

Identifying criteria for a quality management system in a construction company

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ABSTRACT

Quality has become an essential element in completing a construction project in South Africa. In the last decade, various construction failures have been reported in the news, with some incident causes directly related to poor quality work. Through incidents like these, companies have realised that a good quality product is crucial in commercial development and success (Dharani & Ganapathy Ramasamy, 2015:605). Quality is also an essential and competitive strategic tool that various companies have implemented to ensure product and service development (Dilawo & Salimi, 2019:1138; Masindi, 2019:24) as customers evaluate construction companies based on their reputation for quality, reliability, price, and delivery (Emuze & Mhlwa, 2015:1225). This reality creates a challenge for various small to medium-sized companies as they are not equipped or experienced in implementing a quality management system (QMS). This is exacerbated by a lack of QMS guidelines in South Africa, causing various companies to implement a partial QMS or no QMS at all.

The study investigated a QMS in a South African construction company. The primary objective of the study was to identify five criteria for the implementation of a QMS. This qualitative study included three companies within the construction industry specialising in three sectors, namely, building, civil and mechanical works. Nine participants were interviewed, using open-ended questions to gain data to answer the primary and secondary objectives of the study.

Four themes were identified relating to implementing a QMS, benefits and limitations, criteria for implementation and recommendations for implementing a QMS. A new amended model for implementing a QMS was designed and discussed to provide implementation guidelines and recommendations for construction companies, especially small to medium companies that finds it difficult to achieve ISO accreditation. A matrix provided correlate comparative findings between literature and findings of the study.

Keywords: quality management system, criteria, principles, construction, implementation.

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LIST OF DEFINITIONS AND ABBREVIATIONS

The following terms and abbreviations are present in the research document. They will be briefly described to allow the reader a better understanding when encountered.

B-BBEE	Broad-based Black Economic Empowerment
Competence	The demonstrated ability of a person or company to apply knowledge and skills
Cross-sectional survey	A study aimed to analyse data from a group/population at a certain point in time
Customer satisfaction	The level or degree to which the customer's requirements or standards have been achieved
ISO	The International Company for Standardisation is a body setting the standards on various products, systems, and services
Management System	A system utilised to establish quality policies and objectives aiming to achieve those objectives
Population	Refer to all members of a defined group
Procedure	The specific way an activity or process is carried out
Project	A process consisting of coordinated and controlled activities with from start to finish, undertaken to reach the set goal of what is to be installed, built or manufactured to achieve objectives in terms of time, budget and quality
Participants	Individuals partaking in the research interviews
Qualitative study	Qualitative research is exploratory research implemented to gain an understanding of the underlying reason, opinion, and motivations of participants
Quality	The degree to which identified characteristics fulfil quality requirements.

Quality control (QC)	The part of quality management that focused on the complete fulfilment of the set quality requirements
Quality objective	Objectives set out in terms of the quality of work to be performed to achieve the final product
Quality management principle (QMP)	A specific set of fundamental beliefs, norms, rules and values implemented to perform and complete work to set standards
Quality management system (QMS)	A management system implemented intending to direct and control quality within a company
Quality policy	Overall intentions and direction set by the management of a company related to quality
SMME	Small, Medium and Micro Enterprises
Snags	A list of items to be repaired/replaced/fixed to achieve good quality construction work.

TABLE OF CONTENTS

ABSTRACT	I
ACKNOWLEDGEMENTS	III
LIST OF DEFINITIONS AND ABBREVIATIONS	IV
TABLE OF CONTENTS.....	VI
LIST OF TABLES	XIII
LIST OF FIGURES.....	XIV
CHAPTER 1 INTRODUCTION AND PROBLEM STATEMENT	1
1.1 Introduction	1
1.2 Background	1
1.3 Setting of the study	3
1.4 Problem statement	4
1.5 Research motivation	5
1.6 Objectives of the study	6
1.6.1 Primary objective	6
1.6.2 Secondary objectives.....	6
1.7 Scope of the study.....	6
1.8 Research methodology	7
1.8.1 Literature review	7
1.8.2 Empirical investigation	8

1.8.2.1	Research approach	9
1.8.2.2	Study population and sample.....	9
1.8.2.3	Collection of data.....	10
1.8.2.4	Analysing the data	10
1.9	Limitations of the study	11
1.10	Layout of the study.....	12
1.11	Chapter summary	13
 CHAPTER 2 LITERATURE REVIEW.....		14
2.1	Introduction	14
2.2	The construction industry explained	14
2.2.1	The South African construction industry.....	14
2.2.1.1	South African regulatory bodies	14
2.2.1.1.1	Construction Industry Development Board.....	15
2.2.1.1.2	National Home Builders Registration Council.....	17
2.2.1.1.3	South African Bureau of Standards.....	18
2.2.2	The link between construction and quality	18
2.3	Construction challenges and issues.....	19
2.4	The effect of the 4IR on construction.....	19
2.5	Quality overview	20
2.5.1	Quality control and quality management systems	20
2.6	Quality Management systems	21

2.6.1	ISO 9000	22
2.6.2	ISO 9000 and 9001 principles.....	24
2.6.2.1	Customer focus	25
2.6.2.2	Leadership.....	25
2.6.2.3	Engagement of people.....	26
2.6.2.4	Process approach.....	26
2.6.2.5	Improvement	26
2.6.2.6	Evidence-based decision making.....	27
2.6.2.7	Relationship management	27
2.6.3	Elements in ISO 9001 implementation.....	28
2.6.3.1	Process approach.....	28
2.6.3.2	Plan-Do-Check-Act Cycle	29
2.6.3.3	Application of PDCA cycle in a construction QMS	30
2.6.4	Benefits of QMS implementation.....	31
2.7	Criteria for QMS development and implementation	33
2.7.1	Guidance for QMS implementation	33
2.7.2	Criteria for QMS implementation.....	33
2.8	The effect of 4IR on QMS implementation	37
2.9	Current research.....	38
2.10	CHAPTER CONCLUSION	38
CHAPTER 3	RESEARCH METHODOLOGY	39

3.1	Introduction	39
3.2	Research approach	39
3.2.1	Research design.....	40
3.3	Data collection	41
3.3.1	Sampling design	42
3.3.1.1	Sample size.....	43
3.3.1.2	Development of data collection tool	44
3.3.1.3	Interview questionnaire.....	44
3.3.1.4	Transcribing the interview	44
3.3.1.5	Coding and data analysis	45
3.3.1.6	Trustworthiness of the data.....	48
3.3.2	Ethical considerations.....	50
3.3.2.1	Permission and informed consent.....	51
3.3.2.2	Anonymity and confidentiality	51
3.3.2.3	Confidentiality	52
3.4	Chapter summary	52
 CHAPTER 4 ANALYSIS OF RESULTS.....		53
4.1	Introduction	53
4.2	DEMOGRAPHIC INFORMATION	53
4.3	IMPLEMENTATION OF A QMS.....	54
4.3.1	Tools used.....	56

4.3.1.1	Online	57
4.3.1.2	Paper-based	59
4.3.2	Persons responsible	60
4.3.3	Training on QMS	62
4.3.3.1	Formal training.....	63
4.3.3.2	Informal training.....	64
4.3.4	Achieving quality objectives	65
4.3.4.1	Project process.....	66
4.3.4.2	Time to complete QMS	68
4.3.4.3	Top management involvement.....	70
4.3.4.4	Motivation of staff	71
4.4	BENEFITS AND LIMITATIONS OF A QMS	72
4.4.1	Benefits	74
4.4.1.1	Client satisfaction	75
4.4.1.2	Financially	75
4.4.1.3	Quality assurance.....	75
4.4.1.4	Protect manager and company.....	77
4.4.1.5	Marketing value	78
4.4.1.6	Increase competitive edge.....	78
4.4.1.7	Foundation of positive company culture.....	79
4.4.2	Limitations	80
4.4.2.1	Human resources	81

4.4.2.2	Time constraints	82
4.5	FIVE (5) CRITICAL CRITERIA of a QMS.....	84
4.5.1	Knowledge.....	85
4.5.2	Training	85
4.5.3	Planning	86
4.5.4	Inclusion of all departments	87
4.5.5	Proper documentation	88
4.6	RECOMMENDATIONS FOR IMPROVEMENT OF A QMS	89
4.6.1	Holistic approach to QMS implementation	89
4.6.2	Project planning.....	90
4.6.3	Completion of quality assurance	91
4.7	CHAPTER SUMMARY.....	91
CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS		92
5.1	Introduction	92
5.2	Findings – Literature study.....	92
5.2.1	ISO principles as the foundation of a QMS	92
5.2.2	Quality Management Principles	93
5.2.3	Benefits of QMS implementation.....	94
5.2.4	Criteria for QMS implementation.....	94
5.2.5	Adaptation to technology advances and 4IR.....	95
5.2.6	Benefits and limitations of QMS.....	96

5.3	Findings – Empirical study	97
5.3.1	Implementation of a QMS	97
5.3.2	Benefits and limitations of QMS	101
5.3.3	Five (5) critical criteria in QMS	102
5.4	Recommendations to construction companies	105
5.4.1	Implementation of a QMS	105
5.4.1.1	Tools used	105
5.4.1.2	Persons responsible	106
5.4.1.3	Training on QMS	106
5.4.1.4	Achieving quality objectives	107
5.4.2	Benefits and limitations of a QMS	108
5.4.3	Five (5) critical criteria of a QMS	108
5.4.4	Recommendations for improvement of a QMS	109
5.5	Achievement of the objective of the study	113
5.6	Recommendations for future research	115
5.7	Chapter Summary.....	116
	REFERENCES.....	117
	LIST OF APPENDICES	125
	APPENDIX A – ETHICS APPROVAL.....	126
	APPENDIX B – LANGUAGE EDITING CERTIFICATE.....	127
	APPENDIX C – PARTICIPANT CONSENT FORM	128

APPENDIX D – INTERVIEW QUESTIONS	129
APPENDIX E – SAMPLE OF AN INTERVIEW	130
APPENDIX F – SOLEMN DECLARATION AND PERMISSION TO SUBMIT	135
APPENDIX G – TURN IT IN SUMMARY.....	136

LIST OF TABLES

Table 1-1 Data analysis phases	11
Table 2-1. CIDB classes of construction work	15
Table 2-2 CIDB determining financial capability	16
Table 2-3 CIDB CE designation representation North West Province.....	17
Table 2-4 ISO 9000 and ISO 9001 comparison	23
Table 2-5 ISO 9001 benefits.....	32
Table 3-1 Sample selection for the study.....	43
Table 3-2 Transcribing guidelines and rules	45
Table 3-3 Content analysis phases.....	46
Table 3-4 An amended 15 point checklist criteria for quality proper content analysis.....	47
Table 4-1 Demographic information of the participants.....	53
Table 5-1 Benefits of a QMS	94
Table 5-2 Benefits comparison literature vs empirical.....	102
Table 5-3 Criteria comparison between literature and empirical study.....	104

LIST OF FIGURES

Figure 1-1 Chapter layout by the researcher 12

Figure 2-1 Seven Quality Management Principles 24

Figure 2-2 ISO 9000 prescribed PDCA cycle process 30

Figure 2-3 An adopted theoretical framework for QMS implementation 35

Figure 2-4 Schematic QMS on construction project targets 36

Figure 3-1 Data collection process 42

Figure 4-1 Theme 1-Implementation of a QMS with subthemes 56

Figure 4-2 Microsoft Project project application example..... 57

Figure 4-3 Achieving quality objectives and sub-sub-themes..... 66

Figure 4-4 Benefits vs Limitations of a QMS..... 74

Figure 4-5 Five criteria for a QMS 84

Figure 5-1 ISO 9001 Model generated 109

Figure 5-2 Amended QMS application model 110

CHAPTER 1 INTRODUCTION AND PROBLEM STATEMENT

1.1 INTRODUCTION

This study identifies criteria for a quality management system (QMS) in a South African construction company. It is a qualitative study based on three construction companies established in the building, civil, and mechanical industries. This chapter elaborates on the background of the study and the problem statement supported by the research motivation. Primary and secondary objectives investigated during the study are presented together with the methodology used to achieve the mentioned objectives. Limitations of the study are also provided. The chapter concludes with an overview of the study's structure, explicitly describing the report's layout to follow.

1.2 BACKGROUND

The construction industry in South Africa delivers its projects and products in a very complex and unique environment. This creates a volatile business environment where companies are continuously striving to secure new work to be sustainable. To safeguard projects, processes are followed where companies need to portray their skill and competency. They must offer various solutions and have a good record in completing projects on time, within budget, and to a high-quality standard.

Quality has become an essential element in completing a construction project (CIDB,2020a; Dharani & Ganapathy Ramasamy, 2015:604; Masindi, 2019:11; Odiba, Demian & Ruikar, 2021:2). Companies have realised that a good quality product is crucial in commercial development and success (Dharani & Ganapathy Ramasamy, 2015:605; Karimi & Pimplikar, 2020:3620). Quality is highlighted as an essential and competitive strategic tool that various companies have implemented to ensure continuing success for product and service development (Dilawo & Salimi, 2019:1138; Masindi, 2019:24).

Construction companies are evaluated based on their reputation for quality, reliability, price, and delivery (Emuze & Mhlwa, 2015:1225). Due to the recognisable importance, significance, crucial value, and advantages to a company's competitive edge, the value of good quality is further iterated. Once a company is associated with poor quality, it takes tremendous effort to shake off that reputation (Emuze & Mhlwa, 2015:1226).

Ensuring quality work is delivered is only one-way companies can ensure they stay ahead in the vigorously competitive South African construction industry (Emuze & Mhlwa, 2015:1225; Rehmani, Ahmad, Naseem & Syed, 2020:1). Quality of work is taken into account when focussing on the satisfaction of internal and external stakeholders, all in an effort to build a good reputation (Emuze & Mhlwa, 2015:1225). Even though the importance of quality is known, literature is full of examples of projects either not being completed or receiving non-conformances to specific site quality objectives and requirements (Aigbavboa & Thwala, 2014:775; Avelar, Meiriño & Tortorella, 2019:362; Emuze & Mhlwa, 2015:1225; Hussain, He, Iqbal, Ahmed & Taskheer Mumtaz, 2019:1; Karimi & Pimplikar, 2020:3620; Masindi, 2019:14). These deviations can significantly affect competitiveness and reputation and reflect on the industry's norms and standards (Avelar *et al.*, 2019:362; Emuze & Mhlwa, 2015:1225; Hussain *et al.*, 2019:1; Rehmani *et al.*, 2020:2).

Ninety-five per cent of all operating companies worldwide are small, medium and micro enterprises (SMMEs) (Bianchi & Ferraz, 2020:2). Furthermore, the South African government continuously promotes the employment of local labour and sub-contracting on government projects to increase work opportunities for SMMEs (SAICE, 2015). However, the principal contractor stays responsible for delivering a product that needs to be on time, on budget, and of good quality, regardless of whether a local sub-contractor performed the work. In this way, the role of quality is becoming more critical due to local requirements outside the contractor's control. Various studies supported the vital importance of promoting quality on the global stage and in South Africa (Rehmani *et al.*, 2020:2) and concluded that the local construction industry could benefit significantly from increased quality (Avelar *et al.*, 2019:362; Bianchi & Ferraz, 2020:1; Chountalas & Tepaskoualos, 2019:12; Ershadi, Najafi & Soleimani 2019:1093; Ibrahim, 2019:163; Jeong, Kim & Jung, 2017:2139; Neyestani, 2016:4; Rehmani *et al.*, 2020:2). The studies further focused on the causes and results of poor work quality resulting from inadequate or lack of a quality management system.

The cost and availability of a Quality Management System (QMS) make it difficult for the average construction company to comply with International Organization for Standardization (ISO) standards. ISO developed standards and procedures resulting in the implementation of QMSs, assisting the contractor in delivering good quality products (Bravi, Murmura & Santos, 2019:64; ISO,2020). However, the cost, requirements, and implementation are a tall order for most South

African small to medium companies. The result is limited to the non-existent implementation of QMS versions.

As a result, are many companies do not implement any system at all. The lack of QMS systems in construction companies is evident in the quality of work and projects not being completed (Karimi & Pimplikar, 2020:3). The involvement of local sub-contractors in government projects further put pressure on the principal contractor. With South Africa's unique requirements regarding local labour, local sub-contracting, and Broad-Based Black Economic Empowerment (BBBEE), one can argue that implementing and developing a QMS tailored for the South African market would benefit the contractors and clients. This will ultimately enable better performance and completion of projects.

1.3 SETTING OF THE STUDY

All South African contractors working in the civil industry and particular public sector projects must be enrolled at the Construction Industry Development Board (CIDB) (CIDB, 2020a). According to experience and projects completed, contractors are graded according to registered focus areas in designated levels, such as civils (CE) or building (GB). The classification is done in relation to the size of the projects completed. The grading received from CIDB will allow contractors to tender only within the limit of their graded level. When a contractor receives a grading of 7 CE, can the company tender on projects falling into the civil section to the upper limit of R60 000 000,00.

Contractors utilised for the study operate in the civil (CE) and general building (GB) fields with a grade of 7 to 9, as illustrated in Table 2-2 below. A CIDB grading is not subject to the approval of a QMS or required to be ISO registered or compliant. Construction companies are not required when tendering on government tenders to be ISO 9001 registered. As a result, companies can implement their own QMS format. The guidelines for QMS implementation in South Africa are vague, resulting in limited execution and performance, especially in small to medium companies. It is no longer required to submit formal QMS documentation or registration to a body to be considered for a project (Fisher, 2016:18). Determining criteria for QMS implementation can assist and benefit construction companies and the industry (Karimi & Pimplikar, 2020:3).

CIDB grading is merely one way to distinguish between contractor quality and experience. One of the industry's biggest mistakes is evaluating a contractor's quality on the companies' value or

CIDB rating/grading. CIDB has no correlation to the level of quality of work presented or the companies level of QMS implemented.

1.4 PROBLEM STATEMENT

Various studies determined recommendations on the process of how to obtain a quality certificate. Still, information on the design and implementation of a QMS in a construction company is lacking (Bianchi & Ferraz, 2020:3; Lukichev & Romanovich, 2016:1717; Neyestani, 2016:2). Despite a lack of implementation information, the construction sector received tremendous interest due to the warranty mark indicating eligibility for higher value construction contracts. To ensure a construction company's survival and effective operation, the need for QMS development and implementation or improvement is of utmost importance (Rehmani *et al.*, 2020:2).

Various small to medium construction companies have difficulty in completing projects, especially on a sub-contractor level. This affects the principal contractor in achieving a quality project on time and within budget. The lack of training, understanding and implementation of a QMS is causing pressure to complete projects. As such, the availability of a QMS that applies to the South African standards, affordable and manageable, would greatly benefit principal and sub-contractors. Effective implementation of a QMS may prevent or limit construction accidents caused by structural failure. The South African construction industry was repeatedly in the news the last ten years due to multiple structure failure accidents that could've been prevented or limited if adequate QMS had been implemented (Department of Employment and Labour, 2017; Swift, 2012).

Establishing requirements and criteria of a QMS for the South African construction industry SMMEs would enable more companies to comply with quality standards. To resolve the ongoing problems is the first step to establishing criteria requirements for implementing a QMS in a construction company. The result may assist principal contractors in the selection and managing of sub-contractors. Secondly, the importance of top-down implementation of QMS is necessary for any company. The involvement and attitude from top management toward QMS indicates how the system is implemented further down the hierarchy.

Most companies are stranded during the implementation phase of a QMS. An implementation plan or guideline would enable small to medium-sized construction companies to start

implementing a QMS. Therefore, this study is intended to answer the primary research objective by identifying criteria for a QMS in a construction company.

1.5 RESEARCH MOTIVATION

The availability of criteria for an effective QMS would greatly benefit small to medium-sized construction companies, who typically are not able to afford the cost of an accredited QMS system equivalent to ISO. Implementing such a QMS would enable contractors to increase compliance and increase quality products' delivery, resulting in an improved company reputation. The availability of criteria and an implementation plan would further assist top management in enabling a mindset and attitude change towards implementing a QMS.

Most QMS's are paper-based, and implementation takes a lot of time from the site manager's day. A streamlined, online-based QMS will enable managers to utilise the system online, enabling top management and consultants to have immediate access to and availability of the updated documents and results. Various other benefits could accrue from the study (Bianchi & Ferraz, 2020:3; Karimi & Pimplikar, 2020:3622; Lukichev & Romanovich, 2016:1717; Neyestani, 2016:2; Odiba *et al.*, 2021:3) :

- Identification of possible critical causes of poor quality on construction sites.
- Propose quality improvement strategies and solutions to causes identified.
- Propose better methods of improving the QMS.
- Suggestions for the effective implementation of quality awareness in construction companies.
- Identifying required skills that can help in improving the quality of products in a manufacturing environment; and
- Identify factors that will help principals and sub-contractors work together to deliver a good quality project.

An outline of the study objectives is provided below.

1.6 OBJECTIVES OF THE STUDY

The research objectives were divided into primary and secondary objectives.

1.6.1 Primary objective

This research's primary objective was to identify critical criteria required in a QMS for a construction company. Due to South African contractors' diversity and backgrounds, it would be unrealistic for all contractors to comply with ISO standards. However, it does not take away that all contractors must fulfil and comply with specific construction standards. By implementing the critical criteria into their QMS, construction companies should comply with the minimum requirements to complete a project regardless of size.

1.6.2 Secondary objectives

The following secondary objectives were identified to support and achieve the primary objectives of the study:

- To conduct a literature review to identify barriers and enablers for implementing a QMS in a construction company.
- Empirically determine the management perception of the criteria necessary for a successful QMS.
- Empirically identify guidelines for the implementation of a QMS in a construction company.
- To determine the influence of 4IR on the criteria for the successful implementation of a QMS.

1.7 SCOPE OF THE STUDY

This study involved investigating principles and criteria related to QMS implemented in a South African construction company. Furthermore, it reviewed benefits and limitations when implementing a QMS.

Three companies participated in the study, all registered with the CIDB. Contractors utilised for the study operate in the civil (CE) and general building (GB) fields with a grade of 7 to 9.

1.8 RESEARCH METHODOLOGY

The following section summarises the methodology used to conduct this research. Sub-sections 1.8.1 and 1.8.2 present the research design's two areas applied for the study: the literature review and the empirical study.

The empirical study elaborates on the research question, formulation of the grounded theory, sample and sampling techniques, and the interview questionnaire. Issues and challenges experienced during the study are outlined, and the statistical analysis is also provided.

1.8.1 Literature review

A literature review was conducted with the primary aim to identify, analyse and explain current and available research on the research topic related to the implementation of a QMS. This allowed the researcher the opportunity to provide a sound theoretical foundation and context for this study:

The following topics were covered in the literature study:

- The construction industry: focussing on the South African construction industry, South African regulatory bodies, and the link between construction and quality.
- Construction challenges and issues.
- Quality overview: quality control and quality management systems.
- Quality management systems: a review of ISO 9000, ISO 9001, ISO principles, elements in ISO 9001 implementations and benefits of QMS implementation.
- Criteria for QMS development and implementation.
- The effect of the fourth industrial revolution on QMS implementation in construction.
- Review of current research.

The literature review was conducted by studying relevant scientific journals, articles, books and research documents. The following databases and search engines were consulted: Internet, SACat: National catalogue of books and journals in South Africa, Emerald: International Quality journals, Premier, Communication and Mass Media Complete and EconLit, EbscoHost: International journals on Academic Search Premier, Business Source and SAePublications: South African journals.

Keywords included: Quality management, quality management system criteria, construction, South Africa, ISO, 4th Industrial Revolution.

1.8.2 Empirical investigation

One of the primary considerations for a qualitative approach is that it allows the researcher to discuss the theories and research directly with the participants, to gather and share personal experiences and views about QMS implementation (Bryman, Bell, Hirschsohn, du Toit, dos Santos, Wagner, Van Aardt & Masenge, 2018:42). To enable the researcher to meet the study's objectives, the research needed to be qualitative. Qualitative data analysis further aims to identify inherent patterns. Therefore, this method enabled the researcher to structure the design to accommodate and categorise items to answer the various research objectives (Bryman *et al.*, 2018:64; Cohen, Manion & Morrison, 2018:301).

The flexible nature of qualitative methods can help handle and overcome complex and challenging situations by changing or making alterations to, for example, the semi-structured interviews (Bryman *et al.*, 2018:224). The empirical research was based on the observation, analysis and measurement of the participant's actual experiences, opinions and beliefs related to the specific topic. The qualitative research approach assisted in conducting interviews in the participants' natural setting, allowing the researcher to understand a QMS better and identify criteria for an effective QMS in a construction company.

Content analysis is an inductive process where volumes of raw text data containing employees' honest and personal comments, perceptions and opinions (Creswell, 2012:214; Nieuwenhuis, 2020a:123) regarding the theory were systematically examined and compacted into content categories by following coding rules (Nieuwenhuis, 2020a:126). Consequently, the raw text data was developed and structured into themes, concepts, explanations, interpretations, understandings and summaries, which expansively explained the theory under study (Cohen *et al.*, 2018:645). The four steps applied during content data analysis were preparation, coding, categorising, and interpreting the transcribed text regarding the criteria and understanding of a QMS in a construction company (Nieuwenhuis, 2020a:134).

1.8.2.1 Research approach

A cross-sectional survey design was utilised for the study due to its association with social surveys (Bryman *et al.*, 2018:107). Exploratory research was used by making use of semi-structured interviews conducted with the sample group. Due to the possibility of using this method during the qualitative study and the data collection on more than one case at a single point in time, this method was best suited for this study (Bryman *et al.*, 2018:106). The interviews were transcribed, which enabled the research to identify codes. The codes were evaluated, organised and grouped into themes, sub-themes and categories.

It enabled the researcher to define critical criteria for implementing a QMS in a South African construction company. Furthermore, the researcher described the benefits and limitations of QMS implementation and recommendations gathered from the interviews.

1.8.2.2 Study population and sample

In this study, the sample comprised of purposively selected employees and managers in construction companies. Initially, the unit of analysis was restricted to only civil construction companies. The motivation behind this was to evaluate the implementation of a QMS amongst civil construction companies only. Upon further investigation into the construction industry, the conclusion was that companies specialising in general building could contribute significantly to the research. The quality criteria in the general building do have parallel similarities to the civil sector, although significant differences do exist.

The sample group comprised three construction companies with CIDB ratings between 7-9 CE (civils) and GB (general building). The initial study planning included at least five companies, but COVID restrictions and the pressures experienced due to COVID in the industry greatly affected the ability of companies to participate. All participating companies are situated in the Dr Kenneth Kaunda District within the North West province. The one company is where the researcher is employed, and two other companies are within the researcher's network. Nine interviews across the three companies were conducted with employees ranging from Site clerks to top management.

1.8.2.3 Collection of data

Data collection is the systematic approach or tools utilised to gather information (data) from various sources. It can include but is not limited to groups, individuals, text and but not limited to any other source of medium (Nieuwenhuis, 2020b:82). In this study, two types of data collection methods were applied. The first was a literature review done to gather background into the concept of a QMS and various historical data presented in previous studies about QMS implementation. The information gathered was used to compare data found in this study with other studies done internationally and in South Africa on the same topic.

The second method was semi-structured interviews conducted with participants working for companies working within the civil and general building construction sectors. All the companies and participants chosen for the purposeful and snowball samples have given written consent. The open-ended questions aimed to allow probing and were done face-to-face at the offices of the companies. All interviews were recorded and transcribed. The completed transcribed interviews were used for the data analysis of the study.

1.8.2.4 Analysing the data

Qualitative content analysis was utilised while focusing on the text's content, underlying themes, and meaning. A conventional content analysis using coding categories and readers identified keywords under each questionnaire and interview questions (Bryman *et al.*, 2018:301). To enhance and ensure a meaningful investigation, the data analysis for the study was grounded as an interpretive philosophy of the collected qualitative data (Nieuwenhuis, 2020a:123). The qualitative data analysis turned the participants' experiences, knowledge, and views into new findings to establish criteria for a QMS for a construction company. It further assisted in answering the research questions. This inductive process enabled the researcher to process raw text data containing the participants' views, feeling, experiences, opinions, and knowledge after a systematical examination of the data (Nieuwenhuis, 2020a:123). The data was categorised by following a set of coding rules (Nieuwenhuis, 2020a:126).

Table 1-1 Data analysis phases

PHASES	DESCRIPTION OF PROCESS
Preparation	Prepare the transcribed text for analysis
Coding	Code the text into meaningful analytical units
Categorising	Coded text data will be processed by categorising it into various codes into a system to grasp its meaning allocating themes
Interpreting the data	Processed data will be interpreted to synthesise answers to the research questions

Source: (Bryman et al., 2018:337; Nieuwenhuis, 2020a:141)

ATLAS.ti™, a computer program used in qualitative research data analysis, was utilised for this study. ATLAS.ti™ is a sophisticated tool to assist researchers in arranging, reassemble, and managing materials and data in a systematic but creative way (ATLAS.ti, 2020). The results and findings of the different sections are discussed using graphs and descriptions of the qualitative data gathered during the research. A critical assessment and interpretation of each interview question will be addressed.

1.9 LIMITATIONS OF THE STUDY

The main limitation experienced in the study was that a limited number of employees of each of the identified participating companies was utilised. Due to COVID-19 regulations set out by the South African Government, face-to-face interaction was restricted during lockdown level 4. Companies restricted interaction with staff. Several participants were uncomfortable conducting interviews over online platforms like Microsoft Teams and Zoom. Therefore the results of the study may not be an accurate representation of those in the industry. The reality of COVID-19 and the pressure is placed on the industry were dually noticeable, limiting the companies willing to participate in the study.

Further, there was no way of capturing the participants' true feelings, measuring how truthful they were or assessing how much thought was put into answering the interview questions. Despite efforts taken to the contrary, it is unsure whether participants took enough time to think before answering the questions within the situation's full context.

The one company that participated was the same company where the researcher is employed. To ensure the researcher didn't influence those interviews, all interviews with participants at the specific company were interviewed by an independent person.

1.10 LAYOUT OF THE STUDY

The research paper contains five chapters. For a graphical illustration of the chapter layout, refer to Figure 1-1 below.

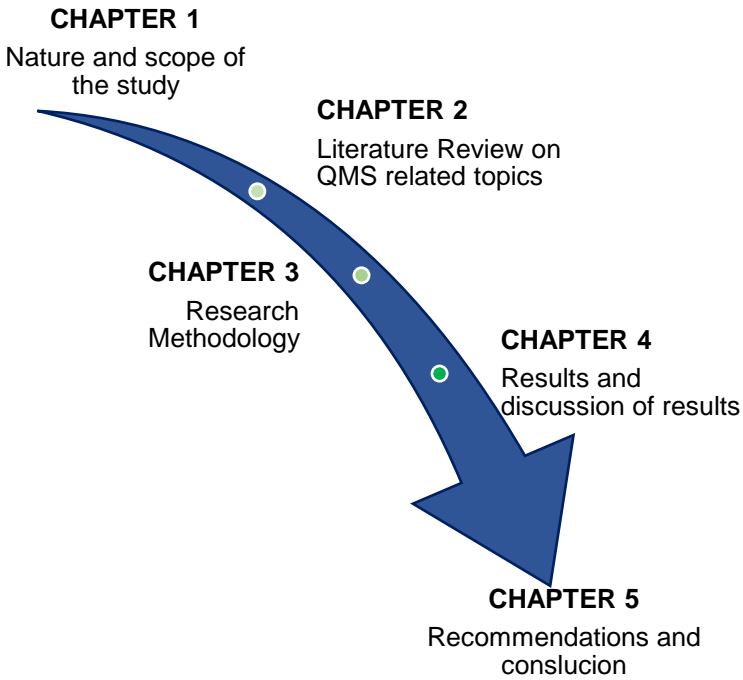


Figure 1-1 Chapter layout by the researcher

Source: Author's own.

The layout and chapters of the mini-dissertation were presented as follows:

Chapter 1: Introduction and problem statement

This chapter discussed the study's context and the causal factors, the problem statement, objectives, scope and limitations, and the research methodology.

Chapter 2: Literature Review

The literature applicable to this study includes evaluating QMS's, criteria for the effective implementation of a QMS and barriers and enablers for implementing a QMS.

Chapter 3: Empirical Study

The research design, sampling method and testing of the reliability and validity of the interviews and questionnaires are discussed. The qualitative questionnaire to managers in construction companies is contained in this chapter. This chapter develops and administers the instruments for data collection and analysis. The last item in this chapter analyses the interviews and results, which are checked against the objectives.

Chapter 4: Results and discussion

This chapter includes all the tables, figures and models compiled from the research instruments. This section handles all the references drawn from the results, focusing on solving the research problem. The data obtained through the study is analysed, followed by discussions and interpretation of the various data and verifying the results.

Chapter 5: Conclusions and recommendations

This chapter focuses on the conclusions gathered after the discussion of the results. It further aims to make relevant recommendations. Discussion and answering of the research objectives conclude this chapter.

1.11 CHAPTER SUMMARY

This chapter provided background to the study and aimed to the study in motion. It further sought to define the problem statement together with the primary objectives and secondary objectives. It outlined the research methodology as well as the limitations of the study. The next chapter will further dilute the theoretical portion of the research.

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

This section of the research provides an in-depth study of relevant articles, books, case studies, and reports on selected methodologies to investigate the literature related to a QMS in construction. The mentioned methodology provides background, definitions, tools, and techniques applied explicitly to answer the research questions and objectives identified for the study. The theory of value creation to give construction companies a competitive edge is reviewed, an overview of ISO 9000 conducted, and a summary of the latest ISO 9001:2015 amendments is provided. The challenges of the fourth industrial revolution (4IR) on construction are also investigated, and criteria for implementing a QMS to assist construction companies with more straightforward implementation are assessed.

2.2 THE CONSTRUCTION INDUSTRY EXPLAINED

2.2.1 The South African construction industry

The construction industry globally and in South Africa are significant contributors to the economy, create a substantial number of new job opportunities, and play an essential role in the local economy (Dixit, Mandal, Sawhney & Singh, 2017:650; Emuze & Mhlwa, 2015:1224; Karimi & Pimplikar, 2020:3623; Odiba *et al.*, 2021:2). The consensus is that all construction companies must meet a particular minimum set of building regulations and standards (Meijer & Visscher, 2017:146).

2.2.1.1 South African regulatory bodies

Various regulatory bodies are available for engineers and contractors in South Africa (Statutory Council, 2019:39). The two main regulatory boards for contractors in South Africa are the Construction Industry Development Board (CIDB) and National Home Builders Regulatory Council (NHBRC) (CIDB, 2020b; NHBRC, 2020). Specifications on standards are provided by the South African Bureau of Standards (SABS) (SABS, 2020).

2.2.1.1.1 Construction Industry Development Board

The CIDB is a schedule 3A public entity established by the Act of Parliament (Act 38 of 2000) to promote a regulatory and developmental framework that ensures that the construction industry delivers capable projects to ensure South Africa's social and economic growth. They aim to enable a South African construction industry with globally competitive standards (CIDB, 2020d).

The Construction Industry Develop Board (CIDB) focus on the sustainable growth, capacity development, empowerment of all South African contractors, and improving industry performance and best practices. It aims to present a transformed industry underpinned by consistent and ethical procurement practices by enhancing clients' value within society (CIDB, 2020d).

The construction industry in South Africa is split into various categories as laid out by the CIDB (CIDB, 2020c) and are presented below in Table 2-1:

Table 2-1. CIDB classes of construction work

CODE	CLASS OF CONSTRUCTION WORKS
GB	General Building
CE	Civil Engineering
EB	Electrical Engineering Works - Building
EP	Electrical Engineering Works - Infrastructure
ME	Mechanical Engineering
SB	Asphalt works (supply and lay)
SC	Building Excavations, shaft sinking, lateral earth support
SD	Corrosion protection (cathodic, anodic and electrolytic)
SE	Demolition and blasting
SF	Fire prevention and protection systems
SG	Glazing, curtain walls and shop fronts
SH	Landscaping, irrigation and horticulture works
SI	Lifts, escalators and travellers (installation, commissioning and maintenance)
SJ	Piling and specialised foundations for building and structures
SK	Road markings and signage

CODE	CLASS OF CONSTRUCTION WORKS
SL	Structural steelwork fabrication and erection
SM	Timber buildings and structures
SN	Waterproofing of basements, roofs and walls using specialist systems
SO	Water supply and drainage for buildings (wet services, plumbing)
SQ	Steel security fencing or precast concrete

Source: (CIDB, 2020c)

All registered CIDB contractors are classified according to their speciality fields, as indicated in Table 2-1 above. The rating represented in a designation format indicates the upper value of contracts that the contractor can tender on. Registration for a CIDB grade is a vigorous process with a financial capability calculator applied to determine the contractor code and designation (CIDB, 2020c). The requirements per code are set out below in Table 2-2:

Table 2-2 CIDB determining financial capability

DESIGNATION	UPPER LIMIT OF TENDER VALUE RANGE	BEST ANNUAL TURNOVER	LARGEST CONTRACT	AVAILABLE CAPITAL
2	R650 000	-	R130 000	-
3	R2 000 000	R1 000 000	R450 000	R100 000
4	R4 000 000	R2 000 000	R900 000	R200 000
5	R6 500 000	R3 250 000	R1 500 000	R650 000
6	R13 000 000	R6 500 000	R3 000 000	R1 300 000
7	R40 000 000	R20 000 000	R9 000 000	R4 000 000
8	R130 000 000	R65 000 000	R30 000 000	R13 000 000
9	No limit	R200 000 000	R90 000 000	R40 000 000

Source: (CIDB, 2020b)

As presented in Table 2-2 above, contractors' financial determination becomes more strenuous the higher the designation. All contractors are required to register and automatically receive a designation of level 1. Therefore, the quantity of designation one contractors (regardless of class)

is much higher in relation to higher graded contractors. As projects are completed, contractors must submit a comprehensive list of proof to be evaluated for a possible upgrade in the designation. Table 2-3 below presents registered contractors specifically applicable to the civils (CE) grading in the North West Province.

Table 2-3 CIDB CE designation representation North West Province

DESIGNATION	QUANTITY
Level 1 CE	5000+
Level 2 CE	280
Level 3 CE	92
Level 4 CE	140
Level 5 CE	87
Level 6 CE	84
Level 7 CE	66
Level 8 CE	16
Level 9 CE	3

Source: (CIDB, 2020d)

As clearly visible from the data presented in Table 2-3, the difficulty in designation and requirements to fulfil is seen in the drop in numbers as the designation becomes higher.

2.2.1.1.2 National Home Builders Registration Council

Although the general building is one of the categories set out by the CIDB, home building is regulated by the NHBRC (NHBRC, 2020). The NHBRC was established in 1998 per provisions set out in the Housing Consumers Protection Measures Act, 1998 (Act no. 95 of 1998) (NHBRC, 2020).

The NHBRC aims to protect the housing consumer's interests by ensuring that building contractors comply with the various prescribed building industry standards in the NHBRC home

building manual. Homebuilders are regulated and inspected during the building process to prevent substandard housing delivery, identify lousy artistry and poor quality material (NHBRC, 2020).

All home building contractors are required by law to register with the NHBRC. Failure may constitute a criminal offence that is punishable by law. After completing an examination process, are building contractors certified as NHBRC approved builders (NHBRC, 2020). The Act requires that all new homes be registered with the NHBRC at least 15 days before construction. Building inspectors will inspect various construction phases to ensure and expose any structural failure that may arise (NHBRC, 2020).

2.2.1.1.3 South African Bureau of Standards

Legislated policies assuring quality products are set by the South African Bureau of Standards (SABS), a member and the South African representative for ISO (SABS, 2020; Statutory Council, 2019:42). Furthermore, the South African Bureau of Standards is the originator of the quality standards applied in South Africa, namely the South African National Standards (SANS) series (Aigbavboa & Thwala, 2014:773; SABS, 2020).

2.2.2 The link between construction and quality

Despite the legislated policies and other associated quality control bodies, poor-quality construction work is still present globally and in South Africa (Aigbavboa & Thwala, 2014:773; Emuze & Mhlwa, 2015:1224; García-Bernal & García-Casarejos, 2016:28).

In the global construction market, companies compete in more areas than mere price. As customer demand for companies increases rapidly, more affordable prices and improved delivery of quality products are required. In recent years, the importance of a QMS grew to become a crucial element of any construction company regardless of size (Bianchi & Ferraz, 2020:2; Rehmani *et al.*, 2020:3). Though various studies concluded on the process of obtaining a quality certificate, information on actions for implementing the QMS in construction companies is lacking (Lukichev & Romanovich, 2016:1717).

2.3 CONSTRUCTION CHALLENGES AND ISSUES

Globally procedures and requirements for the fulfilment of quality control are well defined. Although basic principles exist in South Africa, one major factor has been left out: the conditions and satisfaction of a quality management system implemented on construction projects.

Various studies concluded that a significant loss of production and cost on a construction project could be related to managing labour, machinery, and process. Losses to 30% have been recorded, raising questions for construction practitioners and putting constraints on construction projects' successful and timely completion (Dixit *et al.*, 2017:650). The main contributor to the losses can be related to the lack of implementation of a QMS.

The problems and challenges faced in the construction industry in South Africa are significantly more fundamental, serious, and more complex (Aigbavboa & Thwala, 2014:773; Dharani & Ganapathy Ramasamy, 2015:604; Emuze & Mhlwa, 2015:1224; García-Bernal & García-Casarejos, 2016:28). Previous studies concluded that the lack of skilled general workers and artisans contribute to the continuous poor-quality control and management processes. Whereas defects and rework contributed to some of the main reasons for project quality deviations on construction sites (Emuze & Mhlwa, 2015:1224). This problem is further exacerbated in South Africa by principal contractors having to sub-contract between 25-30% of a contract to a sub-contractor fulfilling the requirements set out by the Government (SAICE, 2015:12).

The problem is not the fact that sub-contracting needs to take place. It is more a question of the quality of work the sub-contractor can deliver. The principal contractor stays responsible for providing a quality product that needs to be on schedule, regardless of whether the work is performed by him or the sub-contractor (SAICE, 2015:1). This further relates to the importance of quality and the way it is set out and managed on-site. Not only can it have potential financial implications, but it also affects the reputation of a company.

2.4 THE EFFECT OF THE 4IR ON CONSTRUCTION

The effect of the technological developments and impact of the Fourth Industrial Revolution (4IR) had various disruptive effects on the different production, service and value chain systems. The

4IR and QMS share various similar objectives because of the continuous improvement of clients' process performance needs (Asif, 2020:1). Despite the evolution of 4IR, the QMS models have remained stagnant. They failed to keep up to date with the technological developments around it, especially in the construction industry, where QMS is mainly paper-based systems in a large portion of South African companies (Maisiri & van Dyk, 2019:135).

The reality that companies strive to convey confidence to customers via implementing a QMS contradicts the lack of innovation and moving along with the 4IR developments (Asif, 2020:2). A study concluded by Asif (2020:2) indicated that QMS and the 4IR are not aligned and that 4IR have outpaced the QMS causing QMS to lose relevance and value in the modern business context. However, this argument can be turned around for QMS to retain universal applicability by implementing new and improved strategies. Limited opportunities are available for the effective implementation of a web or cloud-based QMS. When implemented, it may come with a heavy price tag. For any SMME construction company, is it difficult to see themselves paying a hefty price tag. The result is that no QMS is implemented instead.

2.5 QUALITY OVERVIEW

The concept of quality has received greater attention in the last decades since its conception in 2584BC during the construction of the Great Pyramid of Giza (Vosloo, 2019:5). The mass production and manufacturing of goods and services forced modern standards as more companies indicated their dedication to higher quality standards and products. With the increasing evaluation of the quality concept and the connection to the reputation of a company, the attention to quality, quality control and quality management systems have increased (Aigbavboa & Thwala, 2014:773; Bianchi & Ferraz, 2020:2; Dharani & Ganapathy Ramasamy, 2015:604; Emuze & Mhlwa, 2015:1224; García-Bernal & García-Casarejos, 2016:28; Rehmani et al., 2020:1; Vosloo, 2019:5).

2.5.1 Quality control and quality management systems

In recent years, quality control and quality management systems received increasing attention (Aigbavboa & Thwala, 2014:773; Bianchi & Ferraz, 2020:2; Dharani & Ganapathy Ramasamy, 2015:604; Emuze & Mhlwa, 2015:1224; García-Bernal & García-Casarejos, 2016:28; Rehmani et al., 2020:1). For the study, quality is defined as how a set of inherent characteristics fulfils the set

requirements. Quality control also forms part of quality management and meets the set quality requirements (Botha, 2012:11; Masindi, 2019:24). A quality management system's primary purpose is to direct and control a company regarding fulfilling all quality requirements (Botha, 2012:11; Masindi, 2019:24).

2.6 QUALITY MANAGEMENT SYSTEMS

A construction company's sustainable development and competitiveness are directly related to the successful implementation of a QMS (Bravi *et al.*, 2019:65; Lukichev & Romanovich, 2016:1717; Odiba *et al.*, 2021:2; Rehmani *et al.*, 2020:1; Vosloo, 2019:8). The primary purpose of a QMS is to improve and manage quality serviced and products within a company. It may provide an added benefit to the continuous improvement of activities within the company. Therefore, the implementation of a QMS seen as a voluntary process broadly supported by company motivation, objectives, and policies regardless of whether subsequent certification is achieved or not (Bravi *et al.*, 2019:65; Rehmani *et al.*, 2020:2).

The American Society of Quality (ASQ) accurately defines QMS as: "The application of a QMS in managing a process to achieve maximum customer satisfaction at the lowest overall cost to the organisation while continuing to improve the process" (ASQ, 2020).

Various QMS models exist to implement the best-suited QMS applicable to achieve the company's quality objectives (Asif, 2020:3; Rehmani *et al.*, 2020:7). One of the most known and prominent international standards developers is the International Organisation for Standardisation (ISO) (ISO, 2020; Lukichev & Romanovich, 2016:1718). ISO dates to 1947 and has published over 21 thousand standards covering various aspects involving technology and production. The ISO 9000 first edition was targeted to precisely describe the QMS requirements for organisations and companies dating back to 1987 (Keen, 2019; Lukichev & Romanovich, 2016:1718).

The compliance with the ISO 9000 family standards proved to be a popular QMS. The ISO 9001 standard further provides the criteria for a QMS and is the only standard enabling a company to become certified. To gather background into the development and implementation of QMS, the overall ISO 9000 system will be discussed.

2.6.1 ISO 9000

According to ISO (2015), the concepts and principles are sufficient to enable a company to meet the capacity and challenges presented in the present accelerated, globalised markets and economy. The impact and benefit of ISO can reach beyond customer satisfaction and enhance its reputation in the industry. ISO set out principles to assist the company in the implementation of its QMS. These principles must be seen and implemented as a whole and not in individual segments. No one is more important than the other. The formally planned or unplanned ISO provides the necessary guidance to ensure every company can successfully implement the system. Continuous improvement ensures that the system is updated and applicable to current standards (ISO, 2015; Keen, 2019).

The ISO 9000 aimed to provide basic yet fundamental concepts, principles and vocabulary to be used and implemented in QMS's. This proved to be the foundation for all QMS standards, enabling the effective and efficient implementation of a QMS (Lukichev & Romanovich, 2016:1718; Rehmani *et al.*, 2020:7; Vosloo, 2019:12). The ISO 9000 series consists of various ISO standards, and much confusion arises between the various ISO standards within the ISO 9000 standard family. The sought-after ISO certification is only issued to a company after the complete fulfilment of all set-out requirements. The certification provided is extra support to competitors and customers of the rigid satisfaction to a formal QMS (Keen, 2019). ISO 9000 accreditation is issued to all companies complying with standards, regardless of size, complexity or operating business model (Keen, 2019; Vosloo, 2019:13).

Although ISO 9000 is focused on QMS, do they serve different applications. For ease of understanding, can the leading ISO 9000 and ISO 9001 functionalities be summed up as set out in Table 2-4 below.

Table 2-4 ISO 9000 and ISO 9001 comparison

ISO 9000	ISO 9001
DIFFERENCES	
An entire family of standards	An individual standard within the ISO 9000 family
It is also an individual standard	Provide specific requirements for a company
Outlines vocabulary/definitions for the entire QMS series	Require gap analysis and internal audits, assessing current QMS
Defines the terminology to be used and implemented in ISO 9001	No clear outline as to how to enforce regulations into the company
Adding benefit to ISO 9001	Consistent with specific requirements for a company
Something to read up on and get familiar with	Something to put actions behind to implement.
Primary purpose - definition	Primary purpose – action towards more quality procedures
No certification available	Organisations can get certified
	Most recent version – ISO 9001:2015
SIMILARITIES	
Both operate under the quality management category	
The same terminology recognised across both standards	
Both require review and maintenance	

Source: (ISO, 2015)

The ISO 9001 standards, as set out in Table 2-4, seems to be the most popular standard due to their strong customer focus, top management involvement and motivation, the implementation of the process approach and continual improvement focus. More than one million companies and organisations in 179 countries are currently ISO 9001 certified (ISO, 2020). The ISO 9001 is also the preferred ISO standard to implement in construction companies. The importance and understanding of what to look for and how to implement are of utmost importance. Below are the ISO 9000 and ISO 9001 principles the standards operate on further discussed.

2.6.2 ISO 9000 and 9001 principles

A principle significantly influences the implementation thereof and can be described as a fundamental belief, theory or rule (ISO, 2015; Vosloo, 2019:12). Quality management principles (QMP) are a set of fundamental beliefs, norms, traditions and values and are implemented in the foundation of QMS implementation (ISO, 2015; ISO, 2020).

According to ISO (2015), the QMP's set should be utilised as a steering guide in any company for performance improvement. The seven QMP's used for ISO 9000 and 9001 are listed below and set out in Figure 2-1 (ISO, 2015; Vosloo, 2019:12):

- Customer focus
- Leadership
- Engagement of people
- Process approach
- Improvement
- Evidence-based decision making
- Relationship management



Figure 2-1 Seven Quality Management Principles

Source: (ISO, 2015)

Based on the principle set out in Figure 2-1, Seven Quality Management Principles can be defined as described below.

2.6.2.1 Customer focus

Quality management's primary focus is to retain individual specifications and requirements to meet and exceed customer expectations. The rationale is the retained, sustained and successful attraction of confidence from the customer. This is achieved through continued customer interaction and to be understanding future requirements, commitments and critical milestones. The spin-off and increased customer value and satisfaction increased revenue and loyalty (Vosloo, 2019:10). This will enhance and promote repeated business and an excellent company reputation.

Prescribed actions include recognising customer focus by direct and indirect value to the company (Rehmani *et al.*, 2020:2). The internal company objectives need to be linked to the expected customer needs to align better with the desired results (Vosloo, 2019:10). Continuous communication between the contractor and customer will enhance the customer need and provide an exact focus point for the contractor. Client satisfaction can be improved by proper and precise planning, design development, production, delivery and support (Rehmani *et al.*, 2020:8). Customer relationship improvement and continuity are essential and need to be actively managed (ISO, 2015).

2.6.2.2 Leadership

Leaders play a pivotal role in creating conditions in which people can operate and engage to achieve the company's purpose. This will equip and increase the achievement of the company objectives by aligning policies, processes, and strategies (Vosloo, 2019:10). The increased coordination amongst various levels and functions within the company will improve the company's ability to deliver the desired results (Rehmani *et al.*, 2020:4).

The communication of the company's vision, mission, strategies, processes and policies will increase and sustain the shared values at the various levels (Vosloo, 2019:10). This will create

trust and integrity, critical importance in the drive to quality performance. A lively and committed attitude and top management involvement will increase company accountability and inspire employees to be more quality-driven (ISO, 2015).

2.6.2.3 Engagement of people

Competent, empowered, and engaged people are of utmost importance to enhance the creation and delivery of valued products and services. All individuals, regardless of level within the company, are to be respected. Constant recognition and empowerment are essential and will increase the company's position to achieve quality objectives. This will further increase the activities, personal development, creativity, satisfaction, trust, and collaboration (Vosloo, 2019:10). Constant communication will lead to a clear understanding of the quality objectives. Engaging and sharing knowledge should be encouraged to open two-way discussions. All constraints should be identified and mitigated by the continuous review acknowledgement of improvement and contribution by employees in the process (Rehmani *et al.*, 2020:4). Surveys should be encouraged at least twice a year to track and determine the company's satisfaction (ISO, 2015).

2.6.2.4 Process approach

The process approach forms part of a quality system and enables predictable and sustainable quality consistency. Systems and processes are an integral part of any QMS. To optimise results, it is essential to understand how these results are achieved. The systems and processes, as mentioned, create focus and allow for more predictable and sustained results (Vosloo, 2019:11). The allocating of accountability, responsibility and authority will assist in the establishment of quality objectives. Resource constraints and interdependent systems should be identified to manage effectiveness and efficiency as a whole (ISO, 2015).

2.6.2.5 Improvement

A successful QMS implementation is achieved and maintained by focusing on the implementation of continuous improvement. Encouraging progress should be supported through all levels of the company (Vosloo, 2019:11). Internal and external changes will create opportunities where new strategies can be identified and possible solutions are explored. The creation of a positive attitude

towards change will improve the capabilities and performance of the company. The implementation of root cause analysis can identify reoccurring problems. This will ensure a better preparedness to react to the system's various changes, providing an added advantage for improving quality objectives (Vosloo, 2019:11). Continuous training and monitoring of employees after enhancements or modifications to the system have been made (ISO, 2015).

2.6.2.6 Evidence-based decision making

Decision-making should be based on root analysis results and proper evaluation through multiple inputs, data assessment, and available information. This will ensure envisioned results. Clear understanding and impacts of decisions on various companies' levels must be considered (Vosloo, 2019:11). For this purpose is well defined and accurate data of great value, resulting in easy tracking of historical decisions. Critical indicators can be identified and monitored by sharing correct, reliable and precise data through data distribution optimisation. It is essential to ensure decision making is guided by analysed and proven data (ISO, 2015).

2.6.2.7 Relationship management

Supplier relationships play an integral part and need to be managed effectively. Optimal working relationships and networks need to be built as key relationships can positively impact company performance. Possible constraints need to be identified and consulted to improve values and vision to achieve common set goals. Once a stable supply chain and understanding have been created, the road set to continuous improvement is made. One way to achieve the above is to identify and prioritise the various relations to create balanced short- and long-term goals. Constant monitoring and recognition by the invested parties to be incorporated to identify constraints, reduce bottlenecks and improve achievements (ISO, 2015).

All of the principles above is merely a topic when standing alone. When combined and collaborated into one, they become the backbone and operating drive force of the ISO standard to be implemented. One of the significant barriers to implementing a QMS is understanding and combining the various elements and principles to be implemented.

2.6.3 Elements in ISO 9001 implementation

ISO 9001 specifies precise requirements for implementing a QMS (Keen, 2019; Vosloo, 2019:14). The ISO 9001 standards are updated to keep up with the market and economic changes impacting the standards related to QMS. The ISO 9001:2015 standards introduced significant differences compared to the previous 2008 edition. These changes can be summarised in the following nine points (Bravi *et al.*, 2019:66; Fisher, 2016:18):

High-Level Structure (HLS) has been adopted; this structure is typical in ISO standards, and adopting a risk-based thinking approach to support and improve the understanding and implementation of the process approach includes:

- Prescriptive requirements have been limited.
- A better and increased applicability to services.
- The boundaries of the QMS to be defined.
- Increase emphasis on company context.
- Increased leadership requirements from the management.
- Focus on improved achievement process results to increase customer satisfaction.

2.6.3.1 Process approach

The importance of the process approach and the added value in implementing a QMS is essential to elaborate further into this critical Quality Management Plan (QMP). According to ISO (2015), a structured process approach must be adopted to develop and implement an effective QMS of great value (Vosloo, 2019:14). This will ensure and enhance customer requirements and satisfaction (Dawson, 2019). An essential aspect of the process approach is understanding and managing or interrelations between systems that can further contribute to company efficiency and effectiveness. Interrelations enable control, interdependency and proper management of the implemented processes. Further interactions drive companies towards achieving quality policies and strategic objectives.

When implementing the process approach in a construction company, the process and critical indicators would comprise the company objectives and would thus differ between companies: (Dawson, 2019; Vosloo, 2019:14). Identification, documentation, and management of the process most directly impact the customer and overall business performance. Development of documentation and policies to reliably measure the performance aims to achieve the following:

- Assigning responsibility for the implementation, monitoring and improvement of each process.
- Identification and development of procedures to be implemented.
- Assessment of processes utilising internal audits and reviews.

The process approach enables and promotes consistency in how to set requirements and indicate how the process can add value, increase efficient process performance, and improve the process through current and accurate quality data (Vosloo, 2019:15). The management of critical processes needs to be set as a 'top-level' priority in the QMS. An effective way to manage and implement the strategies is using a PDCA cycle (Chen, 2019:4; Vosloo, 2019:16).

2.6.3.2 Plan-Do-Check-Act Cycle

The Plan-Do-Check-Act (PDCA) cycle encourages risk-based thinking. This will increase opportunity advantage and prevent undesirable results (Chen, 2019:4; Vosloo, 2019:16). The expert in quality management, W. Edwards Deming, first developed the PDCA cycle to implement a helpful project management tool (Chen, 2019:4).

Before implementing the PDCA cycle, the system needs to be evaluated and reviewed throughout the implemented QMS. The PDCA circulation method will continue to go through the next cycle until all resolved issues in the previous process have been sorted out or completed. The PDCA Cycle consists out of four cycles and can be described in the following steps (Liu & Cai, 2016:19.12; Vosloo, 2019:16):

- **PLAN:** Contains the design of a specific implementation program based on project or company objectives and guidelines. Objectives, resource requirements, risks and opportunities should be identified.
- **DO:** The implementation of the planned, designed programs or processes are defined in this phase.
- **CHECK:** The implementation results should be monitored and measured to determine the success rate.

- **ACT:** This phase's objective is to act on any problems that arise during the check phase. Successful experiences or processes will be standardised according to the checks, and the items needing action will continue to go through the process to improve performance.

2.6.3.3 Application of PDCA cycle in a construction QMS

Due to the versatility of the PDCA cycle in various industries, is it important to relate the cycle to the implementation and use in a construction project. The multiple links in the process can be described as follows, as indicated in Figure 2-2 below:

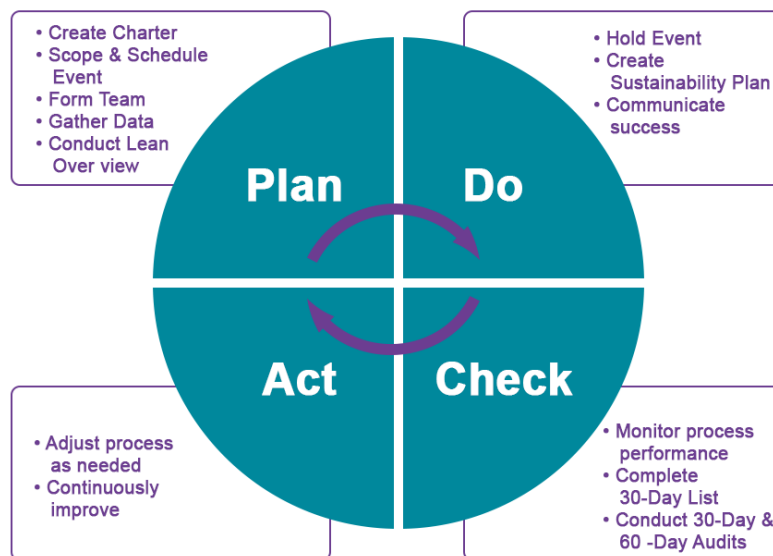


Figure 2-2 ISO 9000 prescribed PDCA cycle process

Source: (Martin, 2011; Vosloo, 2019:14)

- **Plan**

This will entail quality management before the commencement of work on-site. In this phase of the cycle are materials collected to formulate standards and plans to demonstrate the feasibility and prepare for implementations. In a construction project, this will relate to the design stage. The engineering consultant will collect the required data to establish client objectives to provide high-quality drawings and designs in this stage.

- **Do**

Quality management on site is equivalent to the 'DO' stage in the cycle. During this phase, the site control and inspections elected to form part of the site and project QMS are also performed.

This will relate to site supervision/management, ensuring product delivery is according to drawings provided in spec, measurements, levels, etc.

- **Check**

After the construction of works according to drawings set out and spec according to designed form relating to the works performed. This phase is essential as the scope of works are checked to ensure and avoid occurrences of any engineering quality problems. In the case that quality accidents or non-conformance is present, on-site processing will be required. The content in this phase incorporates both the D and C portions of the PDCA cycle.

- **Act**

At the end of the construction project, all involved parties must review the QMS and supporting documentation. The project quality to be summarised and questions asked will add to resolving quality issues through thorough consultation. The emerged problems can be of importance in the design and implementation of future project QM. This phase is also implemented during the construction phase once quality issues arise. It is recommended to not wait until after the project to implement this phase.

Implementing the PDCA cycle during the project quality management will increase and promote the continuous improvement of the QMS. It can further ensure that the QMS is implemented and running following the PDCA cycle's various phases. The construction quality will be improved by the one step at a time approach. Therefore, it is essential to note that the four links are interlocked and cannot be implemented individually.

2.6.4 Benefits of QMS implementation

Several South African consumers adopted the international view and were contractors tendering on major projects forced to adapt and be ISO 9001 certified. This approach proved to be irresponsible as the real motivation for implementing a QMS must come from within a company as an essential part of its values (Neyestani, 2016:1; Vosloo, 2019:8).

The implementation of any QMS derives from two sources of motivation: internal and external. Internal motivation can be linked to objectives' achievement, with the main focus being internal management improvement. External motivation focuses on the benefits of promotional and marketing issues, customer pressures and improvement of market shares (Bravi *et al.*, 2019:66).

Two types of companies can be identified based on their primary purpose for which they strive to implement a QMS: firstly, non-developmental companies, merely aiming to get certified, and secondly, developmental companies, who adopt standards because they genuinely believe there is an internal benefit for the implementation of an effective QMS (Bravi *et al.*, 2019:65).

Implementing a QMS is an added advantage because it provides a platform for planning, executing, monitoring, and improving the various QMS activities. Implementing a QMS is an excellent benefit for the business owner(s), management, employees and customers. The benefits of the implementation or certification of a QMS can be set as per Table 2-5 below:

Table 2-5 ISO 9001 benefits

BUSINESS OWNER	MANAGEMENT
Increased customer base	Better organised workplace
More revenue and cash flow within company operations	Easier managing operations, a clear set of tasks
Longevity with management and employees	More control over employees
	Ethical procedure for correcting employee behaviour

Source: (Keen, 2019)

As can be concluded from Table 2-5 above, the internal benefit for companies results in increased quality end products, resulting in an added advantage for the customer in the form of continuous and consistent, good quality products and services, in return the increased benefit for the company doubled in value.

Chen (2019:1) did a study, further analysing the benefit of implementing a QMS related to practicality, reliability, durability and investments benefits of construction projects and companies. The mentioned benefits relate directly to the safety of site personnel and property. It further relates directly to a construction project's critical tasks by implementing a QMS to prevent accidents and ensure that projects quality objectives are achieved.

A great myth about QMS is the fact that it is an overload of complicated documents. The reality is that QMS implementation and supporting documentation can be straightforward and must mainly capture the company's requirements. The implementation of online QMS systems can add further benefit and motivation for the effective implementation thereof.

2.7 CRITERIA FOR QMS DEVELOPMENT AND IMPLEMENTATION

2.7.1 Guidance for QMS implementation

Clear guidelines into the effective implementation of a QMS further include planning and addressing possible risks and opportunities that may arise. Quality objectives need to be established with the means to achieve them. Guidelines into the planning and action of new changes for the positive, further development of a QMS are set out (Vosloo, 2019:15).

QMS planning is a continuous process entailing the reviewing, implementation and improvement of the system. Construction quality mainly refers to the activities forming part of a construction project and the delivered projects' quality. This entails coordinating the company's quality control during the construction until completing the project, including inspections, supervision and auditing (Chen, 2019:3).

Various factors can affect the construction quality and include five significant aspects: people, materials, machinery, methods and the environment. The construction quality control characteristics and objectives must be described as the need to control more. Realising it isn't easy to manage, high process control requirements exist, and final inspection limits are significant (Rehmani *et al.*, 2020:4).

2.7.2 Criteria for QMS implementation

The literature dissection has the following items been identified and combined as critical criteria for the development and implementation of a good QMS (ASQ (American Society of Quality), 2020; Eniola, Olorunleke, Akintimejin, Ojeka & Oyetunji, 2019:2; ISO, 2015; ISO, 2020; ISO, 2017; NQA (National Quality Association), 2020; Rehmani *et al.*, 2020; Vosloo, 2019:73):

- Top management commitment

The involvement of top management in the vision and mission of a QMS is of utmost importance. To be successful, the implementation needs to be driven from top to bottom and can be seen as one of the top drivers of a QMS (Neyestani, 2016:2; Rehmani *et al.*, 2020:4).

- Strategic vision, planning and development initiatives

To move a QMS from mere quality control or quality assurance is developing a strategic vision, plan and development initiatives imperative to link performance, strategic objectives and competitiveness to quality efforts at hand (Rehmani *et al.*, 2020:4).

- Quality culture

The standard or level of company culture is imperative in the effective implementation of a QMS. Positive company culture will add to the achievement or disappointment of QMS implementation in enhancing company performance (Eniola *et al.*, 2019:2).

- Customer focus

See section 2.6.2.1 above. Research indicated that the implication of a QMS significant positive effects has on customer behaviour and satisfaction through the continuous improvement of quality and innovation of products and services (Ershadi *et al.*, 2019:1093).

- Quality assurance & control

The quality concept has a rich history with a dedicated focus on product-oriented quality and user-oriented quality. Focusing on the user's needs and expectations has become an essential quality and enhanced competition among businesses. Implementing a QMS as a unique tool to further ensure companys' long-term growth has increased since the mid-'80s (Ershadi *et al.*, 2019:1093; Parasuraman, Zeithaml & Berry, 1985:45).

- Continuous Improvement and system alignment

See section 2.6.2.5 above.

- Employee knowledge, skills, motivation & commitment

See section 2.6.2.3 above.

- Cost-effectiveness

The cost of accreditation and implementation of a QMS like ISO and others alike comes at a price. It is a cost of the actual process and for companies to get themselves in a position to be evaluated (Neyestani, 2016:1558).

- User satisfaction

The integration of 4IR in the implementation of QMS will collaboratively enhance process performance improvement (Asif, 2020:1; Mendling, Baesens, Bernstein & Fellmann, 2017:3). This continuous process collates directly with the PDCA process discussed in Section 2.6.3.2.

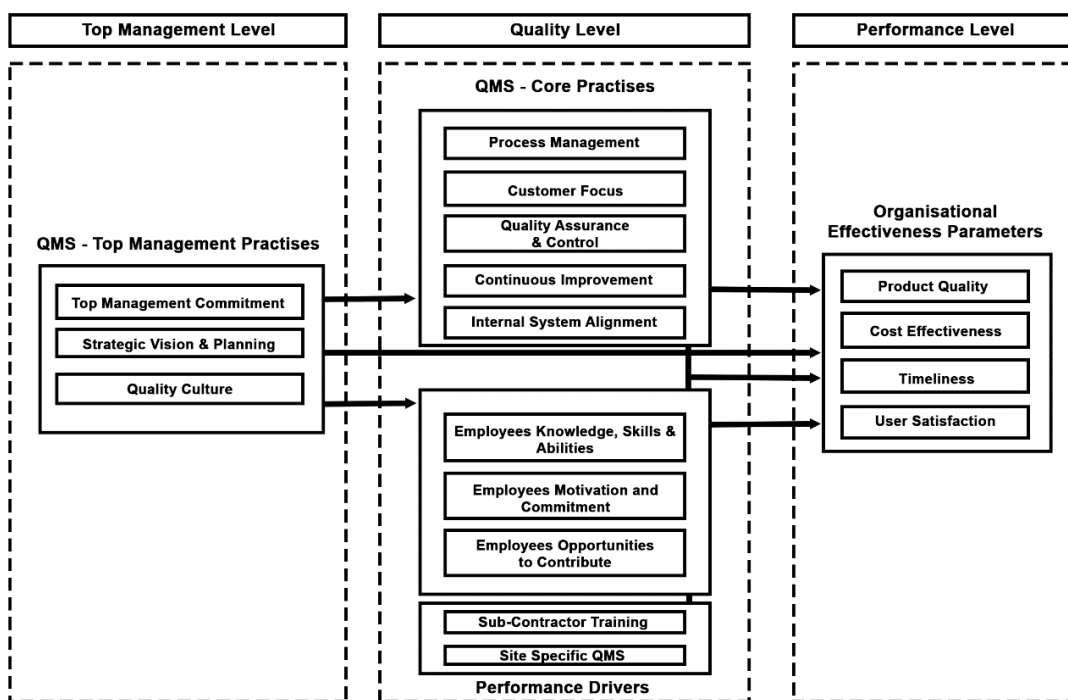


Figure 2-3 An adopted theoretical framework for QMS implementation

Source: (ASQ, 2020; ISO, 2015; ISO, 2020; ISO, 2017; NQA, 2020; Rehmani *et al.*, 2020; Vosloo, 2019:73).

The provided criteria can be further divided into three main divisions: top management level, quality level and performance level (Rehmani *et al.*, 2020:7). Figure 2-3 below shows the QMS implementation levels clearly outlined (ASQ, 2020; ISO, 2015; ISO, 2020; ISO, 2017; NQA, 2020; Rehmani *et al.*, 2020; Vosloo, 2019:73). The sub-divisions in each level is a clear guideline and indication of the steps and process to follow. The criteria identified cannot be eliminated or implemented on its own alone. Incorporating and implementing all aspects is crucial for the QMS

system to successfully and benefit the company. The identified criteria can be effectively implemented when incorporating the process approach and PDCA cycles discussed earlier. A combined visual representation of the above criteria and levels will assist in implementing an effective QMS as exact steps can be identified and followed as per Figure 2-3 illustrations above.

Literature iterates the positive effect of an implemented QMS on construction projects. The QMS can provide consistency and satisfaction, focusing on methods, materials, and equipment to meet customer requirements and achieve company goals and targets. A schematic presentation of how a QMS is incorporated into construction project goals are illustrated in Figure 2-4 below.

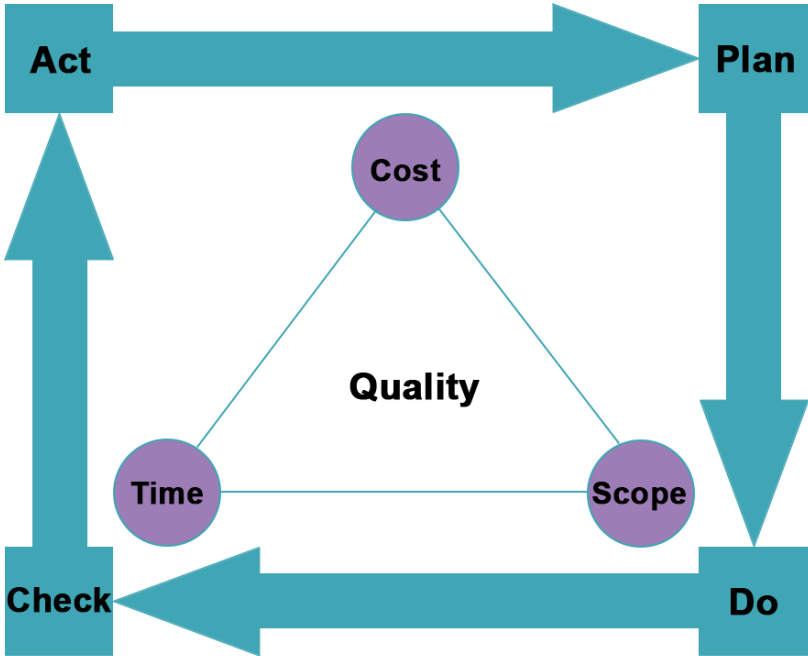


Figure 2-4 Schematic QMS on construction project targets

Source: (ASQ, 2020; ISO, 2015; ISO, 2020; ISO, 2017; NQA, 2020; Rehmani et al., 2020; Vosloo, 2019:73).

Implementing a QMS on the basis presented above in Figure 2-4 can be efficient and straightforward to further improve a construction company's project performance. Although it is included in a system like ISO 9001 and the ISO 9000 framework, construction companies that are not ISO accredited can quickly implement the system presented to receive the same company goals. The QMS and its processes can continuously be improved by implementing the PDCA methodology presented in section 2.5.3.2.

2.8 THE EFFECT OF 4IR ON QMS IMPLEMENTATION

The effect of 4IR might seem to many companies as a daunting task. The reality is painting a much more colourful picture. Although implementing a cloud-based QMS seems daunting, is the overall implementation much more aligned with the practice than one might think.

Applying artificial intelligence into a QMS will first assist with making intelligent decisions, help reduce material, decrease energy consumption, clean energy, and solve project problems where traditional wisdom is lacking (Asif, 2020:2). Secondly, increased automation enables construction companies to achieve higher productivity and efficiency and reduce the stress on both staff and the environment. Moving away from a typical paper-based QMS to a more streamlined online system will enable site management to complete QMS paperwork on a tablet or phone while standing on site. This will result in significant time saving and will inevitably increase site productivity (Asif, 2020:2).

The third major contributor of 4IR on construction sites is the ability to share across devices and facilities. This will allow site managers to process and send filled-in QMS documentation while standing with their tablet on-site to other critical stakeholders like the quality manager, engineer and company management.

Implementing 4IR in construction projects focusing on QMS will require a new set of skills, work ethics and commensurate management systems. Based on the literature, are QMS models are to be reviewed and aligned to implement the 4IR advantages. Research has indicated that QMS models lack alignment between the QMS and company initiative/features, although limited research is available on the alignment of QMS with 4IR.

Further research on South African companys' readiness to implement 4IR has concluded that a limited number of companies are ready. It further diluted the fact that most South African companies are far from implementing 4IR in their industry - the lack of strategy, equipment infrastructure and skill are some of the main contributors for this (Maisiri & van Dyk, 2019:134).

2.9 CURRENT RESEARCH

Various research studies looking into construction and QMS have been conducted. A key contributor through the studies is the importance of implementing a QMS to assist companies in reaching their planned goals and objectives and, therefore, improve business processes, products, and services (Emuze & Oladokun, 2019:477). Various studies confirmed the importance of implementing a QMS to fast track a construction programme. Despite the importance of looking after reputation, the significance of QMS implementation relates strongly to the inferior quality products delivered in various South African construction projects.

2.10 CHAPTER CONCLUSION

This chapter aimed to provide an in-depth literature study by reviewing selected methodologies related to QMS implementation and criteria in construction companies. Although the construction industry in South Africa is ever-evolving, quality incidents are on the rise. The number of construction projects not completed due to shoddy quality work is ever persisting. ISO provides clear guidelines for the implementation of a QMS. Based on the literature, crucial criteria and critical characteristics for implementing a QMS are well defined. Employing an implementation plan based on South African requirements and standards for construction projects would further assist construction companies in the process.

The next chapter provides an overview of the implemented research methodology of the study. The goals and objectives of the research are presented. Furthermore, it postulates the research design, ethical considerations, research population and sample and the interview questionnaire used. The process of data collection and analysis is also provided in table format.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter two examined views relating to the background, principles and implementation requirements relating to QMS implementation. A basis for the identification of criteria for the implementation of a QMS was reviewed and discussed. The application of a QMS in South African construction companies is limited compared to information related to ISO accredited companies influencing various decisions regarding the research approach and design. To explore the various criteria for QMS implementation a qualitative study approach preferred. This chapter will discuss the various information regarding the data collected and the process to analyse the collected data.

3.2 RESEARCH APPROACH

The research design aims to illustrate and outline the process to be followed by the researcher during the collection, measuring and analysis of the research data. This logical progression allows the researcher to answer the proposed research questions and objectives identified whilst adhering to ethical, data validity and reliability standards.

Silverman and Marvasti (2008:147) accentuate no clear right or wrong method, whether qualitative or quantitative. The best method appropriate for the chosen research topic should be selected to answer the specific research question. To meet the study's objectives, the focus will be qualitative to explore and understand QMS implementation in the construction industry during the investigation.

Qualitative research measures are not numerical but oral or written responses such as surveys or content analysis. Qualitative research is the choice of approach in any of the following (Bryman *et al.*, 2018:65; Cohen *et al.*, 2018:301):

- For generating and investigating newly proposed theories.
- Achieving a more in-depth understanding of the theories investigated.
- Developing a more detailed story to describe a specific theory.
- Various mixed-method surveys.

Qualitative data analysis aims to identify inherent patterns mainly. Therefore, this method will enable the researcher to structure the design to accommodate and categorise items to answer the various research questions (Bryman *et al.*, 2018:64; Cohen *et al.*, 2018:301). Qualitative research will help conduct interviews in the participants' natural setting to better understand their view on a QMS and establish criteria for an effective QMS in a construction company. Furthermore, it will allow the opportunity to gather information about benefits and limitations from the participant's point of view. One of the primary considerations for a qualitative approach is that it allows the researcher to discuss the theories and research directly with the participants, to gather and share personal experiences and views about QMS implementation (Bryman *et al.*, 2018:42). The flexible nature of qualitative methods can help handle and overcome complex and challenging situations by changing or making alterations to, for example, the semi-structured interviews (Bryman *et al.*, 2018:224).

Content analysis is an inductive process where volumes of raw text data containing participants' honest and personal comments, perceptions and opinions (Bryman *et al.*, 2018:31; Creswell, 2012:214; Nieuwenhuis, 2020a:123) regarding the theory were systematically examined and compacted into content categories by following coding rules (Nieuwenhuis, 2020a:126). Consequently, the raw text data will be developed and structured into themes, concepts, explanations, interpretations, understandings and summaries, which expansively explain the theory under study (Cohen *et al.*, 2018:645). The four steps followed during content data analysis are preparing, coding, categorising, and interpreting the transcribed text regarding the criteria and understanding of a QMS in a construction company (Nieuwenhuis, 2020a:134).

3.2.1 Research design

A cross-sectional survey design will be utilised for the study due to its association with social surveys (Bryman *et al.*, 2018:107). Exploratory research will be utilised using semi-structured interviews with the sample group due to the possibility of using this method during the qualitative study and the data collection on more than one case at a single point in time (Bryman *et al.*, 2018:106). It will enable the researcher to define critical criteria for the evaluation of a quality management system.

3.3 DATA COLLECTION

Data collection is the systematic approach or tools utilised to gather information (data) from various sources. It can include but is not limited to groups, individuals, text and but not limited to any other source of medium (Nieuwenhuis, 2020b:82). In this study, two types of data collection methods were applied. The first was a literature review done to gather background into the concept of a QMS and various historical data presented in previous studies about QMS implementation. The information gathered was used to compare data found in this study with other studies done internationally and in South Africa on the same topic.

The second method was semi-structured interviews held with participants working for companies within the civil and general building construction sectors. The open-ended questions aimed to allow probing and were done face-to-face at the offices of the companies. The interview questions can be seen in Appendix D. The interview questionnaire contained 14 questions to gather background information of the participants. It further aimed to assist the researcher in gaining a better understanding of the participant's involvement and experience in the QMS of the company. The questions were directed to retrieve information regarding how the QMS is applied and identify benefits and limitations. This allowed the platform to discuss the critical criteria required for a QMS in a construction company in South Africa.

Before each interview, the consent form, as the example in Appendix C, was discussed and signed by each participant. All interviews were done at the offices of the various companies. The interviews ranged from 25 to 45 minutes, with an average duration of approximately 30 minutes. All interviews were recorded and transcribed. The completed transcribed interviews were used for the data analysis of the study. For this study, the recording of the data collection process to be utilised is set out in Figure 3-1 Data collection process below:

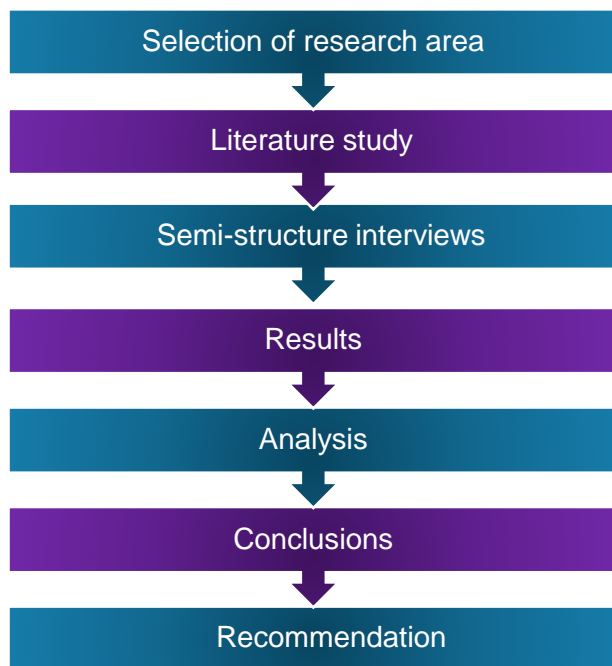


Figure 3-1 Data collection process

Source: Author's own.

3.3.1 Sampling design

The population represented in a study is often too big, and factors such as time limit of the survey, expenses, time and accessibility in most cases will force the researcher to choose a smaller group, called the sample, which portrays the population (Bryman *et al.*, 2018:179). In this study, the sample comprised purposively selected employees and managers in construction companies falling within the researcher's network.

The sample group comprised three construction companies with CIDB ratings between 7-9, within the designation of CE (civils) and GB (general building). The initial study planning included at least five companies, but COVID restrictions and the pressures experienced due to COVID in the industry greatly affected the ability of companies to participate. The one company is where the researcher is employed, and two other companies are within the researcher's network. Nine interviews across the three companies were conducted with employees ranging from site clerks to top management.

3.3.1.1 Sample size

Sample size refers to the number of participants selected in the sample. Sample size can differ and depends on the purpose of the research, the type of questions to be asked and the kind of design and sample the study will use (Cohen *et al.*, 2018:203).

A minimum of 5 participants was identified in each of the participating companies. Due to work responsibility and site location, some identified participants were not available for the interviews. Poor signal reception made it impossible to do interviews via Microsoft Teams or Zoom. Three participants in each company falling within the selected hierarchy levels participated in the research. Table 3-1 Sample selection for the study below shows that the personnel were selected in various company designation levels. The sample size comprised both site personnel and head office personnel to gain a clear perspective on the various views of the two departments regarding their views on implementing the QMS within the company.

Table 3-1 Sample selection for the study

SAMPLE SELECTION		
PURPOSIVE	WITHIN RESEARCHERS NETWORK	
Company A	Company B	Company C
Junior Site Management	Junior Site Management	Junior Site Management
Senior site management	Senior site management	Senior site management
Top Management	Top Management	Top Management

Source: Author’s own.

The researcher is related to Company B's owner but has no direct line authority over the participants. However, to mitigate the risk, the researcher used an external interviewer for the interviews in this company. For all other discussions, the interviews were carried out by the

primary researcher. As per Table 3-1 Sample selection for the study above, the selection and participation of both site and office personnel included perspectives from different companies in the same industry, which is valuable to the research.

3.3.1.2 Development of data collection tool

Based on information obtained during the literature review, crucial elements to be included in the interview were identified. The key areas were used as critical elements with sub-questions under each of the essential aspects. The interview questions were designed to align with the research questions by making use of open-ended questions.

3.3.1.3 Interview questionnaire

The interview questionnaire designed for the research study aims to cover various aspects of designing and implementing a QMS in the construction industry. Questions relate to years' experience, current position, and to test the familiarity regarding QMS's. Emphasis is placed on the implementation, training and objectives of QMS in the company. Furthermore, to ensure proper implementation, the focus is placed on the implementation, specifically on the construction site and resource availability. The criteria for a QMS in a construction company are investigated to enable the researcher to answer the study's related objective. The helpful review from site managers is valuable to answer the research objectives. The questionnaire layout is provided under Appendix D.

3.3.1.4 Transcribing the interview

Transcribing of the interviews forms part of the vital phase of content analysis. Transcription is the process that needs to be completed before the coding process can commence. It is essential during data analysis and must be done meticulously (Parameswaran, Ozawa-Kirk & Latendresse, 2020:630). In transcribed interviews, the chances are high for errors (Parameswaran *et al.*, 2020:632). To mitigate possible mistakes, the interviews were transcribed utilising the voice recognition application Otter. The accuracy of the transcriptions was re-checked against the initial transcribing and that of the recording. The researcher did all transcribing. The transcription guidelines and rules provided by Dresing, Pehl and Schmieder (2015:28) were applied to allow

for simple transcriptions due to time constraints experienced. An example of one of the transcribed interviews is provided in Appendix E.

Table 3-2 Transcribing guidelines and rules

TRANSCRIBING GUIDELINES AND RULES	
1	Do not summarise the interview. Transcribe literally
2	Use standard language. Transcribe informal language applications like 'yeah' into 'yes.'
3	Despite that syntactic errors might occur, maintain the sentence structure
4	Omit stutters or repeated words, apart from when used for emphasis
5	Smooth punctuation for increased legibility
6	Indicate pauses with (...)
7	Do not transcribe affirmative utterances like "Uh-huh."
8	Word used to emphasise are capitalised
9	Leave a blank line between speakers
10	Transcribe laughter or any other emotional utterances in bracket (laughing)
11	Incomprehensible sections to be indicated by (inc.)
12	Participant speech to be marked by "P:" and interviewer by "I:"

Source: (Dresing, Pehl & Schmieder, 2015:28)

3.3.1.5 Coding and data analysis

Qualitative content analysis was utilised while focusing on the text's content, underlying themes, and meaning. A conventional content analysis using coding categories and readers was utilised to identify keywords under each questionnaire and interview questions (Bryman *et al.*, 2018:301). To enhance and ensure a meaningful investigation, the data analysis for the study was grounded as an interpretive philosophy of the collected qualitative data (Nieuwenhuis, 2020a:123). The qualitative data analysis was utilised to turn the participants' experiences, knowledge, and views into new findings to establish criteria for a QMS for a construction company. It was further assisting in answering the research questions.

Content analysis was best suited for this study. This inductive process enabled the researcher to process raw text data containing the participants' views, feeling, experiences, opinions, and

knowledge after a systematical examination of the data (Nieuwenhuis, 2020a:123). The data was categorised by following a set of coding rules (Nieuwenhuis, 2020a:126).

A four-step content data analysis process was followed, as illustrated in Table 3-3 below: preparation, coding, categorising and interpreting the data. The first step was to prepare the data; this process aims to prepare the transcribed text for analysis. This entails the detailed description of the sample, participant and context into computer data files by reading and re-reading text to ensure a proper understanding of the text (Bryman *et al.*, 2018:337; Nieuwenhuis, 2020a:134). The second step was to code the text into meaningful analytical units. The reader has labelled the text with symbols, descriptive words, or categories identified during the reading process under each of the question sections (Bryman *et al.*, 2018:337; Nieuwenhuis, 2020a:136). Thirdly, coded text data will be processed by categorising it into various codes into a system to grasp its meaning (Nieuwenhuis, 2020a:140). Finally, the processed data will be interpreted to synthesise answers to the research questions (Bryman *et al.*, 2018:337; Nieuwenhuis, 2020a:141).

Table 3-3 Content analysis phases

PHASES	DESCRIPTION OF PROCESS
Preparation/Transcription	Prepare the transcribed text for analysis
Coding	Code the text into meaningful analytical units
Categorising	Coded text data will be processed by categorising it into various codes into a system to grasp its meaning allocating themes
Interpreting the data	Processed data will be interpreted to synthesise answers to the research questions

Source: (Bryman *et al.*, 2018:336; Nieuwenhuis, 2020a:134).

ATLAS.ti™, a computer program used in qualitative research data analysis, was utilised for this study. ATLAS.ti™ is a sophisticated tool to assist researchers in arranging, reassemble, and managing materials and data in a systematic but creative way (ATLAS.ti, 2020).

After completing the coding, the codes were organised into four themes, eight sub-theme and 21 categories. The three levels of code company were utilised as a guideline to enable the researcher to discuss the results systematically. The complete list of the codes can be made available upon request. The final phase of content analysis is the interpretation of the data into a report. To ensure proper quality interpretation of the data, the researcher amended the checklist

created by Braun and Clarke (2006:296) to make it fit for purpose but mainly to be used as a guideline to ensure proper content analyses are applied.

Table 3-4 An amended 15 point checklist criteria for quality proper content analysis

PHASES	DESCRIPTION OF PROCESS	
Preparation/ Transcription	1	Ensure transcribed data is on the appropriate level of detail and checked against the recordings 'accuracy.'
Coding	2	All data items received equal attention in the coding process
	3	Ensure the coding process was thorough, inclusive, and comprehensive for themes not to have been generated from a few vivid examples.
	4	All relevant extracts for the various themes have been collected
	5	Themes have been checked and compared against each other from front to back in the original data set.
	6	Themes to be internally coherent, consistent and distinctive.
Categorising/ analysis	7	Coded text data will be processed by categorising it into various codes into a system to grasp its meaning allocating themes
	8	The analysis and the data to match each other with analytics claims are well present and visible.
	9	The analysis to be able to tell a convincing and well-organized story regarding the data and the various topics
	10	A well-established balance between the analytical narrative and illustrative extracts are provided.
	11	All phases to receive ample time for completions
Interpreting the data	12	All assumptions relating to a specific approach of content analysis are explained clearly.
	13	A good balance is to be evident between what was claimed to be done and what was done. The described method applied and the reported analysis are to be consistent throughout.
	14	The language and concepts used in the interpreting of the data are consistent with the epistemological position of the analysis
	15	Ensure researcher positioning and active involvement in the research process.

Source: Amended from Braun and Clarke (2006:296).

3.3.1.6 Trustworthiness of the data

In qualitative research, trustworthiness is measured rather than reliability and validity. According to Bryman *et al.* (2018:38), measuring validity correlates with whether or not a concept is measuring what it is intended to measure. Therefore, the validity of a research study relies on how accurately and precisely the study can embody the actual situation compared to what the real case is. Validity will be achieved if the research can demonstrate what the researcher intended to accomplish with the study's outcome compared to what the researcher designed. Reliability refers to the principle of whether the same results would have been achieved if the study had been conducted differently with other participants. The research could be deemed reliable if measuring the research results could be replicated and the same results obtained (Bryman *et al.*, 2018:36).

The adequacy and credibility of the reporting detail during qualitative research is of utmost importance. The utilisation of the core attributes and common standards for quality research needs to be incorporated as measuring criteria (Bryman *et al.*, 2018:107). The attributes and standards related to trustworthiness relate to the following: credibility, transferability, dependability, confirmability (Nieuwenhuis, 2020a:144).

Credibility refers to the degree to which the collected data is truthful and appropriately generated in concurrence with the accepted procedure and valid truth value (Cohen *et al.*, 2018:248). The researcher's ability to take all complexities presented during the study into account and deal accordingly with the patterns that are difficult to explain will add to the truth and credibility value of the research and data (Nieuwenhuis, 2020a:144). When accurate, trustworthy, and credible findings are reported, they reflect the participants' reality and lived experiences. Presenting a true and accurate account of the results will further add to the truth and credibility of the data presented. The researcher also ensured that the information obtained from the participants was recorded and analysed accurately to ensure the credibility of the data presented. As an acquaintance of the purposive and snowball sample of construction companies selected, the participants will support the researcher in the mentioned matter to enhance credibility (Bryman *et al.*, 2018:186; Nieuwenhuis, 2020a:144). As said in the assumptions and delimitations, the study population only comprises a maximum of three (3) construction companies, and one assumes that the participants will answer the questions honestly and truthfully. One also believes that the

participants identified by the company will reflect and represent the companies views, beliefs and opinions. This will, therefore, to a degree, affect the overall credibility of the conclusions drawn.

Trustworthiness reveals the truthfulness of data. In this qualitative study, data will be collected through semi-structured interviews. This method must be reliable and consistent with the findings (Bryman *et al.*, 2018:192). As the researcher will be subjectively immersed in the research by being part of the personnel corps at the research site, trustworthiness is of utmost importance in this qualitative study (Nieuwenhuis, 2020a:143).

Transferability considers the possibility of the research comparable to other similar contexts or the option of applying the research findings to other comparable construction companies or participants working with quality matters (Nieuwenhuis, 2020a:144). A comprehensive description of the results and context-specific information will be provided as context-specific information to increase the transferability of the research (Nieuwenhuis, 2020a:144). During data analysis, the researcher will use specific coding procedures, such as signs and symbols, to ensure descriptive findings that enhance applicability or transferability to other comparable scenarios and add value to future research (Nieuwenhuis, 2020a:136). As most of the participants are managers within the construction company, they should be able to give insight into how the rest of the population view the implementation/operation of the QMS in the company.

Dependability refers to the researcher's capability to demonstrate and provide as much detail through the research design and its implementation. The process of operational point data-gathering and the reflective appraisal of the project will be enhanced through a comprehensive strategy and execution of accurate, in-depth detail. Environmental conditions, social conditions, economic conditions, and trends all affect construction site conditions and can result in inconsistent views that may even contradict previous beliefs (Cohen *et al.*, 2018:248; Nieuwenhuis, 2020a:144). Interviews will be conducted on the same day due and completed within ten days. This will ensure that results are not influenced by different work conditions or outside interference.

Confirmability refers to the degree to which the findings are formed by the opinions and perceptions of the participants. This is compared to the prejudice, stimulus or attentiveness of the

researcher. Or simply put the degree of neutrality (Nieuwenhuis, 2020a:145). Strategies that increased the confirmability of this qualitative study included minimising the effect of researcher prejudice by declaring the researcher's predisposition, regular member check with the participating construction companies and the involvement of others through debriefing and sounding out sessions (Nieuwenhuis, 2020a:145). The conclusions and recommendations are drawn by interviewing the selected participants, mainly managers aware of current/daily quality issues should guide the research findings into unbiased, neutral grounds as the participants can ask verifying questions.

3.3.2 Ethical considerations

Ethical considerations form a considerable component in a research study. Specific standards are set to be complied with to ensure the purpose and aim of the research are met: imparting authentic knowledge, actuality and prevention of error. Ethical considerations form a vital key element in a research study (Bryman *et al.*, 2018:128). A business research study needs to comply with specific ethical standards to encourage the objectives of the research. Ethical principles can be set out as follows by the following questions:

- Will it be harmful to participants?
- Will there be a lack of informed consent?
- Will there be an invasion of privacy? and;
- Will deception form part of the study? (Bryman *et al.*, 2018:128)

The following requirements have been met to comply with the North-West University's ethical guidelines for research (NWU, 2016):

- A Letter of consent from participating companies was obtained.
- Permission from the selected company's CEO's to partake in the study.
- Permission from the selected company's CEO's for the researcher to incorporate the results into the study.
- Informed consent was obtained since all interviews were voluntary. Participants were given sufficient information and background about the study before engaging in the interview.
- Participants were protected from any harm since all interviews were conducted in a facility of comfort and without stress or embarrassment on the participant's behalf.

- The participant's right to privacy, dignity and reputation was respected at all times. All responses were disclosed in such a manner to ensure anonymity and confidentiality.
- All references used in this study will be acknowledged according to the North-West University referencing requirements.
- The researcher was honest by only reporting the truth and did not present any data in a biased manner.
- For the interviews, written consent was obtained for audio recordings by each participant.
- The research study received approval for ethical clearance from the Ethics in Commerce Research Committee (ECRM).

The term ethics refers to an investigation of right or wrong. In planning any study, the researcher's responsibility is to safeguard those ethical concerns relating to respect, dignity, and welfare of people who partake in the research. For reference, refer to Annexure A for the ethical clearance application and consent letters to both companies and participants.

3.3.2.1 Permission and informed consent

The participants in each participating company were identified and selected via assistance from the company directors. Participants were informed about their selection and role in the study, and they were provided with a background to the research. Written consent for participation in the study was sent out before the commencement of the study. Consent forms were filled out and signed after being informed about the purpose, procedure, risk involved, benefits and the estimated length of the interviews. Interview dates were scheduled with a selected group representing each identified level group in each company participating in the research. Interviews were conducted in person, either on-site or at the company's head office.

3.3.2.2 Anonymity and confidentiality

The anonymity and confidentiality of participants need to be kept during a qualitative research study (Bryman *et al.*, 2018:122). Participants need to be assured that the information given during interaction will be kept stringently private. Their identities won't be revealed during the research report, audio recordings or field notes. The results will be presented to the participating companies; no part of the results will be separately discussed with the directors of the HRD of the

companies. To assure privacy, the participants and companies will receive names or letter codes as their identities to be only known to the researcher, e.g. company 3, participant 1. Care will be taken not to connect data to any of the participants. As part of data collection instruments, audio recordings will be carried out. The participants will need to permit the interviews to be recorded (Bryman *et al.*, 2018:228).

3.3.2.3 Confidentiality

The qualitative research approach allows the researcher to be part of the research. It can be hard to eliminate the researcher from the research process. (Bryman *et al.*, 2018:123) The researcher forms part and can be seen as another research instrument during data gathering (Bryman *et al.*, 2018:122). The researcher will also be busy recording interviews and taking notes of the said interview as it unfolds.

3.4 CHAPTER SUMMARY

This chapter aimed to provide background and motivation for the qualitative research design. The chapter furthermore discussed the selected research methodologies building on the information provided in Chapter 1. The method of data capturing and analysis was elaborated on to give a complete understanding of the approach and method the researcher decided on.

CHAPTER 4 ANALYSIS OF RESULTS

4.1 INTRODUCTION

This chapter discusses the results obtained from the semi-structured interviews with various role players in the participating construction companies. Demographic information of the participants participating in the study is provided, and four themes have been identified through the study relating to identifying critical criteria of a QMS. The themes and sub-themes will be discussed in full detail in a logical application of information and not in sequence of importance. The chapter concluded with a summary view of the results presented.

4.2 DEMOGRAPHIC INFORMATION

This study is focused on identifying the critical criteria of a QMS in a construction company in South Africa. Due to the study's alignment, the demographic information focuses on the related information regarding a QMS in a construction company and not on the participant itself. The demographic information of the participants is summarised in Table 4-1 below.

Table 4-1 Demographic information of the participants

Participant	Type of company	Province of operations	Year registered	CIDB rating
RBC 1	Residential building	North-West	2006	None
CCC 1	Civils construction	North-West, Gauteng, Limpopo, Mpumalanga, Free State, Northern Cape	1999	7 CE (Civils) 6 GB (General building)
MCC 1	Mechanical & Civils construction	National representation	1991	8 CE PE (Civil) 7 GB (General building)

Source: Author's own.

A code will identify participating companies and participants. The codes are listed as follows:

- RBC = residential building company.
- CCC = civils construction company.
- MCC = mechanical & civils company.

- P1-9 = participant number

The experience levels of the participants in the construction industry varied. Two participants were fairly young in the industry, with three and five years of experience.

“I have three years of construction experience.” – P2

All the other participants were well established in the construction industry, with active years ranging between eight and thirty-five years.

“I have eight years of experience in the construction industry.” – P4

“I have 14 Years of experience in the construction industry.” – P1

“I have 35 years of experience in the construction industry.” - P9

The participants proved to have ample experience in the various positions they occupy within the company and industry. Despite the years of experience, are there still various grey areas identified within the implementations of a QMS. The following section will mainly explore participant views regarding the implementation of a QMS in their company.

4.3 IMPLEMENTATION OF A QMS

A strong theme that emerged was identified as the implementation of a QMS. The most well-known implemented QMS is the format that ISO prescribes (ISO, 2015). The cost and availability of such a QMS make it impossible for all construction companies, especially small to medium-sized companies, to apply (Bravi *et al.*, 2019:64; ISO,2020). However, does it not mean that companies, not ISO registered are non-compliant in their QMS application. In the results discussed below, it will become evident that staff are aware of the terms QMS.

“Yes, quality management system.” – P9

“Yes, it stands for the quality management system.” – P5

In South Africa, no regulations or guidelines are set apart from accredited suppliers regarding the relevant information or requirements a QMS needs to fulfil. Due to the lack of regulations, various construction companies in South Africa do not implement any system at all (Bravi *et al.*, 2019:64). Furthermore, construction companies are only required to submit their version or format of a QMS as proof to a client. Companies like those that participated in the study are taking the initiative to implement their own QMS to ensure that quality work is continuously done on-site. The main aim for implementing a QMS is discussed in Section 4.4.1 under the benefits of a QMS.

“Yes, I think we use quite a few programs...” – P2

“We have a system; it's an application (app). It's called Fieldwire.” – P3

“Yes, we use checklists; standards and procedures explain how certain earthworks or formwork must be performed. The SANS 1200 specification also guides us in giving precise specifications on how items need to be built.” – P4

The implementation is essential for a construction company as it will ultimately enable better performance and completion of projects leading to increased profitability and increasing the companies reputation. The QMS in one particular company emphasises the focus and aim of implementing the QMS on reputation.

“... I believe it's insignificant if you look at all our projects and comebacks we have compared to the monetary value of the projects. None are of such nature that reputational damage would occur.” – P4

Effective implementation of a QMS may further prevent or limit construction accidents caused by structural failures, as was seen in the last decade in South Africa (News24, 2021).

The theme can further be divided into four sub-themes, tools used, responsible person, training on QMS and achieving quality objectives. Sub-sub themes will be discussed under each of the themes. Figure 4-1 illustrates the implementation theme of a QMS and the four sub-themes and categories forming part of each sub-themes provided. The four themes play a vital role in the implementation of a QMS. Each theme can stand individually on its own, but collectively are they the centre pivot point of a QMS.

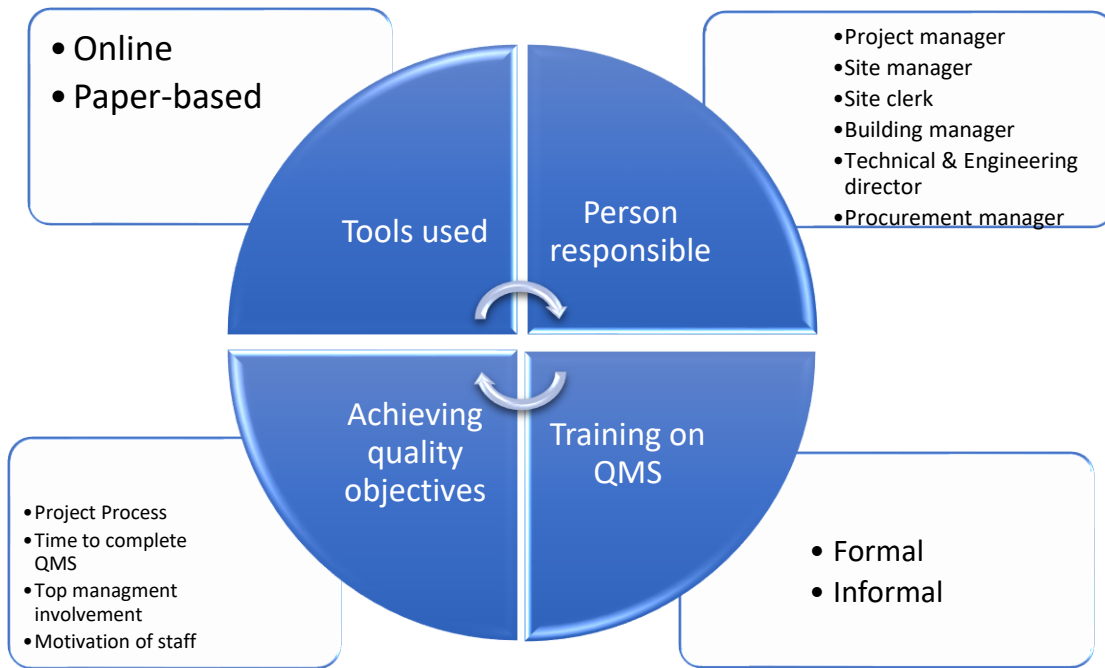


Figure 4-1 Theme 1-Implementation of a QMS with subthemes

Source: Author's own.

4.3.1 Tools used

Various tools and applications are used to implement the QMS and can be divided into online and paper-based tools as per Figure 4-1. One company make use of an online tool, namely Fieldwire (Fieldwire, 2021). Fieldwire is a collaborative system that allows the entire project team to collaborate and share various information in real-time as it progresses or takes place on-site. The application has three benefits:

- Efficient coordination,
- Performance tracking, and
- Risk reduction.

The other two companies utilise a more paper-based system consisting of checklists that are either filled in or completed and then scanned to form a soft copy or kept as a paper-based system to hand it into the client in hard copy. The paper-based system received more support from the participants compared to a purely online system. The participants using the online application Fieldwire shared their reservations regarding the application and will be discussed in Sections 4.3.1.1 and 4.3.4.2 below.

Therefore, the tools used as part of the QMS can be divided into online and paper-based. Both approaches have their benefits and limitations and will be discussed in the discussion of the results below.

4.3.1.1 Online

Various online applications have been identified that can be implemented and incorporated into a construction company’s QMS. Online refers to various construction programmes that can be utilised during the construction process like:

- Microsoft Projects is utilised to write and plan a construction project. It identifies the critical path and provides the site manager with a thorough plan with critical dates on construction activities. One of the companies also included items in the programme: sign-off or approval of structures or completion of their QMS documentation to keep track of it.
- Editable PDF consists of the documentation of the various checklists used in the paper-based system. The editable PDF docs allow for quicker fill in times as all sections to be filled in have drop-down boxes where the site manager can make his selection as the specification on the drawings are indicated.

Seven out of the nine (7/9) participants indicated that Microsoft Project forms an integral part of the planning and execution of the QMS. As discussed above, Microsoft Projects can be utilised to identify items in the construction programme that need to be completed in the implemented QMS. For example, the quality documents (as per Figure 4-2 on the next page) can be indicated on the programme to give proper guidelines to the site manager.

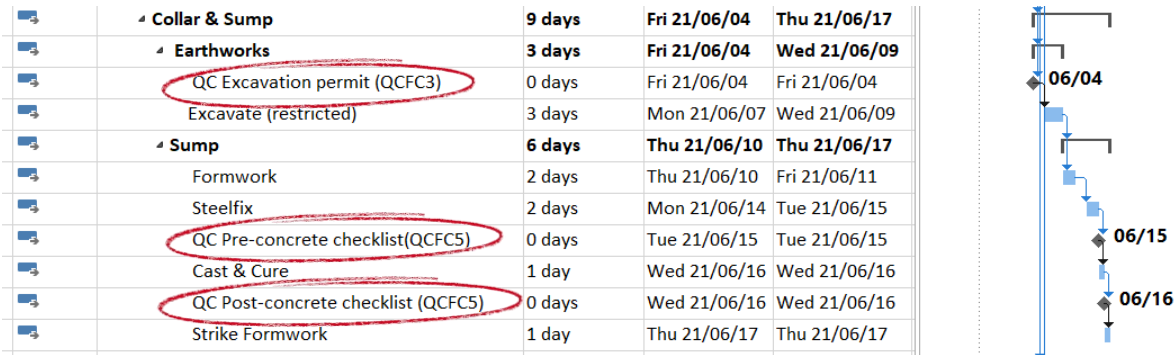


Figure 4-2 Microsoft Project project application example

Source: Author’s own.

“...One specific tool we implement is MS projects. On MS projects, we schedule quality management intervals at distinct work stages of the project.” - P1

“Yes, definitely. By using your program, you know exactly when what activity will take place. You plan your quality checklists and test to be signed off and done into the program. It is another reminder and guide, and therefore, will you continuously work on your quality rather than leaving it till the last minute.” - P4

“Yes, it does because it gives you a firstly a time record and secondly a futuristic planning record that you use to set up your quality insurance plan. For instance, if you are doing earthworks, you'll use your MS Projects program timeline and prepare your quality insurance plan.” - P7

Two out of the three participating companies use an editable pdf system with a checklist that needs to be signed off as on-site work progress. The specific format is not always suitable or preferable for all site managers and can it lead to a limitation, as discussed in Section 4.4.2.2.

“We do have the documentation on an editable pdf system, but I don't like that format.” - P4

“It is available in an editable pdf format which helps me quite a lot.” - P6

Only one of the three companies that participated in the study uses a software application that can be used to do all the required signoff checklist and supporting documentation. The Fieldwire application is used at a monthly fee calculated in Dollars (\$). The application is installed on-site personnel phones on which they need to fill in and complete all relevant checks.

“...And then also a particular tool we use to capture our quality management is Fieldwire. On Fieldwire, we use our development quality forms.” - P1

“For example, the program that we use is Fieldwire, which allows us to capture information as we go along with the work to ensure that we check everything and ensure that we got everything on record.” - P2

“We have a system; it's an application (app). It's called Fieldwire, where we implement all the qualities. It's a checklist that we do just before we go on-site or before the establishment off-site.” - P3

The Fieldwire application of all three concepts is discussed as the most technologically advanced application of an online QMS. However, some limitations or restrictions will be discussed in Section 4.3.4.2 relating to the time to implement QMS. An implemented QMS aims to support and build up a report to prove that the contractor constructed items or structures according to specification. As discussed in Chapter 2, the main concern for an implementation is the time constraint. The concept around time will be discussed in Section 4.3.4.2 below in full detail.

4.3.1.2 Paper-based

According to Maisiri and van Dyk (2019:135), the implementation of QMS models remained stagnant despite the evolution of the 4IR with construction QMS mainly remaining paper-based systems.

The main recommendation for a paper-based system can be derived from various on-site limitations that need to be kept in mind. Various construction sites in South Africa are situated in areas where cell phone reception are limited or even non-existent. This allows limited options for connectivity and makes the use of wifi impossible. Therefore will a paper-based system be more preferable. Furthermore, client preference can not be excluded.

“Paper-based. And obviously, we do have the electronic version and are not on-site physically with pen and paper. We are not using an application (app) or website version. It is internally designed.” - P5

“Yes, well, we have checklists that we fill in.” - P6

The compilation of the paper-based QMS system in construction is mainly guided by the SANS 1200 specification to which designs and construction are measured. This further forms the basis of the quality guidelines and quality checks that will be performed. All relevant documentation forms must be included in a quality control plan supported by a quality policy that needs to be signed off and approved by the client and engineer before the commencement of construction work.

“Yes, we use checklists; standards and procedures explain how certain earthworks or formwork must be performed. The SANS 1200 specification also guides us in giving precise specifications on how items need to be built.” - P4

“It is site-specific with quality insurance control spreadsheets. Civil projects, for instance, can't commence if the client didn't sign off the quality policy and plan for that specific project. It is further guided by the specifications of SANS together with the engineer's drawings.” - P7

“We have documentation that needs to be filled in from the third parties side to inspect the pipes we manufacture. They check the painting, NDT testing checking thickness, NDI checking on the welding, and ensure that everything is standard. There is also shop drawings that are added to complete and provide requirements from my side is correct.” - P8

“Yes, we have various checklists that need to be filled in when structures are done, or specific tools are delivered to the site. Calibration certificates and lifting chain certificates are essential. If the site manager doesn't have that, will they not be able to perform their work.” - P9

When reviewing the results and considering the company's size, it is evident that the construction industry has difficulty adapting to new technological advances as identified in the literature (Maisiri & van Dyk, 2019:135). Despite the ability to move over to a fully electronically QMS system, most companies prefer to continue to use their paper-based system. Client specification also plays a role as most clients prefer to receive the quality pack in original printed format at the end of the project. Various quality checklists and sign-off sheets incorporated into the quality pack must be signed as original and not printed or copied.

The method of application can be assigned to preference. An essential part of the application, however, is the person responsible for completing the documentation. The following section will explore the various roles in a construction company responsible for completing the documents and ensuring that quality work is adhered to.

4.3.2 Persons responsible

As shown in Figure 4-1, various personnel and departments are identified to be partially or fully responsible for implementing a QMS in a construction company. The person responsible on-site to ensure work is done on standard and according to the procedure and requirements set out by the SANS 1200 is of utmost importance to any construction company. Six of the participants occupy their duties on site. During the interview, they all identified the main responsible person to be themselves as the responsible person. An important point that stood out during the interview is the confidence that the site managers and site clerk took up their responsibility towards quality.

A site manager plays a vital part of a construction team, being responsible for progress, planning, quality, and cost on a site. During the interview, the roles and positions within a construction company responsible for ensuring quality were identified as the site manager, site clerk and building manager.

“Myself as site clerk and my site manager.” - P3

“The site manager is responsible for ensuring all work on-site are done according to the SANS specifications and as stated on the construction drawings. The procurement manager will order the materials and check the quality docs of suppliers are in place. The engineering director takes full responsibility and liability and therefore needs to check site manager works are up to standard.” - P4

“Site Manager but also all staff involved with the work.” - P6

“Definitely the site manager and his foreman. I would say the contracts manager at the head office, let's say we call it the directors responsible for the executes of projects to make sure our site managers and procurement comply with what to comply with.” - P7

“The site manager has the most considerable responsibility.” - P5

For a QMS to be effectively implemented, the on-site site manager's work is only a partial part of the bigger picture. Site managers are supported by various support roles mainly occupied by office-based personnel. These positions are those of the procurement manager, project manager, technical director and engineering director. Depending on the company size, specific roles like a quality manager or quality administrator assist in completing a quality pack for the client. They also play an integral role in the overall implementation of a QMS in the company.

“I think it's from my side to my program management side, and then we have a project manager underneath a project manager. We have our site managers. We expect that the tools will be checked every week...” - P1

“The Site manager at the factory, the factory manager, the third party inspector and myself as Divison manager.” - P8

The essence of a responsible role or person to ensure quality is well captured by one of the participants, as confirmed by Karimi and Pimplikar (2020:3620), is the importance of top management support but ultimately that all staff involved are responsible for ensuring quality work

are constructed. The role and responsibility of top management in the implementation of a QMS are two-fold. Firstly, they are responsible for setting the company culture, creating awareness and importance and value of the QMS, and ensuring that competent and experienced staff are allocated to manage and lead the QMS. It is of utmost importance for top management to evaluate and inspect the related documentation of a QMS regularly. The importance and view of top management will motivate staff further down to ensure proper implementation. Based on the information retrieved from the interviews, it is important to iterate a fine line between merely implementing a QMS and producing quality work. The one can not replace the other. To give a practical example, one company spends so much time completing their QMS documentation that they don't spend time on-site to see that the work performed is of high quality. Here the role of top management is of importance to give a clear guideline and find the perfect balance.

“All staff must understand the impact of quality on the reputation of the company. It is not just one person's responsibility. Quality is for all staff to implement from management to labour.” -

P4

One of the participants capitulated the essence and responsibility of who is responsible for implementing a QMS very accurately when he stated that everybody in the company is responsible. In essence, it can be summarised that although certain positions within the company can be highlighted that in the end, when influenced positively by the company culture, all staff plays a role in the implementation and successful upkeep of a QMS. Proper implementation of a QMS requires understanding what needs to be filled in or done and how the quality pack needs to be sequenced. Training of staff is vital as it is the foundation of your QMS.

4.3.3 Training on QMS

Despite the years of personnel experience across the participating companies, it was prominent how site personnel training on implementation and preparation of a quality pack was lacking. When evaluating Figure 4-1 above, is it clear that a staff complement responsible for QMS implementation and the link between training can not stand individually in the QMS implementation process. When bearing in mind that site personnel are mainly responsible for completing the set-up of the quality pack on site. In larger construction companies, it is the norm to appoint a quality manager with a team reporting to them. The primary responsibility is to ensure and complete the quality packs to be presented to the client. In small to medium construction companies are the responsibility lies with the site manager to complete such tasks.

According to Karimi and Pimplikar (2020:3624), the lack of staff training is noticeable across various construction companies. According to Odiba *et al.* (2021:2), QMS implementation must be regarded as a holistic approach towards managing and delivering a construction project. When reviewed from that angle, it is questionable why construction site personnel will receive various training on how to perform their work. Still, limited training is done on the implementation of a QMS. Evaluating the value and benefit of a QMS as per Section 744.4.1 below compared to the lack of training as presented in Section 4.3.3.1 and 4.3.3.2 are areas for immediate improvement in the implementation of a QMS.

In this study, formal and informal QMS training was identified as critical to implementing a QMS. It was also noted as one of the five critical criteria for a QMS, as discussed in Section 4.5 below.

4.3.3.1 Formal training

ISO accredited construction companies undergo formal training in the preparation and completion of their accreditation process. For companies not ISO accredited, formal training is either not a requirement or an internal need. Short courses or diplomas in, for example, Project Management focus on areas regarding QMS implementation. The same level and quantity of information can't be compared with that of a Diploma in Quality management. Out of the nine participants of the study, only two (2/9) participants have received or done some form of formal training constituting to modules that formed part of a project management course or training set out by ISO 9001.

“...the quality management system was part of project management. I studied project management at Cranfield College for my post-graduate diploma, and my project management profession,...” - P1

“I am currently busy with quality management (let's call it a course, I won't call it a diploma), But yes, we received training when I started here.” - P2

As mentioned in Section 4.3.3, training forms a critical part of the QMS implementation. Senior management appointed in a quality management position will benefit the company if they have the relevant formal training or education to support their position. Due to the focus of responsibility shift between a typical quality manager and site manager, informal training provided by a third party or informal internal training provided by the company would be sufficient for site personnel.

4.3.3.2 Informal training

Informal training would constitute training provided by the company. This form of training would consist of information and background into the internal processes implemented by the company with regards to the implementation of a QMS. As mentioned in Section 1.4, when discussing the study's problem statement, companies are not required to be ISO accredited to perform construction work for the public or private sector. Construction companies that are ISO registered are required to do so due to either client specification or a manufacturing department or division. Although ISO accreditation is advisable, is it not a standard requirement in the South African construction sector. The only requirement is to provide the internal QMS applied by the company. Therefore would informal training be sufficient to train staff on the QMS implemented. The type of informal training the participants received mainly formed part of the participant's background, including in-service training and experience gained on-site as provided by a senior staff member, client specification or SANS 1200 guidelines.

“For myself, I learned through the sites we have done and guidelines from my boss. I didn't receive training. I am also completing documents on the application (app), and then my site manager verifies the quality.” - P3

“I didn't receive formal or structured training. I was taught as I worked on-site.” - P4

“No, I haven't received formal training; I do apply what I know. There were short discussions, and documentation was sent to me.” - P7

Apart from understanding processes regarding the implementation of the QMS as mentioned above, informal training can be further broken down into the expanding general quality view and perspective of the site manager. For example, site managers are required to evaluate a structure in terms of specifications and construction principles. A significant concern about the effective implementation of a QMS in a South African construction company can, apart from concerns raised in the literature study in Chapter 2, also be supported by the lack of training participants received within their companies. The number of participants only receiving informal training (7/9) indicates that management might think that if discussions are done, staff are trained and knowledgeable at what is required of them.

“It was more a discussion, not formal training.” - P6

Based on the lack of training received, as discussed above, it can be further identified as a limitation on South African construction companies as it diluted to results found in other studies (Emuze & Mhlwa, 2015:1225; Karimi & Pimplikar, 2020:3620; Odiba *et al.*, 2021:2). The limitations of QMS implementation will be discussed in Section 4.4.2 below. The lack of training will emphasise other departments or factors within the company to ensure successful implementation, as discussed in Section 4.3.4.

4.3.4 Achieving quality objectives

The implementation of a QMS is left to the discretion of the construction company itself. Limited guidelines or requirements are assigned to the implementation of it. This leads to the study's opportunity to identify focus areas construction companies are leaning upon to ensure optimal implementation with the primary focus to ensure the company's quality objectives are achieved. As illustrated in Figure 4-1 above, the outflow of the project process, with the responsible person identified and trained on the QMS, is that collectively will ultimately lead to the achievement of the company's quality objectives.

To achieve a construction companies quality objective, in essence, capitulates the core mandate of the company. The core mandate quality objectives are critical in the construction industry due to the evaluation of a companies competence based on previous projects completed and the level of quality achieved. In a cutthroat industry like the construction industry, a company's reputation plays a significant role in continuing existence and growth.

Four sub-themes emerged from the interviews with the participants relating to the achievement of quality objectives:

- Project process
- Time to complete QMS
- Top management involvement
- Motivation of staff

Great emphasis is placed on the sub-themes of achieving quality objectives, and the results are presented in Figure 4-3 below.

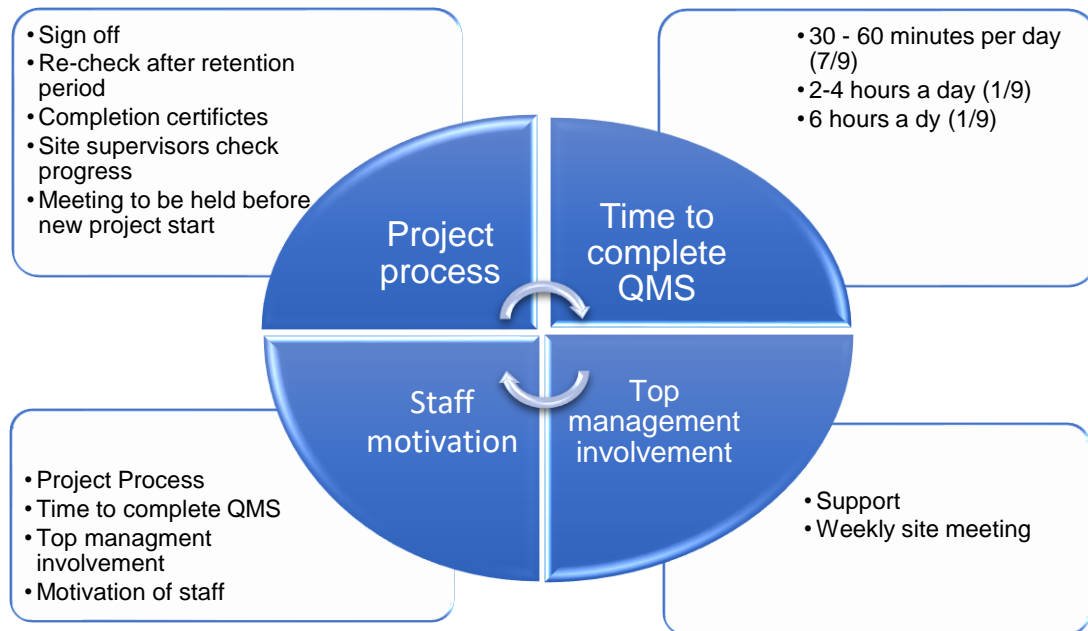


Figure 4-3 Achieving quality objectives and sub-sub-themes

Source: Author's own.

4.3.4.1 Project process

Any QMS implemented in a construction company refers to more than one process or system identified in Figure 4-3 on the previous page. Although QMS brings formality to the front, it includes various documents, processes, procedures, and responsibilities collaborating to achieve its quality objective. Each system can stand individually, but when applied collectively, it comes to life in what is referred to as a QMS. The project process in construction is unique from site to site. Regardless of how the typical structure is constructed, the specifications and design might suit the application. This will have a direct implication on the design and requirement of the quality documentation. Client specification will determine the extent and detail of the documentation to be provided. Regardless of detail and spec are two factors relevant and their importance undeniable, the involvement of top management in the process and the motivation directed to staff.

The project process refers to all QMS related activities required during the construction period that plays a role in the implementation of QMS. This includes and is not limited to sign off of quality policy, quality plan and construction process quality checks as work progress.

Specifically, in the residential building, we address all the tasks in the process flow. We are also trying to capture all the quality-related items in the process.” - P1

Participants voiced the need to have sit-down meetings before the start or move to a construction site. Participants differentiated between sites that started with a kick-off meeting and those that started without a meeting. Valuable information is shared to prepare the site manager. Planning together with other departments within the company allows all departments to be aware of site-specific requirements, cash flow requirements, manufacturing or material specification and requirements. The meeting further allows the quality plan to be discussed and implemented, but weighing high on the priority list can influence motivation and morale.

“Yes, it is the quality of the projected and human resources to call everybody on-site to understand what type of quality is required for the project.” - P3

“I think we are doing yes. I think we are achieving and setting quality boundaries that most companies are not able to achieve. And I believe that we are setting the standard for, especially companies in our area. So, are you confirming that quality and the brand you're building is that of a good quality management system?” - P5

When the project process has been updated and implemented during a project, it alleviates pressure when the final inspection after the twelve-month retention period is done. In most cases are the contractor is required to correct items on a snag list. But on various occasions, is it common for the contractor to be highlighted and labelled to have not followed the correct procedure or specification if profound items are recorded on the snag list. The project process will enable the contractor to have the relevant evidence that the work was completed on specification and of good quality.

“Yes, one of our values is "on time". Rarely, one of our projects is not completed and signed off on time. We do not get comebacks for significant quality or structural defects. The projects are signed off, and a practical completion certificate is issued. Snags can be rectified, and the project completion certificate is issued.” - P4

An essential part of the project process includes the various checks the supervisor or manager needs to complete during the construction process. Without the correct forms or fill in forms are the implemented QMS falls apart. This is also one of the site managers or relevant person

responsible for the quality pack's primary responsibility to ensure that these documents are filled in as required and signed off by the relevant parties.

"Then we got site supervisors and staff from the office that come to the site from time to time to check if what we are doing is on standard and is done correctly as per plan." - P2

"I think so. On-site, we need to ensure that the quality is correct and that our structures are built according to standards. Even the quality control papers help to check that you know that your structures are correct." - P6

The project process plays an integral part in the construction process and encapsulates the attitude of the construction company towards the quality process within.

"Yes, there is also room for improvement. We don't have much or any comebacks." - P8

The project process collectively is a critical driving force in the implementation of a QMS. A thorough understanding of the process is critical for effective and efficient implementation. The specification and in-depth application directly correlate to the time it takes to complete the QMS.

4.3.4.2 Time to complete QMS

The time constraints identified with implementing a QMS can also be one of the critical limitations of implementing a QMS. In Section 4.4.2.2. will this concept be alluded to in full detail. One of the contributing factors for construction companies not to present a quality pack at the end of the project is time and motivation. Comparing time requirements to implement a QMS between the two companies using a paper-based system to an online system like Fieldwire raises concerns. Apart from constructing items or structures to specification, one of the key responsibilities is to complete a project on time. It is of essence to note that the application Fieldwire is not under scrutiny, but merely the difference in application between an online and paper-based system. The difference in completion time can also be attributed to the amount and quality of training received to operate the application.

In South Africa, various projects were either not completed or completed long after the contractual completion date identified. A cut through an industry where time is of essence is the last thing a company can afford to have a site manager or foreman spend more time on a phone or tablet to

complete documentation. This takes time away vital parts of the roles, duties and responsibilities of a site manager and foreman to ensure that the work gets done. An interesting observation during the interview is how the top management and site management perspective relates to the time to complete the documentation.

Based on the results, seven (7/9) participants indicated that it requires between 30 – 60 minutes out of their day to complete or work on their QMS documentation. The high number of participants confirming 30 – 60 minutes is sufficient to indicate that a small amount of time allocated towards the QMS daily is sufficient to keep the system up to date. It is also interesting to note that the 7 participants who were comfortable with their time frame prefer to work on an editable pdf QMS document or strictly paper-based.

“So I would say so 30 minutes a day.” - P9

“Half an hour a day. If you do it daily, then it won't haunt you later on in your project.” - P4

“You are required to stay up to date. If you work on it daily for 30 minutes or so, you will never fall behind. The moment you receive your support documents, print and file them in your quality file. It is part of the job, no big deal.” - P5

“No, if you do it in time, it won't take time. It would maybe take an hour. That is part of your work.” - P6

An observation made during the interviews was the optimism the participants that strickly work on the application had towards the preference in the company, regardless of taking up most of their workday and taking them away from the work they are also responsible to due. One participant (1/9) indicated that it requires 2-4 hours a day to complete the relevant checks on site.

“ I think to look into that first cause I can always catch up on quality, but anything between 2-4 hours a day I send just on quality checking and completing the forms.” - P2

One participant (1/9) indicated that completing quality checks and documentation is a full-time job, and completing checks on the application can take up to 6 hours a day. The fact that it is a full-time job is understandable if that was the participants only responsibility. The specific participant is a site foreman, required to do typical construction-related work like setting out and

managing material and sub-contractors. He is therefore not appointed as a quality inspector on-site. When reviewing the time QMS related tasks taken out of a typical construction 9-hour workday, it can be said that he just spent 2 hours on construction site related work with a 1-hour lunch break per day.

“That is a full-time job; it needs to be consistently updated, consistently be around the site, and know what is going on on-site. I spend half a day spending time on quality checks. Fill in on application (app) takes about 6 hours to capture it on site.” - P3

From a top management perspective, it is clear that the construction staff's focus on site is to do the work on standard and with good quality. The completion of the checklist and quality-related documents would only need approximately 30 minutes a day. Notable is that the participant which role is top management is unaware that employees in his company are spending hours per day to ensure the document and checklist on the application are filled in and not spending it on work on site.

“Of myself, it would require at least depending on how many projects we are doing. I would spend at least 2 to 3 hours a week on that. During site visits, that is one of the prominent roles I play.” -P7

“They must set aside every day 30 minutes to an hour to capture their quality management system.” – P1

As referred to in Section 4.3.1.1 and when reviewing results in Section 4.3.4.2 above, is it evident that participants using the application to fill in a quality checklist compared to the participants preferring an editable pdf or paper-based system requires a magnitude of time more to complete their checks.

4.3.4.3 Top management involvement

Top management involvement plays a pivotal role in how a construction company will address matters related to quality. Leadership refers to top management involvement as one of the ten clauses ISO recommends for successful QMS implementation (Odiba *et al.*, 2021:4). It was noticeable how the participant views in all three participating companies differed. In one company, it is clear that effective QMS implementation is a non-negotiable topic. On the other were conflicting views from the top managers, with some being strict and understanding of the process

and the others having a no care attitude towards it. And in the third company, they are actively driving their QMS, and all staff is committed to it. Thus can it be concluded that a top-down approach with motivation and support forms a vital part of a QMS.

“Top management is 60% of the whole project. You have to have that side...” - P3

“Marginally active. We do have weekly meetings also discussing quality.” - P5

“They are both very involved, just in different ways. The one is strict on quality work delivered on-site, and the other emphasises the supporting documents to support further the work you've done on-site.” P6

“They are very active. It is a critical factor for them. They are very strict about it.” - P8

Top management plays a critical role in the successful implementation of a QMS. Top management support set the way for lower-level managers to follow.

“Yes, I keep it with me. When the time is right, I issue it. Well, first I go through the checks myself, and then I give it to them, and then they also check them on their site, then I sign off the sheet, and they sign it too. It's just to say we checked it from both sides.” - P2

The top management has a two-sided role in the implementation of a QMS. Firstly is the instruction to implement a direct order which is of importance. Staff needs to align with the instruction, understand it and act on it. Secondly, it is the role and responsibility to motivate the staff. Firstly, staff needs to understand why they must do or implement the system and the benefits. Secondly are top management motivation of essence to keep the system implemented. Any system is only effective and efficient if it can be implemented on a long term basis. The biggest downfall for a QMS would be if one part of the company is motivated to implement it, and the rest of the company is creating the potholes in the road to slow them down. Therefore is overall staff motivation of essence.

4.3.4.4 Motivation of staff

The support and motivation from top management are crucial to increase the motivation of staff on site. Without a proper understanding of why specific actions are required to fulfil the company's quality objective, is it difficult for the construction team to be motivated. Based on the results, is it

evident that staff motivation is achieved and correlates with the company achieving its quality objectives as per Section 4.3.4.

“If I think about my supervisors or the building supervisors, it's the people I come in contact with. Yes, they are very motivated; I would say I work with Mr XXX. I enjoy working with him.” - P2

“I think they are very motivated.” - P1

“Everybody knows their targets, and we motivate each other sometimes. We have a toolbox talk on-site to uplift the spirit on-site so that the guys know what is expected from them.” - P3

“They are very motivated.” - P8

“I think the guys are, in general, are motivated. The staff working for the company feel part of the process and get the incentive when they deliver quality work.” - P5

Staff motivation collectively plays an integral part in how staff attitudes towards the work performed on-site are presented. Quality requirements and standards need to be communicated from a top management level to all sites and the process to be the same for all sites.

“No, not as it must be. One of the directors constantly needs to nag site managers to complete their documentation. I don't think staff understand the value of a quality pack. Most see it as more paperwork, but it covers you and the company if questions are asked later. It is also proof that you've done your work according to the standards.” - P4

Staff inherently will ensure proper implementation of the benefits to themselves and the company are understood. The information provided above coincides with the findings in Section 2.7.1 in the literature study focussing on the guidance of QMS implementation.

4.4 BENEFITS AND LIMITATIONS OF A QMS

A second theme that emerged from the study is the effect of the perceived benefits and limitations of a QMS implementation.

Evident from section 2.6.4 above are there various benefits but also limitations presented in a QMS. The motivation to implement a QMS in a construction company mainly derives from two

types of motivational sources, internal and external. The benefits of QMS implementation and longevity will carry more weight if the implementation is derived from an internal source of motivation. As confirmed in section 4.3.3, it is essential to train staff on the benefits and limitations of a QMS. If the motivation for implementation internally and the benefits are known, it will be an added advantage for the construction company.

When the benefits of a QMS as reviewed in Figure 4-4 below, is it clear that it elementally forms part of the motivation of the employment process. Implementing a QMS can also act as a tool for staff performance evaluation as per clause 9 in the ISO implementation plan (Odiba *et al.*, 2021:4). When a QMS is implemented, it inherently steers a manager or project to increase performance, with both company and employee reaping its benefit.

The positive effects of QMS implementation identified during the study correlate with a recent study done by Odiba *et al.* (2021:1):

- the speedup of projects
- the increasing of profitability
- to assist towards satisfying clients
- to reduce the number of defects
- Limit inspection cost
- enhancing workmanship efficiency and
- the improvement of construction reputation

Training towards the implementation of a QMS serves various purposes. As with the results below, it is noticeable that the benefits far outnumber the limitations. The perspectives of the participants will outlay the various benefits and limitations below.

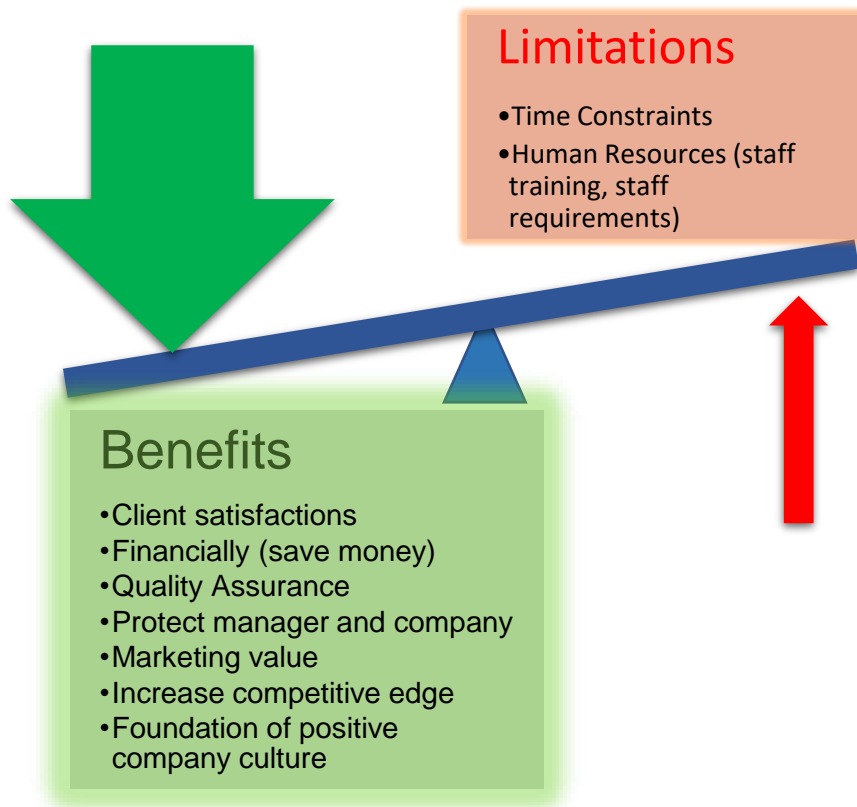


Figure 4-4 Benefits vs Limitations of a QMS

Source: Author's own.

4.4.1 Benefits

The benefits, as illustrated in Figure 4-4 above, weigh heavier than the limitations. When reviewing the time required to complete documentation as per Section 4.3.4.2 above weighed up against the benefits. It relates to previous research and literature in Section 2.6.4 relating to the benefits of a QMS. However, the benefits identified during the interview is related are various new added benefits identified during the study. Despite the benefits, construction companies do still find it challenging to comply with an operational QMS. Regardless of limitations of implementation on site can the benefits of a QMS can be summed up as:

- Client satisfaction,
- Financially - save money (no need for repairs and comeback),
- Quality assurance - eliminates rework/snagging, keep track of work done, know next step + what have missed, work up to standard,
- Protect manager and company = proof of work done,
- Marketing value,
- Increase competitive edge, and

- Foundation of positive company culture.

4.4.1.1 Client satisfaction

The participants supported the perspective gathered from literature in 2.6.4 that identified the role of a QMS to keep the client or customer satisfied. Network building is of great value in the construction industry, and numerous continuous projects result from it. One key consideration to client satisfaction is to confirm client specifications and requirements, especially for the quality pack, before the commencement of the project.

“Firstly, it assists you in complying with the expectations of the clients.” - P7

“Giving them the insurance that you gave the client a quality product.” - P8

4.4.1.2 Financially

One of the main objectives of a company is to be profitable. One critical criterion to achieve profitability is to save costs where possible. Proper applications of a QMS can assist a company in ensuring work is done to size and standard the first time, eliminating the time and cost of repairs and comebacks during the construction phase and the 12 month retention period. The view of the participants supports the financial benefit identified in Section 2.6.4 above.

“It can save you money as you don't need to do repairs or comebacks during your retention period.” - P4

“In the long run, it saves money for the company.” - P9

4.4.1.3 Quality assurance

Quality assurance collaboratively assists in the insurance that works on site have been done in accordance with the drawings provided by the consulting engineer. It further relates to a study by Chen (2019:1), who related the benefit of an implemented QMS to the practicality, reliability, durability of construction work being directly related to possible investment benefits linking back to Section 4.4.1.2 above. Furthermore, it ensures that works have been done according to the standards and guidelines in the SANS 1200 specifications. The quality concept has a rich history with a dedicated focus on product-oriented quality and user-oriented quality. Implementing a QMS as a unique tool to further ensure companys' long-term growth

can ensure that the construction company can prove that what needs to be done were done, according to standard, following the correct procedure and with good quality (Ershadi *et al.*, 2019:1093; Parasuraman *et al.*, 1985:45).

“The benefits of the QMS I would say it forces you to go to the quality checks system. You can easily be held up with getting the guys sorted on-site or getting them materials, or talking to them about, specific part of the work you can easily forget about. I think the system helps my boss and me to keep track of it, and if he's not happy, he will put pressure on me to make sure that the quality checks are being done. I think the system helps us to do the work that we need to do. It keeps track of the work we do.” - P2

As discussed in Section 4.5.3 below, planning allows the site manager to keep track of the work done and identify areas of the outstanding works, allowing the site manager to know the next steps in the construction phase. It furthermore acts as a reminder of outstanding work or items that were not completed for whatever reason.

“The benefit is that it's a system and you work from a point as progress the way we capture the checklist in the application (app), so it goes hand in hand in whats the next step, so it helps us a lot you cant miss a step in building construction, you might be of one or two days, but you'll see where it stop and how much you missed out on.” - P3

“Yes, definitely. By using your program, you know exactly when what activity will take place. You plan your quality checklists and test to be signed off and done into the program. It is another reminder and guide, and therefore, will you continuously work on your quality rather than leaving it till the last minute.” - P4

The most important part of the QMS is to ensure that works were done on standard and, in the process, will eliminate rework or snags to be completed before achieving practical and final completion. As pointed out by the participants, the final stages of a construction project can be daunting as the projects quality assurance pack needs to be checked. The final evaluation and inspection phase is mainly based on the documentation gathered during the implementation of a QMS.

“The benefits are that it eliminates rework or snagging at the end of the work.” - P1

“Firstly, it assists you in complying with the expectations of the clients. Secondly, it limits the redo of work, as it helps you do work right the first time. Thirdly, it has a considerable marketing value. If you knock on your previous clients' door again and have good quality, the benefit is you walk in with an open door. You don't have any knots and crosses behind your companies name.” - P7

Quality assurance is an ongoing process, and the main benefits are visible when the company is faced with an inquiry on works done during a project. The support and protection a QMS can provide for a manager and the company will become visible.

4.4.1.4 Protect manager and company

Contractually are a lot of responsibility and liability is put on the manager and the construction company to fulfil the required standards and specifications set out by the SANS 1200 spec and construction drawings. It is not uncommon for fingers to be pointed firstly to the construction company when structures fail or non-conformance have been identified. During the interviews, the participants mentioned that if a structure fails, it will always be the contractor's mistake, something he did or did not do. It is in times like this that the value of an implemented QMS will come to full force. The one participant mentioned that when faced with a typical scenario once before, it became evident that it was no fault of the contractor but a poor structure designed by the consulting engineer on the project. Suppose it wasn't for the implemented QMS they had in the company. Would the company name be easily recognised like so many other construction companies making the South Africa news in recent years (News24, 2021)? The QMS is the perfect system for a construction company to gather the required proof to argue the contrary.

“In the end, you cover yourself and the company.” - P4

“It leaves a good impression and covers the company and me.” - P6

“Giving them the insurance that you gave the client a quality product.” - P8

“It is like a fail save. If something happens, the company can prove that we delivered quality work.” - P8

“It also keeps staff accountable for what they do.” - P8

“It's absolutely to have control. Of what has been done. It is proof.” - P9

The value of the QMS in protecting the manager and company will only be realised when required in a specific situation. The additional value of using good quality work from a marketing perspective will be discussed next.

4.4.1.5 Marketing value

Having good quality work done benefits a company when used as part of the marketing material and strategy. Client feedback and recommendation play an integral part in the marketing network in construction (Lamb, Hair & McDaniel, 2019:85). As discussed in Chapter 2 are construction companies partially evaluated the quality of work done in previous contracts. Being able to provide relevant proof is a valuable advantage when marketing the construction company. The participants mentioned during the interviews that based on the completion of quality projects and being able to show photo and video evidence to potential clients have on various occasions led the client to make the final call on appointing the company. Apart from creating or confirming potential new projects, it also creates pride for the site manager and his staff working with him, adding to the internal motivation mentioned above.

“It's good for the company's reputation, especially when we started with the ISO registration.” -

P8

“...Thirdly, it has a considerable marketing value. If you knock on your previous clients' door again and have good quality, the benefit is you walk in with an open door. You don't have any knots and crosses behind your companies name.” - P7

Securing new projects is an added benefit of a good implemented QMS and allows the company to increase its competitive edge amongst its competitors.

4.4.1.6 Increase competitive edge

For companies in the construction industry, are activities and interests closely linked together, primarily if they compete on the same CIDB rating. It is usual for these companies to make their competition strategy part of their overall corporate strategy to gain a competitive advantage over their competitors (Kirabo & Jinzhao, 2017:51). A study by Rehmani *et al.* (2020:4) confirmed that a QMS could allow a company to develop further a strategic vision, plan and development initiatives imperative to link performance, strategic objectives and competitiveness to quality

efforts at hand. In a cutthroat industry that is recognised by high levels of corruption, this provides a competitive edge that will allow the company to stand out from its competitors.

Good quality work allows companies to build on their brand name to take advantage of their competitive advantage in the already competitive construction industry.

“It leaves a good impression and covers the company and me.” - P6

“Good quality work increases my ability to market the company, and if I can show a client what we are capable of achieving through good planning, a good implemented QMS to back our work and achieving programme goals...well then I’m in the driving seat.” – P7

As mentioned in Section 4.4 are the motivation of implementing a QMS contributed to external and internal motivation. The ultimate benefit of a positively aligned motivation is the benefit of an increased competitive edge. All of the above benefits are fundamental in the process towards a good implemented QMS. The ultimate foundation lies in the value of positive company culture.

4.4.1.7 Foundation of positive company culture

Company culture plays an integral part in guiding employees' behaviour by defining the appropriate behaviour in various situations to increase overall staff morale (Shaari, 2019:3). According to Ungerer, Unger and Herholdt (2016:79), company culture can be defined as a complex set of values, beliefs, assumptions, and symbols representing how a company conducts its business. Several of the participants indicated the value of positive company culture and the positive relation towards implementing of a QMS in their company.

Furthermore, Shaari (2019:8) agrees with Ungerer *et al.* (2016:179) on identifying three critical characteristics required to develop a company culture value, rarity and imitability. First, company culture is increasing if resources are more effective and efficiently utilised compared to its competitors. This positively relates to suggestions by participants that a decided quality person be employed to drive the implementation of the QMS and oversee the quality pack to be presented to the client.

“The start of a project is crucial. You will not win your client's confidence if you haven't properly planned and can implement it. The best way to increase morale and show confidence in your site manager is to set him up for success. Providing the right mix of resources will give him the ability to shine, grow and be confident of what he needs to do.” – P7

Second, the company culture and overall staff performances can be increased if flexibility is supported as part of the culture. The flexibility not only refers to the actual work on-site or the planning or resources and the flexibility in the preparation and presentation of the QMS.

“The only constant thing in construction is that something will change. We need to be adaptable.” - P6

And finally, if a company is committed to further developing its culture, it will increase overall staff performance (Shaari, 2019:3). Guiding employees through the implementation process, ensuring the system's benefits are known, and giving support as employees grow into the system will encourage staff to perform better and stay motivated during the implementation of the QMS. Participants indicated that as they learned and developed in the implementation of the QMS, were they able to see the results of their hard work not only physically on-site but also on paper. Confirming that a structure is signed off almost represented the proverbial stamp of approval, leaving them with pride and satisfaction. In essence, creating purpose, drive and motivation to be better at their work, taking on any challenge or project with responsibility and focus.

“The benefit is that you can always grow and always be up to your standard...In the end, you feel so good and positive about the work and effort you've put in.” - P5

4.4.2 Limitations

As mentioned in Section 4.4 and illustrated in Figure 4-4, the benefits of a QMS far outweigh the limitations. When reviewing the literature in Section 2.7 on implementing a QMS in South Africa are the limitation mainly based on a QMS based or reviewed by ISO. The literature and participant view on QMS limitations are contradicting. With only two limitations mentioned by the participants, it raises questions as to why implementation of a QMS is lacking in so many construction companies. Furthermore, it is alarming that no standards and guidelines of QMS implementation are provided in the South African construction industry, especially on Government projects, as

explained in Section 1.4 above. The limitations of a QMS from the participants perspective are concluded to be human resources and time constraints.

4.4.2.1 Human resources

Human resources at the start and end of a construction project prove to be the most challenging, as mentioned by the participants, a specific challenge for site managers in starting a project and aligning all employees on what the project will require and what objectives to be achieved. The human resource limitation also relates to the number of local labour employed on projects in the public sector. Government requirements force contractors to employ up to 30% local labour on every project. The principle, in essence, is a positive outcome for many families. However, the reality is that the principal contractor needs to train staff on implementing a QMS on an ongoing basis. Although this level of employee will not be responsible for filling in QMS related documentation, it does relate to establishing a positive company culture and related quality objectives.

At the start of the project and the end, human resources are critical contributors to effectiveness during the construction process. As mentioned in Section 4.4.1.7 is the correct blend of resources a critical part of a QMS. At the start of a project, the main limitation of human resources is that not all staff are trained on what is required during the construction process.

“The only limitation is that staff is not always trained.” - P6

Another significant limitation in the construction process is the requirement of human resources during the closing part of the construction process. It is standard practice for a construction company to move its primary resources to another project near a current project. When the application of a QMS is limited or the quality of work performed is not standard, is it normal for a contractor to receive an extended list of snags to be corrected. However, it is precisely what a construction company would like to prevent if it limits financial losses due to poor quality. As per Section 4.4.1.2, the chances of an extended snag list increased if the implementation of a QMS is lacking or maintenance of it lacks. The consequences from the participant perspective are that snags can be limited if the focus on quality products and quality documentation can be maintained during the project.

“Still, the human resource side of the closure of a project and our human resources are limited at that stage.” - P1

“From the company's perspective, most of the things where we feel a bit of challenge is in the snagging period where you need to start dealing with the end-user client and facilitate timelines actively and complete the snag related work after the owner or tended occupies the unit. There we need to tie the grip a bit, because of timing to keep with the timing what was provided by the client and also the human resources because the human resources we do not have a team that deals explicitly with snags the team we have is once we complete a project the team moves to the new project and the focus shifts on to the new project so definitely on the closure of the project we need to put in more human resources.” – P1

Human resource limitations have a direct financial implication for the contractor, but it also relates to the second limitation, namely time constraints, to be discussed below.

4.4.2.2 Time constraints

The magnitude of a QMS not receiving daily attention and a conscious and disciplined effort for implementation can easily be viewed as a time constraint, especially when time needs to be set aside after hours to catch up on the documentation filled in. When time after-hours needs to be spent, a limitation like a time constraint can easily create a negative mindset towards implementing a QMS. The limitation of time constraint is contradicting when compared to participant views. Seven of the participants mentioned that it only takes 30-60 minutes out of their day, as discussed in Section 4.3.4.2. above.

The time constraint might be linked to some critical criteria required to implement a QMS in a South African construction company. Criteria like top management involvement, company culture, training and staff motivation all play a pivotal role in the implementation and general motivation of staff to include basic principles like quality documentation sign off as the project progress. The critical criteria will be discussed in more depth in Section 4.5 below.

The different views in implementation time requirements between top management and site managers can be related to the lack of discussions relating to quality before and during the project. The participants experiencing the most time constraints are the ones making use of an application. Compared to the other participants in the study there is a 4-5 hour difference. The time difference, in essence, means that some site management and personnel are spending more

time completing quality documentation than time spent on site doing the actual work they are appointed for. This, in essence, create potential red flags for a construction company.

“It's just the time that it takes. I think something I am constantly trying to condition is they must set aside 30 minutes to an hour to capture their quality management system because they know the more they postpone it, the more they will get behind. The more difficult it is to catch up.” - P1

“The only limitation I can think of is that if you don't do it daily or before a pour, for example, you'll spend too much time later on trying to catch up. It can get very time-sensitive.” - P4

“The only disadvantage is spending some time and effort in doing this, although it may be after hours mostly to do paperwork that might be the only negative part of QMS.” - P7

Furthermore, it is contradicting when time constraint is viewed as a limitation when participants view the completion of quality on-site documentation as part of their roles and responsibilities as site managers.

“The site manager is responsible for ensuring all work on-site are done according to the SANS specifications and as stated on the construction drawings. The procurement manager will order the materials and check the quality docs of suppliers are in place. The engineering director takes full responsibility and liability and therefore needs to check site manager works are up to standard.” - P4

When daily effort is put in, construction companies will realise that most of the requirements needed to fulfil the implementation of QMS are based on knowledge. As mentioned in Section 4.5.1, discipline, as discussed in Section 4.6.2, is two critical contributors to saving time.

“I don't think there are any limitations except that it takes a lot of time at times.” - P8

The participants' perceptions of the benefits and limitations of a QMS are a critical driving force for/against the implementation of a formal QMS. Therefore, a concerted change management programme (which is outside the scope of this study) might be required to “sell” the benefits of adhering to a QMS to employees in a company. A collective holistic approach might be required

from construction companies to combat the negative views hanging over QMS limitations. The findings as presented apart of this theme coincide with guidelines provided in various sections of the literature study. When management of human resources and time constraints are viewed as the only limitations, does it raise the question of why not more construction companies practice QMS implementation?

4.5 FIVE (5) CRITICAL CRITERIA OF A QMS

The third theme identified is the five critical criteria required for successful QMS implementation. It is evident that participants have a solid knowledge base on the required criteria required or implemented in their companies.

Based on the results and reviewing Section 4.2 – 4.4 are presented in Figure 4-5 below. As mentioned above, each of the criteria can be operating as an individual component of a QMS. But when combined holistically approached as part of the QMS implementation, are they reaching their full potential as part of the system. Criteria like knowledge, training, inclusion of all departments and planning collectively enable site management responsible for quality on-site to record quality requirements and progress on proper documentation. This coincides with the findings in Section 2.7.2 in the literature study, where the successful implementation criteria of a QMS were listed.

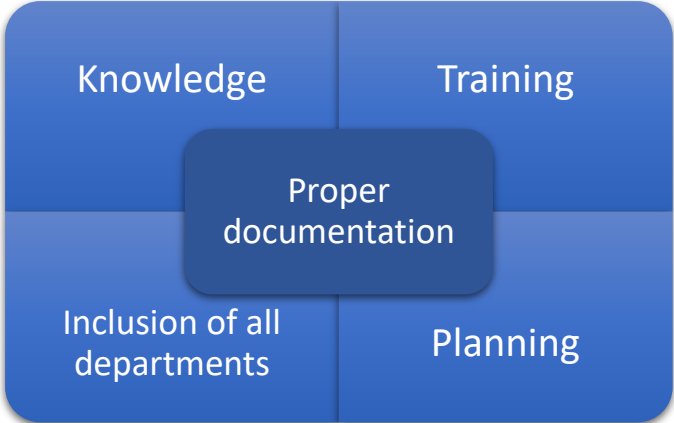


Figure 4-5 Five criteria for a QMS

Source: Author's own.

4.5.1 Knowledge

Related knowledge in terms of QMS can be concluded as a collaboration of three factors; SANS 1200 guidelines and specifications, related construction knowledge and the required knowledge to complete a quality pack as part of a construction QMS. According to the participants, it can be closely related to training, as discussed in Section 4.3.3 discussed above.

“Knowledge” - P1

“Have the knowledge” - P2

One participant explained that when an application is used to gather relevant QMS information and sign off the checklist, knowledge of how to use the application is of the essence.

“It’s limited to how much people know about this application (app).” - P3

The saying “knowledge is power” in this instance can not be denied. The biggest mistake a construction company can make is to assume that when new personnel appointments are made, the person automatically knows how the QMS in the new company is working. This led to another critical criteria name training.

4.5.2 Training

As per Section 4.3.3 above, training is an integral part of a QMS, yet is it one of the limitations presented in the results in Section 4.4.2.1 above. It is also imperative that the principal contractor staff be trained but also that of the sub-contractor. The literature identified sub-contractor QMS training as lacking in South African construction companies. Participants mentioned below must complete documentation, but they are not trained or knowledgeable enough to clearly understand the purpose and method for completion or application.

“As the person doing the checks on the system, would I like to be trained and should I know what to look for.” -P2

“I think training for all staff will be beneficial for everybody.” - P5

“All staff to receive training before you start.” - P6

“All staff needs to be trained. If people aren't trained, will they not understand why they are doing it.” - P9

The consensus from participants was that they wanted to learn more about QMS implementation. Not only to enhance their skills but to enhance the quality of work delivered to increase its reputation. The only way this change in momentum can be created is to allow for proper planning.

4.5.3 Planning

Planning plays an integral part in the construction process. Not only because each site has its related specifications, but also structures are different from project to project—likewise, the QMS requirements and quality data pack layout will differ. Therefore is planning a critical part of construction planning and is attentive to even the smallest detail of importance. The participants indicated that planning plays an integral part in successful project completion. Furthermore, have they indicated that it plays a vital role in the kick-off of QMS implementation on site. The critical contributor of planning, as referred by a participant, comes done to communication. All employees on-site need to understand what is to be done, how it will be done, when it needs to be done, and where it needs to be done. As mentioned in Section 4.3.1.1, the planning can be taken from the boardroom and implemented on-site using a typical programme like Microsoft Projects.

“Proper scheduling of quality management... Planning – brief your employees; We need to do a proper review when it comes to the end of our project.” - P1

“Use your construction programme to guide you to start your quality file index.” - P4

A key area of construction planning is the maintenance of the construction drawings sequence. Constructing from the wrong drawing revision can have subsequential cost and time effects, not to mention the reputational damage to the companies name (Karimi & Pimplikar, 2020:3625).

“Yes, we sit and plan the project, going through the drawings, looking at unique materials that need to be ordered. Tricky and complicated items to be built. Because projects differ from each other, is it essential.” - P5

4.5.4 Inclusion of all departments

According to Section 4.3.2, most departments within a construction company are entirely or partially responsible for ensuring that work is done up to satisfactory standards. Due to the complexity of construction work, the inclusion of all departments is one of the five critical criteria for the successful implementation of a QMS. Understandably, one department or one site cannot be held solely responsible for carrying an entire company's reputation. Top management plays a vital role in the motivation and drive of personnel towards implementing a QMS. Likewise, the procurement manager needs to ensure quality products are procured to assist the site manager in constructing quality work.

“Top management involvement” - P1

“All departments have to be involved.” - P4

“Everybody needs to be involved, and top management needs to support and drive the QMS. There needs to be a control board, like an excel system telling you or warning you if you haven't completed the required documents.” - P5

“Must be driven by top management.” - P7

“Top management needs to keep up their strict view on it. They, in essence, motivate the rest of the company.” - P9

Quality on-site, although the responsibility of the contractor, are only partially contributing to the quality construction. Prior commencement of construction is the consulting engineer playing a pivotal role in the design of the construction. Critical calculations and approvals need to be in place before the construction by the principal contractor can start. The consulting engineer also needs to approve critical elements in the construction process before progressing to the next phase. Thus all parties forming part of the professional team play a critical role in the overall quality on site.

“Documents to be signed off by all the relevant parties involved.” - P6

On-site quality documentation can only be signed off if the company provides proper documentation. Participant views are that some formats lack the requirements they would like to see. Therefore it is of importance to include site managers in the design of documentation.

4.5.5 Proper documentation

Various documents are incorporated into a QMS, ranging from a quality plan and policy to sign off before commencement of the construction process to a checklist to be signed during the construction period. Supporting documentation like calibration certificates for tools and equipment used during the construction period to be included as part of the quality pack. Construction specific supporting documentation like test cube results or compaction test results to further be included.

“Calibration certificates for all tools used to be up to date and available.” - P4

“All checklists to be updated and filed with the relevant supporting documentation.” - P4

“Manage your quality control documents, determine what you'll need before the project start, update it daily if possible.” - P4

“Move towards a paperless system, but that is dependant on client needs. Needs to be supported by supporting documents, like photos and test results.” - P7

The ultimate objective of a QMS is to indicate to the relevant parties that all set-out standards and procedures have been followed during the construction process. When needed is the quality pack apart from the structure built is the only proof that the contractor has followed the standards and procedures.

“Proof. You need to be able to prove what you've done. So you need to have supporting documentation like a calibration certificate or a signed quality document.” - P9

Proper documentation refers to supporting documents to act as proof and the standard template to be signed off during the construction project. Related documentation referring to, for example, earthworks or concrete works needs to entail all the relevant information that needs to be reported. Furthermore, it needs to be aligned with the SANS 1200 specification and includes the various items required to prove good-quality work constructed.

4.6 RECOMMENDATIONS FOR IMPROVEMENT OF A QMS

The fourth theme that emerged from the research is that participants have a structured opinion on the future of a QMS in the company and have come up with constructive recommendations for improving a QMS.

Based on information in Section 2.7.1 have other researchers have noticed a lack of QMS implementation in South African construction companies. Various contributing factors can be linked to it based on the results of this study with knowledge, training and discipline, to name a few. The criteria mentioned above in Section 4.5 can play a fundamental role in improving the implemented QMS. The recommendations for the improvement of a QMS was the final theme identified during the study. Apart from general recommendations discussed in Section 4.2 – 4.5, the following sub-themes can be added; project planning and daily completion of quality assurance.

4.6.1 Holistic approach to QMS implementation

The commitment and value for site managers in implementing or improving a QMS can not be denied. Participants in the study made valuable contributions, and construction companies can benefit and gain insight when related discussions are held with their staff. A significant realisation during the study was the generally positive view of employees towards the implementation of a QMS. The lack of support or different view from top management in some companies was noticeable. QMS can be metaphorically related to a rugby game. Forwards and backs combined constitute the team. Each position has a specific role in the field to be fulfilled. A player receiving a yellow card and being sent off for ten minutes has a significant impact on the team. At scrum time, players need to be swapped the scrum to be implemented and to be effective. Likewise has each employee in the company has a particular role and responsibility to be fulfilled. When employees or management are not committed to implementing a QMS, the effect on the rest of the team could be the same as when a rugby player is sent off the field for foul play. When all employees and management work together and put in a conscious effort to implement and keep up a QMS will the benefits reflect significantly on the company, almost like a WorldCup trophy in rugby.

“All departments have to be involved.” - P4

“All staff to receive training before you start.” - P6

“Everybody, the whole company, from top to bottom.” - P9

All members responsible for construction works have a role to play in implementing a QMS. A significant part of project success can be attributed to project planning.

4.6.2 Project planning

Project planning can positively be linked to Section 4.3.4.1 discussing the project process. The central aspect of project planning is focussing on the discussions held before the start of a project. Discussing is to be linked and in line with the quality objectives of the company. This is an excellent opportunity for top management to link company quality objectives to project outcomes. Due to changes and design requirements can quality specs differ from project to project. The only constant guideline is that specified in the SANS 1200. A proper discussion with the various role-players within the construction company will prepare the site manager to go out and to fulfil the required objectives. Participants in the study were concerned that project planning discussions are sometimes done but that it is the one aspect they think companies can improve. The times project planning discussions took place made a valid contribution in preparing them to deliver a quality project.

“Yes, I would. Discuss the programme and sequence of activities, check budget requirements, and discuss special items to be ordered.” - P6

“Yes, definitely, you need to discuss the start of the project, the different activities and specifications required to get everybody on board. It will also determine the quality pack you are going to build for the client.” - P7

“Yes, we have meetings before the projects start. Various departments sit in on that meeting, finance, procurement, logistics, quantity surveyor, management. The type of project, what material and tools they'll require, all that information gives you a better understanding of what quality documentation the site manager will require. Then from my side, can I ensure that he has everything he needs to perform his work.” - P9

The inclusion of various departments within the company can not be denied. The participants indicated that the various department like finance, quantity surveying, plant and procurement all play a vital role in fulfilling and ensuring quality on a construction project, ensuring the completion of the required quality assurance.

4.6.3 Completion of quality assurance

A key contributor to a successful QMS implementation is to spend time daily on completing the required documentation. One example would be to print and file the test results the same day it is obtained. That way, won't it be forgotten, and will it prevent it from piling on. Participants' general view and realisation were that they sometimes do not complete or regularly update the required quality assurance documents. Furthermore, have they realised that it is one of the contributing factors putting their time management later in the project under pressure.

“If you do it daily as required, it will not take time off your day. If you let it slip, and you must catch up, it's going to take time out of your work. You need to make it part of your daily programme, and it is your responsibility as site manager to ensure structures are built on spec according to the construction drawing. It is related to the work you perform.” - P4

“I think that the quality management system needs to become more of a daily thing or weekly thing.” - P5

“It needs to become a daily habit.” - P6

The recommendations for implementing a QMS from a participant perspective can add value to QMS implementation in a construction company. A full spectrum of recommendations will be provided in Section 5.4 below.

4.7 CHAPTER SUMMARY

This chapter aimed to lay out the four themes identified after the data analysis was done. The themes identified after the semi-structured interviews with various role players in the participating construction companies were the implementation of a QMS, the benefits and limitations of QMS, five critical criteria of a QMS and recommendations for improvement of a QMS. The themes coincide with the information provided in the literature review. It is notable to mention that participants found it most challenging to name limitations of a QMS and thus raise the question of why not more construction companies are implementing a QMS if clearly, the benefits outweigh the limitations.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter's primary purpose and focus are to conclude the findings from the empirical study and literature review. The conclusions aim to summarise the various themes identified in Chapter 4 during the discussion of the study results. The conclusion will be utilised to compare the study results with existing research elaborated on in the literature review.

The chapter progresses into recommendations on the criteria and implementation of a QMS in a construction company in South Africa. The primary and secondary objectives of the study are critically assessed, evaluating the achievement of the various objectives. The chapter concludes with recommendations to be undertaken or considered for future research.

5.2 FINDINGS – LITERATURE STUDY

A construction company's sustainable development and competitiveness are directly related to the successful implementation of a QMS (Bravi *et al.*, 2019:65; Lukichev & Romanovich, 2016:1717; Odiba *et al.*, 2021:2; Rehmani *et al.*, 2020:1; Vosloo, 2019:8). The primary purpose of a QMS is to improve and manage quality serviced and products within a company. It may provide an added benefit to the continuous improvement of activities within the company. Therefore, the implementation of a QMS seen as a voluntary process broadly supported by company motivation, objectives, and policies regardless of whether subsequent certification is achieved or not (Bravi *et al.*, 2019:65; Rehmani *et al.*, 2020:2).

5.2.1 ISO principles as the foundation of a QMS

One of the most known and prominent international standards developers is the International Organisation for Standardisation (ISO) (ISO, 2020; ISO, 2016:1718). According to ISO (2015), the concepts and principles are sufficient to enable a company to meet the capacity and challenges presented in the present accelerated, globalised markets and economy. The impact and benefit of ISO can reach beyond customer satisfaction and enhance its reputation in the industry. Despite the benefits of being ISO accredited, most South African construction companies cannot attain accreditation due to the financial burden, application and accreditation requirements. Various construction companies in South Africa implement their variation of a QMS, and others do not implement anything because of a lack of knowledge.

5.2.2 Quality Management Principles

Literature suggests that a set of QMP's should be utilised as a steering guide in any company for performance improvement. The seven QMP's used for ISO 9000 and 9001 can easily be implemented in an internal own regulated QMS implemented in a construction company (ISO, 2015; Vosloo, 2019:12). The seven principles, as referred to in Section 2.6.2, attain to:

1. Customer focus
2. Leadership
3. Engagement of people
4. Process approach
5. Improvement
6. Evidence-based decision making
7. Relationship management

The Plan-Do-Check-Act (PDCA) cycle implemented during the QMS implementation provides a focused and dedicated approach for implementation based on the seven QMP's provided above. Further does it encourages risk-based thinking. This will increase opportunity advantage and prevent undesirable results (Chen, 2019:4; Vosloo, 2019:16). The expert in quality management W. Edwards Deming, first developed the PDCA cycle to implement a helpful project management tool (Chen, 2019:4).

Before implementing the PDCA cycle, the system needs to be evaluated and reviewed throughout the implemented QMS. The PDCA circulation method will continue to go through the next cycle until all resolved issues in the previous process have been sorted out or completed. The PDCA Cycle consists out of four cycles and can be described in the following steps (Liu & Cai, 2016:19.12; Vosloo, 2019:16):

- **PLAN:** Contains the design of a specific implementation program based on project or company objectives and guidelines. Objectives, resource requirements, risks and opportunities should be identified.
- **DO:** The implementation of the planned, designed programs or processes are defined in this phase.
- **CHECK:** The implementation results should be monitored and measured to determine the success rate.

- **ACT:** This phase's objective is to act on any problems that arise during the check phase. Successful experiences or processes will be standardised according to the checks, and the items needing action will continue to go through the process to improve performance.

5.2.3 Benefits of QMS implementation

The benefits of implementation of a QMS are described by literature in detail and can be summaries as follows:

Table 5-1 Benefits of a QMS

BUSINESS OWNER	MANAGEMENT
External motivation	Internal motivation
Increased customer base	Better organised workplace
More revenue and cash flow within company operations	Easier managing operations, a clear set of tasks
Longevity with management and employees	More control over employees
Increased quality product	Ethical procedure for correcting employee behaviour
Practicality, reliability, durability and investments benefits of construction projects	Provides a platform for planning, executing, monitoring and improving on QMS activities

Source: Author's own.

Despite the legislated policies and other associated quality control bodies, poor-quality construction work is still present globally and in South Africa (Aigbavboa & Thwala, 2014:773; Emuze & Mhlwa, 2015:1224; García-Bernal & García-Casarejos, 2016:28).

5.2.4 Criteria for QMS implementation

The following items have been identified and combined as critical criteria for the development and implementation of a good QMS (ASQ (American Society of Quality), 2020; Eniola *et al.*, 2019:2; ISO, 2015; ISO, 2020; ISO, 2017; NQA (National Quality Association), 2020; Rehmani *et al.*, 2020; Vosloo, 2019:73):

- Top management commitment.

- Strategic vision, planning and development initiatives.
- Quality culture.
- Customer focus.
- Quality assurance & control.
- Continuous Improvement and system alignment.
- Employee knowledge, skills, motivation & commitment.
- Cost-effectiveness.
- User satisfaction.

The criteria for the effective implementation of a QMS correlate with the literature and empirical study findings. Recommendations towards the effective practical implementation of a QMS will be discussed in Section 5.4 below.

5.2.5 Adaptation to technology advances and 4IR

Although implementing a cloud-based QMS seems daunting, is the overall implementation much more aligned with the practice than one might think. Applying artificial intelligence into a QMS will first assist with making intelligent decisions, help reduce material, decrease energy consumption, clean energy, and solve project problems where traditional wisdom is lacking (Asif, 2020:2). Secondly, increased automation enables construction companies to achieve higher productivity and efficiency and reduce the stress on both staff and the environment. Moving away from a typical paper-based QMS to a more streamlined online system will enable site management to complete QMS paperwork on a tablet or phone while standing on site. This will result in significant time saving and will inevitably increase site productivity (Asif, 2020:2). The third major contributor of 4IR on construction sites is the ability to share across devices and facilities. This will allow site managers to process and send filled in QMS documentation while standing with their tablet on-site to other critical stakeholders like the quality manager, engineer and company management. The useability and implementation of technology advances into implementing a QMS can add more benefits for the company. The attitude of the top management and the clients combined will significantly affect the type of implementation online compared to paper-based.

The main aim of a QMS is to provide relevant backing support documentation to prove that the work on-site was constructed according to SANS 1200, the engineering drawing, and relevant supporting proof like a test cube result or compaction tests are provided. The benefits of a QMS

can prove to have various benefits for the company, employee and the project, as discussed in full in Section 2.6.4 above.

5.2.6 Benefits and limitations of QMS

Evident from Section 2.6.4 above are there various benefits but also limitations presented in a QMS. The motivation to implement a QMS in a construction company mainly derives from two types of motivational sources, internal and external. The benefits of QMS implementation and longevity will carry more weight if the implementation is derived from an internal source of motivation. As confirmed in Section 4.3.3, it is essential to train staff on the benefits and limitations of a QMS. If the motivation for implementation internally and the benefits are known, it will be an added advantage for the construction company.

When the benefits of a QMS as reviewed in Section 4.4 below, is it clear that it elementally forms part of the motivation of the employment process. Implementing a QMS can also act as a tool for staff performance evaluation as per clause 9 in the ISO implementation plan (Odiba *et al.*, 2021:4). When a QMS is implemented, it inherently steers a manager or project to increase performance, with both company and employee reaping its benefit.

The positive effects of QMS implementation identified during the study correlate with a recent study done by Odiba *et al.* (2021:1):

- The speedup of projects.
- The increasing of profitability.
- To assist towards satisfying clients.
- To reduce the number of defects.
- Limit inspection cost.
- Enhancing workmanship efficiency and
- The improvement of construction reputation.

The literature findings can be iterated when compared to the empirical study findings discussed below.

5.3 FINDINGS – EMPIRICAL STUDY

The construction industry in South Africa delivers its projects and products in a very complex and unique environment. Quality has become an essential element in completing a construction project (CIDB,2020a; Dharani & Ganapathy Ramasamy, 2015:604; Masindi, 2019:11; Odiba *et al.*, 2021:2). Construction companies are evaluated based on their reputation for quality, reliability, price, and delivery (Emuze & Mhlwa, 2015:1225). Due to the recognisable importance, significance, crucial value, and advantages to a company's competitive edge, the value of good quality is further iterated.

Focusing on three different companies, each specialising in a different construction industry sector, provided the study with a broad view, interpretation and implementation of a QMS in a South African construction company. The findings of the empirical study are structured following the discussion of the results in the previous chapter. The themes will be discussed in the four main categories identified during the study, namely:

- Implementation of a QMS.
- Benefits and limitations of a QMS.
- Five (5) critical criteria of a QMS.

The fourth theme identified, namely recommendations for improvement of a QMS, will be discussed in Section 5.4 below.

5.3.1 Implementation of a QMS

In South Africa, no regulations or guidelines are set out for construction companies to fulfil if they are not ISO accredited (Bravi *et al.*, 2019:64). This provides a gap in the South African industry for construction companies to either not implement a QMS or implement it at their discretion. Construction companies are only required to submit their version or format of a QMS as proof to a client. Implementing a QMS is essential for a construction company as it will enable better performance and completion of projects, leading to increased profitability and increasing its reputation. Effective implementation of a QMS may further prevent or limit construction accidents caused by structural failures, as was seen in the last decade in South Africa (News24, 2021).

The participants described several vital factors that need to be considered during the implementation of a QMS. The most sub-themes identified include tools used, responsible person, training on QMS and achieving quality objectives. Each of the critical factors identified has a

unique place in any construction company and the implementation of a QMS. However, they come to their full potential and right when incorporated into the QMS as a collaborated function.

Various tools and applications are used to implement the QMS and can be divided into online and paper-based tools. The participants indicated that they mostly prefer to work on an editable pdf or paper-based system. The participants' opinions are strongly lean that clients perception and utilisation of the quality pack after construction still lean towards an utterly paper-based system. Despite the evolution of 4IR, the QMS models remained stagnant (Maisiri & van Dyk, 2019:135). They failed to keep up to date with the technological developments, especially in the construction industry. This is evident as participants optimising an online QMS system are stranded 2-6 hours a day behind a tablet or phone to fill in the various checklists. The length of time to complete an online QMS might be constituted by various factors, as pointed out by the participants. Firstly the level of training received to operate the system. Secondly, the American-based QMS application in South African conditions is not in line with the SANS 1200 specifications and, thirdly, the requirements set out by top management.

The utilisation of an editable pdf is favoured by participants over the use of an application. Although participants were intrigued by the ability to complete the QMS documentation and checklist online, the primary concern raised the amount of time it would take. The participants raised concerns about the reception quality on some construction sites, primarily civil and mechanical companies. Not all areas in South Africa have access to good quality internet reception, which would mean that an online system would not be functional. A paper-based QMS is still the preferred method of application in South Africa. The lack of cell phone reception or wifi in some parts of South Africa naturally favours a paper-based system. Client specification also plays a role as most clients prefer to receive the quality pack in original printed format at the end of the project. Various quality checklists and sign-off sheets incorporated into the quality pack must be signed as original and not printed or copied.

A site manager plays a vital part of a construction team, being responsible for progress, planning, quality, and cost on a site. The participants identified the roles and positions within a construction company responsible for ensuring quality: the site manager, site clerk, and building manager. However, it is essential to highlight that the site manager's work is only a partial part of the bigger picture. Site managers are supported by various support roles mainly occupied by office-based personnel. These positions are those of the procurement manager, project manager, technical director and engineering director. Depending on the company size, specific roles like a quality

manager or quality administrator assist in completing a quality pack for the client. They also play an integral role in the overall implementation of a QMS in the company. One of the participants capitulated the essence and responsibility of who is responsible for implementing a QMS very accurately when he stated that everybody in the company is responsible. In essence, it supports the view of Karimi and Pimplikar (2020:3620) that a QMS are not for the selected few but needs a holistic approach and participation within the company.

Training on a QMS was one of the critically important but critically lacking areas of a QMS identified. When bearing in mind that site personnel are mainly responsible for completing the set-up of the quality pack on site, is it of concern the lack of training participants across all three companies received. In larger construction companies, it is the norm to appoint a quality manager with a team reporting to them. The primary responsibility is to ensure and complete the quality packs to be presented to the client. In small to medium construction companies the responsibility lies with the site manager to complete such tasks. The study confirms the views of Karimi and Pimplikar (2020:3624) the lack of staff training is noticeable across various construction companies. According to Odiba *et al.* (2021:2), QMS implementation must be regarded as a holistic approach towards managing and delivering a construction project. A significant question raised after reviewing the results is why construction site personnel will receive various training on how to perform their work. Still, limited training is done on the implementation of a QMS? All participants mentioned that they receive pressure from top management to provide a quality pack at the end of the project, yet are limited time and resources available to personnel for training on the QMS. Companies not registered with ISO need to complete training to expand the site manager's general quality view and perspective. For example, site managers are required to evaluate a structure in terms of specifications and construction principles.

Based on the lack of training received, as discussed above, it can be further identified as a limitation on South African construction companies and does it support the view of other studies done on South African construction companies or projects (Emuze & Mhlwa, 2015:1225; Karimi & Pimplikar, 2020:3620; Odiba *et al.*, 2021:2). Implementing a QMS in the South African construction industry is mainly left to the discretion of the construction company itself. Limited guidelines or requirements are assigned to the implementation of it. Achieving the construction companies quality objective, in essence, capitulates the core mandate of the company. Various processes and key areas were identified during the study to assist a company in achieving its quality objectives.

Although QMS brings formality to the front, it includes various documents, processes, procedures, and responsibilities collaborating to achieve its quality objective. The project process in construction is unique from site to site. Client specification will determine the extent and detail of the documentation to be provided. The project process refers to all QMS related activities required during the construction period that plays a role in the implementation of QMS. This includes and is not limited to sign off of quality policy, quality plan and construction process quality checks as work progress. Participants voiced the need to have sit-down meetings before the start or move to a construction site. Planning together with other departments within the company allows all departments to be aware of site-specific requirements, cash flow requirements, manufacturing or material specification and requirements. The meeting further allows the quality plan to be discussed and implemented, but weighing high on the priority list can influence motivation and morale. When the project process has been updated and implemented during a project, it alleviates pressure when the final inspection after the twelve-month retention period is done. The project process will enable the contractor to have the relevant evidence that the work was completed on specification and of good quality.

One of the contributing factors for construction companies not to present a quality pack at the end of the project is time and motivation. In South Africa, various projects were either not completed or completed long after the contractual completion date identified. A cut through an industry where time is of essence is the last thing a company can afford to have a site manager or foreman spend more time on a phone or tablet to complete documentation. This takes time away vital parts of the roles, duties and responsibilities of a site manager and foreman to ensure that the work gets done. An interesting observation during the interview is how the top management and site management perspective relates to the time to complete the documentation. Seven participants indicated that the time allocated to complete QMS documentation and checklist requires only 30 minutes out of their workday. A concern raised during the study was the amount of time some participants needed to spend on a phone or tablet to complete the required checklist merely. Raising a question as to when the participant can start to do the work he is appointed for. Serious consideration into the application of the app needs to be considered.

It was found that top management involvement plays a pivotal role in how construction companies address matters related to quality. This correlates with a study done by Odiba *et al.* (2021:4) confirming and iterating top management involvement as one of the ten clauses in the ISO recommendations for QMS implementation. Participant views confirmed that top management

involvement differs between all the participating companies from non-negotiable to view QMS as unimportant. Thus can it be concluded that a top-down approach with motivation and support forms a vital part of a QMS. It was found that top management plays a critical role in the successful implementation of a QMS. Top management support set the way for lower-level managers to follow. Top management involvement is found to be critical in staff motivation. Understanding the implementation and QMS benefits can significantly add to the staff motivation towards the proper implementation of a QMS. A direct correlation to staff motivation and achieving the companies quality objective was evident. As pointed out by the participants, staff motivation plays a vital role in how construction works are performed on-site. The value of being aware of the benefits might be an added benefit to the company.

Literature suggested a streamlined online-based QMS will enable managers to utilise the system online, enabling top management and consultants to have immediate access to and availability of the updated documents and results. However, this is contradicting based on the results of the study, as consultants and clients prefer a paper-based system.

5.3.2 Benefits and limitations of QMS

The benefits established during the study correlate with the benefits presented in previous research. Evident from the study are there various benefits but also limitations presented in a QMS. When reviewing the results, it is noticeable that the benefits far outnumber the limitations. The perspectives of the participants outlay the benefits of a QMS describing it as: client satisfaction, financially in essence to save money, quality assurance as it eliminates rework/snagging, protect manager and company as it can provide proof of work done, marketing value, increase the company's competitive edge and the foundation of positive company culture.

The value of an effective implemented QMS for companies competing on the same CIDB can not be underestimated. The overall benefit of the company's competitive edge and market value is based on participant views underestimated by top management. The findings correlate positively with previous studies by Kirabo and Jinzhao (2017:51) and Rehmani *et al.* (2020:4), iterating the same point.

The benefits identified in the literature and provided by the participants have been combined in one matrix as per Table 5-2 below. The aim is to link, compare and illustrate where benefits are linked between the two sections. For instance, the benefit of external motivation has been linked

to all the related benefits identified in the study, for instance, client satisfaction, marketing value, and an increased competitive edge.

Table 5-2 Benefits comparison literature vs empirical

Benefits of a QMS Literature study	Benefits identified in the empirical study										
	Staff evaluation	Fast track project	Increase Profitability	Client satisfaction	Saves money	Quality assurance	Limit rework/snags	Protect manager and company	Marketing value	Increased competitive edge	Positive company culture
External motivation				X					X	X	
Increased customer base				X					X	X	
Increase revenue and cash flow within company operations			X		X						
Increased quality product				X	X	X	X		X	X	
Practicality, reliability, durability and investments benefits of construction projects		X						X	X	X	X
Internal motivation	X										X
Better organised workplace											
Easier managing operations	X	X				X	X	X			X
Better employee control	X										X
Ethical procedure for correcting employee behaviour	X										X
Provides a platform for planning, executing, monitoring and improving on QMS activities		X	X	X	X	X	X	X			

It is noticeable that various benefits identified in literature can be linked to more than one benefit identified in the empirical study, adding to the value of the benefit and the real motivation for QMS implementation. Furthermore, is it noticeable that participants identified fewer benefits than available from the literature and that the benefits listed, like increasing profitability and saving money, can be combined into one. The reason can be attributed to the fact that participants have limited exposure to formal QMS implementation.

5.3.3 Five (5) critical criteria in QMS

Criteria like knowledge, training, the inclusion of all departments and planning were identified by participants as the most important criteria to be implemented to ensure the QMS is optimally

performing. The biggest mistakes construction companies potentially make is to assume all staff are knowledgeable in implementing a QMS. It was found that the training was to be extended to sub-contractors due to the principal contractor's responsibility and liability still taken. A valuable contribution by the participants was the eagerness to learn more about QMS implementation. Added training will enhance their skills and the quality of work delivered to increase the company's reputation.

Planning plays an integral part in the construction due to the project specifications unique from project to project. Participants believe that planning plays a critical part in construction planning and is attentive to even the smallest detail of importance. Furthermore, participants have voiced the importance of kick-off quality meetings before the commencement of works on site, incorporating all relevant assisting programmes and quality plans drawings to encourage discussion with all relevant departments. The importance of incorporating various documents into a QMS was highlighted to include a quality plan and policy to sign off before commencement of the construction process to a checklist to be signed during the construction period. The importance of supporting documentation accompanying the checklists, like calibration certificates for tools and equipment used, can not be denied. Construction-specific supporting documentation like test cube results or compaction test results plays a vital role in providing proof of quality work done.

Various contributing factors can be linked to it based on the results of this study with knowledge, training and discipline. The recommendations for improving a QMS were the final theme identified during the study and related to project planning and daily completion of quality assurance. The commitment and value for site managers in implementing or improving a QMS can not be denied. Participants in the study made valuable contributions, and construction companies can benefit and gain insight when related discussions are held with their staff. A significant realisation during the study was the generally positive view of employees towards the implementation of a QMS. The lack of support or different view from top management in some companies was noticeable. All members responsible for construction works have a role to play in implementing a QMS. A significant part of project success can be attributed to project planning.

The inclusion of various departments within the company can not be denied. The participants indicated that the various department like finance, quantity surveying, plant and procurement all

play a vital role in fulfilling and ensuring quality on a construction project, ensuring the completion of the required quality assurance.

A key contributor to a successful QMS implementation is to spend time daily on completing the required documentation. Furthermore, have they realised that it is one of the contributing factors putting their time management later in the project under pressure.

A comparison between the criteria for QMS implementation gathered from the literature review and provided by the participants were combined in the matrix as per Table 5-3 below.

Table 5-3 Criteria comparison between literature and empirical study

Criteria of QMS implementation Literature study	Criteria of QMS implementation Empirical study				
	Knowledge	Training	Planning	Inclusion of all departments	Proper documentation
Top Management involvement				X	
Strategic vision, planning and development initiatives	X	X	X		
Quality culture					
Customer focus					
Quality assurance & Control					X
Continuous improvement and system alignment		X			
Employee knowledge, skills, motivation & commitment	X	X	X		
Cost-Effectiveness					
User satisfaction					X

Although participants were limited to five criteria, is it important to note that items mentioned as benefits, as illustrated in Section 5.4.2 above, are not viewed by participants as critical criteria for QMS implementation. Participants view items like quality culture, customer focus and cost-

effectiveness as an outflow of QMS implementation and not as criteria for implementation. If participants were limited, might the results look different and be more aligned with the literature.

5.4 RECOMMENDATIONS TO CONSTRUCTION COMPANIES

This section will provide recommendations for the study themes identified. This section will mainly focus on how construction companies in South Africa can improve or implement a QMS in their company.

5.4.1 Implementation of a QMS

The South African government continuously promotes the employment of local labour and sub-contracting on government projects to increase work opportunities for SMME's (SAICE, 2015). However, the principal contractor stays responsible for delivering a product that needs to be on time, on budget, and of good quality, regardless of he or a local sub-contractor performed the work. The lack of QMS systems in construction companies is evident in the quality of work, structural failure incidents, and the number of projects not completed in specifically South Africa. The statement above is not including or refer to a substantial amount of construction companies performing above par. The participants described several suggestions to increase application or assist in the implementation of a QMS. The following recommendations are provided to assist in implementing a QMS in a South African construction company.

5.4.1.1 Tools used

Two types of tools have been identified. Online and paper-based. The following recommendations are made based on information provided by the participants.

- If a construction company is not ISO accredited is suggested that the company invest time and resources to review and start implementation into their own internal QMS.
- With the structure and format of the QMS differing from company to company and project to project, it is recommended to review requirements from engineering consultants working with clients in the construction industry to establish a regularly approved format.
- The benefit of online QMS systems is that they can save time and frustration in the long run. A thorough review of the brand or type of online QMS must ensure that employee and project time are optimally utilised.

- A paper-based system in the South African construction setup is still the preferred system to apply. The paper-based system can be reviewed to identify areas that can be changed to an editable pdf format to save time.
- Microsoft Projects construction programmes to be written to allow reminders for QMS application to remind the site managers to complete the required checklist. It is also a managing tool for the contracts manager to have the opportunity to review the quality pack progress.
- Checklist to be reviewed to ensure that all required information is included for check off.

5.4.1.2 Persons responsible

The following suggestions are made in terms of the responsible person for quality application on site:

- The responsible persons on-site to be identified to ensure double work are eliminated.
- A dedicated quality person to be employed if the project can support such a position. This will alleviate the time of the site manager to focus on work on site.
- Other departments in a construction company like the procurement manager, project manager and technical director will be trained on the implementation and requirements of a QMS.
- Top management involvement and support in implementing a QMS are of utmost importance and vital in staff motivation. It is suggested that top management drive the QMS to gain the most benefits out of the system.

5.4.1.3 Training on QMS

Training employees on the implementation of a QMS pose a significant challenge, and the following recommendations are presented:

- Regardless of the position responsible for QMS implementation, it is suggested that employees receive some form of training.
- Managers and employees alike to be trained for all staff to understand the implication and benefit of a well-implemented QMS.
- Managers to receive extra training to ensure knowledge and skills relating to SANS specification applied on the project is known.

- Quality specific positions like a Quality manager needs to have formal training in the forms of a degree or diploma
- Site managers can either receive training from a third party supplier or structured informal training.
- Training to be extended to certain positions in sub-contractors to ensure the principal contractor are assisted throughout the construction process.

5.4.1.4 Achieving quality objectives

A CIDB grading is not subject to the approval of a QMS or required to be ISO registered or compliant. Construction companies are not required when tendering on government tenders to be ISO 9001 registered. As a result, companies can implement their own QMS format to achieve quality objectives, one of the main driving forces in a construction company. The following recommendations are aligned to assist in the achievement of the set-out objectives:

- The determination of criteria for QMS implementation can assist and benefit construction companies and the industry.
- Effective implementation of a QMS may prevent or limit construction accidents caused by structural failure and are to be included as part of the quality objectives. Closing the gap between quality and safety.
- A QMS implementation plan to be drawn up by the relevant parties involved with quality in the organisation.
- The project process to be included as part of the QMS plays a pivotal role in achieving quality objectives in a company.
- The quality objectives to be available and a conscious effort to be made to achieve it.
- Sit down meetings needs to be implemented before the start of a project to ensure the construction team is aligned and objective and requirements are set out.
- Regardless of the online vs paper-based approach, is it recommended to ensure that time management of site personnel is utilised effectively.
- Construction companies need to put a conscious effort into reviewing time spent on the QMS to ensure site management still has ample time to focus on the actual job at hand.
- Top management involvement can not be underestimated. Regular reviews and checks are also recommended to increase staff motivation in the process.

5.4.2 Benefits and limitations of a QMS

The following recommendations relating to the benefits and limitations of a QMS are provided:

- An internal measuring assessment for the review of client satisfaction, financial benefit and overall quality assurance will be designed to review company progress on the mentioned items.
- A competitive analysis based on quality achievements is to be done annually to evaluate the company's competitive edge amongst competitors.
- The alignment of company culture is to be reviewed and strategically aligned by top management to support the company's quality objectives.
- Human resource application and training need to be aligned with the requirements of the project. Future movement of staff needs to take place whilst keeping the quality objectives of the company intact.
- Time constraints to be internally reviewed and suggestions made for the better allocations of QMS related tasks to site personnel.
- The type of approach towards implementing is to be reviewed and supported by the company from top to bottom.
- All personnel working on and in the QMS to be motivated and encouraged to complete quality-related work daily to prevent a bottleneck later in the project.

5.4.3 Five (5) critical criteria of a QMS

Based on the five critical criteria identified for implementation of a QMS can the following recommendations be provided:

- A great need for gathering more information and the need for training has been identified. It is therefore recommended that scheduled training on QMS implementation are worked into the company training schedule.
- Training on SANS requirements to be done before the commencement of site works.
- Planning meetings incorporating quality before a project start will enable site managers to perform efficiently and effectively. Time needs to be allocated to regularly include these meetings with other departments before and after a project.
- Therefore is it of importance to include site managers in the design of documentation.

- The various departments must provide proper supporting documentation to assist the site manager or the quality manager in compiling the quality pack.
- Supporting documents are to be added to the pack as it becomes available.
- Quality pack and checklist format to be confirmed to confirm fit for client specification before the commencement of the works.

5.4.4 Recommendations for improvement of a QMS

The theme relating to recommendations for the improvement of a QMS were provided in the recommendation section above. This section will provide a holistic view of QMS implementation based on research done by Odiba *et al.* (2021:3). The model supports QMS implementation as set out by ISO (ISO, 2020; ISO, 2016:1718). The model presented by Odiba *et al.* (2021:3) correlates to a typical QMS implementation model, as discussed in the literature study. Figure 5-1 gives a clear illustration of the holistic approach to QMS implementation. It refers to outside driving forces, the internal process and the outfall benefits related to it.

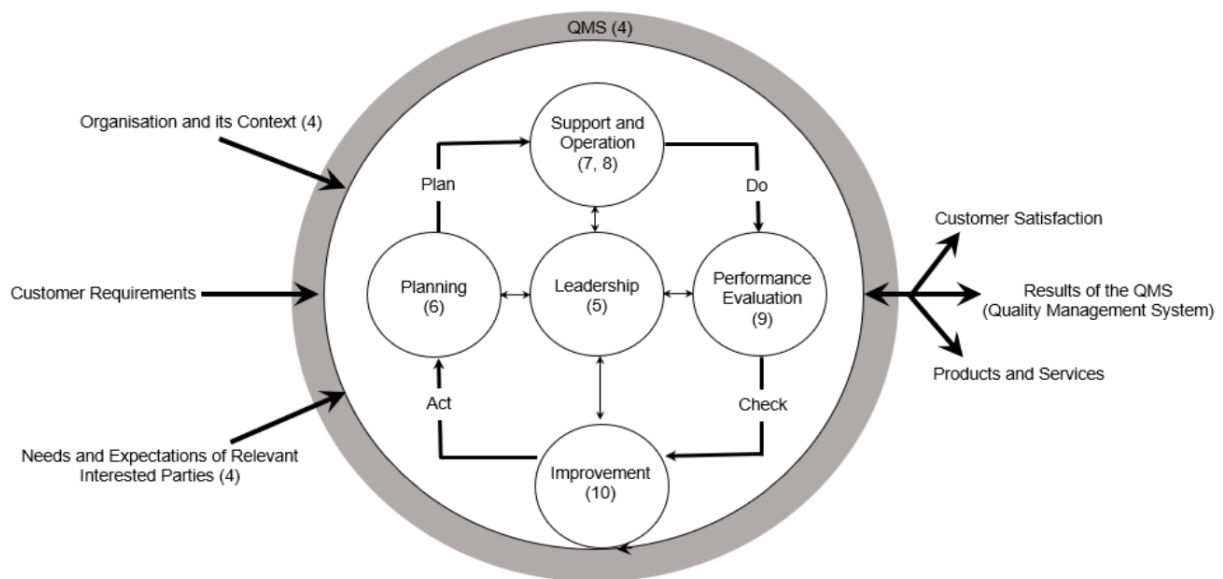


Figure 5-1 ISO 9001 Model generated

Source: (Odiba *et al.*, 2021:3)

In South Africa, various construction companies, especially small to medium-sized companies, can't afford the ISO accreditation. Therefore leaving the door open for contractors to implement their own designed system or no system at all. Based on the literature and the empirical results of this study, the researcher realised that South African construction companies are unique in

their approach, view and implementation of a QMS. Based on the study results, the model from Odiba *et al.* (2021:3) has been adopted based on suggestions of the study. The newly adopted model can be explicitly applied to South African construction companies that are not ISO accredited.

As mentioned previously, the South African construction industry is unique in various aspects. Therefore, the same principles practices elsewhere in the world will not be suitable for all South African construction companies, especially for various small to medium-sized companies. Implementing a QMS in the South African construction industry is mainly left to the discretion of the construction company itself. Limited guidelines or requirements are assigned to the implementation of it. Therefore, as illustrated in Figure 5-2 below, the newly amended model provides a practical guideline that South African-based companies can utilise to ease the implementation of a QMS.

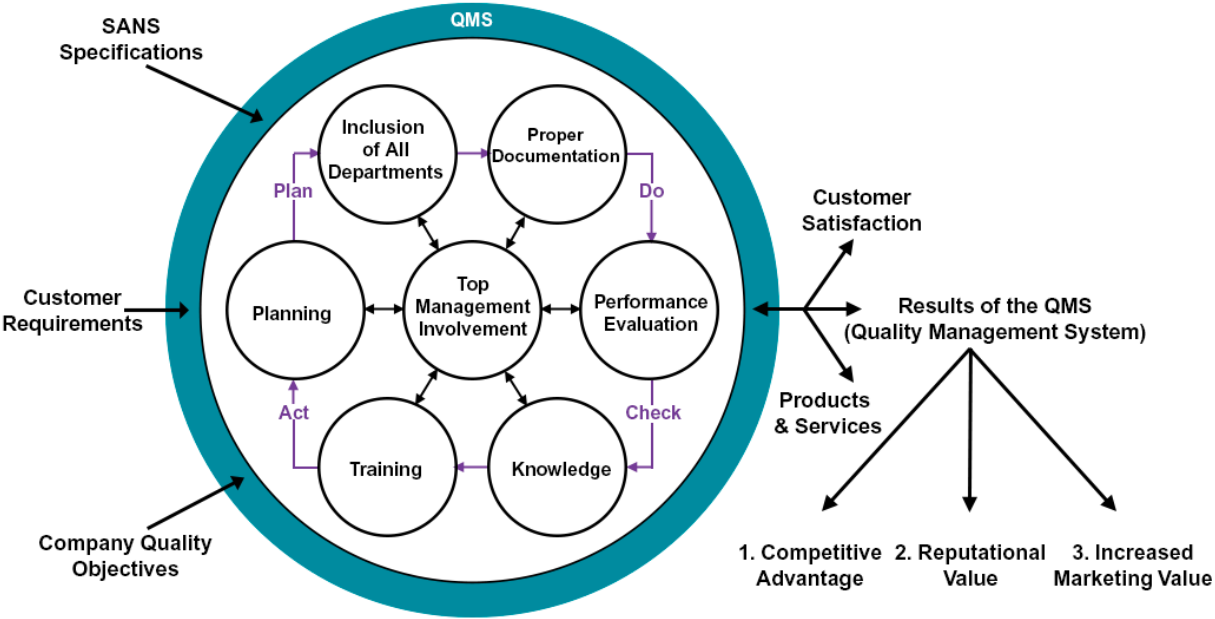


Figure 5-2 Amended QMS application model

Source: Author’s own.

Based on the new model are specific QMS driving forces were identified. In the South African construction industry context and based on participants' insights, it can be identified as:

- SANS specifications
- Customer requirements

- Company quality objects

These driving forces will influence the process of QMS application and implementation. It is notable to mention that no QMS regulation or requirements are part of the driving forces of QMS implementation. It is recommended for construction companies to familiarise themselves with the various SANS specifications applicable to the specific classification within the industry they specialise in. The various trades are provided by CIDB, as illustrated in Table 2-1 above. As determined by participant views, the client requirements mainly determine the requirements and provisions of QMS implementation on a specific site as described in Section 4.3.1.2. Regardless of technology advancements and the availability of online applications, as discussed in Section 4.3.1.1, are the determining factor still surrounding the client. Various limitations of QMS application, specifically small to medium-sized construction companies, were discussed in Chapters 1 and 2. Apart from client specification or preference, it can be concluded that the company quality objectives play a vital and pivotal role in the drive towards the implementation of a QMS. The role of top management in the determination of the company quality objectives are pivotal in the process to follow. It furthermore is included in the planning phase of the PDCA cycle.

The critical criteria identified in the implementation of a QMS in a South African construction company were based on results from interview discussions concluded as:

- Inclusion of all departments,
- Proper documentation,
- Performance evaluation,
- Knowledge,
- Training,
- Planning, and
- Top management endorsement.

One of the reoccurring themes identified during the discussion of the results was the importance of inclusion of all departments. Various construction companies create challenges by thinking that quality is only reserved for the site manager and his team. The value of all departments was iterated on various occasions. The value of inclusion of the procurement, finance and quantity surveying departments can not be iterated enough. One effective way to include all departments

is the inclusion of all in the kick off-site meeting before the commencement of construction work. It aims to increase teamwork, but does it value the contribution of all departments within the company.

Persons responsible for the implementation of quality on-site need to be identified, with explicit instruction and requirements in terms of QMS implementation to be provided. Proper documentation for the implementation of a QMS to be provided. This includes all relevant and required checklist that needs to be signed off during the construction process. These two processes fall under the planning process in the PDCA process discussed in Sections 2.6.3.2 and 2.6.3.3 above.

Performance evaluation combines two factors, the evaluation of quality on a construction site and the related performance evaluation of the construction team. QMS is identified earlier, can be a holistic approach where staff performance measuring can be included in the process. This model step falls under the Do in the PDCA cycle to implement the designed programmes and processes in the QMS.

Knowledge and training are two key contributors identified that are lacking in QMS implementation. Knowledge of the QMS and how to implement it are critical factors in implementing a successful QMS. Without that, it would merely be impossible. Understanding the process, requirements and documentation would enable construction personnel to step up and drive the QMS. The only way to be gain knowledge of what needs to be done is to undergo training. Training can be categorised into construction-related training and internal QMS related training. This falls under the Check part of the PDCA cycle, where the implemented result should be monitored and measured to determine the success rate. In essence, this can be seen as an improvement phase in the construction process, where objectives want to be achieved and targets met.

The criteria mentioned above are glued together by top management's involvement, motivation, and dedication. The process within the QMS circle illustrates the incorporation of various vital principles to be incorporated as identified as critical criteria or recommendations for the effective implementation of a QMS.

The part of the PDCA cycle implies action on any problems that arise during the check phase. Improvement in knowledge through training and suggestions to be implemented are designed and finalised in part of the PDCA cycle. This resolves back to planning, going through the processes, see where amendments can be made.

All of these various pillars within the QMS process, including the various phases of the PDCA cycle, will directly correlate to customer satisfaction, the results of the QMS and the type of products and services that the construction company will and can deliver. The outflow result of the QMS will be related to the effort put in within the process. The outflow results are driven by internal and external results or satisfaction. The key for a construction company is firstly the level of customer satisfaction that wants to be achieved. This relates to the external results of the QMS. Secondly is the result of the QMS, which is an internal result the company would like to achieve. The outflow of results will lead to an overall increase in the competitive advantage, the reputational value and increased marketing value of the company. Achievements in these areas are invaluable for a company. They can only be achieved if the QMS is applied and implemented with a holistic approach to each item forming part of the model. The application of a change management intervention might be needed to assist with implementing a QMS in a construction company not having the related experience in application. Change management intervention was not part of the scope and will be a recommendation for future studies.

5.5 ACHIEVEMENT OF THE OBJECTIVE OF THE STUDY

A critical factor determining the success of a research project is whether the study's objectives have been met. The study's primary objective was to identify critical criteria required in a QMS for a South African construction company. The study has four secondary objectives assisting with the primary objective achievement. This section will review the objectives and will aim to describe how each objective has been met.

To identify critical criteria required in a QMS for a South African construction company.

The literature review in Section 2.7.2 illustrated various criteria required in a QMS in a construction company. The results provided in Section 4.5 support the literature reviewed, and four themes were identified with various sub-themes elaborating on each. The four main themes were the implementation of a QMS, benefits and limitations of a QMS, five critical criteria of a QMS and recommendations to improve a QMS.

To conduct a literature review to identify barriers and enablers for implementing a QMS in a construction company.

Various facets of QMS implementation were reviewed as part of the literature review in Section 2.6.2.7. Barriers and enablers were identified that could add value to the implementation of a QMS, as discussed in Section 5.2 above. The literature study iterated the various quality management principles and gave clear guidelines for QMS implementations while focussing on the relations to ISO and QMS in construction companies. The discussions on benefits, limitations and the criteria identified correlate with the results of the study.

Empirically determine the management perception of the criteria necessary for a successful QMS.

The participants in the study add valuable insights into the perception of the criteria necessary for a successful implemented QMS. The insights partially correlate with the criteria presented in Section 2.7.2. More insightful details have been identified that will benefit the literature but also South African construction companies.

Empirically identify guidelines for the implementation of a QMS in a construction company.

The guidelines for QMS implementation provided in Section 4.5 supports that of the literature in 2.7.2. The guidelines identified assisted to the amended implementation model presented in Section 5.4.4 above. The new amended model is based on the results of the study.

To determine the influence of 4IR on the criteria for the successful implementation of a QMS.

As supported by the literature in Section 2.8, the construction industry is slow to adopt technological advances, especially small to medium-sized companies. Client specification is the main holdback as they prefer paper-based quality packs forcing contractors to continue with the paper-based system. Companies that use applications for QMS implementation can experience time constraint challenges that need to be addressed.

All primary and secondary objectives of this study were achieved during the study. The criteria for implementation of a QMS were identified and explored through qualitative interviews with three

construction companies operating on the same CIDB level. The results and findings of the interviews are described in Chapter 4. The problem statement revealed the lack of guidance of QMS implementation for companies not accredited with ISO. The study findings supplement the academic research on the implementation of a QMS in a construction company. However, the opportunity is available for future research on implementing a QMS in a construction company with particular reference to South Africa.

5.6 RECOMMENDATIONS FOR FUTURE RESEARCH

A key contributor through the study is the importance of implementing a QMS to assist companies in reaching their planned goals and objectives and, therefore, improve business processes, products and services further (Emuze & Oladokun, 2019:477). However, various studies have focussed on the implementation of a QMS around the world, whilst limited studies focussed on South African construction companies. It is recommended for future studies to focus on the difference in implementation between corporate construction giants to small to medium companies. Valuable information might come to the fore that can assist small to medium companies to streamline their QMS application. Further study into the comparison of online vs paper-based QMS implementation might provide various other options for online applications that can be implemented. The amended model designed in this study can be tested as a part of further studies. A concerted change management programme (which was outside the scope of this study) might be required to promote the benefits of adhering to a QMS to employees in some companies. The effect and implementation of such a programme can also be considered for future studies. Future studies expanding to other size companies can further investigate the effect of a suitable change management programme for implementing and improving a QMS in this size business in the construction with the possibility to expand it to other industries with the same size companies.

The study followed a qualitative approach, thus limiting the number of participants that were interviewed. The results on the implementation of a QMS, benefits and limitations, criteria for QMS implementation and recommendations can be utilised to design a quantitative questionnaire in future studies. The benefit of reaching a larger field of participants through a quantitative study might be more beneficial to allow for statistical analysis allowing the revelation of additional information.

5.7 CHAPTER SUMMARY

This chapter's primary purpose and focus were to conclude the findings from the empirical study and literature review. The conclusions aimed to summarise the various themes identified in Chapter 4 during the discussion of the study results. The conclusion was utilised to compare the study results with existing research elaborated on in the literature review.

The chapter concluded with recommendations on the criteria and implementation of a QMS in a construction company in South Africa. The primary and secondary objectives of the study were critically assessed, evaluating the achievement of the various objectives. The chapter was concluded with recommendations to be undertaken or considered for future research.

Based on the empirical research results, several critical criteria were identified that allowed for recommendations for each of the themes identified in the study. The four themes identified emphasise a holistic approach to the implementation of a QMS in a construction company. The results allowed the design of a new amended model for the implementation of a QMS. Several recommendations are mainly focused on a top management application. Due to the role of top management in the implementation and motivation of a QMS, the recommendations support the realignment of QMS implementation within a construction company. An essential contribution was that QMS implementation can not be secluded to one person or department but that the holistic approach included the company as a whole.... "Everybody, the whole company, from top to bottom."

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LIST OF APPENDICES

Appendix A – Ethics Approval

Appendix B – Language Editing Certificate

Appendix C – Participant Consent Form

Appendix D – Interview Questions

Appendix E – Sample Of An Interview

Appendix F – Solemn Declaration and Permission to Submit

Appendix G – Turn It In Summary

APPENDIX A – ETHICS APPROVAL



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Economic and Management Sciences Research
Ethics Committee (EMS-REC)

21 April 2021

Dr J Jordaan
Per e-mail
Dear Dr Jordaan

EMS-REC FEEDBACK: 26032021 (Round Robin)
Student: Fuller, E (12128635)(NWU-00043-21-A4)
Applicant: Dr J Jordaan - MBA

Your ethics application on, *Identifying criteria for a quality management system in a construction company*, which served Round Robin, refers.

Outcome:

Approved as a minimal risk study. A number **NWU-00043-21-A4** is given for one year of ethics clearance.

Please note that the ethics approval of this application is subject to the Covid-19 protocols.

Kind regards,

Mark
Rathbone

Digitally signed by Mark Rathbone
DN: cn=Mark Rathbone, o=North-
West University, ou=Business
management,
email=mark.rathbone@nwu.ac.za,
c=ZA
Date: 2021.04.21 17:07:59 +0200

Prof Mark Rathbone
Chairperson: Economic and Management Sciences Research Ethics Committee
(EMS-REC)

APPENDIX B – LANGUAGE EDITING CERTIFICATE

Thesis Surgeons



LANGUAGE EDITING CERTIFICATE

This document certifies that the manuscript listed below has been edited for proper English language, grammar, punctuation, spelling and overall presentation by one or more editors of Thesis Surgeons Research Improvement and Language Editing Services.

Manuscript Title:
**Investigation of a quality management system in a South African
construction company**

Author(s):
E. Fuller

Date Issued:
17 November 2021

Certificate Verification Key:
QMSEIIZNov2021

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APPENDIX C – PARTICIPANT CONSENT FORM



PARTICIPANT INFORMED CONSENT

Letter of permission to undertake interviews.

Date: _____

Dear Interviewee,

I, with this, kindly request your participation in a short informal interview session as part of a research dissertation in partial completion of my degree Master's in Business Administration at the North-West University.

The research dissertation title is: "Identifying criteria for a quality management system in a construction company".

The interview will take approximately 40-50 minutes. Your responses in the interview will be recorded and documented for the study. Your identity will always be kept confidential. In the study, you will be referred to as a 'participant' or 'respondent'. You will receive background information about the research and the questions per e-mail before the interview is conducted.

None of the information discussed during the interview will be shared directly with your managers. It will only form part of the results of the study.

With this, permit your answers to be recorded, transcribed, and used in the dissertation as and where necessary.

If you need more information, you could contact Elizma at 082 775 8448 or my study leader, Dr Johan Jordaan, at 071 366 2262.

Consent is with this given to Elizma Fuller to proceed with her research study: Yes / No

Interviewee name:

Elizma Fuller

Interviewee Signature:

APPENDIX D – INTERVIEW QUESTIONS



SEMI-STRUCTURED INTERVIEW/ DISCUSSION

"Investigation of a QMS in a construction company."

Date of Interview		Company	A	B	C	D	E
Place of Interview		Interview no	1	2	3	4	5

INTERVIEW QUESTIONS

1. The number of years of experience in the company/construction industry.
2. Your current position in the company.
3. Are you familiar with the term QMS (QMS)?
4. Are you aware of any quality control measures implemented in your company? Would you please mention them?
5. Did you receive training in the quality management plan/system in your company? Would you please explain what the training consists of and how long it took?
6. Do you think the company is achieving the quality objectives of its core mandate or values? Please explain.
7. Are discussions held at the beginning of a project discussing how quality will be planned and implemented? Please elaborate.
8. What are the positions in the company responsible for ensuring that quality products are delivered? Would you please name the positions?
9. How is the QMS implemented on-site? Is it a paper-based or computerised system that can be accessed remotely?
10. How motivated are employees in your company towards the successful implementation of the QMS?
11. How much time does the implementation of the QMS require of you? Is it taking time away from the work you are supposed to do? Please explain.
12. Explain the benefits and limitations of the QMS in your company.
13. Give five critical criteria you would like to see in a QMS.
14. How active is your company's top management in the implementation and goal setting of the implemented QMS?

Please take note:

You may, at any time, terminate the interview/discussion.

Should you feel uncomfortable answering any question, you may continue to the next one.

All answers will be transcribed and inserted into an excel spreadsheet for further conclusion as disclosed in the consent form.

APPENDIX E – SAMPLE OF AN INTERVIEW

COMPANY B

PARTICIPANT 4

I: The number of years of experience in the company/construction industry.

P4: I have eight years of experience in the construction industry.

I: The current position in the company.

P4: I am a Site Manager for XX.

I: Are you familiar with the term QMS (QMS)?

P4: Yes, Quality Management System.

I: Are you aware of any quality control measures implemented in your company? Would you please mention them?

P4: Yes, we use checklists; standards and procedures explain how certain earthworks or formwork must be performed. The SANS 1200 specification also guides us in giving precise specifications on how items need to be built.

I: Can you explain a specific example?

P4: When we build a concrete structure, you have a checklist that needs to be signed off before you can pour the concrete. It will guide you, and items like cover, rebar, alignment and levels will be checked and signed off before pouring concrete.

I: Would you say project program like Microsoft projects forms part of quality management?

P4: Yes, definitely. By using your program, do you know exactly when what activity will take place. You plan your quality checklists and test to be signed off and done into the program. It is another reminder and guide, and therefore, will you continuously work on your quality rather than leaving it till the last minute.

I: Did you receive training in the quality management plan/system in your company? Would you please explain what the training consists of and how long it took?

P4: I didn't receive formal or structured training. I was taught as I worked on-site. Although the principles of what needs to be done are exact, are client specifications and requirements in the Quality data pack differ.

I: Do you think the company is achieving the quality objectives of its core mandate or values? Please explain.

P4: Yes, one of our values is "on time". Rarely, one of our projects is not completed and signed off on time. We do not get comebacks for significant quality or structural defects. The projects are signed off, and a practical completion certificate is issued. Snags can be rectified, and the project completion certificate is issued. After 12 months, the project is inspected again, and a final completion certificate is issued if no problems are identified. Most of the time do we only need to repair minor issues. We had to go back to fill an area where the material saged a bit on the last pipeline project. Still, it was with elements of the project that we discussed that is going to application (app)en. So, I think it was because he was uneducated, not us.

I: Would you say that the comebacks you get are minor or of such nature that it's old reputational damage to the company?

P4: I think it's minor. I believe it's insignificant if you look at all our projects and comebacks we have compared to the monetary value of the projects. None are of such nature that reputational damage would occur.

I: What are the other values of the company on time?

P4: Work with joy, scientific approach, quality work, on time, no waste.

I: Are discussions held at the beginning of a project discussing how the quality of the project will be planned and implemented? Please elaborate?

P4: Yes, I don't think in-depth enough. It is mainly between the Technical Director and site manager.

I: So, what do you think can your company improve on?

P4: I think if we sit down with our project, look at all the elements of the project, the quality that must be checked, worked out into the budget, determine the best quality suppliers, build a quality pack that needs to be updated continuously. The suppliers also need to provide their related quality documentation for the material supplied.

I: Which department must all be incorporated at the beginning of a project?

P4: Finance, to be aware of budget requirements and needs, engineering, we have a technical director who will give guidelines and tips to follow to increase production, Quantity surveyor as they know the client requirements and needs as well as the prices and quality spec of the client, procurement as they will need to ensure the best prices material are procured. Our top

management is generally involved, but it can be a more structured approach with meeting minutes to refer back to.

I: What are the positions in the company responsible for ensuring that quality products are delivered? Would you please name the positions?

P4: The site manager is responsible for ensuring all work on-site are done according to the SANS specifications and as stated on the construction drawings. The procurement manager will order the materials and check the quality docs of suppliers are in place. The engineering director takes full responsibility and liability and therefore needs to check site manager works are up to standard.

I: How is the QMS implemented on-site? Is it a paper-based or computerised system that can be accessed remotely?

P4: It starts with paperwork, then scanned digitally to give to the client in a quality pack format. But clients needs change from project to project, making it confusing and frustrating for the site manager. Most of the time, the client wants a paper-based file that is printed in duplicate.

I: How motivated are employees in your company towards the successful implementation of the QMS?

P4: No, not as it must be. One of the directors constantly needs to nag site managers to complete their documentation. I don't think staff understand the value of a quality pack. Most see it as more paperwork, but it covers you and the company if questions are asked later. It is also proof that you've done your work according to the standards.

I: Do you think if you do training with your staff, you receive proper training as to what qms it entails? And what are the requirements that you everybody will understand better and be more motivated?

P4: Yes. All staff must understand the impact of quality on the reputation of the company. It is not just one person's responsibility. Quality is for all staff to implement from management to labour.

I: How much time does the implementation of the QMS require of you? Is it taking time away from the work you are supposed to do? Please explain.

P4: Half an hour a day. If you do it daily, then it won't haunt you later on in your project.

I: So is it taking time away from the work that you're supposed to do?

P4: If you do it daily as required, it will not take time off your day. If you let it slip, and you must catch up, it's going to take time out of your work. It would help if you made it part of your daily programme, and it is your responsibility as site manager to ensure structures are built on spec

according to the construction drawing. It is related to the work you perform. The only difference is to add it to a checklist as prove and add the relevant supporting documentation like test cube results or compaction tests. In the end, you cover yourself and the company.

I: Would you prefer doing the quality completion documentation on paper or a website or app (application)?

P4: I prefer paper. We have the documentation on an editable pdf system, but I wouldn't say I like that format.

I: Explain the benefits and limitations of the QMS in your company.

P4: Benefits I would say it protects you against any faults or defects on a project. Let's say, for instance, there is a crack in the concrete, and you can prove that you had your rebar checked off and that it was fixed according to the drawing; you can prove you've done quality work. If you can provide a test cube result with the approved mix design, with the slump test results, you can again prove you've done it to standard. Same with setting out, you cover yourself and the company if you can provide your surveyor results and report. And then the fault needs to be found at either the engineer who made a design error or the supplier providing a bad concrete batch.

P4: It can prove that all the requirements you were supposed to uphold were done on spec and standard.

P4: Every quality pack is site-specific, as activities differ from project to project. It can be designed to fill in what you need on sit, so you're covering yourself.

P4: It can save you money as you don't need to do repairs or comebacks during your retention period.

P4: If questions arise afterwards, you have all the required documentation to cover yourself and the company.

P4: In the end, it will save costs to the company

P4: Protect the reputation of the company.

P4: Another benefit is your company name; your company drive will go forward by showing that quality matters to you. And even if it's a small or big project, you come in with a big project mentality. So, you have a quality standard right through the firm and will benefit us our name show quality.

P4: The only limitation I can think of is that if you don't do it daily or before a pour, for example, you'll spend too much time later on trying to catch up. It can get very time-sensitive.

I: You say that if you've done that training, and everybody understands the requirements or purpose, it will assist all staff in following your values in the company?

P4: There's no doubt that all the principles of a qms are incorporated into our company values. We only lack the discipline to capture the data and reports.

I: Can it play a role in the competitive advantage of a company.

P4: Yes, definitely. Same as what I just said, your standards and your name are built on the way.

I: What are the limitations of a quality management system?

P4: Experience, if you don't have the experience, it won't benefit you. If you don't know how to do it, it will be the most daunting task. Get in the habit of doing it daily, get the required supporting documentation as you progress on site. Do not leave it till the last minute. I don't think there are many limitations.

I: Give five critical criteria you would like to see in a QMS.

P4: Use your construction programme to guide you to start your quality file index.

P4: All departments have to be involved.

P4 Calibration certificates for all tools used to be up to date and available.

P4: All checklists to be updated and filed with the relevant supporting documentation

P4: Manage your quality control documents, determine what you'll need before the project start, update it daily if possible.

I: How active is your company's top management in implementing and goal-setting the implemented QMS?

P4: Support is good. If you ask for something, you receive it. From a site manager perspective, I think we can be more supportive by filling in our quality documentation. Think at times do they need to ask too many times to get the results.

APPENDIX F – SOLEMN DECLARATION AND PERMISSION TO SUBMIT



NWU Higher Degrees Administration

SOLEMN DECLARATION AND PERMISSION TO SUBMIT

1. Solemn declaration by student

I,

declare herewith that the thesis/dissertation/mini-dissertation/article entitled (exactly as registered/approved title),

which I herewith submit to the North-West University is in compliance/partial compliance with the requirements set for the degree:

is my own work, has been text-edited in accordance with the requirements and has not already been submitted to any other university.

LATE SUBMISSION: If a thesis/dissertation/mini-dissertation/article of a student is submitted after the deadline for submission, the period available for examination is limited. No guarantee can therefore be given that (should the examiner reports be positive) the degree will be conferred at the next applicable graduation ceremony. It may also imply that the student would have to re-register for the following academic year.

Ethics number: ORCID:

Signature of Student Digitally signed by Elizma Fuller Date: 2021.11.11 18:54:43 +02'00' University Number

Signed on this day of of 20

2. Permission to submit and solemn declaration by supervisor/promoter

The undersigned declares that the thesis/dissertation/mini-dissertation/article:

- complies with the A-rules and the technical requirements provided for in the Manual for Master's and Doctoral studies and in faculty rules;
- has been checked by me for plagiarism (by making use of Turnitin software for example) and a satisfactory report has been obtained;
- and that the work was language edited before submission for examination.

Faculty specific requirements as per A-rules: 1.3.2, 433, 4.2.4, 4.10.4, 5.3.2

- complies with regards to faculty rules on submission or acceptance by an accredited scientific journal;
- complies with regards to faculty rules on peer reviewed conference proceedings;
- the student is hereby granted permission to submit his/her article/mini-dissertation/ dissertation/thesis for examination.

Signatures of supervisor(s) and Promoter(s): (only compulsory in cases where there are co- or assistant- supervisor(s/promoters))

Digitally signed by Johan Jordaan Date: 2021.11.22 10:37:40 +02'00'

APPENDIX G – TURN IT IN SUMMARY

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