Project Management and Proposal |
| 3.2. Microsoft Visio | Process Mapping |
| 4. Documentation | |
| 4.1. Standards and Regulations | Research and Development |

Table 2 - Resource List

5.3 Project Budget

The student is employed by the Company and all costs related to the planning and development of the Quality Management System project is the responsibility of the Company. The budget for this project is therefore calculated as per the actual cost to the company. The Company calculates an overhead rate for each employee, based on the expenses of each regional office.

Each employee's overhead rate per hour is calculated with the following equation:
(Assume 1 month = 21.7 working days per month = 260.4 working days per year=2083.2 working hours per year)

$$Rate = \frac{\left[Employee\ Annual\ Salary + \left(\frac{Employee\ annual\ salary}{Total\ Salary\ of\ region} \times \frac{\sum_{Month=1}^{Month=n} Regional\ Expenses \times 12}{n} \right) \right]}{2083.2\ working\ hours\ per\ year}$$

The project budget is calculated using Microsoft Project, where the planned hours needed per employee, the employee overhead rate, and their availability are taken into account. The resource rates used in Microsoft Project with the various overhead rates are provided in Annexure B.

The total project cost is estimated to be **R 683 041.54**. Table 3 shows a breakdown of the high-level project budget/cost.

| DESCRIPTION | COST |
|--|---------------------|
| Resource Cost (as per overhead calculation) | R 663 529.54 |
| Training | R 11 550.00 |
| CESA: Managing Projects with Microsoft Project | R 2 750.00 |
| CESA: Implementing Quality Management Systems | R 2 750.00 |
| CESA: Internal Auditing | <u>R 6 050.00</u> |
| Travel and Accommodation | R 3 588.00 |
| Return Flights | R 1 718.00 |
| Shuttle | R 300.00 |
| Hotel | <u>R 1 570.00</u> |
| Printing & Graphical design | |
| All File Dividers at Minute Print | R 37 166.28 |
| All File Covers at Vavro Plastics | <u>R 9 019.68</u> |
| Additional Software | R 4 374.00 |
| Microsoft Visio Professional 2010 FPP | R 4 374.00 |
| TOTAL COST | R 683 041.54 |

Table 3 - Project Cost Breakdown

5.4 Project Gantt Chart

A top level view of the project plan is illustrated in Figure 1 below. A detailed Project Gantt Chart is provided in Appendix A.

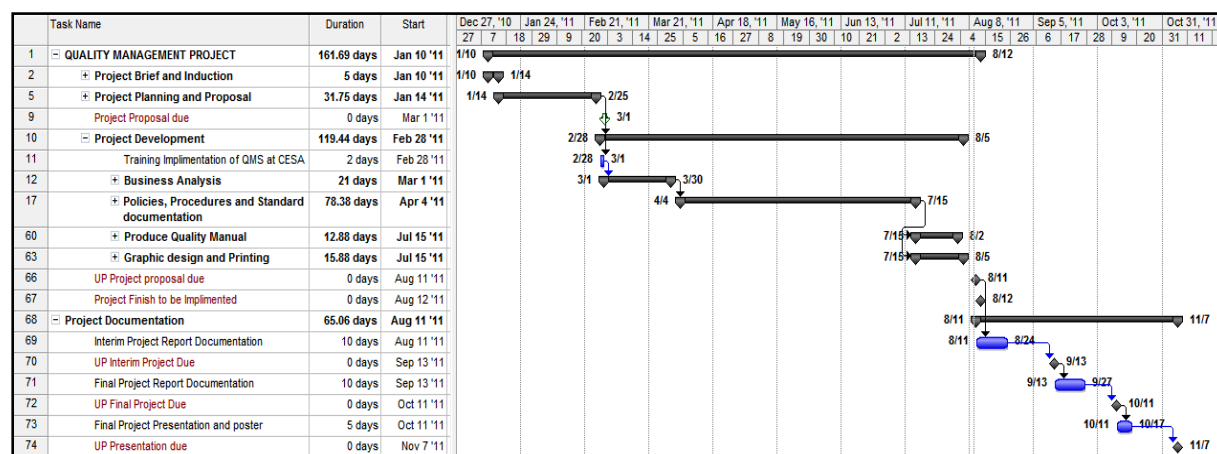


Figure 1 - Top level Gantt chart

6 Literature Review

6.1 Introduction

A literature review has been conducted to review currently available Quality Management Systems. These systems are compared with each other to determine which system complies best with the requirements of the Company and therefore is the most appropriate system to implement.

A short survey has been conducted in the Civil Engineering and Project Management Industry to determine the most recommended Quality Management System to implement. Thereafter, a detailed literature review has been done on the recommended Quality Management System.

6.2 Quality Management

Progressively, more organisations are realising the importance of managing quality and what impact quality has on organisational performance. Numerous organisations have come to the conclusion that the effective management of quality can increase competitive skills and tactical advantages in the marketplace. (Anderson, Rungtusanatham and Schroeder, 1994). The effective management of quality can be achieved through the development and implementation of a Quality Management System.

Standards Australia (Australia, Standards, 2006) refers to a Quality Management System as “part of the organization’s management system that focuses on the achievement of results in relation to quality objectives, to satisfy the needs, expectation and requirements of interested parties as appropriate.”

Various Quality Management Systems are available to organisations. During an interview with a consultant of the South African Bureau of Standards (Van Schalkwyk, 2011) it was stated that the most commonly implemented Quality Management Systems in South Africa were ISO 9000, Six Sigma, and Kaizen.

6.3 ISO 9000 Quality Management System

ISO 9000 is a collection of formal International standards, technical specifications, technical reports, guides, and electronic documents based on Quality Management.

The ISO 9000 series of quality management standards were originally published by the International Organization for Standardization (ISO) in 1987, and was first revised in 1994 so that it can be applied to all industries. In 2001 it was determined that at least 561 747 certificates of conformity to ISO 9000 standards had been issued in 159 countries and economies (Dissanayaka *et al.*, 2001). By January 2010, at least 1 064 785 ISO 9001 (2000 and 2008) certificates had been issued in 178 countries and economies. (Organization, International Standards, 2009)

ISO 9001 contains a non-specific set of requirements for implementing a Quality Management System in any organisation, regardless of nature, size and product or service provided (Organization, International Standards, 2009). ISO 9000 can be implemented in virtually any business. It was developed in such a way that the general guidelines used in the process can be integrated into any type of industry. The process may use simple words, but is not simple to implement. However, the rewards received after the implementation are more than worth the effort put into the system.

The ISO 9001:2008 Standard (Organization, International Standards, 2009) recommends implementing the “Plan-Do-Check-Act” Methodology (PDCA) to process based systems when developing the system.

The steps in PDCA are:

- Step 1 - Plan:** establish the objectives and processes required to deliver results in accordance with customer requirements and the organisation’s policies.
- Step 2 - Do:** implement the processes.
- Step 3 - Check:** monitor and measure processes and service delivered against policies, objectives and requirements for the product and report the results.
- Step 4 - Act:** take actions to continually improve performance.

If a Quality Management System is appropriately implemented, all of an organisation's stakeholders should benefit as follows:

- Customers receive products that conform to their requirements - products that are reliable, available when needed and maintainable.
- The system ensures improved working conditions, job satisfaction, health and safety and an enhanced stability of employment for the organisation’s employees.

- Top Management will experience increased returns on investments, market shares and profits.
- The system ensures stability and growth for organisational suppliers and partners.
- The general public will experience improvements on health and safety and environmental impacts.
- The system is internationally accredited.

In conclusion, ISO 9001:2008 can be implemented in virtually any business as it was developed in such a way that the general guidelines used in the process can be integrated into any type of industry (Organization, International Standards, 2009).

6.4 Six Sigma

Six Sigma was found by Bill Smith at Motorola in 1986, and was initially defined as a metric for measuring defects and improving quality. Six Sigma is designed to manage process variations that cause defects.

Six Sigma is considered to not only be an integrated approach to generating effective working models, but also a tool for improving productivity, creating solidarity and reducing costs. Six Sigma is an effective approach to an international quality control program if implemented successfully.

The five steps to the Six Sigma Approach are:

- Step 1 - Define** the current process and high-level project objectives.
- Step 2 - Measure** key aspects of the current process and collect relevant data.
- Step 3 - Analyse** the data to verify cause-and-effect relationships. Determine what the relationships are and attempt to ensure that all factors have been considered.
- Step 3 - Improve** or optimise the process based upon data analysis using techniques like design of experiments.
- Step 4 - Control** to ensure that any deviations from target are corrected before they result in defects. Set up pilot runs to establish process capability, move on to production, set up control mechanisms and continuously monitor the process.

Six Sigma is not an international accredited Quality Management System. In the United States, Six Sigma certification is offered by the Institute of Industrial Engineers, the

American Society for Quality and by The International Association for Six Sigma Certification. (DE FEO, Joseph and Barnard, 2005)

6.5 Kaizen

Kaizen is derived from the Japanese word for “improvement”. It is a continuous process that is usually incremental in nature; it is participative and involves the participation and intelligence of the workforce (Brunet and New, 2003). It has been applied in various industries such as medical, governmental, economical, and other industries. Kaizen refers to activities that continually improve all functions and involves the entire workforce from top management to operational level.

The most recognized implementation of Kaizen is probably the Toyota Production System (Brunet and New, 2003). The system ensures that the entire production line is stopped in the case of an abnormality and, together with their superior, improvement recommendations are made to resolve the abnormality which may initiate a Kaizen.

The Kaizen Cycle is as follows:

- Step 1 - Standardise** an operation, task or activity.
- Step 2 - Measure** the standardized operation, task or activity.
- Step 3 - Test** measurements against requirements.
- Step 4 - Improve** to meet requirements and raise productivity.
- Step 5 - Standardise** the new, improved process or activity.
- Step 6 - Repeat** the cycle.

The benefits of implementing Kaizen are:

- waste reduction;
- improved space utilisation;
- improved quality;
- improved production capacity; and
- immediate results.

Kaizen is not an international accredited Quality Management System, but is considered to be an internationally recognised tool used for continual improvement.

6.6 System Comparison

The Quality Management Systems discussed above has been analysed and compared to determine the most appropriate system that suites the problem definition of the company. The comparison is provided in Table 4.

| Factors | ISO 9001:2008 | Six Sigma | Kaizen |
|--------------------|---|---|--|
| Preferred Industry | All industries | All industries | Manufacturing |
| Recommended by | CESA and SABS | Institute of Industrial Engineers | Kaizen Institute |
| Benefits | <ol style="list-style-type: none"> 1. Customer Satisfaction 2. Quality Control 3. Financial benefits 4. Supplier and customer relations 5. Health & Safety improvements 6. Manage defects | <ol style="list-style-type: none"> 1. Quality Control 2. Productivity Improvement 3. Solidarity 4. Cost Reductions 5. Improve and manage defects | <ol style="list-style-type: none"> 1. Waste reduction 2. Improved Space Utilization 3. Improved Quality 4. Improved production capacity 5. Immediate results. |
| Accreditation | International | USA | N/A |

Table 4 - System Comparison

6.7 Industry Survey

A short survey was conducted by the student in January 2011, based on the implementation of a Quality Management System within the Civil Engineering and Project Management Industry to determine the possible constraints the Company may incur from self-implementing a Quality Management System, and to determine the most recommended Quality Management System to implement. The companies considered were asked to answer the following 5 questions:

- a) What benefits have you obtained from implementing a QMS?
- b) What difficulties have you encountered from implementing a QMS?
- c) How long did it take for your company to implement this System?
- d) What difficulties have you encountered with maintaining the System?
- e) Would you recommend implementing an ISO 9001:2008-based QMS?

Unfortunately only the following six companies responded:

- Vela VKE Consulting Engineers
- African-Innovative

- HHO Africa
- Sizatech
- Spoomaker & Partners
- Goba

An analysis of the survey-data was done and the results obtained are as follows:

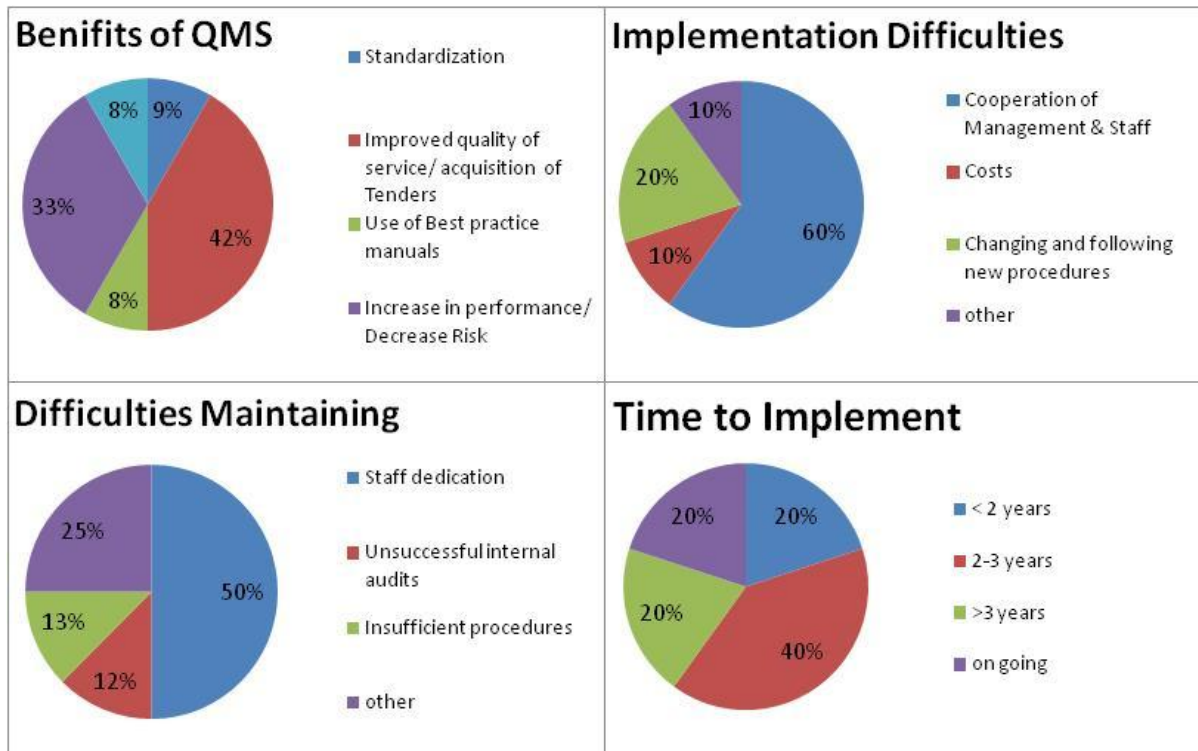


Figure 2 - Survey Graphs

From the survey analysis the following conclusions were made:

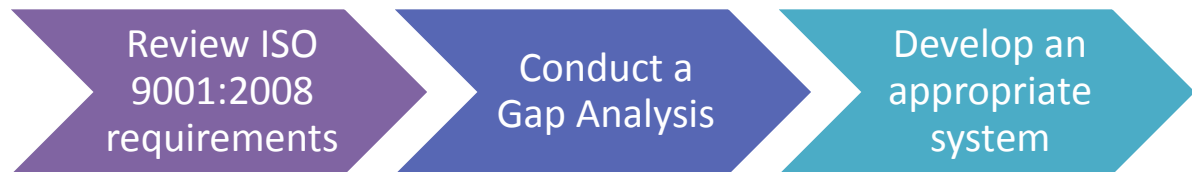
- Improved quality may directly influence the acquisition of tenders.
- Commitment from Management would be a significant problem with the development of a Quality Management System.
- It may take up to two years to fully implement a Quality Management System.
- Staff dedication would be the primary problem with maintaining the system.
- ISO 9001:2008 is recommended by all industries analysed.

6.8 Conclusion on the Literature Review

The ISO 9001:2008 was found to be the best Quality Management System based upon how well the outcomes of the industry survey and the system comparison complied with the company's problem definition.

7 Solution Approach

The following steps were taken to effectively develop a Quality Management System that complies with the requirements of the ISO 9001 Standard and is appropriate to the Company.



7.1 Review ISO 9001:2008 Requirements

The ISO 9001:2008 Standard specifies the requirements for a quality management system that can be used for internal application by organisations with the aim of applying for certification. The ISO 9001:2008 requirements consist of the following:

- **General Requirements**

The Standard requires the organisation to develop, document, implement, and maintain a Quality Management System and continually improve on its effectiveness in line with the requirements as stated by the International Standard by:

- determining the processes needed for the Quality Management System,
- determining the sequence and interaction of these processes,
- determining methods to ensure effective control over these processes,
- ensuring that the needed resources are available to operate and control these processes,
- observe and assess the processes; and
- implement actions and sub-systems needed to ensure continual improvement is achieved.

- **Documentation Requirements**

The Standard mentions only six mandatory procedures to be documented. The development of other operational procedures is encouraged as it ensures control over core and support processes. The Standard requires that the following documentation be developed:

- Quality Policy

- Quality Manual - consisting of the Scope of the Quality Management System, documented procedures and a description of the interaction between processes.
- All necessary documents and records needed to ensure effective control over processes (These documents and records must be controlled to ensure their effective use and retrieval).

- **Management Responsibility**

The Standard requires top management to be committed to the development and implementation of the Quality Management System and the continual improvement thereof.

- **Resource Management**

The Standard requires that the organisation effectively manages and supplies resources needed for the effective development and implementation of the Quality Management System. It is the responsibility of the organisation to ensure human resources are competent to perform work affecting product realisation and that the necessary actions are implemented to ensure their competence.

- **Product Realisation**

The Standard requires that the necessary processes be implemented to ensure product realisation. Where design and development are applicable, the sufficient design reviews, validation of design outputs against inputs and the verification of the product delivered against the needs identified need to be demonstrated.

- **Measurement Analysis and Improvements**

Where the organisation fails to comply with any requirements or delivering a product that does not conform to the requirements it was intended for, necessary actions to correct the non-conformance need to be implemented. It is recommended that effective risk management is implemented to attend to potential non-conformances that may result from unforeseen circumstances. The Standard also requires the organisation to internally audit their Quality Management System to determine whether the system complies with the requirements of the Standard and if the system is effectively implemented. For the organisation to be certified by an accredited institution, sufficient records need to be established as evidence of compliance with the requirements stated in the International Standard.

The results of the Gap Analysis, as indicated in Figure 4 and 5 below, reveals the sufficient need for improvement and development in current processes.

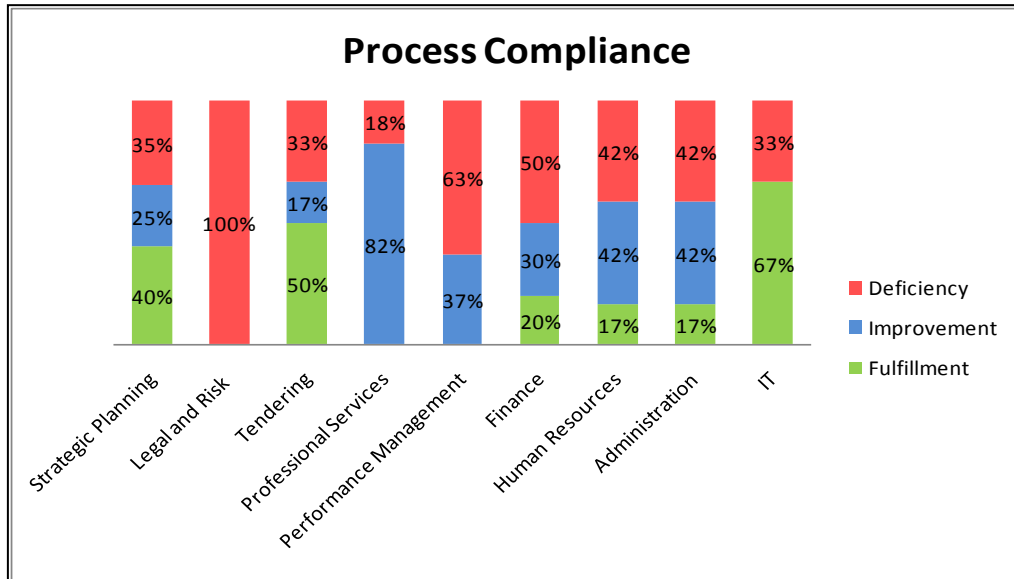


Figure 4 - Process Compliance Graph

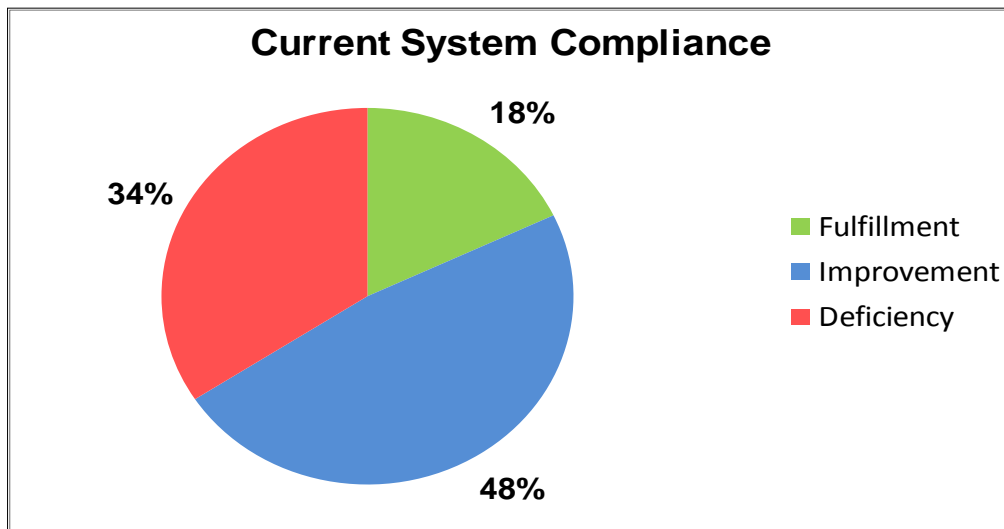


Figure 5 - Current System Compliance Graph

The development of an ISO 9001:2008-based Quality Management System is highly recommended as it would improve the overall business with **82.04%**.

8 System Development

The Afri-Infra Group's Quality Management System has been developed through a Quality Manual that consists of the following:

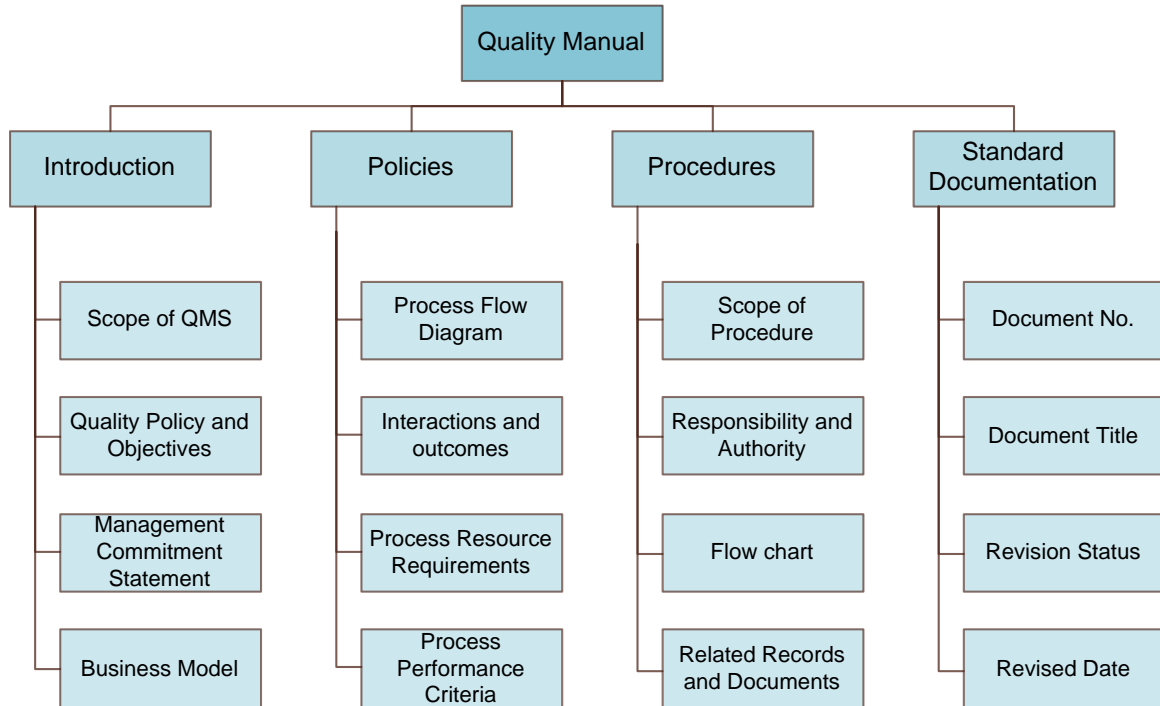


Figure 6 - Quality Manual Breakdown structure

8.1 Introduction

The introduction to the Quality Manual states the scope of the Quality Management System; a Business Model describing the interaction of the processes of the Quality Management System; a Quality Policy; Quality Objectives; and a statement from management declaring their commitment to achieving the Quality Objectives. The Introduction Document is found in Appendix C.

The Quality Policy is based on the Company's vision mission and values, with the aim at customer satisfaction through the effective management of quality. The Quality Objectives were set to adhere to the 5 SMART Principles:

- Specific
- Measurable
- Attainable
- Realistic
- Timely

8.2 Quality Manual Policies

The Quality Manual consists of ten policies describing each of the various processes of the company (For illustration purposes the contents of the Finance Policy will be used).

Each policy consists of the following:

- **Process Objective**

The objective of the process and a short description of the overall process are clearly stated.

- **Process Flow Diagram**

The process flow diagram illustrates the horizontal flow of the specific process from start to finish.

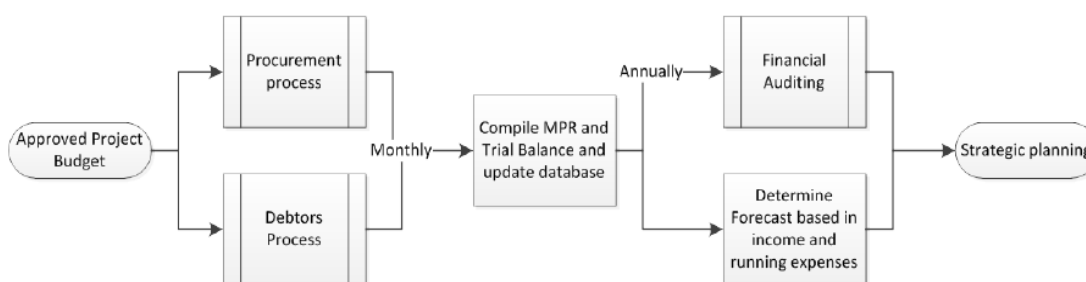


Figure 7 - Finance Process Flow Diagram

- **Interaction Table**

Each process consists of various inputs and outputs that lead to various outcomes. These inputs, outputs and outcomes are illustrated by a Process Interaction Table as shown below in Table 5.

| Inputs | Outputs | Outcomes |
|------------------------------|--|---------------------------------|
| Procurement requests | Records of purchase, invoices and quotes | Income from clients and debtors |
| Petty cash requests | Payments of purchases | Payment of creditors |
| Recommendations from IT | Records of petty cash purchases | Update database |
| Order and disbursement forms | Financial statements | Financial reviews |
| Project Budget | Monthly progress reports | Financial strategic Planning |
| External Audit | Monthly trail balance | Updated database and forecasts |

Table 5 – Finance Process interaction table

- **Activity and Sub-process Description**

A detailed description of the sub-processes and activities in each process as shown in a flow diagram is described in full, with referral to specific agreements, documents, records and procedures.

- **Process Performance Criteria**

The standard requires that the process of the Quality Management System is continually monitored for effectiveness. Each policy states the specific performance measurement criteria applicable to the process that should be measured for continual improvement. The performance measurement criteria for the Finance Process are provided in Table 6 below.

| OBJECTIVE | TARGET |
|--|--|
| Current ratio | Current assets / Current liabilities >1 |
| Profit Margin | Profit Before Tax x 100 / Turnover ≥ 8% |
| Liquidity Ratio | 0.6 < Current Assets / Current Liabilities < 1 |
| Issue all tax forms and instructions on time | 100% accuracy |

Table 6 - Finance Process Performance Criteria

- **Process Resources**

The specific intellectual and physical resources needed for the effective management and operation of the process is stated in the policy and shall be reviewed by management continually.

The complete set of process policies can be referred to on the Quality Manual CD-ROM attached to this document. The Finance Policy is used as an example and is provided in Appendix D.

8.3 Quality Manual Procedures

The International Standard refers to only six mandatory procedures to be documented:

- **Procedure for Document Control**

The aim of *Document Control* is to ensure that:

- documents are approved prior to use;
- documents are reviewed, updated and re-approved;
- changes, and the current revision status is of documents are identified;

- the relevant versions of documents are available at points of use;
- obsolete documents are controlled;
- documents stay legible and easily identifiable; and
- all external documents applicable to the operation of the company are identified and controlled.

All internal and external documents have been revised and amended with a document number, title, revised date, and revision status. As a requirement stated in the *General Management Policy*, personnel shall clearly indicate on a superseded document that the document is obsolete.

To ensure that the relevant versions of documents are available at points of use, a web-based *Afri-Infra Group Global Access File Server* was created. The website ensures that all authorized personnel can access the latest versions of documents from home, office, construction site, or any location where the Internet can be accessed.

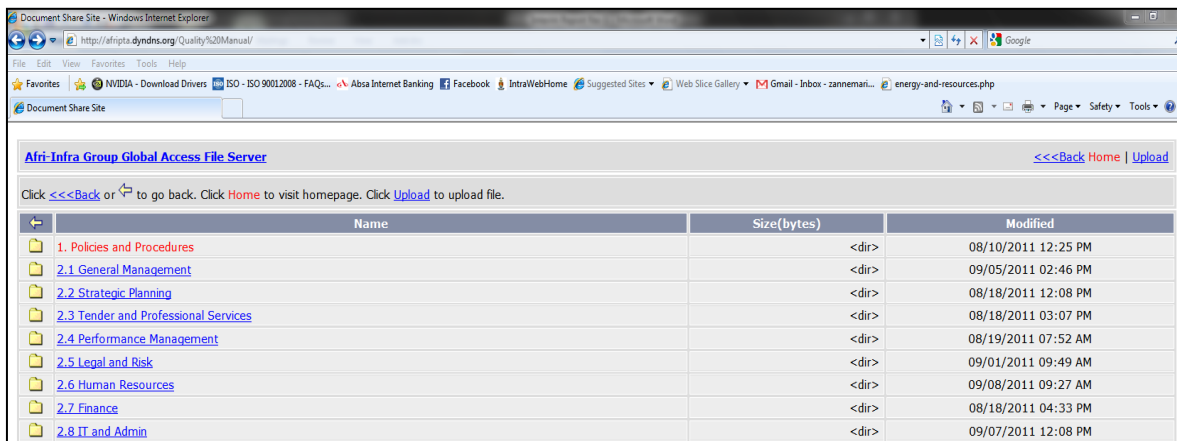


Figure 8 - Document Share Site

The *Procedure for Document Control* is provided in Appendix E.

- **Procedure for Record Control**

Record Control is achieved through the implementation of a *Record Control Register* applicable to each regional office. The register indicates the title, location, retrieval, retention, protection, owner, and disposal of every record kept. Effective record control ensures that the location of any record can be determined easily. A descriptive *Procedure for Record Control* is provided in Appendix F.

- **Procedure for Control of Non-conforming Product**

A documented procedure was developed to ensure that any product/service, which does not conform to its requirements, is identified and controlled, and its unintended delivery or use is prevented. The *Procedure for Control of Non-conforming Service*, as shown in Appendix G, stipulates the appropriate action to take to:

- eliminate the non-conformance;
- authorize its use, release or acceptance;
- prohibit its original use; or
- attend to the effects or potential effects of the non-conformance when detected after delivery.

- **Procedure for Corrective Action**

The *Procedure for Corrective Action*, as shown in Appendix H, was developed to ensure that, when the company fails to adhere to any requirement stated by the client, the company procedures, the Government, or the ISO 9001:2008 Standard, the following actions are taken:

- define the problem;
- determine the root cause;
- establish the appropriate action to take to correct the problem; and
- evaluate the effectiveness of the action implemented.

- **Procedure for Preventive Action**

The *Procedure for Preventive Action*, as shown in Appendix I, is directly related to effective risk management. The process of risk management has been newly developed and implemented within the Company. The steps of effective risk management, as stated in the *Legal and Risk Policy* with reference to ISO 31000:2009 (Organization, International Standards, 2009), is shown in Figure 9 below.

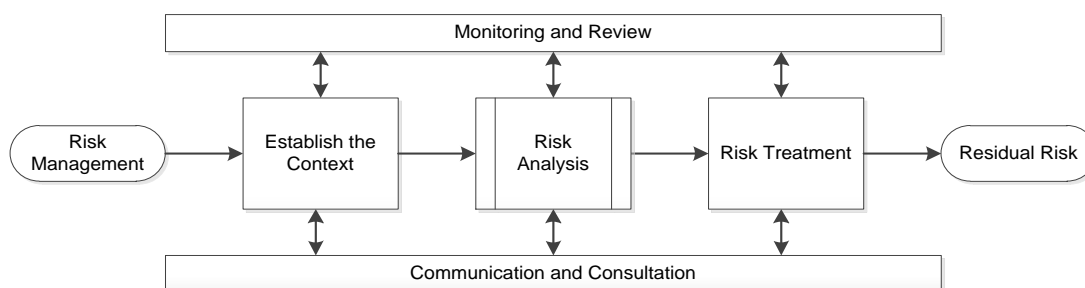


Figure 9 - Risk Management Process

A *Risk Analysis Spreadsheet* was developed in accordance with the Risk Assessment Techniques stipulated in ISO 31010:2009 (Organization, International Standards, 2010) for each stage of a civil engineering project as well as for health and safety in the workplace. The spreadsheet analyses risks based on the probability of occurrence and the severity of the consequences of the risk.

As a result of the risk assessment, preventative actions are taken to mitigate risks or to prevent the occurrence of defects and non-compliance to requirements.

- **Procedure for Internal Audit**

The company shall schedule and conduct internal audits on the Quality Management System according to the *Procedure for Internal Audit* as stated in Appendix J, to determine if the Quality Management System is effectively implemented, maintained, and compliant to the requirements of ISO 9001:2008.

To ensure control over all processes of the Quality Management System, various process-specific procedures were developed and simplified by using flow diagrams. A *Service Level Agreement* between the company and a sub-contractor is recommended to ensure control over outsourced processes.

The complete set of procedures can be obtained on the Quality Manual CD-ROM attached to this document.

8.4 Standard Documentation

The company uses various documents, templates, forms, and checklists as an input to various processes of the Quality Management System. The current documentation were reviewed for adequacy and amended to ensure efficient document control. Various new documents were established and developed in line with the requirements of the International Standard. Some of these documents are:

- **Delegation of Authority Document**

The *Delegation of Authority* document, as shown in Appendix K, is used as a referencing document, specifying the authority personnel have with regards to specific activities.

- **Compulsory Site Clarification Meeting Assessment Form**

The *Compulsory Site Clarification Meeting Assessment Form*, shown in Appendix L, is used when attending a compulsory site clarification meeting. The form analyses whether tendering for the specific project would be financially feasible by reviewing the time required, the scope of the project, and the resources available. This document is essential for client and tender analysis.

- **Project Plan**

The *Project (Quality) Plan*, as shown in Appendix M, was developed to assist in planning and project management. The document clearly states:

- the various roles and responsibilities related to the project;
- the project Gantt Chart;
- the project progress;
- the budget;
- the quality objectives of the project;
- the monitoring and measurement requirements; and
- the methods for validation and verification of the project deliverables.

- **Supplier Evaluation Form**

Suppliers of products and services will be evaluated to determine the effectiveness of the procurement policy and the quality of service received. The *Supplier Evaluation Form* can be referred to in Appendix N.

- **Client Feedback Form**

To effectively measure customer satisfaction, the client is presented with a *Client Feedback Form* as shown in Appendix O.

- **Quality Assurance Checklists**

Quality Assurance Checklists have been developed to verify that the requirements of each stage of a project are attended to. The *Quality Assurance Checklist for Design and Development* is shown as an example in Appendix P.

- **Validation of Measuring Equipment**

The company uses various measuring equipment such as Dumpy Levels, Dynamic Cone Penetrometers (DCP), and measuring tapes. Measuring equipment that is not calibrated may have severe effects on calculations and designs. To ensure that

measuring equipment is regularly tested against an appropriate standard, a *Validation of Measuring Equipment Form*, as shown in Appendix Q, was developed.

- **Management Review**

To ensure continual improvement of the Quality Management System, a Management Review Matrix as shown in figure 10 below, has been developed in conjunction with the appropriate meeting agendas to ensure that the system is reviewed on planned intervals.

| MANAGEMENT REVIEW MATRIX | | | |
|---|---|--|--|
| Forum | Weekly Work Coordination Meetings | Monthly Management Meetings | Half yearly Strategic Meetings |
| Attendance | MD on request Regional Manager All staff of Regional Office | QMS Representative MD Management | MD Management Secretaries (all staff - August) |
| Internal Audit Results | x | x | x |
| Quality Policy | | | x |
| CA/PA Status | x | x | x |
| C@PS | | | x |
| Changes Assessment (QMS) • External and Internal Influences on QMS | x | x | x |
| Customer Feedback/ Complaints | x | x | |
| Design Management | x | | |
| Follow-up on previous Meeting | x | x | x |
| Improvement Recommendations | x | x | x |
| Process Performance Review | | | x |
| Project Status | x | | |

Figure 10 - Management Review Matrix

The complete set of standard internal and external documents can be obtained on the Quality Manual CD-ROM attached to this document.

9 Inspection and Results

Specific areas of the Quality Management System have been implemented during the development stage to inspect the effectiveness of the action taken during development.

- **NCS 001 - 2007/11**

The procedure for Control of Non-conforming Service has been applied to a recent project in Duva Park, Mpumalanga. The problem was inspected, the root causes

identified and appropriate internal and external actions implemented to correct the non-conformance. The *Non-conforming Service Report* for Project 2007/11 Duva Park Roads and Storm Water is shown in Appendix R.

- **Health and Safety Management**

As part of managing the work environment (Clause 6.4) and adhering to the legislation stated by the Occupational Health and Safety Act (The South African Department of Labour, 2004), various safety measures were taken which contributed to a safer work environment.

- **Validation of Measuring Equipment**

Upon inspection of the various measuring equipment used by construction site staff, two Dumpy Levels, a levelling staff and two measuring tapes were found to be defective. Actions were implemented to calibrate the defective equipment and to validate previous measurements.

The actions implemented during the development stage forecast a positive implementation plan that may only be affected by management and employee commitment.

10 Recommendation

The implementation of the ISO 9001:2008-based Quality Management System is highly recommended. The effective management of the system and implementation of the documents developed will increase the probability of international accreditation drastically.

Commitment from management was found to be a major problem with regard to maintenance of the system. Top management is strongly advised to promote the Quality Management System and to ensure the system is clearly communicated to all personnel.

11 References

- AUSTRALIA, Standards. 2006. AS/NZS ISO 9000:2006. *Quality management systems - Fundamentals and vocabulary.*, p.30.
- BRUNET, Paul Paul and Steve NEW. 2003. Kaizen in Japan: an empirical study. *International Journal of Operations and Production Management.*, p.21.
- CESA, Consulting Engineers South Africa. *CESA website.* [online]. [Accessed 20 July 2011]. Available from World Wide Web: < HYPERLINK "file:///F:\ZM\Skripsie\www.cesa.co.za" www.cesa.co.za >
- DE FEO, Joseph A. and William BARNARD. 2005. *JURAN Institute's Six Sigma Breakthrough and Beyond - Quality Performance Breakthrough Methods.* Tata McGraw-Hill Publishing Company Limited.
- DISSANAYAKA, S. M, M. M KUMARASWAMY, and K KARIM. 2001. Evaluating outcomes for ISO 9000 - certified quality systems for Hong Kong constructors. *TOTAL QUALITY MANAGEMENT, VOL. 12, NO. 1.*, p.12.
- JOHN C. ANDERSON, Manus Rungtusanatham and Roger G. Schroeder. 1994. A Theory of Quality Management Underlying the Deming Management Method. *The Academy of Management Review Vol. 19, No. 3.*, p.38.
- KENNEDY, William. 2010. Implimenting ISO 9001:2008. *In: The Implimentation of a Quality Management System for Consulting Engineers.* Johannesburg: CESA, p.93.
- LABOUR, The South African Department of. 2004. *Amended Occupational Health and Safety Act No 85 of 1993.* Cape Town: Department of Labour.
- ORGANIZATION, International Standards. 2009. *ISO 31000:2009.* Pretoria: SABS Standards Division.
- ORGANIZATION, International Standards. 2009. *ISO 9001:2008 Quality Management System - Requirements.* Pretoria: SABS Standards Division.
- ORGANIZATION, International Standards. 2010. *ISO 31010:2009 Risk Management - Risk Assesment Techniques.* Pretoria: SABS Standards Division.
- SCHALKWYK, H van. 2011.

12 Appendices

Appendix A: Project Gantt chart

Appendix B: Resource Rates

| RESOURCE NAME | RATE |
|--------------------------|---------------|
| Surveyor | R 1,500.00/hr |
| Geotech Eng | R 1,500.00/hr |
| EIA Official | R 1,500.00/hr |
| NDM Ad. Cost | R 2,500.00/hr |
| Waiting time | R 0.00/hr |
| 1320/12 Disb Equiliser | R 772.82/hr |
| Lundie BC | R 1,747.68/hr |
| Bisschoff F | R 999.92/hr |
| Lombard G | R 681.77/hr |
| Dumas H | R 599.10/hr |
| Jooste E | R 553.90/hr |
| Watts AD | R 565.22/hr |
| Prinsloo C | R 647.77/hr |
| Parsons G | R 364.99/hr |
| Small FG | R 299.60/hr |
| Grobler H | R 370.91/hr |
| Lundie CH | R 445.41/hr |
| Mulder R | R 291.13/hr |
| Boshoff L | R 196.12/hr |
| De Bruin K | R 256.04/hr |
| Mulelu T | R 239.00/hr |
| Zimu S | R 213.64/hr |
| Mokgokong MM | R 156.04/hr |
| Basson F | R 196.84/hr |
| Van Niekerk Z | R 126.22/hr |
| Van Den Bergh C | R 136.54/hr |
| Nel N | R 139.81/hr |
| Ratau PB | R 97.37/hr |
| De Lange M | R 151.30/hr |
| Mathebe SD | R 226.19/hr |
| Grove Z | R 273.75/hr |
| Curlewis A | R 269.64/hr |
| Davel H | R 101.70/hr |
| Schwab J | R 97.41/hr |
| Vermeulen D | R 80.39/hr |
| Van Den Heever M | R 104.13/hr |
| Khoza PC | R 53.71/hr |
| Kekana MS | R 45.29/hr |
| Thebethe MM | R 57.51/hr |
| Geotechnical Engineer | R 1,000.00/hr |
| Environmental Specialist | R 500.00/hr |
| Topographical Surveyor | R 700.00/hr |
| Not Applicable | R 0.00/hr |
| Observer Advertising | R 2,000.00/hr |

Appendix C: Quality Manual - Introduction

Appendix D: Quality Manual - Finance Policy

Appendix E: Procedure for Document Control

Appendix F: Procedure for Record Control

Appendix G: Procedure for Control of Nonconforming Service

Appendix H: Procedure for Corrective Action

Appendix I: Procedure for Preventive Action

Appendix J: Procedure for Internal Audit

Appendix K: Delegation of Authority Document

Appendix L: Compulsory Site Clarification Meeting Assessment Form

Appendix M: Project Plan

Appendix N: Supplier Evaluation Form

Appendix O: Client Feedback Form

Appendix P: Quality Assurance Checklist for Design and Development stage

Appendix Q: Validation of Measuring Equipment Form

Appendix R: Nonconforming Service Report - Duva Park