

An Evaluation of the Quality Management Systems (QMS) at a South African Electricity State Owned Company Compared to the Requirement of ISO 9001:2015

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Abstract

This paper assesses the gap between an established QMS at the South African national electricity company in the metering division compared to ISO 9001:2015 requirements standard and finding ultimate ways to close the gaps. The study follows a quantitative approach with questionnaires distributed and semi-structured interviews conducted to collect the data for more reliability and validity of the study. A sample of 200 employees was selected from the metering division, however, the response rate translated to 82.5%. It is found that some of ISO 9001:2015 clauses are not respected, and the expected requirements were not met in terms of process approach, with 77% of respondent indicating that there is a lack of resources and competencies, while 73% indicated that there is a deficiency in design and operation compatibility. Recommendations made on the failure in the process approach include the use of internal and external audits and the development of quality awareness programs of metering employees.

Keywords

Quality management systems, ISO 9001:2005, Maintenance

1. Introduction

The distribution of QMS (Quality Management System) which improves the performance of the company is influenced by the organization the strategy of quality management (Solomon *et al.* 2017). This study is based on the gap assessment of the current QMS in the metering division of the state-owned electricity company compared to the requirements of ISO 9001:2015. Metering in an electricity state company is the discipline that helps to measure the electricity consumed by customer to bill the customer for the electricity used and again it helps to do the load forecasting meaning that it is through metering that the electricity company can estimate the electricity that will be needed in the future by the whole country. It is therefore very imperative to highlight the ISO family of standards background.

1.1 The ISO Family Standards

The ISO 9000 family of standards was first released in 1987 and updated in 1994 . The purpose was to deliver a standard methodology and framework for defining the QMS in a consistent way, with a focus on users. There are multiple standards with divergent scope such as production, design transmission and inspection (ISO 9001); only production, inspection and transmission (ISO 9002); and final inspection and testing (ISO 9003) (Tata 2009). These three models should be used in control situations, while the ISO 9004 standard, which is the highest quality of a standard, is voluntary access to an organization. All these standards provide quality requirements, explain what a QMS must contain, without setting how to achieve them. According to Aggelogiannopoulos *et al.* (2007), the new Standard set consists of:

- ISO 9000:2000 - Quality Management Systems - Fundamentals and vocabulary.
- ISO 9001:2000 - Quality Management Systems - Requirements.
- ISO 9004:2000 - Quality Management Systems - Guidance for performance improvement.

1.2 Background of the Study

The objective of the QMS is to better the supply chain of a company and improve the business environment. ISO 9001 is a particularly tested process to settle what the customer wants, to assure those wishes (Solomon *et al.* 2017). There are many benefits to installing ISO 9000-compliant QMS, even if it depends on the type of system installed (Hoyle 1998). The ISO 9000 quality system model was built on the principle of customer satisfaction by avoiding disclosure at all stages of the production chain. Although organizations need to install quality systems to improve business performance, they are strongly motivated by customer pressure. This leads to two ways of applying the ISO 9000 rules, stakeholder motivated and management motivated. The stakeholder approach is governed by the search for certification and is therefore more widespread than the management one.

1.3 Problem Statement

Secondary Plant department is a department with a QMS in place, however failure to maintain its QMS has left gaps that need to be filled. Maintenance is the utilization of management ideas is the parts of the quality management process to keep this procedure in a flawlessly characterized state, to keep the philosophy presented for the members of the organization highly relevant and to implement state control over all aspects of the content (Leong *et al.* 2012).

1.4 Purpose and Objectives of the Study

The study's purpose is to assess the gap between QMS at the state-owned electricity company in metering division compared to the requirements of ISO 9001:2015 standard and finding ultimate ways to close those gaps.

The main objective is to identify the gaps between the existing quality management systems in the metering department compared to the requirements of ISO 9001. The sub-objective, however, are to investigate if legal, statutory/regulatory, and technical requirements are adhered to by the metering department, and to provide recommendations on how to bridge the gaps between the existing QMS at the local electricity company and the requirements of ISO 9001:2015.

2. Literature Review

Long-term economic success depends on a company's capability to deliver high quality products and services to its consumers. The ISO (International Organization for Standardization) is composed of 130 national standardization bodies whose general objective is to promote standardization. ISO supports organizations through its international presence with ISO 9000 as a quality standard (Solomon *et al.* 2017).

There are several definitions of quality, yet, all these definitions provide and complement operational significance in different phases of quality activity. According to Goetsch and Davis (1986), quality is a dynamic state associated with people, services, products, procedures and environments that fulfill desires and hopes of consumers that help produce higher results value.

The literature has identified five definitions of quality (Garvin 1986). The first two are reasoning, grounded on people's perception who value the quality of the goods or service. The other three are in terms of quality sense function and ease of evaluation with other firms. The first two definitions include the transcendental vision of quality, the summary that we learn to identify through experience ("I know it when I see it"). The determination of price is a subjective judgment of the consumer.

2.1 Total Quality Management (TQM)

TQM has gained wide acceptance amongst industry practitioners as well as amongst academics as a management philosophy and it is a key term for organizations seeking a competitive edge in the markets (Sureshchandar *et al.* 2001). TQM focuses on the ongoing process improvement of the organization to provide better customer service and consistently meet customer needs (Wang *et al.* 2012).

TQM, being a management philosophy, looks to incorporate all organizational capacities to center around addressing customer needs and organizational purposes. It considers organizations to be an arrangement of procedures. It contends that organizations endeavor to consistently enhance these procedures by coordinating the information and experience of employees. An organization that believes that traditional methods of quality control and how they have always been used to solve their quality problem are incorrect. The use of more inspectors, strict standards, the development of rectification, repair and reward teams do not advance the quality.

Traditionally, quality is considered a quality control service, and some organizations have not yet recognized that there are many quality issues around maintenance or service. Quality management goes beyond transferring the responsibility of auditing the customer to the manufacturer, this requires an all-encompassing methodology that should be recognized and executed when you need to get compensation.

The present organization environment is that directors need to strategically maintain market share without increasing traffic. Customers now have greater loyalty to their domestic producers, and price is not a decisive factor in the customer's choice. The cost has been supplanted instead of industrial services and many other markets. The errors have a chance to double, and if the requirements in one part or area do not meet, problems arise in other places, resulting in even more errors and other problems. The benefits of doing it correct everywhere are enormous, everybody experiences problems in their work life, as a result, people spend a lot of their time on non-productive activities such as correcting mistakes, searching for items, finding reasons why shipments are late, checking, correcting suspicious information, apologizing to customers for mistakes, late delays.

Probably the most energizing uses of TQM have emerged from departments, which could see little reference when initially acquainted with the ideas. Following preparing, numerous cases from various departments or organizations demonstrate the utilization of the strategies. sales staff can monitor and increment effective sales calls, office staff have utilized TQM techniques to anticipate mistakes in word-handling and enhance contribution to computers, customer benefit individuals have observed, and decreased dissensions and appropriation staff have controlled and interruption in conveyances.

TQM is a technique for liberating people's lives of wasted exertion by including everybody during the improvement process, i.e. enhancing the adequacy of work with the goal of accomplished the results in less time. The strategies and systems utilized as a part of TQM can be connected all through the organization.

2.2 Quality as a Quick Fix or an Integrated Long-term Plan

Establishing a quality program is a difficult task that complicates everything by increasing tension on outcome at senior levels and the interest often divided by employees and management (Deming 1981). A global understanding of the meaning of TQM is essential to the accomplishment of its implementation. Therefore, it should be noted that TQM is not a "quick fix" (Dahlgaard and Mi Dahlgaard-Park 2006), solid and ready for the competitiveness of any business. It must be a continuous system, integrated and professionalism, that rely on the commitment of management and staff, cooperating with clients to meet the needs of all. Most businesses have not been able to implement the TQM because they have tried to apply methods such as just-in-time and graphics techniques, without implementing the TQM team's philosophy which is to empower team workforce and vice versa.

Researchers identify a variety of different reasons for TQM error. Most management programs failed because they focused on the improvement of manufacturing, which is easily identify and neglected workers empowerment (Barbucci *et al.* 1993). A survey conducted by McCullough (1993) cited that most investigators the lack of training as the main cause of failure. Other failures of Total quality management's success incorporate the market's competitiveness, poor field managers and working with unproductive positions. Different researchers report other issues with TQM implementation: failure to meet the quality standard (Gitlow 1990), lack of employee incentives to

systematically deliver quality products and services (Papa 1993), and adequate commitment by management to implement quality works (Maul and Gillard 1993, Radovilsky *et al.* 1996).

According to Saraph (1989), TQM is a frame of inter-functional and integrated means of reaching a sustainable competitive advantage. Curkovic *et al.* (200) further enunciate by citing Samson and Terziovski (1999) who said that TQM is a combined management philosophy and a group of practices that emphasize the quality of the organization to achieve consumers satisfaction and improve the organization performance.

It is important to state that companies and organizations occasionally actualize an idea verbatim, select the part reasonable or probable to enhance absolutely their own activities and adjust and alter the idea in execution (Harnesk and Abrahamsson 2007). The TQM idea is, nonetheless, additionally alterable and versatile to the soul of time. TQM has additionally progressed toward becoming to some degree an umbrella for a few ideas and apparatuses, for instance six sigma, 5S, add up to profitable support (TPM) and adjusted scorecard, i.e. TQM is available in assortments and translations (Harnesk and Abrahamsson 2007).

2.3 The Need for Quality

We live in an imperfect world with deterioration, failures, rejects, waste, accidents, etc. and if management do not deliberately and scientifically manage quality, they will not get it. Quality has many advantages and is the single thing everyone seeks. Quality matters to everyone and from a business perspective the focus will be on the market. Quality matters to the external customers because they want to:

- To be respected and do not want any hassles.
- Products and services that are value for money.
- Products and services that are reliable and meet all their requirements.
- Products and services that is available on time.
- Products and services that improve their quality of life.

Increasingly, organizations have begun to understand that a sound quality management system, such as that required by ISO 9000 or TQM is a viable approach to becoming and remaining competitive (Goetsch and Davis 2002). The marketplace is rapidly approaching the point when a recognized quality management system will become the "admission ticket" to doing business.

Consequently, organizations are better off making the ISO 9000 investment sooner rather than later (Goetsch and Davis 2002). The literature indicates that a possible recommendation to management is to take a serious look at ISO 9000, and it appears beneficial now, or appears that it will be, make the commitment to become certified (Yeung *et al.* 2003). Only the highest levels of management can make the necessary commitments on process improvement, cultural change, and organizational development. Only the person at the very top can enlist the full support and cooperation of all employees to work toward a common corporate objective (e.g., ISO registration). If a genuine commitment from the top is not made, it is pointless to proceed with ISO 9000, TQM, or other quality initiative.

More companies are certified by ISO 9000 auditors, the economic pressure on certified companies can only increase. What starts to ensure a certain level of steadiness of quality can be a vital access to the game of international business (Goetsch and Davis 2002).

3. Methodology

3.1 Research Design

The research approach utilized in this study was a mixed one combining the quantitative approach followed by the qualitative one. The quantitative approach is used to make an appreciation of a specific subject, condition or event, while the qualitative was used to elucidate the findings from the quantitative approach. The key issue is to encourage the perception of the mulled over issue, gathering, separating and interpreting data that can't be conveyed in numbers. This study was an investigation on identifying the gap of the application of quality management system based on the requirements of ISO 9001:2015, hence the use of the questionnaire to get

useful information but to get more insights on the matter a semi-structured interview had to be done to get the view of the managers as well as supervisors at firm when it comes to the application of quality management system based on the requirement of ISO 9001:2015 according to their knowledge.

3.2 Data Collection Method

A non-probability sampling was picked as this gave the researcher as much interesting information on the examination inquiries as could reasonably be expected. The inspecting units spoke to representatives from different positions (strata), they could offer alternate points of view on the field of study through the interviews. For this investigation two techniques were utilized to gather information in this examination the semi-organized meeting and the review survey. Both methods had two parts respectively Part 1 which covered the description of the respondent, although the participants took part in the study anonymously, and Part 2 which covered three sub-sections: A – the Planning of work activities, made of 5 questions; B – Documentation requirement, made of 6 questions; and lastly C – Control of monitoring and measuring devices, made of 5 questions.

Table 1. Part 2 of the Research Instrument

Q.#	Questions Description	Scale				
		1	2	3	4	5
	Section A. Planning of Work Activities					
Q.A-1	Are all the parties involved during the planning of projects?					
Q.A-2	Is there any validation and verification of activities?					
Q.A-3	Is there any resources and competencies?					
Q.A-4	Is there any design and operation compatibility?					
Q.A-5	Is the risk assessment and mitigation in place?					
	Section B. Documents Required					
Q.B-1	Does the Business unit manage documents and records?					
Q.B-2	Are the documented procedures required by ISO 9001:2015 in place, known and implemented?					
Q.B-3	Are documents formally approved for adequacy prior to use?					
Q.B-4	Are documents reviewed and updated as necessary as well as re-approved?					
Q.B-5	Are document changes and revision status of documents identified?					
Q.B-6	Are documents and records legible readily identifiable and retrievable?					
	Section C. Control and Monitoring of Measuring Devices					
Q.C-1	Are devices confirmed at specific intermissions, or before use, against measurement standards attributable to international or national standards?					
Q.C-2	Are devices adjusted or re-adjusted as necessary?					
Q.C-3	Are devices identified to allow the standardization status to be determined?					
Q.C-4	Are devices protected on or after changes that would invalidate the measurement outcome?					
Q.C-5	Are ddevices protected against deterioration and damage during handling, maintenance and storage?					

Table 1 above depicts Part 2 of the research tool which is based on five-point Likert Scale with the following scales: 1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree nor Disagree, 4 = Agree and 5 = Strongly Agree. The Likert Scale is five (or seven) point scale which is utilized to enable the respondents to express the amount they rate the level of strengthening from strongly disagreeing to strongly agreeing to a given statement (McLeod, 2008).

3.3 Data Analysis

The analysis of data is portrayed as "the way toward bringing request, structure and importance to the mass of gathering information" (De Vos *et al.* 2002, Given 2008). This investigation goes for evaluating the hole between QMS at the state-claimed power organization in metering division contrasted with the prerequisites of ISO 9001:2015 standard and discovering extreme approaches to close those gaps. The data analysed for this study was collected via semi-structured interview and surveys. This investigation divided into two phases: information planning, which comprises of cleaning and sorting out the information to be utilized for the examination; and distinct insights, which give a comprehensive portrayal of the gathered data utilizing Excel

3.4 Data Validity and Reliability

A measurement is effective when measurement results are truly measurable, and reliability is the level to which measurements give consistent results and are free. There are two parts to the reliable question: unwavering

external and internal quality. External reliability means that the studied dimension does not change, which means that it is stable (Hardy and Bryman 2004).

The reliability of the research tool was tested by using the Cronbach's Alpha coefficient. Reliability tests were performed on the questionnaire items used to gather data. According to Maree (2007), the following guidelines were applied in the test to ascertain the research tool's reliability: (1) 0.90 – high reliability, (2) 0.80 – moderate reliability and (3) 0.70 – low reliability. Following the guidelines on Cronbach's Alpha Coefficient, the measuring tools is deemed fairly high in terms of its reliability, since all the measures which constituted the study have reliability that are higher than 0.80.

4. Results and Discussions

The research targeted a sample of 200 individuals with questionnaires sent out to all of them at the Secondary Plant Metering division. A total of 165 responses were received, which translates to an 82.5% response rate. The data obtained from the questionnaires was captured on MS Excel, then transferred to IBM SPSS Statistics (Version 25) for analysis.

4.1 Part 1 – Frequency Distribution on the Demographic Variable

The gender distribution of the respondents is pretty unequal, with 82% being male and only 18% being female. As per the data depicted in Figure 1 below, the majority of participants to the study is aged below 30 years (47% of respondents), followed by those between 30 and 40 years of age (30% of respondents) and the lowest age representation is those above 40 years of age with 23% of the respondents.

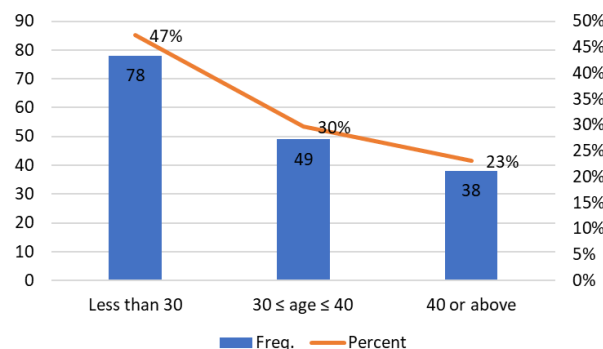


Figure 1. Age Frequency Distribution

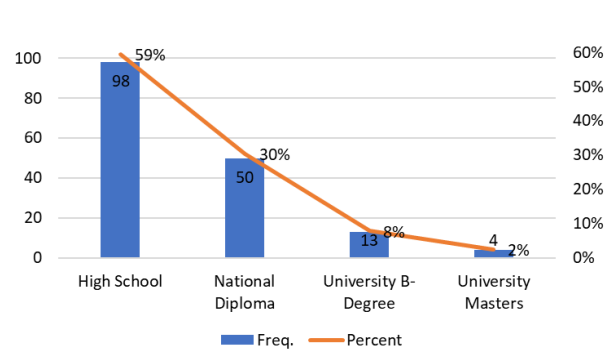


Figure 2. Level of Education Frequency

Figure 2 above speaks of the level of education of respondents. Majority of respondents, or 59%, have indicated that they only hold a high school or matric certificate (matric is the equivalent of the final year of high school or secondary school certificate examination), followed by 30% of respondents who hold a National Diploma (or three year university/technical college degree), then 8% of respondents hold a BTech degree (or have completed a fourth year university or technical college degree), and the reaming 2% of respondents holding a Master's degree.

The highest representation with respondents below the age 30 years and respondents without university qualification but only matric is due to the fact that the metering division employs many field workers who have to go and read meter figures, which is a type of a job that does not require advanced skills and it is appealing to young individuals in search of work.

4.2 Part 2: Section A – Planning of Work Activities

This sub-section provides the results of Section A which covers the planning of work activities. Depicted below in Table 2 – Descriptive Statistics of responses to Section A and Figure 3 which depicts the frequencies of responses to the same section.

Table 2. Descriptive Statistics of Responses to Section A

N	Valid	Q.A-1	Q.A-2	Q.A-3	Q.A-4	Q.A-5
	Missing	165	165	165	165	165
Mean		2.2121	2.8121	2.5030	2.6727	2.4848
Std. Error of Mean		0.09680	0.10620	0.10516	0.10465	0.10338
Std. Deviation		1.24346	1.36412	1.35081	1.34420	1.32796
Variance		1.546	1.861	1.825	1.807	1.763
Range		4.00	4.00	4.00	4.00	4.00

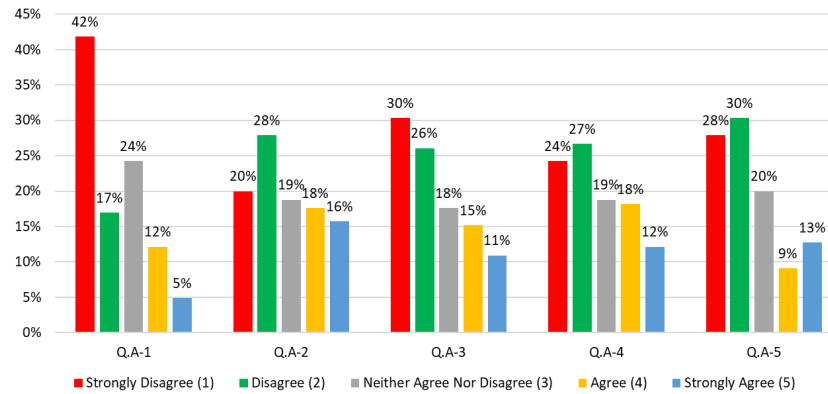


Figure 3. Section A – Frequency of Responses

As shown in Figure 3, majority of respondents have indicated negative responses to all the questions asked with regard to planning of the work activities within the division. The highest negative answers was concerning Q.A-1 which is the enquiry about all the parties being involved during the panning of the project, to which 59% of respondents disagreed while only 17% agreed. 48% of respondents disagreed with Q.A-2 which enquired about the existence of any validation and verification of activities. Majority of respondents, or 56% disagreed with Q.A-3 which asked whether or not there is any resources and competencies. When asked about Q.A-4, there was a majority, or 51% of respondents who disagreed that there is any design and operation compatibility. Lastly, with regards to Q.A-5, which covered the existence of risk assessment and mitigation being in place within the division, majority of respondents, or 58% disagreed, while only 22% agreed.

4.3 Part 2: Section B – Documents Required

This sub-section provides the results of Section B which covers the document required as per ISO 9001:2015. Depicted below in Table 3 are the descriptive statistics of responses to Section B and subsequently in Figure 4 are the frequencies of responses to the same section.

Table 3. Descriptive Statistics of Responses to Section B

N	Valid	Q.B-1	Q.B-2	Q.B-3	Q.B-4	Q.B-5	Q.B-6
	Missing	165	165	165	165	165	165
Mean		2.2121	2.8485	2.4848	2.5879	2.7152	3.3333
Std. Error of Mean		0.09680	0.11295	0.10963	0.12458	0.10800	0.10075
Std. Deviation		1.24346	1.45085	1.40819	1.60026	1.38725	1.29414
Variance		1.546	2.105	1.983	2.561	1.924	1.675
Range		4.00	4.00	4.00	4.00	4.00	4.00

As shown in Figure 4 below, respondents disagree to most of the questions covered in this sub-section, whit four out of six questions showing high rate of negative answers as opposed to only two questions having high rate of positive answers. 45% of respondents answered negatively to Q.B-1 which enquired about whether the business

unit manages the documents and records accordingly. Majority of respondents, or 58%, have indicated negative responses to Q.B-2 which asked if the documented procedures required by ISO 9001:2015 were in place, known and implemented.

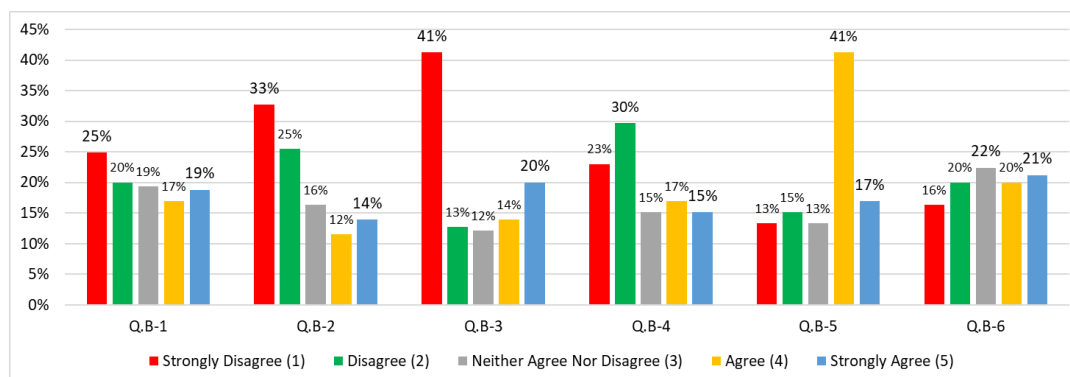


Figure 4. Section B – Frequency of Responses

To Q.B-3 which enquired about whether documents are formally approved for adequacy prior to use, majority of respondents, or 54% answered negatively. 54% of respondents also did not agree with Q.B-4 which enquired about documents being reviewed and updated as necessary as well as being re-approved. However, Q.B-5 and Q.B-6, which enquired about document changes and revision status of documents being identified as well as documents and records being legible readily identifiable and retrievable. Both of which had majority of respondents agree at 58% and 41% respectively.

4.4 Part 2: Section C – Control and Monitoring of Measuring Devices

This sub-section provides the results of Section C which covers the control and monitoring of measuring devices. Depicted below in Table 4 are the descriptive statistics of responses to Section C and subsequently in Figure 5 are the frequencies of responses to the same section.

Table 4. Descriptive Statistics of Responses to Section C

		Q.C-1	Q.C-2	Q.C-3	Q.C-4	Q.C-5
N	Valid	165	165	165	165	165
	Missing	0	0	0	0	0
Mean		2.2121	2.3030	1.9333	1.9152	3.4545
Std. Error of Mean		0.09680	0.10544	0.10464	0.10752	0.08994
Std. Deviation		1.24346	1.35442	1.34406	1.38108	1.15534
Variance		1.546	1.834	1.807	1.907	1.335
Range		4.00	4.00	4.00	4.00	4.00

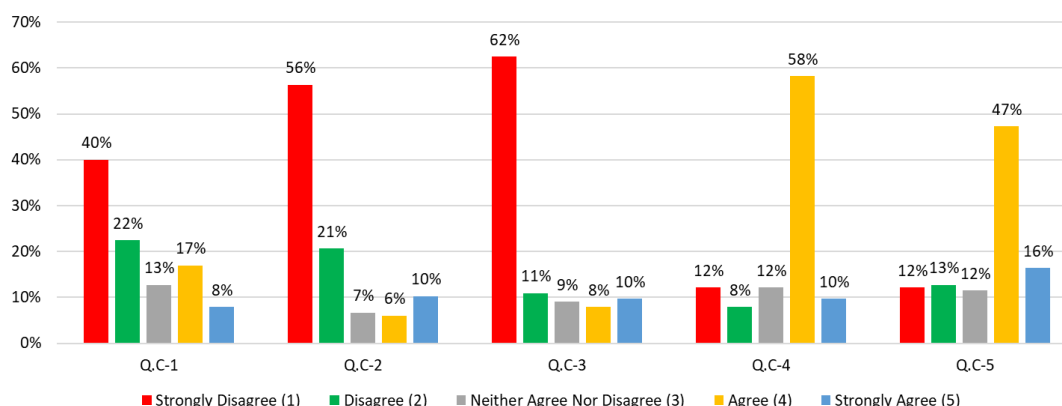


Figure 5. Section C – Frequency of Responses

As shown in Figure 5 above, majority of respondents or 62% strongly disagreed with Q.C-1 about devices confirming at specific intermissions, or before use, against measurement standards attributable to international standards. A staggering 77% and 73% strongly disagreed with the questions Q.C-2 and Q.C-3 respectively. Q.C-2 and Q.C-3 asked whether the devices being adjusted or being re-adjusted as necessary, as well as whether the devices identified devices allow the standardization status to be determined, respectively. Majority of respondents, or 68% agreed in Q.C-4 that devices are protected on or after changes that would invalidate the measurement outcome and lastly, 63% of respondents agreed that devices are protected against deterioration and damage during handling, maintenance and storage.

4. Results and Discussions

From the interviews with managers and supervisors, it was noted that the legal and technical requirements are not being adhered to within the metering division. The whole metering at the electricity state owned company is governed by the National Energy Regulatory of South Africa (NERSA). As such, one of the requirements from NERSA is that measuring equipment should be twice as accurate since they are meters used to bill consumers for electricity consumption. Since there is no proper control of measuring and monitoring equipment, there is no proof that metering division is adhering to regulatory and technical requirements from the National Energy Regulatory of South Africa. Therefore, the following recommendations for a better-quality management can be made:

1. The utilization of internal and additionally outer reviews

Quality frameworks control the instruments that create and convey a service to customers. On the off chance that we depend on customers to let us know of the effectiveness of the controls, it might be past the point of no return and we won't hold their custom. A successful quality framework will contain steady checks, tests and frameworks for restorative activity. In any case, these need the help of free checks of the association from the association. These autonomous checks are called reviews. It is in this manner essential that reviews are completed in metering discipline and the review degree ought to incorporate all metering angles not only certain parts in metering.

2. Quality Awareness Programs of metering employees

Secondary plant department should impart the training for those employees whose work has a significant impact on quality; it is also important that subcontractors whose activities might influence quality management system should also be trained in the areas of their activities that impact the management system. In proving training to employees would close the gaps that seem to be present in the metering quality management system.

3. Proper Training Provision to new employees.

In Secondary plan department metering is not seen as an important discipline when in fact it is very important and therefore management tend to not show its commitment in the discipline therefore all employees of the organization should be made to clearly understand their quality roles and responsibilities. They should be made aware of the importance of quality targets and objectives that they are going to work on. The employee's job description should include the quality responsibilities he has been assigned.

Worthy of note is the indication that this research is limited by the fact that it only targeted the metering division of the electricity state-owned company in Johannesburg. However, there is a need to expand the study to establish the confirmation of this study's finding as the state-owned company is battling with revenue losses, which might also be attributed lack of adequate QMS within its metering division.

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Biography

Sambil C. Mukwakungu is an award-winning academic who has been lecturing Operations Management to first year students, Food Production, and Quality Management at the University of Johannesburg since 2009. His passion for teaching and learning has allowed him to make a difference in at least one student's life every year. He is a young researcher who is still establishing himself in knowledge creation with keen interest in Quality Management Systems, Service Operations Management, Lean Operations, Continuous Improvement, as well as business innovation and innovation in Higher Education. He was awarded Best Track Paper Awards at the 2016 IEOM Conference in Rabat, Morocco, also at the 2018 2nd European Conference in Paris, France, and he is together with his team from the IEOM UJ Student Chapter a recipient of the 2018 IEOM Outstanding Student Chapter Gold Award for exceptional chapter activities and contributions to the field of industrial engineering and operations management.

Kidoge Ibrahimu is a master's student in Operations Management and a young researcher with the Faculty of Engineering and Build Environment at the University of Johannesburg, South Africa. His research interests are in Continuous Improvement in Healthcare Operations, Operations Research Application and Project management.

Jonathan Eljadael Kasongo is young Congolese businessman who has a study background in Operations Management with a National diploma and Bachelor of Technology in Operations Management. He is an award-winning academic who has been tutoring Financial principal to third year students in Operations Management at the University of Johannesburg. His passion for research has allowed him to develop a problem-solving skill that enables him to be very competitive in his business ventures.

Prof Charles Mbohwa is a Professor at the Faculty of Engineering and the Built Environment at the University of Johannesburg (UJ). As an established researcher in the field of sustainability engineering and energy, Prof Mbohwa's specialisations include sustainable engineering, energy systems, Life-Cycle Assessments (LCA's) and bioenergy/fuel feasibility and sustainability with general research interests in renewable energies and sustainability issues. Prof Mbohwa's current research in sustainability engineering includes: Social and climate change comparison of bio-diesel life cycle impacts in Brazil and South Africa; Life Cycle Assessment and Comparisons of Rail and Road Freight Transportation in China and South Africa; The Potential, Energy and Environmental Impacts of Bio-energy in the Sugar Industry in South Africa; and the Economic, Energy and Environmental Evaluations of Biomass-based Fuel Ethanol based on Life Cycle Assessment. He is a co-author of the second chapter of the United Nation's Environmental Programme's (UNEP) Global Guidance Principles for Life Cycle Assessment Databases: A Basis for Greener Processes and Products 2011. In addition, he is Project Leader for the Development of the Climate Change Response Strategy and Action Plan for the Gauteng Department of Agriculture and Rural Development: Use of indigenous knowledge.