

Evaluation of the Attitudes and Perceptions of Employees towards the Implementation of Six Sigma to improve quality in an Electric Cable Manufacturing Company in South Africa

Shithlangu Raymond Khambani

Mancosa Graduate School of Business
16 Samora Machel St
Durban Central, 4001
Durban, SOUTH AFRICA
khambani30@gmail.com

Chipo Mugova

Mancosa Graduate School of Business
16 Samora Machel St
Durban Central 4001
Durban, SOUTH AFRICA
mugovac@gmail.com

Bongumusa Mansuette Bhekamalinda Cebekhulu

Wits School of Mining Engineering
1 Jan Smuts Avenue, Braamfontein 2000
Johannesburg, SOUTH AFRICA
musa.ceb@gmail.com

Abstract

The purpose of this study was to investigate how the adoption of Six Sigma can improve quality in a cable manufacturing company, ABC Electric (pseudonym). The study followed a qualitative research approach utilising interviews, observations, and document review. The study focused on shop floor employees, supervisors and production managers and was constrained to ten participants to elicit in-depth information. The findings revealed that the majority of the respondents felt that there is lack of support by management for quality within the organisation. Negative attitude towards quality cascading from management to shop floor workers, was the second most frequent theme that surfaced, followed by lack of communication and feedback. The majority of respondents however, showed understanding of quality concepts. Based on the findings, the study concluded that lack of management support, norms and values that are not aligned to a quality culture, and leadership that did not infuse corporation with employees, were the causes of poor quality at ABC Electric. It was recommended that a vigorous training program, provision of resources by management, a change of attitude, teamwork were important antecedents to successful six sigma implementation. A paradigm shift to a quality centred culture for the entire organization through leadership commitment is necessary.

Keywords

DMAIC, Six Sigma, Quality Management, Defects, Quality tools.

1. Introduction

Six Sigma methodology is a brainchild of Motorola that was developed with the objective of collecting data and analysing the root causes to problems in an effort to reduce variations in processes. The Six Sigma methodology has helped various organisations to improve their business performance by using the DMAIC (Define, measure, analyse, improve and control) cycle. Every stage of the DMAIC methodology makes use of problem-solving tools and techniques to improve the quality of products or services. Six Sigma is a process improvement initiative that concentrates on improving process performance by reducing waste, increasing customer's satisfaction, changing organisational culture and enforcing employer's commitment.

This research study investigated how a cable manufacturing company in South Africa could improve its quality management by adopting Six Sigma. The purpose of the study was to investigate how quality could be enhanced by using the Six Sigma methodology to solve problems, eradicate defects, transform culture and improve business performance at the company.

The case study company specialises in the manufacture of electrical cables and the company has been having difficulties managing the quality of products. Defects produced range from short length, high voltage failures, sheath breaks, bad flaking and overriding wires. Short length in particular has a detrimental effect on the price of the final products; short length cables are sold at a discounted price thus affecting sales targets. In most cases, cables are scrapped because a customer does not accept short length. There have been no efforts to establish the root causes of the defects. Managers are handling quality related problems haphazardly without accountability within the organisation. The study geared towards finding ways for recommendation to management to improve overall business performance by reducing scrap rate and increase customer satisfaction.

2. Literature Review

According to Fursule, Bansod and Fursule (2012:12), the statistical goal of the Six Sigma method is to maintain functionality and minimise defects. According to Narayanan (2015:1) the "six" was derived from the aim of placing six standard deviations between the mean and the nearest consumer limits or expectations. With the intention to attain Six Sigma high-quality target of (99.9997%), a process is predicted to attain no more than 3.4 defects per million opportunities (DPMO) (Chakraborty and Tan, 2010).

Kumar (2014: 12652) states that the intention of the Six Sigma methodology is a process improvement method that focuses on process capability using DMAIC and DMADV (Define, Measure, Analyse, Design and Verify) cycle. The DMAIC methodology is typically used for current processes (Chakraborty and Tan, 2007:254). The DMADV approach is implemented in new processes or products.

The methodology makes use of numerous tools and techniques and it also incorporates other concepts such as financial analysis and project schedule development. Sleeper (2006) cited in Bhargava, Bhardwaj and Rathore (2010) and Pyzek and Keller (2012) cited in Tennakoon and Palawatta (2015) reiterate the five stages of Six Sigma improvement methodology:

Define - purpose of the project is defined, scope and process background using SIPOC (Supplier, Inputs, Processes, Outputs and Customers), VOC (Voice of customer) and (QFD) quality function deployment.

Measure- root causes of the defects are determined using trend charts, Pareto charts, process charts, process capability measurement and Gage R&R.

Analyse - root causes of the problems are analysed using cause and effect, five whys analyses.

Improve -solutions to the problems are developed by implementing tools like FMEA (failure mode effects analysis).

Control - by using data, an evolution of the solution of the problems, the future plans and standard operating procedures are maintained.

Hendricks and Kelbaugh, (1998) cited in Sasthriyar (2006) state that before Six Sigma can be adopted there should be an introduction to the "belt system". Slater, (1999:1) cited in Schroeder et al. (2007) assert that, full time improvement experts called Black Belts go through weeks of training to improve their process capabilities. The shop floor

employees receive 10 days training qualifying them to be green belts. Six Sigma executives and champions set the direction for selecting and deploying projects (Borror, 2015:1)

For Six Sigma methodology to be successful, there ought to be full commitment of the top management (Fursule et al., 2012:2). Kwak and Anabari (2004:5) assert that Six Sigma requires pinnacle management eagerness and involvement in providing required resources. Top managers have to be hands-on in the implementation of Six Sigma projects (Schroeder et al., 2007:541). Zu, Fredendall and Douglas (2008:632) assert that top management commitment provides strategies and clear goals for quality improvement. Similarly, Sasthriyar (2006:16) state that top management ought to be custodians of Six Sigma. Fursule et al. (2012) support that the execution of the Six Sigma methodology requires buy-in from top management in order to succeed.

Six Sigma uses a set of tools to subjugate quality related problems (Gosnik and Herzog, 2010:206). According to Basau and Wright (2011:3), Six Sigma methodology is a concept that is popularly known for its customer satisfaction and process improvements capabilities. Taneja and Machanda (2013:281) assert Six Sigma to be a good quality management tool that was adopted successfully by organisations such as General Electric and Motorola.

Dambhare, et al. (2013:2) maintain that Six Sigma methodology is problem-focused and its principal objective is to lower scrap while Tennakoon and Palawatta (2015:1) assert that Six Sigma establishes the root causes of failures and provide solutions. According to Khanduja and Singh (2013:1) after the successful implementation of Six Sigma DMAIC, an Indian foundry SME managed to raise sigma level by 0.24 by reducing scrap of non-ferrous piston foundry from 22% to 10%.

Singh (2015) posits that Six Sigma has techniques that identify, reduce defects by addressing their root causes, while De Mast and Lokkerbol (2012:22) assert that Six Sigma methodology is ideal for defining the problem, diagnose, and ultimately provide solutions. Antony and Banuels (2001) cited in Kwak and Anbari (2004) maintain the Six Sigma methodology is ideal in helping organisations to improve their efficiencies, profitability, and effectiveness. According to Cronemyr (2008:1234) Six Sigma can transform an organisation but top management needs to drive the programme. According to Brown (2014:69) transforming organisational culture is not that easy as culture comes out of shared behaviours and the working relationships of organisation members developed over time. Six Sigma was not implemented at General Electrical without difficulties, employees had to cope with challenges of learning statistics (Sohal, 1998:1 cited in Sasthriyari 2006). Before implementing Six Sigma in the organisation, corporate culture needs to be adjusted. The differences in organisational culture from one country to another should be taken into consideration. According to Jirasukpraset, et al. (2012:480) organisations that adopt Six Sigma as their culture of continuous improvement achieve cost savings, increase product quality and enhance customer satisfaction.

3. Methodology

This study investigated how implementation of Six Sigma can lead to improved quality management at ABC Electric. A qualitative research design was adopted since the study required descriptive detail rather than quantitative data. The study sought to establish the culture and attitude of employees towards quality management and to explore the strategic approaches that an organisation can use in order to satisfy its customers.

The research study was based on behavioural patterns. The purpose of the research study was to understand the behaviour, norms, attitude and environment that has an influence on quality management and how quality can be improved using Six Sigma. Hence a qualitative research design was deemed suitable for the study.

The target population for the study was 550 managers and employees of ABC who were directly and indirectly involved in the manufacturing of the product. The sampling frame comprised of 51 managers and employees directly and indirectly involved in the manufacturing of the product and have been in the company employ for more than 5 years. These respondents were selected based on their experience, understanding of the culture of the organisation and have been with the organisation from the time the ISO 9001 quality management system was implemented. The respondents were drawn from production, quality, process, planning, and engineering departments. The sample size for the study comprised of 10 members who were selected using non-probability purposive sampling. Non-probability purposive sampling enabled selection of participants that were considered to possess in-depth knowledge on the subject of inquiry.

Interviews using a semi-structured question interview guide with open-ended questions were used as the main data collection instrument and were taped recorded. Observations and document review were also used for data collection in order to intensify credibility of the findings. Through observations, the interaction between the respondents and their culture in relation to quality management were checked. Hand written field notes were taken.

The tape recorded data was later transcribed and analysed by thematic data analysis using an inductive approach. Inductive reasoning was the preferred approach because it allowed shaping of the collected data into emergent themes rather than forcing the data into a predetermined theoretical framework driven by the research questions and objectives.

4. Results and Discussion

Data from the interviews was transcribed and then coded and categorised using thematic data analysis. The themes discussed below emerged from the data:

4.1 Theme1: Support from the top management and fellow employees

Support from the top management and fellow employees is related to the way the organisation supports its employees by providing the tools and resources that assist them in enhancing quality management. It also refers to the way the employees interact and help each other in managing quality. Table 4.1 encapsulates the sub themes and issues that were unearthed related to Theme 1.

Table 4.1 Support from the top management and fellow employees

Sub Themes	Issues
Lack of Support	<ul style="list-style-type: none"> • Failure to provide quality management tools • Failure to provide education and training • Inability to provide effective supervision
Lack of training and development	<ul style="list-style-type: none"> • Selective training • No skills development • Employees not empowered

4.1.1 Lack of support

Lack of support refers to the inability of top management and fellow employees to assist each other related to quality management at ABC Electric. It also refers to failure by top management to provide quality management tools and resources needed for managing quality.

Lack of provision of resources and lack of support from top management and fellow employees emerged as the main reason for poor quality. The respondents had this to say:

Respondent 1: (a process technician with 20 years of service)

"There is really lot of things that needs to improve because production cannot give us enough time to work on the machines. Sometimes we don't have funds to buy the parts that are needed to fix the machines".

Respondent 3: (a production manager with 20 years of service)

"Currently, we are having a system that I can say it needs to be corrected. Because we don't have in line testing we only rely on results from the laboratory. Sometimes you only realise that the product is defective at the last stage. Which is really, really disappointing".

Respondent 5 (an operator with 20 years of service):

"There is no involvement, I have never seen top managers coming down to help with the quality issues even though our scrap is very high. They are not involved in solving quality problems. Quality is the problem of a particular manager who is involved on that particular product".

Respondent 2: (section leader with 8 years of experience)

"Eish (scratching head), I believe that this things goes according to the levels, from one level to another. Our MD is someone with vision and he wants zero tolerance when it comes to quality. But the reality is not the same with what the MD envision. Management contributes a lot to poor quality. The very same person (manager) will instruct you to run a defected cable. There are no quality tools that are used to solve quality problems".

The study revealed that employees were frustrated by management's failure to provide sufficient budgets to maintain the machines as expressed by Respondent 1. Six Sigma requires pinnacle management eagerness and involvement in providing required resources (Kwak and Anabari, 2004:5). Although Respondent 2 acknowledged the commitment of the Managing Director to quality management, it transpired that the efforts did not cascade down to middle management. Respondent 5 felt that the managers perpetuate poor quality in the organisation by allowing defective products to proceed to the next process. Documentary review showed the MD's commitment to quality management through the company's newsletter where he encourages and motivates employees to change their attitude towards quality. This is in line with Borrer (2015:1)'s assertion that Six Sigma executives and champions should set the direction for selecting and deploying projects. However top managers need also to be hands-on in the implementation of Six Sigma projects (Schroeder et al., 2007:541). The following were the answers to the question:

Can you tell me about the quality management system in the organisation?

Respondent 4: (a machine operator with 8 years)

"Emmmm, quality management system... I can say is not good in our organisation. Because as operators we make plans to run the machines".

Respondent 2:

"In my opinion, the quality is poor (clearing throat) if you have the quality management system in place they should be able to assist in producing good quality products. But unfortunately you cannot eradicate quality problems completely, but there are no efforts that are made in the organisation. There are systems available in the organisation, but they are not enforced".

Respondent 2's utterances support the existence of a quality management framework within the organisation although not enforced. It was observed that there was no documentation, inspections and filing yet the organisation is ISO 9001 certified. The system does not support employees in achieving their objectives, indicative of a quality management system that exists only on paper.

It was observed that there were no quality management tools on plant notice boards to assist the employees in solving problems except for temperature profiles and production data sheets. There were no useful tools for defining, analysing and measuring defects. Using Six Sigma will help resolve these issues because Six Sigma has techniques that identify, and reduce defects by addressing the root causes (Singh, 2015). It also emerged that many defective products go through the process without paperwork and that there is poor housekeeping in the plant also contributing to high level of failures.

4.1.2 Lack of training and development

Lack of training refers to not availing training that can improve the employee's competencies. Development means the ability of ABC Electric to create an on-going learning environment for its employees. According to the participants, there are no efforts made by the top management to provide education and training. But Cronemyr (2008:1234) asserts that top management needs to drive the six sigma programme. The respondents had the following to say:

Respondent 9:

"There are no quality trainings, I haven't attended any quality training for 4 years".

Respondent 1:

"I haven't attended quality training for about two years but I do train operators from time to time. I conduct on-job training and process coaching".

Respondent 10:

"I have been with the company for 20 years, I haven't attended any quality training".

Respondent 6:

Tjoo, very rare I only attended quality training 3 times in ten years' time.

Respondent 4:

"Like I told you that I have been with the company for 8 years. I only attended the quality training once at the beginning of 2016".

Respondent 3: (a production manager)

"As a production manager I do attend quality meetings but this year I haven't attended any training".

From the statements of the respondents it is evident that management has not committed to employees' training for the past 20 years. According to Dileep, Rau and Satish (2014:35) the cultural factors compatible for Six Sigma include more consciousness programmes focusing on the benefits of quality improvement programmes to the employees. The analysis also showed a worrying factor suggesting that training is only given to the production managers. However, Hendricks and Kelbaugh (1998) cited in Sasthriyar (2006) posit that before Six Sigma can be adopted, there should be an introduction to the "belt system". The belt system provides specific training to all levels of the organization. It was further observed that most of the machine operators were running machines without training, training records were absent. For Six Sigma methodology to be successful, there ought to be full commitment of top management Fursule et al. (2012:2).

4.2 Theme 2: Attitude of the Employees towards Quality

The attitude of employees towards quality refers to the positive and negative attitude of the employees in all levels of the organisation.

Table 4.2 Attitude of the employees towards quality

Sub Themes	Identified Opportunities/Issues
Positive attitude	<ul style="list-style-type: none"> • Understanding of quality management frameworks, tools, and concepts
Negative attitude	<ul style="list-style-type: none"> • Lack of pride in workmanship • Don't care attitude • Resistance to change • No corporation among employees

4.2.1 Positive attitude

In this context, positive attitude refers to the willingness of employees to change, co-operate, and to take charge of their performance. The majority of the participants suggested that Six Sigma can improve employee's attitude towards quality management.

Respondent 4:

"Jaa, I think Six Sigma can be able to improve employee's attitude to quality because people are doing as they please because the defects are not monitored. People keep on making scrap and the short length".

Respondent 7:

"Jaa, I think Six Sigma can be able to eliminate defects because cables will get fixed from the previous process".

Respondent 6:

"Yes, the defects can be eliminated because it is the method that will be focusing on quality. The problems will be solved from the start of the process to the end of the process".

Respondent 8:

"I think Six Sigma can reduce defects because it has special tools that assist in solving problems within the process".

The findings revealed that the respondents had an understanding of what six sigma entails. Respondent 4's response showed confidence in the implementation of Six Sigma as a quality management tool.

4.2.2 Negative attitude

Negative attitude refers to unruly behaviours of the employees that relate to resistance to change, lack of discipline, and lack of pride in own work. Some participants did not believe that the organisation is in a good position to improve quality management.

Respondent 5: (an operator with 20 years' experience)

"I think the technology that we are using in our machines is very outdated. Implementing Six Sigma can be challenging because it deals with how best you can reduce the defects and make improvements. With the state of our equipment is highly impossible. I think the management is overlooking that because it can cost the company a lot of money".

From Respondent 5's statement it emerged that proper maintenance strategy of the machines crucial in eliminating defects, was lacking. Through observations it was confirmed that some machines were always making defects because they tripped during the run. A programme such as total productive maintenance (TPM) could assist in reducing breakdowns.

Respondent 5:

"When an operators makes scrap they pass it to the next process, they pass the buck to the next process".

Respondent 10:

"They have this attitude of don't care, the other stages will see. Or the problem is passed to the next process".

Respondent 10 and Respondent 5's statements highlight the attitude of the employees towards quality: defects are not rectified, instead, they are sent to the next process which increases failure rate as defective products will be ultimately scrapped internally or rejected by the customer. Looking at the non-conformance area and product failure analysis, it was evident that some of the defects could have been verified at a previous processes.

Respondent 1:

"Our employees doesn't care much about quality, they do not adhere to the PDS"

According to Respondent 10, ABC Electric employees do not care about quality. The following issues emerged when the respondents were asked the following question:

How can you describe your company's culture in relation to quality management?

Respondent 10:

"I think the culture is poor, because quality gets recognized when there is no workload. Because if you can check, our quality gets neglected when there is lot of work. They based on volumes and neglect the quality".

Respondent 2:

"Eish, I can say people are ignorant, that is the culture, ignorance. Because, I think there are quality and process department that should be making follow ups (Shaking head) it shows that we are ignorant"

Respondent 1:

"The culture is not good, the employees think quality improvement is the job of a process technician. They don't have ownership to the quality of the products".

Respondent 5:

"Well, we still lacking. If you get a customer complain one will ask himself a question as to how did the cable pass the stages without being checked thoroughly. So I would say the quality department is not doing its job properly".

Respondent 8: (a SHERQ coordinator with 20 years of experience)

"There is always a tension between the quality department and the rest of the organisation with regard to who is responsible for quality. Quality is not the responsibility of QA department but each and every employee in all levels throughout the organisation."

It emerged from Respondent 8's utterances that there is role ambiguity when it comes to quality management, certain employees do not want to be accountable. Through observations, it was noted that ABC Electric's top management are result orientated. Top management's concern is on targets, to get the products to the customers on time and the rest of the employees in the organisation behave in the same manner. This confirms the theory posited by (Brown, 2014:69) that transforming organisational culture is not easy because culture comes out of shared behaviours and the working relationships of organisation members developed over time.

According to Jirasukpraset, et al. (2012:480) organisations that adopt Six Sigma as a culture for continuous improvement achieve cost savings, increase product quality and enhance customer satisfaction. The strength of Six Sigma is to establish a culture of continuous improvement that rely on a combination of transforming the way in which work is performed by changing processes, and teaching employees better ways of understanding processes and problem-solving techniques.

4.3 Theme 3: Information and communication

Information and communication refers to the way the employees at all levels communicate with regards to quality management. The theme also takes into consideration the way in which information is disseminated throughout the organisation.

Table 4.3 Information and communication

Sub themes	Identified Issues
Inadequate communication	<ul style="list-style-type: none"> • Lack of clear goals and objectives • Inadequate information on quality management • Role ambiguity • No quality meetings
Feedback on quality targets	<ul style="list-style-type: none"> • Customer feed-back not communicated to employees • Quality targets not communicated • Defects level not reported

4.3.1 Communication

Lack of communication refers to the inability of employees to communicate openly and effectively at all levels throughout the organisation. Lack of communication also refers to poor communication between management and shop floor employees. Additionally, it concentrates on how informed the respondents are. The following were the respondent's views:

Respondent 7:

"Eish, they are the one creating problems because...let me make an example, when there are changes they don't talk to us as operators, they just implement change without informing us".

Respondent 10:

"Even the meetings I haven't attended any meeting, I only sit with my boss and we have discussions but not formal meetings".

Respondent 2:

"Jaa, I hold quality meetings with the operators, quality is an item in a production meeting".

Respondent 10:

I have been with the company for 20 years; I haven't attended any quality meeting.

Respondent 7's statement indicates that management strategic objectives do not cascade down to the shop floor employees and shop floor employees do not have input on changes that are made by the top management. Respondent 10 is a section leader but has never attended any quality meeting. It was observed that there is no effective communication in ABC Electric, there are no visual boards that indicate quality performance. There is no area to hold the quality meetings. Meetings are a very important form of communication that provide feedback to employees.

4.3.2 Feedback

Feedback refers to employees' knowledge of customer complaints, quality targets and defect levels. It includes the organisational structure of ABC Electric and how information is disseminated. The following were responses:

Respondent 2:

"Eeh, after a long time, I haven't heard of customer returns for quiet sometimes".

Respondent 10:

"Well in my department we use to have customers complain sometime last year. On numerous numbers of occasions but now is there but not more often".

Respondent 7:

"Yes, I think communication is very important. Talking with the people and show them their mistake will bring about change".

It is clear that the employees are not getting enough feedback from their customers. Through observations, it was uncovered that customer complaints do not reach shop floor employees. As a result, the employees are not informed about the level of customer satisfaction. Employees do not know failure rate because constant feedback is not provided. Ignorance and lack of information results in uncertainty.

5. Conclusion and Recommendations

This study sought to answer the following research questions:

- What perceptions within ABC Electric on quality management can be leveraged for adoption of six sigma to alleviate quality issues in its value chain?
- What gaps exist within ABC's quality management framework that could be closed through adoption of six sigma?
- What values and norms contribute to the culture within ABC and how do these impact on management of quality?

Research Question 1: What perceptions within ABC Electric on quality management can be leveraged for adoption of six sigma to alleviate quality issues in its value chain?

- Quality management is well understood by both employees and managers at ABC. . Both Managers and shop floor workers are aware of six sigma and ISO 9001 quality management frameworks and the requirements that ensure production of quality products.
- Employees at ABC understand that monitoring and control are an essential component for effective operation of processes and their improvement. This is essential for implementation of a quality improvement programme such as six sigma.

Research question 2: What gaps exist within ABC's quality management framework that could be closed through adoption of six sigma?

- Management does not provide the necessary resources to assist employees solve quality problems. Without quality tools to collect and analyze data, process performance cannot be improved. Root causes of quality problems cannot be identified.
- There is no proper documentation in place. Defective products are passed down to subsequent processes without documentation resulting in high failure and scrap rates.
- Management is not committed to education and training of its workforce. Training is both selective and seldom. Six sigma requires that training be provided to all levels of the organization in line with the belt system.
- ABC Electric's organizational structure is bureaucratic. Information does not flow down to employees due to the many layers of management. Customer satisfaction and feedback information are not communicated to the employees. Lack of quality meetings and quality meeting area are cardinal to culture that is not quality focused.

Research question 3: What values and norms contribute to the culture within ABC and how does it impact on management of quality?

- A quality culture is non-existent at ABC Electric. This is demonstrated by the shift of focus by management from quality to meeting deadlines when due dates approach. Managers at ABC perpetuate poor quality within the value chain by allowing defective products to continue to downstream processes.
- The absence of a quality oriented culture in ABC Electric is clearly demonstrated by lack of support among fellow employees, employees pass down defective products to fellow workers at next processes.
- There is also no accountability for quality of work within the organization. Operators feel that quality management is the responsibility of process technicians, who in turn think that it is the role of the quality department. This ambiguity of roles and responsibility which causes uncertainty is not in line with a quality focused culture. In a quality focused organizational culture, quality is everybody's responsibility, each being responsible for the quality own work.
- The leadership style at ABC is transactional oriented. Transactional leadership promotes compliance rather than corporation among workers. In corporation leaders work with subordinates to identify needed change. Managers at ABC Electric make changes without informing shop floor workers and this has resulted in adversarial relationships and resistance to change. A quality culture cannot be developed under such a leadership style.

Based on the findings of this research study, it is recommended that ABC Electric implement Six Sigma to address the quality problems and reduce failures. There already exists an understanding and appreciation of quality concepts within ABC Electric's managers and employees which can be leveraged for successful implementation of Six Sigma. The understanding most probably stems from the implementation of ISO 9001 which unfortunately has not been maintained resulting in the company not realizing its benefits.

Based on the conclusions to the findings the following were the recommendations:

- ABC Electric should embark on a company-wide training programme. The training should cascade from top management to shop floor workers in line with the Six Sigma belt system. Investing in training will also enable the organization to implement total productive maintenance. Investment in new technology and machines is recommended in the long run.
- ABC Electric should flatten its organizational structure through development of a team based organization. Teamwork fosters accountability, responsibility, and ownership among other benefits. A flattened organizational structure will remove bureaucracy and result in improved communication.
- ISO 9001 must be applied vigorously throughout the entire organization so as to assist in managing the business improvement initiative of six sigma. Compliance to the requirements of ISO 9001 will set the foundation for the implementation of the six sigma methodology while six sigma will provide the necessary tools for process control resulting in the effective operation of the ISO 9001 quality management system. Hence the two will complement each other.

References

- Bhargava, M., Bhardwaj, A., Rathore, A.P.S. (2012). Six Sigma methodology utilization in telecoms sector for quality improvement. *International journal of engineering science and technology* [online], 2(12):7653-7659. Available from: <https://www.researchgate.net/directory/publications> [Accessed 29 February 2016].
- Brown, D. (2014). *Experimental approach to organisational development*. 8th ed. Harlow: Pearson.
- Cordatus Consulting (2010). *International Governance Standards*. Available from: <http://www.cordatus.ie/six-sigma-programme-roadmap/>. Date accessed 06 May 2015
- Crom, S. (2016). *Six Sigma Culture: Better Processes and Problem-Solving*. Available From: <https://www.isixsigma.com/implementation/change-management-implementation/six-sigma-culture-better-processes-and-problem-solving/>. [Date accessed 06 May 2016].
- Dambhare, S., Aphale, S., Kakade, K., Thote, T., Borade, A. (2013). Productivity improvement of special purpose machine using DMAIC principles: A case study. *Journal of quality and reliability engineering* [online], vol. 2013(2013):1-13, July. Available from: <http://www.hindawi.com/journals/jqre/2013/752164/> [Accessed 25 March 2015].
- De Mast, J., Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem-solving. *International journal of economics* [online], vol. 139(2): 604-613. Available from: <https://www.researchgate.net/directory/publications>. [Accessed 25 March 2015]
- Desai, A.D., Patel, M.D. (2009). Impact of Six Sigma in developing economy: analysis on benefits drawn by Indian industries. *Journal of industrial engineering and management* [online], vol. (2)3:521-538, September.
- Fursule, N.V., Bansod, V.S., Fursule, S.N. (2012). Understanding the benefits and limitations of Six Sigma methodology. *International journal of scientific research publications* [online], vol. 2(1):2250-3153, January. Available from: http://www.ijsrp.org/research_paper_jan2012/ijsrp-jan-2012-32.pdf [Accessed 20 March 2016].
- Gosnik, D., Herzog, N. (2010). *International journal of industrial engineering*. Success factors for implementing Six Sigma in Slovenian manufacturing companies [online], 5(3). 200-206. Available from: http://www.iim.ftn.uns.ac.rs/casopis/volume5/ijiem_vol5_no3_2.pdf [Accessed 27 March 2016].
- Jirasukpraset, P., Garza-Reyes, J.A., Soriano-Meier, H., Rocha-Lona, L. (2012). A case study of defects reduction in a rubber gloves manufacturing process applying Six Sigma principles and DMAIC problem solving. *International conference on industrial engineering and operations management*, Istanbul, Turkey.
- Kumar, D.J., Kaushish, D. (2015). Scrap reduction in a piston manufacturing industry: an analysis using Six Sigma and DMAIC methodology. *IUP journal of operations management*, 5(9):471-483, June. Available from: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2675089 [Accessed 14 April 2016].
- Kwaak, Y.H., Anabari, F.T. (2006). Benefits, obstacles, and future of Six Sigma approach. *Science direct-Elsevier* [online], vol. 1(1):708-717, May. Available from: <http://www.sciencedirect.com/science/article/pii/S0166497204001828> [Accessed 21 March 2016].
- Mamatha, K., Vasuki, H.V., Mogaveera, J.B, Guptha, C.K. (2014). Application of Six Sigma methodology to reduce rework at earthmoving equipment. *International journal of science and technology* [online], vol. 6(7):417-422, July. Available from: <http://www.ijest.info/docs/IJEST14-06-07-009.pdf> [Accessed 13 March 2016].
- Morgans., Allen. (2012). getting ethics committee approval for research: a beginner's guide. *Australasian journal of pre-medicine* [online], 3(3):1-7. Available from: http://www.racma.edu.au/index.php?option=com_docman&task=doc_view&gid=1388. [Accessed 11 February 2016].
- Narayanan, V. 2015. *Process Excellence: Six Sigma*. [online]. Available from: <http://www.slideshare.net/VenkadeshNarayananMB/six-sigma-48828612>. Date accessed [06 May 2016]
- Sasthriyar, S. (2006). *The critical success factors for Six Sigma implementation*. MBA Thesis.
- Saunders, G., Lockridge, T.M. (2010). Ethics and culture: is there a relationship? *International journal & economics research journal* [online], vol.9 (1):111-116, January. Available from: <http://www.cluteinstitute.com/ojs/index.php/IBER/article/view/512> [Accessed 05 March 2016].
- Singh, B.J., Khaduja, D.(2013).Leverage Six Sigma disciplines to reduce scrap in Indian foundry SMEs. 26th small enterprise association of Australia & New Zealand: Sydney, New South Wales.
- Taneja, M., Machada, A. (2013). Six Sigma an approach to improve productivity in manufacturing industry. *International journal of engineering trends and technology (IJETT)* [online], (5)6: 281-286, November. Available from: <http://www.ijettjournal.org/archive/ijett-v5n6p152> [Accessed 04 March 2016].
- Tennakoon, M.M., Palatwatta, T.M. (2015). A case study on the application of DMAIC to improve delivery efficiency. [online]. Available from: <http://ssrn.com/abstract=2706992.html> [Accessed 13 March. 2016].

Zu, X., Fredendall, L.D., Douglas, T, J. (2008). The evolving theory of quality management: The role of Six Sigma. *Journal of operations management* [online], vol. 26(1), 630-650, February. Available from: http://www.iem.unifei.edu.br/turrioni/PosGraduacao/PQM07/Six_sigma_aula_10_e_11/six%20sigma%20aia%2010.pdf [Accessed 25 March 2016].

Biography

Shitlhangu Raymond Khambani is an Engineering unit manager at CBI Electric African Cables, South Africa. He holds a National Diploma in Mechanical Engineering and a B-Tech in Operations Management both obtained from Vaal University of Technology (VUT), as well as a Master of Business Administration from the Management College of Southern Africa (MANCOSA), South Africa. Raymond has worked as a production supervisor for the same company for 8 years. His research interests include quality management, productivity improvement, maintenance and reliability engineering.

Chipo Mugova is currently a lecturer in the BCom and MBA Programmes, as well as a supervisor of MBA research at the Management College of Southern Africa (MANCOSA), South Africa. She is also a supervisor of Masters and MBA research at the University of Johannesburg and Regenesys Business School respectively. Chipo holds a Bachelor of Science Honours degree in Engineering and a Master of Science degree in Manufacturing Systems and Operations Management both obtained from the University of Zimbabwe. She has over 20 years of experience working on product and process improvement projects in the foundries, metal fabrication and related industries in Zimbabwe, and over 7 years teaching experience. She has taught courses in project management; quality and environmental management; operations management; business administration, and operations research. Chipo is currently studying for her PhD in Engineering Management and her research interests include quality management, waste management, environmental management, resource efficiency, renewable energy management, and sustainable development.

Bongumusa Mansuette Bhekamalinda Cebekhulu is a senior technician at Wits University's School of Mining Engineering in Braamfontein, Johannesburg. He earned a Diploma in Analytical Chemistry from Mangosuthu University of Technology, Durban, South Africa, a B-Tech in Quality Management and an M-Tech in Operations Management, both from the University of Johannesburg, South Africa. His research interests are in the field of Quality and Operations Management.