IMPLEMENTATION OF QUALITY ASSURANCE PRACTICES AND EFFECTIVESS OF ROAD CONSTRUCTION INDUSTRY: A CASE OF SOUTH AFRICAN LOCAL MUNICIPALITIES

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ABSTRACT

The road construction industry in South Africa suffers from major inefficiency, poor strategic planning and poor quality of infrastructure. Data from Small and Medium Enterprise (SME) emerging contractors and local government suggest that projects suffer from 30.1 percent to 39.4 percent inefficiency, lack of strategic planning and poor quality of rural road building. Inadequate planning and management control has been identified as a major source of inefficiency. The objective of this paper is to discuss and analyse the difficulties and inadequacies of quality assurance processes and to use the findings of the research to recommend how the quality assurance processes can be implemented to improve efficiency. This paper sought to develop a system that explains the rural roads construction projects in South Africa. A quantitative research approach was adopted using the survey method in which a questionnaire was administered to 160 randomly selected project/construction managers, architects, quantity surveyors, client/managers and administrators of a South African local government department. Descriptive statistics were analysed using frequencies, percentages, arithmetic mean and standard deviation, whilst Pearson correlation was used to measure the strength of the relationships and confirmatory factor analysis. Based on our findings, we argue that the results of this study can assist SME contractors, rural societies as well as local

government authorities in implementing the processes of quality assurance (QA) thus ensuring that rural road building inefficiencies are identified and resolved during the planning phase.

Keywords: *Quality Assurance, Processes, South Africa, Construction Projects*

INTRODUCTION

Investment in infrastructure play a significant role in South Africa in dealing with the challenges of economic depriaction (Khumalo, 2013). Particularly, the road infrastructure projects carrying significant for the integrated development of a country (Schachtebeck & Mbuya, 2016). In recent years, increasing emphasis on construction product quality has been exemplified by the introduction of more and more aspects of project management, improvement in quality of road projects. However, the effects of these road projects have been far from satisfactory. Despite the existence of quality standards, ineffective construction quality of rural road infrastructure in construction still remains at a high level. As many researchers reported, the continuous poor quality of infrastructure are mainly due to lack of management commitment and subordinates actions (Fang and Wu, 2013; Martin & Lewis, 2014; Wu et al., 2015). More specifically, road quality has remained a concept held by project managers, owners and supervisors in construction projects. A study conducted by Chen & Luo (2014:64) finds that 1/3 of low-rise building collapses were due to improper construction materials or methods in China. There are many factors that have a potential impact on poor quality and improper construction project control. Chen & Luo (2014:64) further state that 29 per cent of the construction projects accidents in Germany are directly caused by construction quality problems. Construction-site projects accidents due to poor quality assurance processes are significantly worse in South Africa (Statistics South Africa, 2001-2006; CIBD, 2007; Tshivhase & Worku, 2012).

From the perspective of a construction project, the complexity of construction management, uncertainty and inadequate planning and poor quality of construction design within projects settings, quality should be closely controlled and tested throughout each stage of construction (Cheng & Chien-Ho, 2003). It can be argued that quality tools can cope effectively with current construction process complexities (Asim, Zaman & Zarif, 2013). Therefore, many SME contractors continuously attempt to develop and implement quality management practices (Ofori, 2001). Based on extensive literature review and construction experience, quality management is critically necessary for a construction organisation to sustain in current construction market which is highly challenging and competitive and it has to provide the environment in within which related practises, tools and processes can be utilised effectively leading to operational success for an organisation (Khalek, Aziz and Sharabash, 2016).

The Construction product quality can be defined as the degree to which implied or stated needs and internal characteristics are guaranteed during the process of construction (International Organisation for Standardisation, 1994). According to the statistics, it is estimated that it is costing motorists R50 billion in vehicle repairs and injury every year in South Africa due to potholes (Construction Industry Development Board [CIBD], 2010b). A question that arises is what the distinctive circumstances are that affect the adoption of such practices in other companies besides construction organisations and industries.

The research has involved a literature review of implementing Total Quality Management on construction projects, the South African Road Network System**,** quality assurance/quality control in the construction industry, and construction quality problems, and customer focus (Motwani *et al*., 2002; Evans & Lindsay, 2014:67). Each of these is discussed in the following sections:

LITERATURE REVIEW

Implementing Total Quality Management on construction projects

In later years, the word 'quality' has evolved to become a significant part of the language in both the manufacturing and service industries as the government departments. Quality has significant and positive effects on construction process, and that both quality and construction process have as well as positive effects on project management performance outcomes (Black & Porter, 1996; Cheng & Luo, 2014). Thiagaragan, Zairi and Dale (2001) also argue that an organisation's performance is also influenced by the extent to which quality is emphasised in the entire construction organisation's systems and processes. Similarly, Khalek et al (2016) revealed construction organisations with advanced quality systems achieve the required level of quality for the product and service which are well planned and organised. Mafini (2015) also suggest that the adoption of the well-acclaimed TQM concept, which is a sub-component of quality, can enable both manufacturing and service organisations to enhance quality, with the aim of improving organisational effectiveness and flexibility.

TQM can be considered as the evolution of another quality tool in order to integrate manufacturing and services (Davis & Heineke, 2005). However, the main challenge for TQM is presented by the special concepts that influence its application in organisations. These concepts seem to be related to both success and failure of quality management systems (Chen & Luo, 2014; Tsironis & Psychogios, 2015). These factors provide the structure for a basic quality assurance system as well as many other components of a competitive quality management system as a means of control procedures for assuring quality in products and processes (Xu & Chang, 2016).

According to Asim *et al*. (2013), implementation of TQM in the construction industry focuses on continuous improvement and also aims to keep the customer satisfied. Pycraft *et al*. (2010:610) defines the term *total quality management* as a philosophy of how to approach the organisation of quality improvement. Hence this study is devoted to studying quality tools and techniques that could assist construction project-sites and organisations in their pursuit of better quality. Project techniques and tools along with construction quality have been considered as project success parameters (Burke, 2010; Evans and Lindsay, 2014:67). To implement effective quality in any organisation, TQM needs to be applied by all members and during all phases of the project's process (Goetsch & Davis, 2010).

By implementing a TQM approach, construction companies could improve the environment and hence performance (Gunaydin, 1995). It is a methodology that is concentrated on developing and improving quality efficiency in the organisation (Vermeulen, Pretorius, Motjoade & Kruger, 2015). TQM has been applied in the construction industry and in some cases in services and achieves good results, increasing proficiency of processes and improving product quality (International Organisation for Standardisation, 1994). This is mostly true for construction projects, such as road sites and their implementation procedures, due to the fact that total quality has a people and outcome focus (Burke, 2010). This study will concentrate of integrating applications, and approaches to growth and improve process application towards quality assurance in the construction sector.

Olawale and Sun (2015) highlights that construction project control is about assuring that work activities within a project are completed within their respective budgets.

Despite the existence of various studies in this inclusive area, there has been a dearth of studies specific to implementing the construction project assurance process in practice. Studies such Arditi and Gunaydin (1997), Motwani, Mirchanndani, Madan and Gunasekaran (2002), Olawale and Sun (2015:624), Jogdand and Deskmukh (2017) do not focus on the construction project control practice in entirety but only on part of the process, such as techniques and tools. For example, the Arditi & Gunaydin (1997) report highlights the need to implement total quality management (TQM) in the construction process and provide scope for improving the organisational performance. In other words, it has been widely argued that application of TQM puts quality at the heart of everything that is done by processing and linking all activities in the organisation (Pycraft, Singh, Phihlela, Slack, Chambers and Johnstone, 2010:610). This view is also supported by Arditi & Gunaydin (1997) which highlights the need to implement TQM in the construction process and provide scope for improving the organisational performance.

Moreover, it is well-documented that TQM approaches involve a wide variety of tools to plan work activities, collect data, analyse results, monitor development and solve problems (Gunaydin, 1995; Goetsch & Davis, 2010). In this respect, Vermeulen *et al.* (2015) and Krajewski, Maholtra and Ritzman (2016) suggest that each author develops

and summarises an approach to TQM which reflects their own background, values and experience. In this study extensive literature has been reviewed as well as factors and factor-items affecting quality concerning rural road projects in the South African construction industry among SME contractors in the local governments. On this basis, this study sets out to: (1) discuss and analyse the quality assurance processes of ineffective rural road projects, such as lack of strategic planning and poor quality of construction design by SME contractors in practice in South Africa; and (2) use the findings of the study to recommend how quality assurance processes can be implemented in order to improve efficiency.

The South African Road Network System

The South African road network system is the heartbeat of development, and it performs the basic yet critical function of providing access and mobility for the execution of economic and social activities (Department of Public Transport, Roads & Works, 2003-2006). Writing about South African SMEs contractors, Agumba (2006) states that to enable growth and control costs, they need to have strong management and also utilise the various project management techniques available and also assist government to realise some of its broader socio-economic aims to empower previously disadvantaged individuals. This supports the fact that SMEs are a crucial source of job creation, equity and economic growth. Yet conflicting views about the effect of quality performing assurance processes on road construction projects in rural areas still exist. In line with these developments, the road construction industry has grown significantly and is set to continue growing (Construction Industry Development Board [CIDB], 2007). This, in turn, will assist both national and local government in achieving their objective of promoting the sustainable use of resources for economic growth to benefit the community (Department of Public Works, 1999).

Failure is no stranger to public work projects, but construction site projects seem to have far more than their share of problems (Kerzner, 2009; Tshivhase & Worku, 2012). In South Africa, projects play an important role in terms of job creation, stability of social and economic welfare of the communities (Agumba, 2006; Tshivhase & Worku, 2012). It is further stated in the National Treasury's 2013 Medium-Term Expenditure Framework (MTEF), that R865 billion has been approved and budgeted for public-sector projects, with R296 billion for the energy industry and R262 billion allocated to transport and logistics projects (CIDB, 2010b).

Implementation of quality assurance processes and effectiveness of road construction in rural communities remain ineffective. The government spending on infrastructure projects can be an important strategy to provide economic stimulus (Thwala, 2005). According to the CIDB (2007), South Africa has been achieving substantial expansion in infrastructure investments in both public and private sectors accounting for about 65% to 70% of construction works. Findings which emerged from a study performed by Tshivhase & Worku (2012) indicate increasing infrastructure backlogs as current methods were not adequate for municipalities to deliver service, whilst the demand continues to rise.

Quality assurance/quality control in the construction industry

The construction for quality assurance system (QAS) helps organisations to better organise and synchronise their operations documenting their processes and visibly defining duties and sharing of responsibilities between employees and sections (Gotzamani & Tsiotras, 2001:1326; Xu & Chang, 2014:78; Aliverdi, Naeni & Salehipour, 2013:411). During the past decade there has been a trend amongst organisations regarding the use of preventive rather than corrective methods of quality management as the latter increase costs and decrease efficiency without adding real value to the products (Gotzamani & Tsiotras, 2001:1326). It is widely accepted and well documented that implementing quality assurance standards would bring added value to construction project performance (Vanhoucke, 2012; Aliverdi *et al*., 2013; Olawale & Sun, 2015).

Researchers in the literature quoted appreciate the significance of prevention mainly due to the fact that the new competitive challenge for organisations is the successful combination of high quality and low price (Gotzamani & Tsiotras, 2001) As mentioned by Kam & Hamid (2013), such effectively implemented quality reference permits the international quality systems to be integrated in a more convenient manner, permitting the systems to be ratified widely. Having specific procedures, clear policies, standards, training, guidelines and systems is positively

correlated with project success by directing attention, and motivating and maintaining an efficient quality management system (Arditi & Gunaydin, 1997; Krajewski *et al*., 2016). Kam & Hamid (2013) further mentions an example of an industry which heavily implemented the ISO standards as the manufacturing industry. In this study comprehensive literature has been reviewed, factors affecting quality concerning road projects in South African construction industry including global environment have been identified and analysed.

Construction quality problems

In the construction industry, quality is generally considered to be delivered for quite some time as they have been implementing total quality management (TQM) practices in the building and construction sector (Asim, Zaman & Zarif, 2013). Khalek, Aziz and Sharabash (2016) mentions that construction quality problems can be divided into defects, common problems and quality accidents. Vanhoucke (2012) and Kam & Hamid (2013) describes quality as involving products, defects, processes, clients, and systems. Quality can be well defined as meeting the customer requirements and providing people in many functions of an organisation a common language for improvement (Oakland, 2003:15). Quality is an important component of construction or facilities in keeping the customers satisfied. Many organisations have arrived at the conclusion that effective QA processes can improve their competitive abilities and provide strategic advantages in the marketplace (Goetsch & Davis, 2010; Krajewski *et al*., 2016).

Various researchers also highlight that QA processes assure improvements in quality, design of products, services, processes, concurrent engineering, experimental design, design team formation and management (Oakland, 2003). Thus, without a focus on service quality, organisations will face difficulties and protests from both employees and customers, and related monetary and other charges. Some researchers have examined the application of QA processes related to the road construction industry and its positive impact on performance of an organisation.

Customer focus

In general terms, *customer focus* can be defined as the process of acquiring an understanding of customer needs, both existing and future, effective strategies for learning from and listening to customers; and measuring their satisfaction, dissatisfaction, and level of engagement (Evans, and Lindsay, 2014:25; Vermeulen *et al*., 2015). Oakland (2003) adds that in various organisations empowerment involves that the core organisational strategies are decided centrally, with individual leaders delegated to form a discretionary layer around the core. A review of the literature shows that numerous organisations have identified customer satisfaction as crucial to the successful implementation of a TQM approach, irrespective of the industry to which they belong (Nyakala, 2013; Evans, 2014). In a similar vein, Chen, Anchecta, Lee and Dahlgaard (2016:66) emphasises that customer satisfaction helps improve quality, increases sales and helps optimise the organisation's processes. This implies that the practices of customer involvement components (goal-setting, process specifications, and customisation) can lead to improved performance and competitive edge amongst other competitors. Similarly, Nguyen, Ogunlana and Lan (2004:410) point out that people should be knowledgeable about the project direction, expected project outcome, and particularly their roles. Leadership can influence project success by creating an environment where project teams contribute towards success (Aga, Noorderhaven & Vallejo, 2016). According to this argument, an organisation's success depends increasingly on having opportunities to learn, engagement, teamwork and practicing new skills (Nyakala, 2013; Kruger, Ramphal & Maritz, 2014). This could clearly influence project success. Furthermore, Gotzamani and Tsiotras (2001) underline that the critical success factor lies in the organisations' real commitment to quality improvement and their true target of certification, which finally commands the way and depth to which the standards are implemented.

Research methodology

A literature review on quality assurance processes in the construction industry, SME contractors, and rural road building was undertaken. A quantitative design using the cross-sectional survey approach was used for the empirical portion of the study. The positivist approach, or quantitative research approach, stresses observable facts and

eliminates subjective thought (Creswell, 1994). Questionnaire survey was used to find out the current inefficiencies of rural road building. Questionnaires that are completed by respondents themselves are one of the main instruments for obtaining data using a social survey design (Bryman, 2012). The questionnaire was divided into two sections. The first section consisted of respondents' biographical information such as: (1) gender; (2) highest educational level; (3) the position occupied in the business; (4) number of years working in road construction projects, and the second section involved QA processes related to SME-led projects. The survey targeted SME contractors, since they were more likely to construct rural road projects. The sample for the current research consisted of 160 randomly chosen project/construction managers, architects, quantity surveyors, client/managers and administrators of a South African local government department. The sampling frame was a list of Limpopo-based SME contractors and local government officials involved in the rural road building and was accessible from the human resource database of the organisation.

Question responses were measured with a five-point Likert item scale ranging from 1 to 5. A high 73 per cent response are was achieved primarily due to follow-up telephone calls and mails made to targeted respondents. A computer programme, Windows version 22 of the Statistical Package for Social Science (SPSS), was used to analyse data. Spearman's correlation was used to determine the relationships between variables. The data obtained was analysed using descriptive statistics of frequency and percentage. Factor analysis was adopted to uncover potential variables measuring aspects of the same underlying dimensions (Field, 2013).

The simple random sampling technique was used to select respondents, which ensures that all elements within the population are appropriate for selection as sample elements (Welman, Kruger & Mitchell, 2012). Green's (1991) recommendation that, as a rule of thumb, no less than 50 participants are appropriate for a correlation with the number increasing with larger numbers of independent variable (IVs) was used as the nominal anchor in determining the sample size.

Survey findings: Quality Assurance Process in Rural Road Construction

The questionnaires were used to gather information on the demographic characteristics of the SME-led projects such as employees' gender, positions and their business plan profile. Analysing and interpretation of gender, the position occupied in the business, highest educational level, number of years running the business, funding of the project, the ownership status of this business and the total annual income of the business will be provided in this section. It must be noted that these questions were precisely formulated in relation to this study in an attempt to produce information about the participants' background. The data generated from the information acquired about the gender distribution are listed in Table 1.1.

Table 1.1: Gender distribution

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Male	122	76.3	76.3	76.3
Female	38	23.8	23.8	100.0
Total	160	100.0	100.0	

Source: Field work 2016

Table 1.1 shows the gender distribution in the sample which shows that out of 160 respondents, 122 were males (76.3%) and 38 were females (23.8%). This response rate implies that the road construction industry is still dominated by males.

Table 1.2: Highest educational level of respondent in the business

	Frequency	Percent	Valid Percent	Cumulative Percent
Grade 11 or lower (std 9 or lower)	32	20.0	20.0	20.0
Grade 12 (N3) only	31	19.4	19.4	39.4
First degree/ Diploma	55	34.4	34.4	73.8
Honours/ B-Tech	37	23.1	23.1	96.9
Masters/M-Tech	5	3.1	3.1	100.0
Total	160	100.0	100.0	

Source: Field work 2016

Table 1.2 presents an overview of the respondent's highest educational level. It shows that 34.4 percent (n=55) of the respondents had a first degree/diploma, followed by respondents with honours/B-tech (n=37; 23.1%) and 20.0 percent (n=32) of the respondents with grade 11 or lower (Std 9 or lower). Finally, 19.4 (n=31) had grade 12 (N3) only while 3.1 percent (n=5) had a Masters/M-tech degree. The section established if employees had explored all the construction industries qualification programmes available to them for further studies in order to understand the design and construction techniques to take into account capability and the substantial knowledge on quality procedures. Thereafter, it was investigated if contractor had a Masters' degree in Construction/ Project Management or Civil Engineering courses. Data generated from this section shows that the majority of respondents in this study do not have a Masters' qualification.

Table 1.3: Position occupied in the business

	Frequency	Percent	Valid Percent	Cumulative Percent
Quantity surveyor	18	11.3	11.3	11.3
Client/Manager	24	15.0	15.0	26.3
Project/construction manager	19	11.9	11.9	38.1
Architect/ QA Engineer	25	15.6	15.6	53.8
Government Official	67	41.9	41.9	95.6
Project Administrator	7	4.4	4.4	100.0
Total	160	100	100	

Source: Field work 2016

Table 1.3 indicates the staff position frequency of the respondents. It shows that 41.9 percent (n=67) of the respondents indicated that they served as government officials, 15.6 percent (n=25) were working as Architect/QA engineers and 15.0 percent (n=24) were working as Client/Manager; 11.9 percent (n=19) reported that they were employed as project/construction managers whilst 11.3 (n=18) indicated that they were working as quantity surveyors in road construction. The smallest number of the respondents (n=7; 4.4%) reported they were working as project administrators.

Table 1.4: Respondents' number of years working in road construction

	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 3 years	5	3.1	3.1	3.1
3- 6 years	42	26.3	26.3	29.4
6-9 years	37	23.1	23.1	52.5
9-12 years	63	39.4	39.4	91.9
12 or more years	13	8.1	8.1	100
Total	160	100.0	100.0	

Source: Field work 2016

The results indicate the respondents participating in the study were well qualified and experienced as shown in table 1.3. Among the responding employees, 39.4 percent (n=63) indicated that they were employed for more than 9-12 years, 26.3 percent (n=42) reported working for between 3-6 years, 23.1 percent (n=37) indicated working in the business between 6-9 years, 8.1 percent (n=13) had worked for more than 12 years whilst 3.1 percent (n=5) had worked for less than 3 years. Participants represented extensive experience in various business units ranging from construction industry structure in South Africa, project management knowledge areas, operation management, information systems, research and development, local governments, small and medium enterprises, local communities and authorities. As part of the survey, it was deemed necessary to know the SMEs which were implementing quality assurance processes.

Table 1.5: Table KMO and the Bartlett's tests

Factor	**KMO measures of sampling adequacy**	**Bartlett's (Chi-square) test**	**df**	**Sig**
Level of skill acquisition process	.728	2207.910	105	0.000
The planning and control techniques of the project				
Project construction design				
Process Implementation				
Financial management skills	.929	9494.842	595	0.000
Quality standards				
Organisational structures				
Involvement of people				

Source: Field work, 2016

Table 1.5 four (4) factors extracted (level of skill acquisition process, the planning and control techniques of the project, project construction design, process implementation), twenty-two (22) iterations required. In addition to this, four (4) factors were also extracted (financial management skills, quality standards, organisational structures, as well as involvement of people) are related with quality assurance processes implementation. Pearson's chi-square test proves that SME-led projects did not implement QA processes in the road construction projects. This result indicates that there was no statistical difference between the percentages of the SME-led projects implementing processes of quality assurance in the local municipalities in the road construction projects, which can be termed as a positive moderate correlation at the given levels whereby $p<.000$ for all eight scales measured. Table 1.5 indicates sufficient reliability on the eight (8) coefficients. This means there is a strong relationship between the variables used in SME-led projects related to road construction projects, since the Cronbach is 70 which is advantageous. As a significant positive relationship exists, therefore, there is support for this study question.

Percentage of Variance

The factor-loading matrix for implementation of Quality Assurance (QA) processes and effectiveness of road construction is displayed in Table 1.6. All variables loaded above 0.30, in accordance with specifications used as a cut-off basis (Comrey & Lee, 1992). According to Tabachnick & Fidell (2007), the naming of factors is a subjective process and one should always examine the variables that load highly on a factor rather than relying on the name provided by someone else. Seven visible factors were identified.

Table 1.6: Summary evidence of factor-loading matrix

Factor	QA processes implementation and effectiveness of road construction	Factor loading
The planning and control techniques of the project	Every stakeholder becomes involved during the planning process	0.846
	Stakeholder approval of the work package is facilitated	0.937
	All stakeholders receive the project document during the planning phase	0.923
	The community provides input on costs and resources for the project	0.918
	Project manager provides work breakdown detail using computer/software	0.845
	A formal system of record-keeping is used for projects	0.764
Project construction design	Project scope is designed to adopt technology relating to? QA processes for road construction	0.765
	Scope of work or specification supports the reporting of mistakes by the project team	0.852
	Unforeseen and/-or different geotechnical conditions are described during the construction design	0.870
	The design of road construction is formally reviewed	0.866
Process implementation	The implementation of QA processes is part of the organisation's vision, present and future systems, and process architecture	0.819
	The practical implementation of the process follows established protocols	0.863
Financial management skills	Payments or processing time for tax exemption are properly completed according to the initial agreement	0.873
	Contractor's establishment costs are evaluated wisely to minimise delays in interim payments	0.883
	Costs are re-estimated and/or incorporated when there are changes on the project	0.859
	All pricing/incentives of services rendered by contractors/consultants are approved and monitored by the fund management	0.711
	Financial difficulties faced by the contractor are identified and managed on the project according to procedures	0.717
Quality standards	Every survey team adheres to a standard set of guidelines on survey implementation	0.865
	QA procedures are applied to describe monitoring of survey implementation in actual settings	0.953
	Evaluation of the QA process is visible throughout the survey implementation	0.953
	Quality control of construction work is conducted by supervising, monitoring, inspections and evaluations	0.875
	Defective work is reworked or improved prior to approval by the supervisor	0.848
Organisational structures	The organisation improves the execution of strategies and plans through formal structure, e.g. meetings	0.894
	The organisational structure is aligned with QA processes	0.932
	Planning, leading and control are facilitated effectively to ensure successful implementation of tasks	0.959
	The quality of the road is defined, established and controlled at both strategic an process/operational levels	0.865
Involvement of people	Customer feedback systems are in place to link all business process-related communication	0.758
	The workforce has been given the schedules for projects	0.822
	The project objectives are shared with all role players	0.903
	There is cooperation between senior management, workforce and community members	0.777

Source: Field work 2016

The various implementation and effectiveness indicators all loaded on one factor, which was labelled level of skill acquisition process. This 1-factor solution, had an eigenvalue of 4.633, and explained 69.679 per cent of the variance. The rotated factor loadings varied between 0.745 and 0.914 for this factor displayed in Table 1.7.

Table 1.7 Exploratory factor analysis

Factor	**Factor loading**	**Eigenvalue**	**% of Variance explained**	**% of Cumulative**
1-Factor				
Up-to-date training is provided for employees	0.827	4.633	69.679	69.679
Management commitment to providing QA/QC training	0.914			
High level of satisfaction with the training programme	0.895			
Skills development in different roles/areas	0.840			
Management facilitates new employees learning new skills	0.745			

Source: Field work 2016

Eigenvalue

An eigenvalue represents the amount of variance related with the factor. The view is supported by Hair, Black, Babin & Anderson (2014) who state that only factors above 1.0 are retained and other factors with an eigenvalue less than 1 should not be included in the measurement model. In this study, principal axis factoring indicated the presence of one factor with eigenvalue exceeding 1, accounting for 69, 68% of the variance, which is acceptable (Black & Porter, 1996).

Table 1.8: Cronbach's Alpha Results

Internal Code	**Cronbach's Reliability and Validity Factor and Item Analysis Summary**	**Number of Items per factors (n-j)**	**Quality of Implementation – Cronbach's Alpha**	**Rating of importance-Cronbach's Alpha**
C1	Level of skill acquisition process	5	0.850	0.879
C2	The planning and control techniques of the project	6	0.872	0.879
C3	Project construction design	4	0.867	0.873
C4	Process implementation	2	0.773	0.774
C5	Financial management skills	5	0.778	0.790
C6	Quality standards	5	0.827	0.849
C7	Organisational structures	4	0.933	0.937
C8	Involvement of people	4	0.681	0.699
	Total number of Items	**35**		

Source: Field work 2016The result output for the thirty-five (35)

Quality of Implementation Factor-Items and Rating of Importance Factor-Items using SPSS illustrated that the Cronbach's Alpha value for Quality of Implementation Factor-items are α = 0.681 $\Longrightarrow$ α =0.933 and for Rating of Importance Factor-Items to be from α =0.699 $\Longrightarrow$ α= 0.937.The Cronbach's Alpha of all thirty-five (35) Quality of Implementation Factor-Items and Rating of Importance Factor-Items is greater $\alpha \geq 0.80$ illustrating a good internal consistency (rule of thumb regarding alpha is that alpha should not exceed > 0.80) (Hair *et al*., 2014) between factors-items in the scale. Quality of Implementation and Rating of Importance Factor-Items measured is according to the latent (or underlying) construct and show an inter-correlation Cronbach's Alpha measurement of relevancy, reliability and validity.

QA Processes: Kaiser-Meyer-Olkin Test

In this study, the Kaiser-Meyer-Olkin and Bartlett's test statistic was utilised to measure the sampling adequacy index and appropriateness of Critical Success Aspects analysis and inclusive statistics for each item related to the factor analysis, and determining correlation between items (Field, 2012). The SPSS-Output of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's test of Sphericity statistics is shown in table 1.6. In addition to this, KMO values ranges between 0 and 1 show that the sum of partial correlations is relative to the sum of correlations (Kaiser 1970, 1974). It can further shown that KMO values are inadequate if KMO values are less than <0.5 and that the variables require corrective action remedial action, either deleting the "offending variables" or including other variables related to the offenders (Kaiser 1970-1974).

Table 1.8 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin of Sampling Adequacy		.728
Bartlett's Test Sphericity	Approx. Chi-Square	2207.910
	Df	105
	Sig.	.000

Source: Field work 2016

The Kaiser-Meyer-Olkin-Bartlett's test of Sphericity shows that the KMO value was 0.728 and can be considered as good, demonstrating that factor analysis is accepted for items under review as depicted in Table 1.8. However, no remedial action is required as the KMO value is <0.50 (Hair *et al*., 2014). The Bartlett's test illustrates the strength of the relationship between items and tests if the null hypothesis of the variables in the population correlation matrix is uncorrelated (Field, 2012). The Bartlett test should be substantial (i.e., a significance value of less than <0.50), illustrating that the items are correlated extremely highly to offer a reasonable basis for factor analysis (Kaiser 1970, 1974). The observed significance level in the Bartlett's Test p *value* = 0.000 than 0.05 signifying sufficient correlation between items to proceed with EFA (as depicted in Table 1.8) and is small enough to reject the hypothesis. It is concluded that the strength of the relationship between items is strong and to proceed in factor analysis on the data. From the result output, it was determined that the solution(s) cannot be rotated, and the researcher proposes that all the variables be retained as identified and no Critical Aspects will be eliminated or grouped.

CONCLUSION AND RECOMMENDATION FOR FUTURE IMPROVEMENT

There is great potential for quality assurance processes in the construction industry. Rural road projects are considered as important in addressing the challenges in creating job opportunities and help increase economic growth of South Africa. This study aimed at discussing and analysing the processes of quality assurance difficulties, and factors that influence the efficiency of rural road construction projects in South Africa. The local government should increase its efforts in supporting SME contractors implementing QA processes and TQM concepts, which encourage development of SMEs. Firstly, QA processes training programmes need to be arranged by top management for project/construction, project team employees, the government administrators as well as SME contractors/owners. It is imperative to note that most of these QA programmes, particularly in the construction industry are mostly concerned with improving the level of skill acquisition, planning processes, construction design, organisational structures, advanced technology, and involving people. Secondly, it was also noted that the more issues of inefficiencies arise, the less improvement relating to quality of rural road networks and construction design is seen. Overall, the findings show that there is a need for road authorities to ensure that rural road networks are well-constructed and that proper quality management systems are taken into consideration. The issues of lack of strategic planning should be addressed by ensuring that there is commitment and support from top management, adequate planning, QA awareness and improvement activities in place. Advanced QA/QC training programmes should be introduced for SME-led projects, and a wide-range of project management techniques and tools should be applied that are rooted in the perspectives of engineering. Therefore, proper quality management systems and

regular maintenance is recommended. When quality of construction design is implemented in these rural road networks for development, gross domestic product (GDP) improves for the nation and growth of the economy in the country is ensured. Based on the factors addressed which negatively reflect on rural roads networks built by SME contractors, future research should focus on investigating the effect of landscape attributes, the quality of road materials used and linked cost of maintenance. The results of this study can assist SME contractors, rural societies as well as local government authorities in implementing the processes of QA properly, thus ensuring that rural road building inefficiencies are identified and resolved during the planning phase. If this is not done, road experts or consultants could train local societies on how to apply this method in order to define, measure, analyse, implement and control inefficiencies occurring on their local roads. More importantly, the assessment method used in this study could assist local government project administrators/authorities to develop a better quality management system for rural road building. Furthermore, the information from the database could be used by local government road construction planners through the compilation of annual Integrated Development Plans (IDPs). Thus, local government project authorities will be enabled to better manage rural road building.

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