

Optimizing Quality Management in Apparel Manufacturing for Reduced Reworks and Increased Efficiency

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Abstract

Quality is one key parameter that can determine the success of a fashion brand, and this is the key selling point of many luxury fashion brands. Global competition in apparel manufacturing has also pushed manufacturers to make sure they supply high quality products that are defect free. But it is inevitable that defects do occur in production, especially in apparel manufacturing where one product passes through many hands before it is dispatched. Some of these defects result in what is commonly referred to as reworks, and some end up being downgraded. Reworks negatively affect the overall efficiency of apparel production lines, leading to increased decline in profits and loss of customers. Five apparel manufacturing companies were purposively sampled to find the common types and causes of rework. In-depth interviews were conducted with the quality representatives in the five companies and on-site observations were made at the reworks station. The results show that reworks are mainly caused by sewing and seaming defects. There is absence of clear documentation on how a defect is handled in almost all the companies leaving the decision to in-line inspectors to decide. The study revealed that employees lack training in handling reworks thus calling for the need to improve their quality control process so that rework can be reduced. To effectively manage quality and mitigate reworks, it is essential to identify and implement key quality management factors tailored to the unique challenges posed by globalization in textile-apparel supply chains. Addressing quality in apparel manufacturing not only enhances product perception but also serves as a competitive advantage in a global market as it impacts sustainability. In conclusion the model suggested in the study can be used by the apparel manufacturing companies to improve their operations.

Keywords

Reworks, Apparel, Quality, Manufacturing, Defects

1. Introduction

Developments the world over have made customers more knowledgeable about the quality of goods and services they want. The increased global competition among manufacturers has resulted in customers demanding a high-quality product at a more affordable or low cost. Manufacturers on the other hand are trying as much as they can to satisfy these customers' expectations as this determines their survival as they have to produce the right-first-time quality. One major headache these manufacturers face is variance in product quality which can be attributed to workmanship (Lee et al., 2013). Effective quality management in apparel manufacturing is crucial for reducing the incidence of reworks,

which can significantly impact the overall efficiency and profitability of the operation (Fatima & Tufail, 2021). The apparel manufacturing industry ranks top as one of the most labour-intensive industries as many operations during the garment-making process is done manually (Fukunishi, & Yamagata, 2014). Human factors such as skill level determine the chances of an operative making an error in the particular task they will be carrying out. The tasks are usually routine such that the number of years of experience an individual has in doing the same or similar tasks becomes key in garment-making lines. As these tasks are manual, chances of errors are very high as individuals differ in their skill level thus implying a challenge to maintaining high quality at a low cost of the final garment. Most apparel manufacturing companies have human in-line quality inspectors who are responsible for identifying defects on sewn garments or pieces. But according to (Lee et al., 2014) the decisions made by these individuals rely on their experience and judgment skills which can be biased and thus affect the productivity of the company. So whenever there are defects in garment production the first alternative is to fix the problem on the garment or fabric piece usually referred to as a rework. Reworks are very common in apparel manufacturing, and they are caused by human error or faulty machines. Defects along the production lines can be the worst nightmare that every production manager tries to avoid at all costs. These defects can result in total rejection of the final product as it fails to meet the minimum quality standards or can call for reclassification to a rework. Various scientific approaches have been used to reduce defects in apparel manufacturing, and these include Pareto Analysis (Ahmed, 2013), 5S Audit and Time Study (Nunesca, 2015), Lean manufacturing (Kumari, Quazi, & Kumar 2015; Paneru, 2011), Cause and Effect (Alam, 2018; Patil, Rajkumar, Chandurkar, & Kolte, 2017). In all these studies the main aim was to reduce reworks within the apparel manufacturing industries. According to Pazireh, Sadeghi and Shokohyar (2017), the Failure Mode and Effects Analysis (FMEA) can be used to prevent, identify, control and eliminate possible errors that might affect productivity. Some of the defects that can require reworks to be done in garment manufacturing include placement defects, fabric defects, seaming defects, and embroidery defects. Legesse and Singh (2014) opine that apparel manufacturing industries in developing countries lack the capital to invest in new technologies that may improve their productivity as most of them still run lines based on traditional setups. Due to its labour intensiveness, apparel manufacturing in Zimbabwe also faces the challenges of reworks as it is a developing economy in which companies face a cocktail of challenges that affect their productivity. Reworks not only result in additional labor and material costs but can also lead to delays in the production process, ultimately impacting the overall efficiency and profitability of the operation (Ewnetu & Gzate, 2023). The problem of reworks can affect customer confidence as companies fail to meet delivery targets as they try to achieve the set quality standards. The thrust of this study was to audit the apparel manufacturing companies to propose possible solutions that can be implemented to reduce these reworks within the local Zimbabwean context for optimizing quality management in the apparel industry, with a focus on reducing reworks and increasing production efficiency.

1.1 Objectives

In apparel manufacturing, the process is complex as it involves various products at different stages in their life cycles with differing styles and sizes for each season (Syduzzaman et al., 2014). The objective of this study is to identify the types of reworks common in a sampled apparel manufacturing companies in Zimbabwe. The study also seeks to investigate the major causes of these reworks and suggest solutions that can be implemented through to reduce these reworks so that these manufacturers can increase their productivity through a model or framework that is suggested to improve quality

2. Literature Review

The apparel manufacturing sector has contributed significantly to the gross domestic product (GDP) of many developing countries, especially in Asia and South America. The sector has managed to reduce unemployment levels in several nations as a number of manual operations are done by humans in the process of making a single garment. Zimbabwe is a developing economy which had a vibrant apparel manufacturing sector in the early 90s which exported to a number of countries. As of late the sector has faced a cocktail of challenges which have affected the capacity of many apparels manufactures to export. One major area that needs to be addressed is the quality of products and in this study the emphasis is directed on the reworks. Reworks affect brand names and the reputation of the company because according to Patil et al. (2017) one defective garment in a lot of 100 is just 1% which is acceptable to the company, but to the customer it is 100% defective if they purchase it. When the quality of a garment does not meet the standards, it means someone has to rework it to fix the defect translating to increased resources used in terms of time, manpower, and energy and this according to Subhashini and Dinusha, (2020) means more greenhouse gas emissions. Quality management in apparel manufacturing is increasingly recognized as essential for enhancing product quality and operational efficiency. The implementation of Total Quality Management (TQM) principles has shown significant

promise in this sector. For instance, a study in Bangladesh demonstrated that TQM could reduce defects in sewing lines by 1.51%, leading to improved efficiency and cost savings (Joy et al., 2024). Similarly, another investigation highlighted the importance of identifying root causes of sewing defects, revealing that common issues like open seams and skip stitches accounted for a substantial portion of defects, thus emphasizing the need for systematic quality improvement strategies (Moin, 2023). However, challenges persist, particularly in developing economies like Ghana, where a lack of understanding of TQM principles among workers and outdated technology hinder effective implementation (Zanu et al., 2023). Addressing these barriers is crucial for leveraging TQM's full potential in the apparel industry, as quality management not only enhances product perception but also serves as a competitive advantage in a global market. According to Bondarenko, (2024) quality management in apparel manufacturing is crucial for sustainable development and implementing ISO 9001:2015 ensures high-quality, ethical, and environmentally safe products, driving economic, social, and ecological benefits.

2.1 Reworks in apparel

Reworks affect apparel manufacturing companies in that some goods have to be downgraded and eventually sold at lower prices as correcting the defect might be more expensive as compared to selling the garment as it is with the defect. This implies loss in possible revenue from that product and in apparel it might affect the whole batch of garments. To circumvent such situations, it is the duty of the management to set up a system that can quickly detect these defects at points or stages where they are still repairable to reduce downgrades or reworks at later stages where they become more expensive to attend to. Quality should be maintained so that customer demands and expectations are met costs associated with defects are brought to a minimum. The classification of defects shown in Table 1, as adopted from Islam, Khan and Khan (2013) and was adopted in the formulation of the score sheet given to the sampled apparel manufacturers.

Table 1. Classification of defects in apparel

Defect	Cause
Sewing defect	Machine faults
Seaming defect	Human error
Placement defect	Pattern making and cutting, human error
Design defects	Embroidery / printing errors
Fabric defect	Fabric processes

Lingkon et al. (2024) state that machine problems in garment production industries usually contribute more to sewing defects that may be faced in production lines. Problems that may be experienced include needle breaking which might also affect the needle head resulting in machine stoppage and this has an overall effect on production efficiency. Sewing operations in the apparel sector do require highly skilled and experienced individuals if the quality is to be achieved as reworks are more costly (Paneru, 2011). According to Rahman and Chowdhury (2020), success of the ready-made garment (RMG) sector highly depends on factors like quality of product, manufacturing lead time, production costs, and worker efficiency. Pacheco-Bonilla (2020) proposed a quality management model based on Lean Six Sigma, to reduce returns of defective clothing products in SMEs, resulting in a 16.5% decrease in returns and 28.5% increase in productivity. Similarly, Setu et al. (2016) developed a framework for TQM implementation in the textile and ready-made garment industry. Such frameworks or models can be implemented in apparel manufacturing to improve the efficiency of the operations. Reworks can be a result of worker inefficiency and in some cases, this can be attributed to little attention being given to quality procedures that may end up in the form of product returns as the process might fail to detect these defects.

2.2 Reducing reworks

Through the application of lean as a quality improvement tool reworks can be reduced as the waste is monitored and controlled. Several lean management tools have been previously used in apparel industries to improve productivity, and these include Kaizen, Ishikawa, 5S, Poka Yoke, Six Sigma, and DMAIC (Legesse & Singh, 2014). Defects that may occur in garments can be due to the poor quality of the major raw material which is the fabric. In general, the fabric contributes about 50-60% of the final cost of the sewn garment. This means any saving in fabric during the pattern-making process has a huge effect on the overall material usage per design on the production lines. Other scholars like Alagas et al. (2013) report that they tried to improve quality by minimizing cycle time on a garment e line which resulted in increased throughput though they did not address issues at the rework stations. The issue of

rework stations differs with product lines but it should be noted that the inspection point is important so that the defect is identified as early as possible. In their study, Hossain and Sarker (2016) propose a model for the suitable and optimal number of inspection points and offline rework points in a garment manufacturing setup. If a garment is defective, it means it has to be sent back into the line but in some cases, the defects might not be repairable. One solution to reduce reworks will be through an increased number of in-line inspection points but this also brings more operational costs to the company. Hossain and Sarker (2016) argue that setting up a dedicated off-line for reworks or repairs to deal with defective garments can be a good alternative as this improves the throughput rate of the good quality product though it comes at a cost.

3. Methods

In this study, a descriptive multiple case study approach was adopted where a total of five (5) apparel manufacturing companies located in the capital city Harare, Zimbabwe, were purposively sampled from the database obtained from the National Employment Council (NEC) of the Clothing Industry in Zimbabwe. A purposive sampling technique was adopted as this ensured interaction with information-rich companies that are into apparel manufacturing. The data was collected in all five companies for one month and analysed using equation 1 to calculate the number of defects in the period under review. Daily records of Defects per Hundred Units (DHU) were recorded on a chart for analysis. Records for the reworks were also recorded daily on the score sheet. In all five companies, observations were done to summarise the activities on the production lines and investigate how the process of reworks was done. Five quality control managers were conveniently sampled to participate in the face-to-face in-depth interviews.

$$DHU\% = \frac{\text{Total number of defects}}{\text{Total number of pieces}} * 100\%$$

4. Results and Discussion

The data collected over one month from the five apparel manufacturing companies revealed a clear pattern in the types of defects leading to reworks. The distribution of these defects is summarized in Table 2.

Table 2. Reworks in the five cases

<i>Rank</i>	<i>Case 1</i>	<i>Case 2</i>	<i>Case 3</i>	<i>Case 4</i>	<i>Case 5</i>
Sewing defect	35%	38%	27%	40%	32%
Seaming defect	24%	18%	23%	15%	26%
Placement defect	20%	22%	21%	19%	16%
Design (print) defect	15%	10%	15%	11%	12%
Fabric defect	6%	12%	14%	15%	14%
Total	100%	100%	100%	100%	100%

Table 2 ranks the five primary defect categories by their average contribution to reworks across all five companies. Sewing defects are the most significant contributor, accounting for an average of 34.4% of all reworks, followed by seaming defects (21.2%) and placement defects (19.6%). The consistency of this ranking across all five cases, despite variations in individual percentages, indicates that sewing, seaming, and placement-related errors are systemic issues within the sampled Zimbabwean apparel industry. Numerical analysis of this data reveals that the top three defect categories (Sewing, Seaming, and Placement) collectively account for an average of 75.2% of all reworks. This finding critically narrows the focus for quality improvement initiatives. A targeted approach that addresses these three areas could potentially reduce the rework burden by three-quarters. The qualitative data from the in-depth interviews with quality managers provided crucial context for these numbers. One respondent defined reworks as *"returned clothes that need to be redone or that need to be stitched again, also that need a change of material that does not meet required standards."* They emphasized the human factor, stating that *"employee skills are key in reducing these reworks and also employee work morale and ethics."* This sentiment was echoed by another interviewee who noted that demotivated employees may knowingly pass defective fabric to the next operator, a problem often traced back to the cutting table. They attributed this to *"tight order deadlines as everyone becomes so busy that defects pass by undetected."* They went further to state that employee skills are key in reducing these reworks and also employee work morale and ethics. When employees report for duty and they are not motivated to work they do not take extra care

even in identifying the defect in fabric such that they pass on the defect to the next operator knowingly. Such defects on the fabric were traced back to the cutting table also as these could be avoided in the early stages but due to the tight order deadlines, everyone becomes so busy that defects pass by undetected.

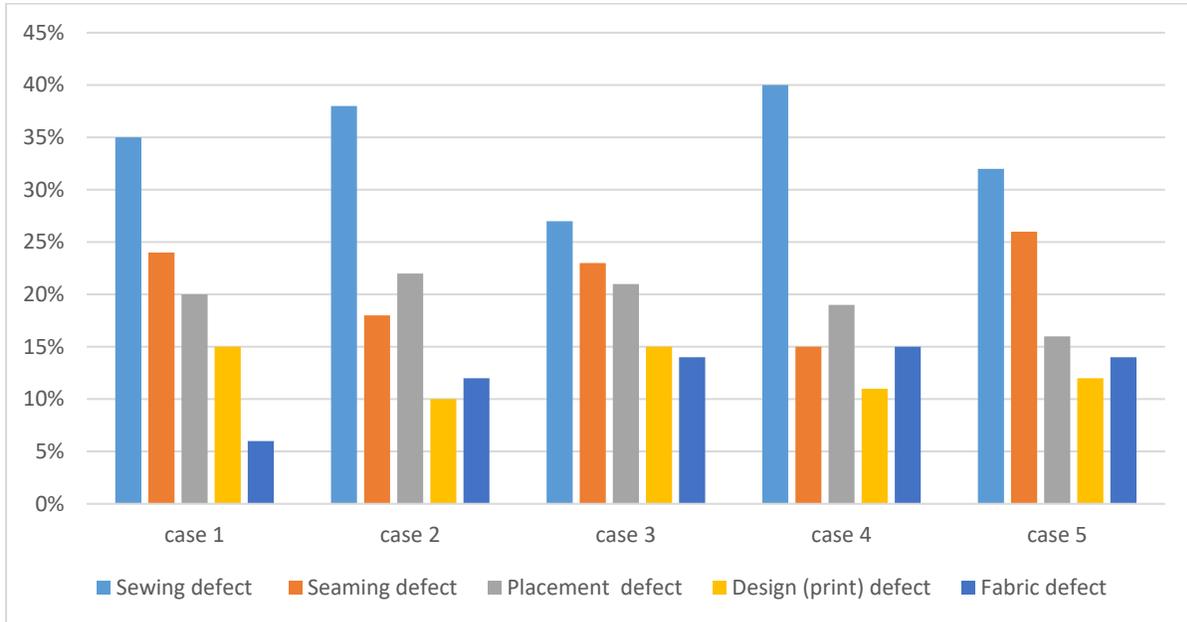


Figure 1. Ranking of causes of reworks

It is shown in Figure 1 that sewing defects had a higher contribution in reworks that were done in all the five cases that were under study. Seaming defects also revealed very high levels of contribution though in case 2 and case 4, they were lower than placement defects. In all the interviews it was noted that all companies do agree on the negative effects of reworks on production efficiency. The point at which inspection should be made is not the same as this depends on the nature of the product and the availability of staff to carry out the process. It was revealed that in almost all cases the issue of inspection points was ignored as the duty to monitor was left to the in-line supervisor and the worker. From one observation it was noted that the pressing team was responsible for inspecting the garment before they handled it. To reduce the effects of reworks various suggestions were made and the common view was to have dedicated in-workers who took the responsibility of monitoring quality as one of their duties. It was also highlighted that workers in these production lines might need further training on issues to deal with quality so that the company can achieve “right the first time” in production. Some of the defects highlighted were a result of employee absenteeism thus forcing changes in the production lines. Such changes meant certain tasks were to be performed by inexperienced staff and it was suggested that employees need to be multi-skilled so that in such cases someone can take over the particular task without any difficulties. Another interviewee stated that sewing lines need a team leader who occasionally inspects the products and also monitors the state of the sewing machines so that defects related to these sources are reduced to a minimum. It was evident in all the companies that there was no clear quality management procedure that was followed despite certain employees having some basic knowledge of quality management. Paneru (2011) posits that a company should implement quality control procedures as it is essential in minimizing costs associated with reworks and these companies need to find a way of making quality management a key result area for their operations.

5. Proposed Improvements

To reduce reworks, the quality should be managed from the early stages in the production lines to make sure all designs and garments produced are of high quality. The decision on where to inspect or check the quality of the product should be related to the nature of garments being produced on the lines as the number of operations determines the outcome. Moreover, by adopting a framework that prioritizes the reduction of lead times and enhances coordination between

fabric suppliers, garment manufacturers, and distributors, the apparel industry can significantly improve its responsiveness and quality assurance processes, which are critical for minimizing reworks and meeting market demands. Effective quality management in apparel manufacturing is crucial for reducing the incidence of work, which can significantly impact the overall efficiency and profitability of the operation. The model frameworks suggested by Setu (2016) and Pacheco-Bonilla et al. (2020) reveal that quality in apparel manufacturing can be improved if the management follows the systematic methods of production suggested in these models. When applied to the real time scenario products with more tasks like a shirt in comparison to a skirt will imply different inspection points. It is therefore left to the supervisor or manager to use checklists that can guide the smooth flow of operations. In managing quality improvement and optimizing production the model shown in Figure 2 can be used. Figure 2 illustrates a proposed cyclical Quality Management Process Model for apparel manufacturing. The model begins with *strategic inputs*: management commitment and quality policy which drive the core *process management phase*. This central phase involves standardized procedures, employee training, and proactive measures like raw material inspection and preventive machine maintenance. The output of this system is then *evaluated* through in-line and final inspections, with data from defects and reworks collected. Finally, the model emphasizes a *feedback loop* where this evaluation data is analyzed (for example using Pareto analysis or lean tools) and fed back into the strategic and process management stages, enabling continuous improvement and systematic reduction of reworks.

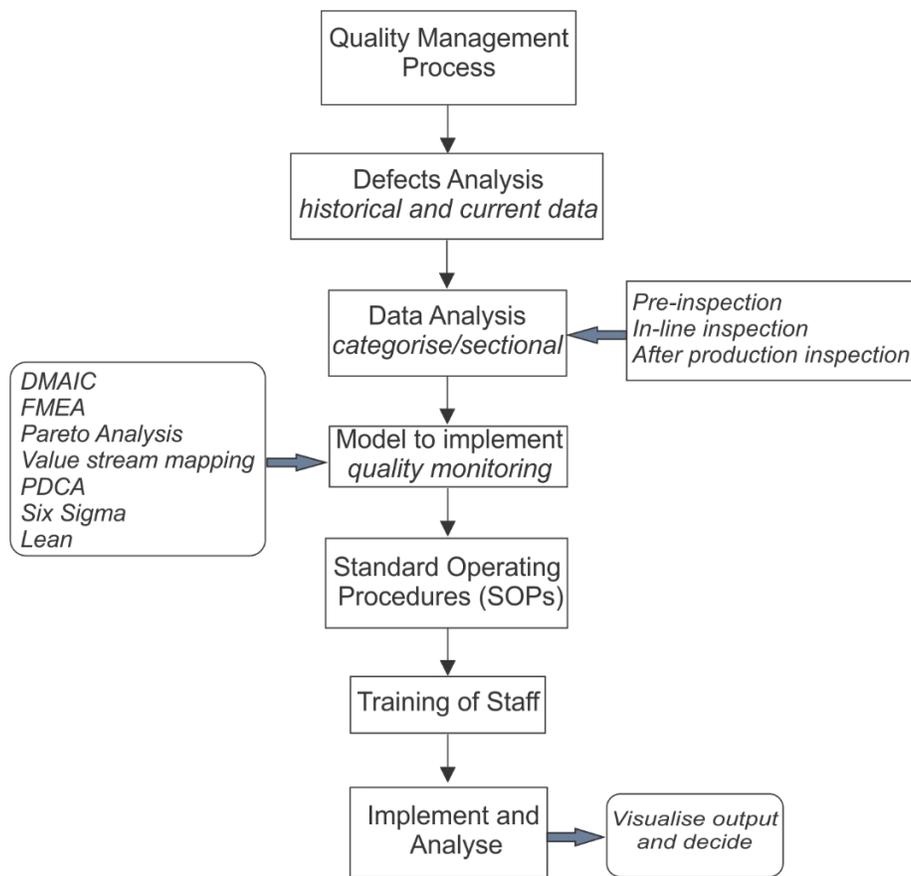


Figure 2. Quality management process model in apparel manufacturing

6. Conclusion

Quality analysis and control systems should be put in place so that defects are identified at the earliest stages in the production lines so that reworks are avoided at later stages where they can become too difficult and expensive to take. Model Figure 2 can be implemented with slight revisions to suit the capacity of the manufacturing entity. The realization of such a model in apparel set up might require an industrial engineer with experience in operations management so that he or she can make the process work smoothly. There is also need for an improvement in communication process so that whenever challenges arise in the production lines even an operative can suggest

solutions. Factory layout can also be improved with a specific target of making sure that certain operations that are usually difficult are done close to where inspection points are centralized for the particular product range. Three basic rules for inspection in apparel should be raw material inspection, in-line inspection and final product inspection. These three should be adhered to irrespective of any other challenges met as this reduces chances of making a defective product and also supplying a defective product. Automation in defect detection can be another way of solving the problem of reworks though it is difficult in apparel to fully rely on as some defects are difficult to classify or identify. This comprehensive approach suggested in this study not only emphasizes the need for systemic changes in production management within apparel manufacturing companies in Zimbabwe, but it also highlights the importance of integrating technologies and methodologies that foster quick response capabilities throughout the entire garment production process. Such improvements can be further bolstered by establishing a set of coherent initiatives aimed at optimizing production efficiencies, thereby creating a robust infrastructure that supports quality management principles across all stages of apparel manufacturing. In conclusion apparel manufacturing companies in Zimbabwe need to view quality control as an essential part of their operations as it can determine their success or failure and should be made everyone's responsibility within these apparel manufacturing companies.

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Mahima Nand is a distinguished academic and researcher specializing in Sustainable Development Goals in Design Industry. She completed Ph.D. in Fashion Management from NIFT Delhi, specializing in women wellbeing assessment using National Wellbeing Index. She has developed strong expertise in Social sustainability and sustainable business models in Fashion, high performance entrepreneurial trainings, capacity building with artisans. Nand is proficient in branding, marketing and management techniques in Design, including qualitative approached of research like SPSS, Tukey Kramer, Anthropology studies. She has published over 18 research articles in peer-reviewed international journals and conference proceedings. In addition to her research, she actively contributes to academic collaborations—and has organized many workshops, conferences and fashion shows. Her core expertise stands in contemporising orthodox ways of business into modern days needs in Design industry demonstrating a major commitment to women wellbeing in Design.