Industrial Processes Performance Improvement using Six Sigma Principles and Tools

تحسين و تطوير أداء العمليات الصناعية باستخدام مبادئ وأدوات Six Sigma

by

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Abstract

For the block bottom paper bag company, the main areas to consider were paper quality, printing, slitting, and glue type. In this project, TQM and Six Sigma DMAIC methodology were used to improve the process of paper bag making to make sure that the output of the manufacturing process meets the demands of customers. This dissertation was implemented in Falcon Pack, a company that is located in Sharjah, United Arab Emirates. The data collected from the Falcon Pack Company was used to make an analysis that would lead to a lasting solution for the company. The analysis was conducted using regression analysis, Pareto Charts, and the Fishbone diagrams. Various techniques were applied during data collection, which included the empirical measurements, observation, and questionnaire method. The analysis of data using Pareto analysis uncovered significant problems. Fishbone analysis allowed for the suggestion of the techniques for improvement using Six Sigma and TQM.

Printing and packaging industries are continuously facing fierce competition and the challenge of meeting increasing demands for higher quality products at economical costs. The triumph of a business is directly related to how effective its implementation of continuous improvement (CI) is. For any manufacturing system, Total Quality Management (TQM) and Six Sigma are principal CI methodologies. An adequate understanding of these methodologies and their relationship provides industries with a competitive advantage. At Falcon Pack Company, the percentage of the waste is very high. This occurs when workers are not included in the continuous enhancement of the products. Workers might make mistakes, although most are caused by defective processes and systems. A lot of time is wasted during bag making, especially during maintenance, setting, and cleaning. Another factor is a low performance that is contributed by operating the machine below the ideal speed, starting the machine, and ending the roll. Sometimes

the company is also concerned by the quality of bags that they produce. The redundant quality is majorly contributed by printing errors, slitting problem, paper quality, and other defects related to glue type.

Data analysis was used to find out the primary roots for the high wastage. Afterward, fishbone diagrams were applied to navigate the root causes for each type of defect that result in a high percentage of waste, which are printing, paper quality, glue type, and slitting. Statistics and regression were used in finding out the means of improving the system. Furthermore, the factors that influence quality and performance in the industry such as the environment, machine breakdown, employees, and machine maintenance, all with respect to customer satisfaction, were analyzed. Afterward, solutions that could be embraced to solve the existing problems, and those that could have been implemented at Falcon Pack Company within three months were considered and implemented.

The enactment of TQM and Six Sigma at Falcon Pack Company improved the availability of services, performance, and quality of the block bottom paper bags. The enactment of TQM and Six Sigma at Falcon Pack Company has improved the availability of services, increased performance, and better quality of the block bottom paper bags. The process improvement with Six Sigma resulted to 99.7 % quality percentage which is 0.02% away from Sigma level. Moreover, there has been a significant waste reduction and operational efficiency, which has greatly reduced the cost of operation and better customer retention. On a scale of 10, Customer satisfaction increased by an index of 2.29 from 5.31 before Six Sigma to 7.57 after Six Sigma. Additionally, evaluation improved by a scale of 2.76 while comparison improved by a scale of 1.04. In general, customer satisfaction increased from 4.8 before Six Sigma to 7.5 after the Six Sigma implementation.

ملخص

بالنسبة لشركة مختصة بتصنيع الأكياس الورقية و بالأخص الأكياس الورقية ذو قاعدة ، كانت المجالات الرئيسية التي يجب مراعاتها هي نوعية الورق والطباعة والحز ونوع الغراء. في هذا المشروع تم استخدام منهجية (TQM) و Six Sigma و DMAIC لتحسين عملية صنع الأكياس الورقية للتأكد من أن ناتج عملية التصنيع يلبي متطلبات العملاء .تم تنفيذ هذه الرسالة في شركة فالكون باك وهي شركة موجودة في الشارقة ، الإمارات العربية المتحدة.حيث تم استخدام البيانات التي تم جمعها من شركة فالكون باك لإجراء تحليل من شأنه أن يؤدي إلى حل دائم للشركة وقد أجري التحليل باستخدام تحليل الانحدار ومخططات باريتو ومخططات هيكل السمكة وتم تطبيق تقنيات مختلفة أثناء جمع البيانات ، والتي شملت القياسات التجريبية ، والمراقبة وطريقة الاستبيان.

كشف تحليل البيانات باستخدام تحليل باريتو عن مشاكل كبيرة و سمح تحليل هيكل السمكة لاقتراح تقنيات للتحسين باستخدام(TQM) و Six Sigma .تواجه صناعات الطباعة والتغليف بشكل مستمر منافسة شرسة وتحدي تلبية الطلبات المتزايدة على منتجات عالية الجودة بتكاليف اقتصادية .يرتبط نجاح العمل مباشرة بمدى فعالية التحسين المستمر، بالنسبة لأي نظام تصنيع ، تعد إدارة الجودة الشاملة (TQM) و Six Sigma منهجيات CI الرئيسية ، حيث إن الفهم الكافي لهذه المنهجيات وعلاقتها يوفر للصناعات ميزة تنافسية في شركة فالكون باك ، لكن نسبة النفايات عالية جدًا و يحدث هذا عندما لا يتم تضمين العمال في التحسين المستمر للمنتجات. قد يرتكب العمال أخطاء ، رغم أن معظمها ناتج عن عمليات وأنظمة غير متكاملة. يضيع الكثير من الوقت أثناء صنع الأكياس ، خاصة أثناء الصيانة والإعداد والتنظيف. هناك عامل آخر يتمثل في انخفاض الأداء الذي يساهم في تقليل السرعة المثالية ، بدء تشغيل الجهاز ، وإنهاء اللفة.

في بعض الأحيان تشعر الشركة أيضًا بالقلق من جودة الأكياس التي تنتجها. تُساهم جودة الطباعة الزائدة بشكل كبير في أخطاء الطباعة ومشكلة الحز وجودة الورق والعيوب الأخرى المتعلقة بنوع الغراء.

تم استخدام تحليل البيانات لمعرفة الجذور الأولية للهدر العالي. بعد ذلك ، تم تطبيق الرسوم البيانية هيكل السمكة لمعرفة الأسباب الجذرية لكل نوع من العيوب التي تؤدي إلى نسبة عالية من النفايات ، وهي الطباعة وجودة الورق ونوع الغراء والقطع. واستخدمت الإحصاءات في معرفة وسائل تحسين النظام. علاوة على ذلك ، تم تحليل العوامل التي تؤثر على الجودة والأداء في الصناعة مثل البيئة ، وتعطل الماكينة ، والموظفين ، وصيانة الماكينة ، وكل ذلك فيما يتعلق برضا العملاء. بعد ذلك ، تم النظر في الحلول التي يمكن تبنيها لحل المشكلات الحالية وتلك التي كان من الممكن تنفيذها في شركة فالكون باك خلال ثلاثة أشهر وتم تنفيذها.

أدى تشريع TQM و Six Sigma في شركة فالكون باك إلى تحسين توافر الخدمات والأداء وجودة الأكياس الورقية السفلية. أدى تطبيق TQM و Six Sigma لدى شركة فالكون باك إلى تحسين توفر الخدمات وزيادة الأداء وجودة أفضل للأكياس الورقية السفلية. نتج عن تحسن العملية مع Six Sigma نسبة جودة بلغت 99.7٪ والتي تبعد 0.02٪ عن مستوى Sigma. علاوة على ذلك ، كان هناك تخفيض كبير في الفاعلية وكفاءة تشغيلية ، مما أدى إلى انخفاض كبير في تكلفة التشغيل وتحسين الاحتفاظ بالعميل. على مقياس 10 ، زاد رضا العملاء بمؤشر 2.29 من 5.31 قبل Six Sigma إلى 7.57 بعد Six Sigma. بالإضافة إلى ذلك ، تحسن التقييم بمقياس 2.76 بينما تحسنت المقارنة بمقياس 1.04. بشكل عام ، زاد رضا العملاء من 4.8 قبل Six Sigma إلى 7.5 بعد تطبيق Six Sigma.

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CHAPTER I

INTRODUCTION

1.1 Background

In the 21st century, many companies will have to rely on Six Sigma and Total Quality Management to survive competition, which implies Statistical Measurement, Quality Culture, and Management Strategy (Raja, 2016). Moreover, improved profitability, efficiency, waste and defects reduction, reduced quality expenses, and high effectiveness are all covered by Six Sigma, which meets and sometimes exceeds the customer expectations (Gold et al, 2013). In general, Six Sigma is a program that targets near-zero defects for all products, transactions, and processes (Hussain, Al Nasser, & Hussain. 2015). Six Sigma finds and eliminate the causes of defects in a process by centering on outputs of a process that are very critical to the customers.

1.1.1 Company Overview

Falcon Pack is a flagship company that was established under the Falcon group to deal with the manufacturing of disposable packaging solutions for the end-user market and foodservice. The company headquarters is in Sharjah, United Arab Emirates. Falcon Pack produces products both for local use and for export across the globe. For more than two decades, Falcon Pack has always been known for its quality and excellent products, and they are always guided by customer satisfaction. The company has always been committed to delivering quality packaging solutions to their respective clients through Falcon group viz.

Falcon Pack Industry LLC, Falcon Pack, and Falcon Detergents complete the vision of being the regional leader as well as a global player in delivering completely disposable packaging solutions for foods. Each of the segments has defined products concerning particular use and application. The packaging is made from different varieties of materials ranging from paper, polymers, and aluminum. The product experts at Falcon Pack recommends the appropriate packaging solutions following a client's application. The company has several competitors that offer similar products, although the company has been striving to develop convenience to its customers while at the same time preserving value. The company also has a long quality process while innovators of developing solutions to food packaging and hygiene work hand in hand with their clients as per the international standards of safety standards and quality.

When considering metrics, Orel, F.D., & Kara, A. (2014) believe that what can be measured can also be executed. When considering the human aspects, most employees find themselves having to do more than ever, making them reprioritize their duties. Thus, the majority of metrics that have been put first by manufacturing supervisors and those that have the attention of the whole business are those that can be measured and enhanced by the teams of employees. Analytics matter for any business that looked forward to achieving a competitive edge in the marketplace. Effective measuring, recording, analyzing, and enhancing metrics of manufacturing might not be a simple task. While particular parameters might work well with specific job roles, multiple integrations of metric pointers are required for a larger organization objective to be met.

To improve the effectiveness of metrics, such demand alignment focused on broader business objectives. The mnemonic SMART goals (Specific, Measurable, Actionable, and Realistic, Time-Based) contains several vital aspects that may be used to guide a company that is focused on achieving quality, performance, and availability. It is always crucial to understand the interconnection between high-level objectives and what approaches can be adopted by a company that wants to achieve such goals, which falls under sub-mnemonic Specific. Measurable and

Actionable sub-mnemonics are applied when metrics are considered. In that case, any desired output should be connected to sets of defined targets, actions, and measurements that should be considered when taking action on metrics that are top or those that are lagging results indicators (Hanenkamp, 2013).

In the packaging industries, every objective demands multiple metrics. Company supervisors will always want various teams along different production lines to surpass their perceived performance. However, if those goals are incredibly lofty, and employees don't believe that they can achieve them, they might give up or disengage. Every purpose also requires a specific deadline, which means the Time-Based aspect must be used to keep every worker focused. To do that, companies are guided by several approaches that they create depending on their specific goals Soliman, (2017).

Six Sigma seeks to improve service quality, product, and process. Six Sigma has been defined as an organized and systematized methodology for planned improvement of the process of service development and new products that rely upon statistical techniques to acquire dramatic cutbacks in customer well-defined defects rates. Six Sigma has been evolving from time to time as it progresses to improve performance, increase customer satisfaction, and improve profitability. Management of quality has been the dominant management practice for realizing a competitive advantage in the business field. Various traditional quality control tools such as Statistical Process Control (SPC), Statistical Quality Control (SQC), TQM, and Zero Defects, have been dominating for the past several years. Six Sigma is the most recent of the control concepts all as it covers all the mentioned tools under the same umbrella. The most fundamental elements of Six Sigma is that it applies SPC, Gage Repeatability, and Failure Mode Effect Analysis (FMEA) to reduce defects and improve quality. Additionally, Six Sigma provides a framework where all tools can be executed through management support (Jasti and Kodali, 2015).

The rapidly changing economics such as a decline in profit margins, increased global competition, reliable deliveries, demand for high-quality products, and product varieties have significantly impacted the processing industries (Amin et al. 2013). In response to those demands, companies are working hard to implement quality monitoring strategies such as TQM, Total Productive Maintenance (TPM), Just in Time (JIT) manufacturing, Kaizen, Business Process Reengineering, and Resource planning have been initiated. Six Sigma allows the management to develop improvement plans in their respective bottom lines through the design and monitoring of activities by means that reduce all kinds of Non-Value Added (NVA) processes and wastes to maximize the levels of satisfaction for their respective customers (Tanco et al., 2012). While all drivers of quality improvement are worthy in different ways, sometimes they fail to force breakthrough enhancements in quality and the bottom line. Six Sigma combines methodological, management, and financial elements to drive positive process improvements in levels that exceed all the other approaches.

1.1.2 Company Performance

Organization performance has been defined as how healthier a company realize its financial goals and market-oriented goals. Performance has also been described as quantifying the effectiveness and competence of actions in a process. Organizational Performance (OP) may be measured using the indicators of financial viability, relevance to investors, efficiency, as well as effectiveness. The performance of an organization is mostly affected by continuous improvement and motivation of employees to realize the performance goals. Performance is also affected by the external business environment as well as the capacity of a business to realize the desired goals of production. Thus, organizations need to focus on the enhancement of capacity, which has been changing as a result of technological transformations and mostly on the call for more innovative solutions. A successful TQM and Six Sigma strategy result in better participation of employees in improving quality, reducing the production cost, a gain of competitive advantage by the organization, better performance, and customer satisfaction (Jasti and Kodali, 2015). In the efforts to improve performance, organizations have integrated their suppliers to the process improvement plan to ensure that they are part of the business goals. Such integration assesses efficiency as well as the effectiveness of the company's process management.

This paper analyses how the Six Sigma quality management techniques can be integrated into the paper bags processing to improve the quality of the product and process. Applying Six Sigma into a project management process requires efficient management of the process to get rid of errors. Six Sigma strategy was initially employed by the Motorola Company in the 1980s to define the management approach that would lead to the best product (Gold et al. 2013). Since then, the Six Sigma approach has been involved in numerous companies like Toshiba, Boeing, General Electric, Ford Motor, and many other organizations. It is quickly becoming a popular strategy of driving companies towards producing the best output products to their clients. The method mainly focuses on understanding the requirements of the customers and getting rid of wastes and defects in the final product. These requirements are met through proper insight into the statistics, project management, engineering, and the underlying systems and procedures. The objective of applying Six Sigma is to improve the processes, products, and services across all disciplines involved in product development.

Zhang et al. (2017) believe the success or failure of a particular organization depends on the quality of its products. Neglecting quality can render the company being unsuccessful. By removing the possible defects in the systems and production processes, Six Sigma helps in producing products with superior qualities. By observing sigma, any form of challenge that is related to organizational processes is treated as a defect that requires to be eliminated. When any business practices Six Sigma, it creates exceptional levels for workers. The most common scales are referred to as Green belts and black belts, although there are other kinds of belts. Any worker who certifies any of such belts is recognized as an expert in the process of Six Sigma. This paper will present the Six Sigma techniques and their application in the paper bag production process. It agrees that the project is piloted under the constraints of quality, time, scope, and cost and will demonstrate the implication of Six Sigma under the four constraints. The paper will also reveal the potential drawbacks of the irresponsible application of Six Sigma in the management of the particular project

1.2 Research Problem Statement

Falcon Pack Company has suffered losses as a result of wasteful practices in the production processes. This occurs when workers are not included in the continuous enhancement of the products. Workers might make mistakes, although most are caused by defective processes and systems. A lot of time is wasted during bag making, especially during maintenance, setting, and cleaning. Another factor is a low performance that is contributed by operating the machine below the ideal speed, starting the machine, and ending the roll. Sometimes the company is also concerned by the quality of bags that they have produced. The redundant quality is majorly contributed by printing errors, slitting problem, paper quality, and other defects related to glue type. The status of the surrounding environment and poor ventilation of buildings also affect both performance and quality, especially during the summer. Furthermore, sometimes, the artwork and the quality of plated provided by the customer are inferior. In case the customer is not satisfied with the quality of bags delivered to them, the company might be required to do rework on the order and in the process, a lot of material and time is wasted.

1.3 Dissertation Research Questions

What improvements are seen in the production process when Six Sigma techniques are implemented in the production line? How does the customer satisfaction change after TQM and Six Sigma techniques are implemented in the production process when compared to customer satisfaction before the TQM and Six Sigma Principles and Tools are introduced to the product's process line?

1.4 Dissertation Aims and Objectives

This section describes the research aims and objectives. The research aims describe main objective of the dissertation, while the research objectives describe the specific aims of the dissertation.

1.4.1 Research Aims

The main objective of this project is to implement Six Sigma and Total Quality Management on the line of production by reducing process defects and at the same time enhancing customer satisfaction.

1.4.2 Research Objectives

- Identifying the underlying defects in the production line.
- Identifying the possible cause of defects.
- Developing alternatives that could reduce the defects.
- Evaluate the level of customer satisfaction.

1.5 The Organization of the Dissertation

The organization of the dissertation was as follows;

Chapter one is the introduction of the dissertation, which starts by part one that introduces Falcon Pack Company, the organization where this study was based on. The company overview describes the fundamental information about the company such as its geographic location, the products they specialize in, the main activities of the company, the market concentration, and the company vision and mission. The introduction of part two describes the competition in the market, the techniques being implemented by organizations to improve performance, and an introduction to TQM and Six Sigma. This part also describes customer satisfaction and metrics such as the human aspects, the technical aspects, and business management. Furthermore, the objective of this dissertation, which was divided into the main objective and the specific objectives, is described at the end of this chapter.

Chapter two presents the literature review related to Total Quality Management and Six Sigma. It describes several existing techniques of process improvement and their shortcomings. This is followed by a detailed description of the Six Sigma DMAIC method of Describe-Measure-Analyze, Improve-Control. This section also compares TQM and Six Sigma and discusses why Six Sigma has gained popularity n modern business strategies. Furthermore, the literature discusses various statistical techniques to be used during the dissertation for the collection and analysis of data, which will be used to suggest solutions to the problems described. These techniques include regression analysis, Pareto Chart analysis, and the Fishbone diagram. The chapter concludes by supporting the reason why Six Sigma DMAIC approach is the best for process improvement for the study in hands.

Chapter three describes the research methodology. In this section, the processes that were observed during the collection and analysis of data are defined. This generally means everything that was done to gather information, identify the problems, and find alternative solutions. The data was collected for Falcon Pack Company within one month and from different departments of the company. It also describes the formulas used as well as how some data was calculated using the correct formulas. The data was collected by observing the Six Sigma DMAIC process where the problems were described, measured, analyzed using statistics, improvements to be made, and the control techniques to be used to monitor process improvements.

Chapter four is the most crucial section of the project. The results obtained after observing the methodology are presented and analyzed. All the tables presenting different data types are illustrated, followed by an in-depth analysis using different techniques of analysis. The data presented include performance data, availability data, quality data, and the primary source of defects. Pareto charts, regression analysis, and fishbone diagrams have been used to analyze the data and find the leading causes of defects. The cause and effect diagrams have been used to suggest solutions to the problems identified. Additionally, customer satisfaction information has been presented to address the levels of satisfaction of customers, which is done on a scale ranging from 0 to 10.

Chapter five summarize the results and findings following the study. The main critical ideas in the literature review have been verified here to show the viability of the study to the process improvement at Falcon Pack. It also presents the significance of Six Sigma to quality improvement, employees' involvement, performance improvement, and customer satisfaction. Additionally, the constraints and limitations of the study have been discussed. In the end, the recommendations for further improvement have been listed.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction to the Quality Management System

The apprehension of company-wide quality control (CWQC) by Japanese companies was manifested through the penetration of those companies into the global markets that had once been dominated by American companies. The CWQC approach allowed the Japanese companies to offer their customers superior quality products at affordable prices. The companies from the western side especially those from America faced serious competition for Japanese and other Asiatic companies. Numerous American companies had the worst experience when their shares were being eroded by Japanese competitors. The situation compelled the western companies, especially American companies, to benchmark CWQC performance while they leaned various quality management controls from Japan. Afterward, Total Quality Management (TQM) was launched and broadly adopted by western industries. The western industries viewed TQM as a great tool to be used to win back their competitive advantage in the global markets. TQM growth was also inspired by several other quality controls such as Deming, Feigenbaum, Crosby, and Juran. Therefore TQM can be viewed as an integrated model encompassing quality concepts, management philosophy, and some other set of practices. However, successful implementation of TQM demands the integration of the technical phases of quality control (hard side) with the phases related to culture, people factor, and the quality concept (soft side). Process standardization, the tool of quality control, improvement, and statistical approaches form the components of the 'hard side' while employees' participation, quality concept, quality culture, and training are elements of the 'soft side'. Since the 1990s, several other quality programs have been launched.

Besides TQM developments, the ISO and Six Sigma, which was launched by Motorola Company, were initiated by 1987. To date, the ISO program has gone through three revisions in 1994, 2000, and 2008. Six Sigma was largely imitated by General Electrics (GE) in 1995. The success experienced by Motorola and GE made SS to be widely adopted by numerous industries across the globe. By 1980, Japanese industries dominated the markets while their key competencies were based on their ability to deliver higher quality, lower costs, and on-time delivery. The core proficiencies were in the effective technological integrations, skills, experiences, specialized knowledge, and techniques, while the main capabilities were in the outstanding ability to manage the core competencies, to establish core products, initiate new business, and penetrate new global markets. Ultimately, the industries would intensify their competitive benefits and enjoy business benefits as well as long-term control over their competitors. During that period, Motorola and GE struggled to retain their markets which compelled Motorola to benchmark the electronics industry in Japan. Motorola realized that most electronics in Japan were with six sigma quality while Motorola products were having four sigma quality. As a result of the weakness in the quality they offered, Motorola initiated the 6δ perfection programs with the aim of achieving the 6δ quality within five years. The 6δ architects at the company focused on improving all operations in every process which produced results more rapidly and excellently. Huge benefits followed the implementation of Six Sigma at Motorola Company. Within the five years of implementation, Motorola realized a great reduction in manufacturing time and defects, which was followed by great financial rewards. Inside four years, the company was able to achieve cost-saving amounting to $2.2 billion. The greatest achievement at the time occurred in 1988 when Motorola was awarded the Malcolm Baldrige National Quality Award. Allied Signal, IBM, and Sony were the next to implement Six Sigma. Allied Signal launched Six Sigma programs in the early 1990s which resulted to cost savings of US$2 billion within 5 years of implementation. The impressive outcome encouraged General Electrics to commence a thorough enactment of Six Sigma in what became GE-6δ. Huge monetary benefit followed the implementation of Six Sigma with the 1999 fiscal report revealing US$2 billion financial paybacks. The remarkable paybacks of adopting Six Sigma in Motorola, GE, and Allied Signaled to the popularity of Six Sigma in the industries and non-profit corporates across the world. Today, SS has become the world's crucial tool in quality management.

Six Sigma has been defined as a methodology for analysis by applying scientific methods (Assarlind & Aaboen 2014). It is considered as a well-planned incessant improvement methodology aimed at reducing waste and process variability. This has been indicated by Anand et al. (2007) with six sigma been considered a popular quality management method. Six Sigma is an extension to some other quality improvement methodologies like the Total Quality Management (TQM) as a result of existing similarities in the six sigma steps of design, analyze, control (DMAIC), measure, Deming's PDCA, and improve. According to Rauch, Unterhofer & Dallasega (2018) applying the DMAIC method integrates the human aspects (customer focus, Culture change, and training) and the process aspects (Stability, variation reduction, and process capability) inside the Six Sigma operation.

Gijo, Bhat & Jnanesh (2014) present three approaches or on-ramps that a company can involve in the implementation of Six Sigma. One is by a company transformation approach where business goes through a complete transformation to change its traditional plans as it looks to reduce heavy losses and regain customer's confidence. Secondly, the industry can adopt the strategic improvement methodology limited to particular needs demanding the industry to concentrate on major weaknesses and opportunities. The third involves a problem-solving approach that emphasizes particularly on persistent challenges. In respect to this, Montgomery (2019) claims that the DMAIC process and the Design for Six Sigma (DFSS) approach are the two modern methodologies that are applied in Six Sigma. Although the core objectives of the techniques differ in that while DMAIC solves the problem to improve the process. DFSS is a process that defines, deliver advanced products, and design to avail attractive value to clients. DFSS is applied in the setting of future product improvements that concentrates on quality from the initialization of a product. According to S. Reosekar & D. Pohekar (2014), businesses that have competitive and robust markets are favored by DFSS while DMAIC favors businesses with less competitive bases and stagnant markets as it focuses on divestiture, cost reduction, and retrenchment.

Various tools that have been used in the implementation of Six Sigma are readily available in the public and the literature domains. Despite the application of such tools being prevalent in many contexts, Six Sigma delivers a customer-based and well-defined methodology that is supported by a set of process improvement tools. The fundamental tools in DMAIC, classically applied in the yellow-belt competence level include scatter diagrams, flowcharts, cause/effect diagrams, check sheets, statistical control processes, histograms, and Pareto-diagrams. In addition to that, Ward & Samra (2014) suggest other advanced tools like the regression analysis (e.g., curvilinear regression, indicator variables, and logistic regression), control charts, hypothesis testing, and experimental designs, which are mostly available in the Black-Belt levels. Talib, Rahman & Qureshi (2013) propose that Six Sigma can also be viewed as a combination of available tools and the techniques that existed before Motorola initiated this approach.

2.2 Six Sigma and TQM Principles and Tools

In the last decade, Six Sigma has been the rising trend while TQM adoption has been decreasing. Successful adoption and implementation of TQM improves business performance. The main benefits of TQM are cost reduction, increased profit, improved competitiveness, and rising market share. Yang & Yang (2012) highlighted several factors that dictate the successful implementation of TQM, which include; visionary leadership, support of senior management, employee involvement, effective management, customer satisfaction, and commitment to quality. However, these business factors are difficult to achieve in practice. For that reason, the literature gives reports of some cases where implementation has not been successful. Dambhare et al. (2013) revealed that about two-thirds of corporates in UAE have either stalled or failed in implementing TQM because some of these programs have a negative influence on profit margins. One reason for such failure is because the administration does not have a clear understanding of TQM. Accordingly, most organizations do not understand that adopting TQM reflects a cultural transformation. Conversely, a well-established TQM model favors business and the decline of its implementation is something apparent, and not real.

As the use of TQM apparently wanes, businesses have switched to Six Sigma management programs (Tang, 2005). General Electric (GE) is one example of a company that as greatly benefited from Six Sigma since 1995. Geared by the remarkable successes experienced by GE and several other large companies, Six Sigma has acquired a new superiority by numerous corporates across the globe for re-engineering strategies and business improvement. The view is that TQM will be replaced by Six Sigma, although such declarations uncover a fundamental misinterpretation of TQM nature and how it relates to Six Sigma. In essence, TQM is not as clear in many companies as it was in the 1990s, which can be associated with several TQM gaffes. Such gaffes include leadership apathy, lack of integration, undefined quality goals, fuzzy concepts, inadequate performance improvement, and existing internal barriers (Chakrabarty and Tan, 2007). In contrast, Six Sigma has been able to get rid of many pitfalls that hinder the successful implementation of TQM and. Therefore Six Sigma reflects a renaissance of the quality movement.

Eretski *et al. (2013*) thoughts that the adoption of TQM leads to an overemphasis on the satisfaction of customers, which sometimes results in reduced pursuit of business profits. This has been supported by several empirical studies that have suggested that adopting TQM does not necessarily have an anti-positive influence on the profitability of firms. Furthermore, the things that might be good for customers might not always be good for the business. In contrast, several empirical studies support that Six Sigma attains both excellent profit performance and customer satisfaction. What is considered the main downside of TQM is the disconnection between administration practices that measure customer satisfaction and those practices that measure the profitability of a business, which has resulted in the unwise venture in quality. Company managers should be able to recognize that TQM plays the role of ensuring customer satisfaction and improve customer loyalty. For profitability and long-term competitiveness, firms should focus on attracting new clients, producing quality products, and holding old customers in a long-term business relationship. Simanová, Sujová & Gejdoš (2019) suggest that customer loyalty must be the central objective of any organization. A business that fails to improve performance, as well as quality, ends up being abandoned by customers. Therefore all indicators of performance, availability, and quality should be included in TQM measurement. In respect to that, Six Sigma maintains the balance between customer satisfaction and profitability.

2.2.1 Implemented Six Sigma Practices

Hietschold, Reinhardt, & Gurtner (2014) surveyed the role of TQM in improving customer satisfaction by the use of meta-analysis methodology on the available research on TQM in manufacturing as well as in the service industry. The findings indicated that QM practices enhance the levels of customer satisfaction. They advanced on and argued that a company that focuses on customer satisfaction also increases the performance of the business. Fotopoulos and Psomas (2009) examined the relationship between the 'hard' and the 'soft' TQM elements based on QM results obtained from 370 Greek industries (Manufacturing, service, commercial). Their findings indicated that the consolidation of the market position and quality improvement are mainly influenced by the adoption of 'soft' TQM elements as well as the secondarily 'hard' elements. Raja Sreedharan, Raju, Rajkanth, & Nagaraj (2016) studied and contrasted TQM implementation involving 18 manufacturing industries and 18 service industries based on 19 different TQM dimensions. The concluded that the service industry has selective TQM practices as opposed to manufacturing ones, which adopt a wide range of practices. However, the study found no big difference in TQM concepts adopted by both the manufacturing and the service industry.

Schroeder (2002) used the term paralle-meso to describe a structure of organization instituted within an organizational setting. The paralle-meso structure of organization in Six Sigma offers a stimulating context for study from the perspective of organizational science. There are two interesting topics in unique paralle-meso structure. The first topic is whether a committed organization structure would make enhancement efforts to be more successful. The second issue is the tension between a mechanistic approach and a considerably adaptive approach. The structure described consists of roles starting from the Green Belt, Black Belt, Master Black Belt, and Champions. The organizational structure is established toward performance improvement.

Schroeder applauded the parallel-meso structure and farther stated that dedication to the structure could drive the successful implementation of Six Sigma. The established parallel-meso structure was particularly in line with the Gold et al. (2013) Quality Trilogy. In the Gold's structure, the pillars that lead to effective quality management include improve, control, and breakthrough. However, no design concerns associated with the three pillars were addressed. Six Sigma mainly advocates creating a distinct organizational unit committed to improvement. Distinct organization unit improves measurability as well as accountability. A separate but parallel structure maintains the linking to the central operational unit. In a paralle-meso structure, the improvement effort is regarded "ours" rather than "theirs", which encourages employees to embrace change. Thus, the paralle-meso structure looks like the most effective approach to implement transformation programs like Six Sigma. However, the in-depth theory behind paralle-meso programs is yet to be established and empirically verified. Paralle-meso means requires an organization to perform operation and improvement tasks simultaneously. Though, the two tasks compete for resources and therefore bring up interesting questions; how can the organization manage the resource conflict? How can organizations balance and coordinate resources demand? What priorities should be assigned to each task? If the answers to the questions can be found, the understanding of the paralle-meso structure can be found.

Six Sigma as a mechanistic approach also raises a remarkable tension because it is greatly prescriptive in guiding how efforts for improvement should be implemented. A mechanistic environment is necessary especially in extremely repetitive tasks in which the efficiency is high but flexibility is weak. In comparison, a dynamic environment suits an adaptive organization. An adaptive organization is determined to be flexible even if it means reducing the efficiency to some extent. The present-day business environment is majorly characterized by complex chains of supply, very demanding customer requirements, and versatile global competition, which means that organizations have to be highly flexible. According to Siva (2016), an interesting question is whether Six Sigma as a mechanical approach can improve the flexibility of an organization. The unique characteristic of Six Sigma is that it permits the use of various exceptional human resources pursuits especially the improvement specialists within the Black Belt. Such practices of human resources generally contribute to success of Six Sigma. Simultaneously, they also deliver other interesting issues such as job design for personnel, selection of personnel, compensation, performance evaluation, and development and training. The selection of personnel using Six Sigma is very crucial. The effectiveness of Six Sigma is dependent on those people who are responsible for ensuring its success. The best employees should be selected for the Black Belt role. However, the meaning of best when considering the employees is not clear. The internal-oriented principle also limits the possibility of a company to hire highly skilled employees externally.

Considering that programs of Six Sigma are expected to last years, the policy of selective staffing should be adaptive as the business move to the advanced Six Sigma stage. The job design used by the employees is also critical to the success of Six Sigma especially when it is organized according to the company strategy. The roles of each belt are clearly specified since Six Sigma has been implemented in numerous organizations. Despite that, job enrichment and enlargement, and rotation remain uncertain. These are relevant issues especially when businesses want to move to the next Six Sigma stages. It is necessary to rotate the personnel back to their functional areas especially after they are done with their assignments. Six Sigma also requires to integrate new personnel although the process is largely chaotic especially in big organizations. Six Sigma also delivers the context of performance appraisal, training, compensation, and employee development.

Intensive training and employees development is the key to the success of Six Sigma in both Motorola and General Electric Companies. Motorola and General Electric spent finances in millions of dollars on development and training. However, the effectiveness of massive training has never been studied carefully.

Comparable issues also exist in performance appraisal. An orientation and a metric focus exist to make the measuring and tracking of savings accrued by Six Sigma easy. Typically, the assessment of Six Sigma in an organization is based on the hard savings like cost-saving, which are clearly measurable. Though, this is more of a mechanistic approach toward performance evaluation. However, it lacks compatibility with other comprehensive approaches of performance assessment such as the 360-degree appraisal. The results of the incompatibility have not been studied carefully. However, compensation goes hand in hand with performance appraisal. Most organizations apply compensation policies when rewarding employees and also encourage acceptable behavior. Inside Six Sigma compensation is inclined toward hard dollar saving resulted from biases in performance evaluation. This positively impacts to encouraging employees to look for farther opportunities to reduce cost and reduce waste. However, it may negatively affect employees' readiness to taking risk to perform risky but valuable projects and this could be harmful to the strategic objectives of the organization.

Innovation is the key concern for modern organizations because of the ever-fluctuating customer demands. Most firms strive to become innovative and the concern is if Six Sigma will provide the opportunity for innovativeness. The existing literature highlight that Six Sigma impede innovativeness because it has a deep focus on process management and production of output that would increase customer satisfaction. Six Sigma reduces process variation to make processes consistent and more stable. Yet, innovation is all about exploration activities that create process variations in a process. A theoretical approach has been established by Assalind (2014) to explain the reason why Six Sigma impedes creativity and progress by testing the connection in a paint company. The findings indicated that process management focuses on exploitation rather than innovation. Exploitation, in this case, refers to application of already existing knowledge to replicate success in an existing process. Exploitation results in clearly visible results and also has comparatively low risk. For that reason, exploitation hinders exploration and over time, organizations might not be able to compete with more innovative companies. However, several counter surveys have been established against the above declarations.

According to Al-Mishari and Suliman (2008), a team of innovative partners may be hired by the organization to ensure that Six Sigma goes hand in hand with innovation. Additionally, Chang, Pan, and Yu (2008) focused on product innovation and ignored process innovation. The study did not consider the nature of the innovation, whether incremental or radical. Thus, in Six Sigma programs, both exploitation and innovation are incorporated in performance improvement. Shokri, Waring, and Nabhani (2016) highlighted that Six Sigma includes both structural exploration and structural control. In what they view, Six Sigma establishes a control mechanism to safeguard effective execution while at the same time encouraging employees to become innovative. In other words, Six Sigma promotes innovation instead of discouraging it. In general, Six Sigma has provided the context of organizational ambidexterity (Raja, 2016). An organization with ambidexterity balances innovation and exploitation and is also adaptive to change. The positive result of organizational ambidexterity is not easy to maintain (Izogo and Ogba, 2015). However, Six Sigma ensures both structural exploration and structural control.

Various manufacturing companies have successfully implemented Six Sigma and expanded farther to implement it in their service operations to make it more effective. Examples of processes addressed by the use of SS include reducing delays in delivering work orders as well as reducing delays in the materials acquisition (Shokri, Waring, & Nabhani, 2016). Ford Motor Co. achieved a significant cost saving by successfully implementing Six Sigma within its facility management, real estate, and maintenance functions. Caterpillar Corporation applied Six Sigma to improve financial services and went on to win the Malcolm Baldrige National Quality Award in 2003 (Siva et al. 2016). The literature validates that the advantages of TQM related to manufacturing are translatable in the service sector. However, some SS challenges related to manufacturing are also encountered in the services. For example, rework as well as scrap also occurs in the service sector of a company; revealing some signs of inconsistency. The inconsistent processes result in similar financial consequences in both manufacturing and service delivery. In that context, SS may be used to initiate a system that tracks the progress in quality improvement processes and establish a more consistent service delivery process. Consistency of processes leads to secondary benefits such as reduced waste, improved quality, increased profitability, and enhanced customer focus.

2.2.2 The Fundamental Principles of Quality Management

To be able to manage and elevate the output of a process, it is crucial to figure out the crucial input variables that would have a significant influence on the output. The basic ingredients of SS play a similar role as any process's input variables. Several key ingredients have been studied Eckes (2000); and Pande et al. (2000). The study of the most crucial factors to be considered in the process would allow each factor to be ranked or prioritized based on the benefits it can deliver especially when considering the Packaging industry. Categorizing the critical success factors (CSFs) enables organizations to comprehend what elements are most crucial for making SS and TQM implementation successful and ignore the elements without a significant impact. People in an organization would also be able to understand the SS implementation process. The most critical factors for a packaging company include:

a. Management Participation and Commitment

For successful implementation of an initiative as large as Six Sigma and TQM, the management should be committed to supporting the initiative by availing the resources and training required. The senior management must be taught the fundamental principles of Six Sigma. Welch, who was the CEO of general electrics during the successful implementation of SS, had strongly influenced and supported the restructuring of the company and encouraged employees to be optimistic about Six Sigma. In the absence of management support, the importance of Six Sigma might not be realized while the vitality behind it will be fade.

b. Cultural Change

If the introduction and enactment of a big initiative such as Six Sigma are to be successful, the organization must be willing to change the old culture and change the employees' attitudes. Every worker should be ready to take responsibility for their respective tasks while the organization should ensure that the workers are motivated. For example, the employees of General Motors were uneasy when they were being introduced to statistics when Six Sigma was first introduced to them because they thought of Six Sigma as a statistical toolset. Afterward, SS became part of their DNA and to date, the technique is the way of handling their responsibilities with the definitive goal of doing things in the right way. According to Soha (1998), the success of any organization in both local and global markets depends on the organizational culture. The initiatives related to SS demands the right attitude and focus of individuals working at all levels in a business setting. All employees should be made aware of the importance of adjusting the corporate culture. Organizations that have achieved success in managing culture changes have shown grit in tackling resistance through education, sustained communication, and motivation. There are two fears in an individual that comes in during a cultural revolution; the fear of not achieving the expected result and the fear of change. To tackle the fear of change, the individuals involved must be made to understand the reason for the change. The management to develop a channel to educate all parties on the need for Six Sigma and how it functions in a business. Restructuring the organization might also be a necessity to drive cultural transformation. After the results of SS have been realized, it is necessary to publish them although not necessarily the success part but also include the limits.

c. Training for the Employees

Training is critical when it comes to communicating why and how Six Sigma is implemented especially in the early stages when most people are unaware of it. Six Sigma consist of a hierarchy of expertise recognized as the 'belt system'. It is the responsibility of the belt system to ensure that all individuals in an organization are speaking a common language, which makes the groundwork and execution of SS much efficient all over the organization. The belt system's curriculum varied depending on the organization and level of the consultant. Nevertheless, the curriculum in an organization should be provided by specifying the roles of individuals who are directly involved in Six Sigma. A good example is Motorola, who specifies that the training to become a black belt should not be less than one year. For someone to be recognized in the black belt, they should demonstrate skills they used to meet the requirements of Six Sigma, in both training and execution. In General Electrics, the minimum training duration to be considered for the black belt ranges between 16-20 weeks. Additionally, the black belt qualification is very central when considering the promotion of employees. In contrast, GE has a sophisticated approach to training employees than Motorola. Moreover, the training duration of GE is comparatively shorter which makes them have a greater count of qualified black belts. Nevertheless, Motorola seems to have a more sophisticated scale of black belt expertise.

d. Organization Infrastructure

Apart from top management, the organizational infrastructure must be integrated into the support of the Six Sigma development program. Generally, the employees working for a Six Sigma based business should be highly skilled, have exceptional statistical skills, and capable to lead teams in recognizing, accomplishing, and managing Six Sigma based projects. In most multinational organizations like Motorola and Honeywell, Six Sigma projects are organized by vice-president or CEO, who is regarded as the champion of Six Sigma. The vice presidents and the CEOs work closely with master black belts and black belts as well as green belts, and other employees who are mandated to support specific projects within Six Sigma. Six Sigma initiatives also need sponsors or champions from other organizations who guide the project teams in terms of providing resources and budgeting. The readiness and timing of the organization are also crucial because SS projects require a huge amount of resources in terms of energy, cost, staff commitment, management commitment, and time.

e. Knowledge of Six Sigma Tools and Principles

An effective training encompasses learning the basic principles around which Six Sigma is built, i.e. DMAIC methodology. While training, employees are taken through three categories of tools and techniques that are grouped into leadership tools, team tools, and process enhancement tools. In many projects, simple quality tools or statistical tools are sufficient to confront the problem in question. For more advanced breakthrough process improvements, several advanced statistical tools are deployed. Such advanced tools include experimental designs, regression analysis, statistical process control, and analysis of variance. Moreover, it is necessary to have well-defined metrics to be used to measure the performance of a process against customer expectations. Such metrics might include cause of poor quality, defect rate, rolled throughput yield, and throughput yield. Accurate information is also needed to analyze the possible root causes and support decisions of particular teams.

f. Linking Six Sigma to Customers and Suppliers

The most important element of Six Sigma success lies in its aptitude to link to customers. Six Sigma initiatives should start with the determination of what the customers required. However, Pande et al (2000) claim that before customer requirements are successfully fulfilled, the empathy of the organization and its connection to several business activities should come first. He also argued that linking Six Sigma to the customer involves two basic steps: one is identifying the critical processes, defining critical customers, and defining critical outputs, while the second one recognizing and defining the customer requirements and needs. The most crucial issue is the choice of critical-to-quality characteristics (CTQs). The CTQs must be chosen quantitatively in the initial phase of Six Sigma practice. Deployment of quality functions is a powerful technique that can be deployed to help understand what the needs and requirements of the customers are and transform them into design requirements. Mostly in the service businesses, the requirements of the customers are often poorly defined, subjective, and ambiguous.

On the other hand, organizations that implement Six Sigma finds it necessary to link SS values to supply chain management. General Electric Appliances (GEA) faced challenges under the concept of “everybody plays” because the company forgot to include its suppliers in the cultural transformation. The most fundamental element to look upon in the integration of suppliers into Six Sigma is the support from the top management of the suppliers. One of the Six Sigma philosophies argues that one method of reducing variability is by having a few suppliers who retain a high Sigma level of performance.

2.3 The DMAIC Methodologies

DMAIC is an acronym for Define-measure-analyze-improve-control. Hsiang-Chin Hung and Ming-Hsien Sung (2011) have applied the DMAIC process in a food processing company located in Taiwan. Using the method, he was able to find a solution for an underlying obstacle of getting rid of significant process variation and reduced the high rate of defect associated with it. The consequences were a reduction in rates of defects of smaller custard buns. By obtaining a 70% reduction in errors, he was able to suggest some factors to be considered for the successful implementation of Six Sigma, especially in process industries. MAJSTOROVIĆ et al. (2010) implemented DMAIC in a metal processing company, and in the end, he was able to achieve process variability, and therefore, the number of nonconformities reduced significantly.

Additionally, Sahu & Dr.sridhar (2012) have applied DMAIC to improve the productivity of a manufacturing company. He analyzes DMAIC in both small and large companies as well as analysis on quality tools applied in industries. Their work provided a framework that can be used to quantify, identify, and eliminate process variations to sustain, optimize operation parameters, and improve performance viz in a process.

Six Sigma DMAIC has also been used by Arslan, Iftikhar & Zaman (2014) in an electronics company that manufactures cartridges used for an inkjet laser printer. These semiconductor materials are tested in the last stage of the process to accept or reject them by measuring their electrical characteristics. After collection and analysis of collected data, they discovered that defects related to electrical failure contributed to 50% of all the flaws. To reduce the level of defects, they established the main shortcomings, their cause, and the possible action. They established the central factors, recognized the optimum tolerances, and any potential opportunities for improvement. By doing that, they were able to reduce the defects by about 45%. Results revealed that a proper understanding of Sigma DMAIC and support from management teams had a positive influence on profits, quality, and other factors that are critical to achieving customer satisfaction.

2.3.1 DMAIC Methodology Steps

Stylidis, Wickman, and Söderberg (2015) suggested the DMAIC steps that had special consideration to service delivery. Their proposal for Six Sigma DMAIC was as follows:

a. Define the Process and Identify the Problems

The suggested SS approaches proposed that the problem identification process and understanding should encompass the customers, employees, and management. The two concerns for services are understanding service practices in a clear way and finding and expending the customer input in the efforts to identify challenges and organize them into context. A number of SS tools such as Pareto analysis, course and effect diagrams, flow charts, brainstorming, and regression analysis can be used to enhance the cognizance of the mentioned processes. Additionally, other quality functions of SS may be used as it focuses on the input of customers during the design stage. Customer surveys and focus groups may be used to gather customer input.

b. Measure the Process Performance

According to Goicoechea and Fenollera (2012), customer or workers factors may cause the implementation of processes to have some variability. Monitoring of processes is a necessity and

SS tools such as the use of check sheets and customer surveys may be used to trace performance. In most circumstances, services must be delivered beyond the existing customers and assess the prospects of stakeholders whose opinions have a great influence on the services. For example in the packaging industry, these might consist of the people who buy food packaged in the packing bags provided by the company.

c. Collected Data Analysis

The primary data analysis may include Pareto charts, process-flow analysis, scatter plots, histograms, and run charts. The subsequent data analysis might involve correlations, Test For Statistical Significance, or regression. The analysis could help reveal the major causes of a problem, predict future trends, and show the variations in data for a large data set.

d. Implement Changes

The suggested tools for implementing service processes include effect analysis and failure mode, project management approaches, force field diagrams, process documentation, and stakeholder analysis.

e. Control Process

To be able to efficiently control the process, variations in the process are measured and examined. Feedback is crucial when it comes to assessing how efficiently the change is responding. To accomplish this, additional surveys on customers must be executed. There is also a possibility that the company can initiate measures and regularly analyze the data. Another crucial aspect of the control stage is to continuously monitor the processes for further development.

2.3.2 Customer Satisfaction

Chang, Pan, and Yu (2008) defined satisfaction as an individuals' sensation of pleasure or disappointment resulting from the perceived performance of a product to expectations. Besides, Teli et al. (2013) said that satisfaction as a result of the perception of value and acquisition cost of the customer, whereas value is the perceived quality of services relative to cost and price. However, in contrast to Omega et al. (2016) research, customer satisfaction is a persuading repurchasing willingness or behavior which reflects higher revenues and profits for an organization. Also, customer satisfaction is the feedback in the form of evaluation by the customer after buying goods or services from a company compared with the expectations of the customer. Satisfaction is measured by assessing customer expectations with respect to the performance of the commodity to meets the customers' desires. A customer is said to be satisfied if there are correspondences between the customer's expectations and the performance of the product delivered, where they are encouraged to repurchase the same product from the same company. On the other hand, a dissatisfied customer would not repurchase and they would probably transfer to another competitor offering similar brands. Besides, they would persuade other prospects to not purchase the commodities form the company. Kotler and Armstrong (2012) proposed that customer satisfaction in the degree to which the perceived product performance equals the customer's anticipations. There are several indicators that reflect customer satisfaction that include; repurchase interest, loyalty, willingness to make recommendations, few complaints, satisfaction, and company reputations.

2.3.3 Customer Value

Doran and Hill (2008) defined customer value as the trade-off between product quality that is perceived by the customer relative to what they perceived in paying the price for the product.

Customer value is built when the expectations of the customer are either met or exceeded in the three areas of quality, benefits, and price. Abdulaziz (2014) thought of customer value from a different perspective and argued that customer value has a direct relation to the benefits accrued to the product or the service. Moreover, Banduka, Veža, and Bilić (2016) expressed customer value as an evaluation of paybacks of a commodity perceived by customers compared to what had been dedicated by the customer to acquire the commodity. In other words, customer value is a ratio of benefits perceived by the customer related to the sacrifice. Implementation of the sacrifice corresponds to the exchange process like the cost of the transaction and the risk associated with the commodity offered by the company. Thus, the customer is disappointed whenever the ration value of the product delivered by the company does not match the financial sacrifices of the customers. Otherwise, the customer will feel satisfied if the ratio value is in accordance with or exceeding the expectations of the customer. Another perspective of customer value suggests that customer value may be measured using functional value, social value, or emotional value.

2.3.4 The Key Performance Indicators (KPIs)

The KPIs deliver the actual data concerning a certain outcome or performance. The results of the Six Sigma projects are required to present in financial terms (Coetzee, van der Merwe, and van Dyk, 2016). With KIPs, financial achievement can be directly measured and understood easily. Financial benefits are the main emphasis of KPI for the implementation of Six Sigma in service delivery. The other KIPS involves measurement of efficiency and customer satisfaction. Efficiency goes hand in hand with timely delivery and reasonable cost. Cost reduction can be attained by reducing waste, which involves eliminating errors and mistakes in manufacturing or even using the minimum time possible to complete a task or an order (Hanenkamp, 2013). For example, taking the minimum time possible to complete one order to allow for more orders to be completed.

Another aspect of KIPs is time-to-deliver which dictates the organizational performance. A good example is just in time delivery of packing bags according to the initial requirements of the client. The quality of services also defines organizational performance because it assesses the extent of customer satisfaction and deliverability. Quality depends on the technical aspects as well as the functional aspects. Technical aspects are represented by the outcome of a process, while the functional aspects are represented by the interaction that the service provider has with the customer. The other factor to consider is customer satisfaction which is difficult to measure because it changes depending on the type of services. For instance, customer satisfaction in a call center service is measured based on timely feedback. For a packaging company, customer satisfaction may be measured depending on whether the customer is happy with the quality of the bags delivered. In general, customer satisfaction can be measured based on the customer retention rate. Employee satisfaction is the other measure of performance of an organization. The retention rate of workers is a clear indicator of satisfaction. Financial benefits that come with SS implementation gives employees a means of visualizing their contribution, which may improve their morale and satisfaction. Reduced variations is another KIP because Six Sigma mainly focuses on reducing performance variations by refining consistency and standards. Reducing variations may be seen in the consistency of delivering quality or reducing the decision cycle in processes (Example is reducing poor quality labels or lateness in material acquisition). Furthermore, the financial benefit is a clear indication of improvement and a vivid indicator of progress. Six Sigma implementation presents a bigger impact in terms of progress in performance, which are reflected in terms of financial gains.

2.3.5 Product Quality

Quality is the excellence or superiority of a commodity. Soliman (2017) defined a product as a commodity that can be presented to the market for consumption, attention, or acquisition to satisfy a need or a want. Thus, product quality is the customer's perception of the general superiority or quality of a commodity depending on the envisioned purpose, whether relative or alternatives. Besides, product quality is the characteristic of a commodity that relies on its capability to satisfy the implied customer requirements. However, the product quality is not well-defined by the company stance but relies on the customers' perspective. Related to that are two crucial factors that affect product quality that is, the perceived quality and the expected quality of a product. Whenever the product quality coincides with the customer's expected quality, the customer perceives such quality as good and they feel satisfied. Contrariwise, if the product quality perceived is not what the customer expected, the customer will perceive the quality as bad and there will be dissatisfaction as a result. Therefore the qualification of a product as either good or bad is in the hands of the company, which is mandated to meet the customer expectations. For a packaging product, the expected quality characteristic is a packaging that endures on its capability to fulfill the customer expectations, whether implied or expressed. The quality of a product is composed of various indicators that include; reliability, performance, compliance, serviceability, features, perceived quality, and aesthetics.

2.4 Six Sigma Successful Implementation Obstacles

Before starting any Six Sigma project, it is crucial to find out the reasons why the implementation may fail by considering the existing literature. Six sigma may fail if an organization does not have a model to guide the Six Sigma implementation. It may also fail if the organization lacks a proper understanding of the sequence of the implementation of the program.

Zimmerman (2005) studied the failure of SS for an aerospace company and recognized that only 50% of the respondents in the survey were satisfied with SS while the rest 50% were dissatisfied. Hussein et al (2015) highlighted that the SS program was expensive yet it never produced the anticipated results. Six Sigma implementation at Home Deport Company reduced the performance of the company's employees and produced unexpected customer satisfaction which led to the worst Customer Satisfaction Index ranking (Jasti and Kadali (2015). Kaura (2015) reported that "about 60% of Six Sigma initiatives do not produce the desired outcomes". Assalind (2014) also highlighted that SS programs become expensive at times than the benefits they deliver mainly because of inappropriate application. The available literature surveys on Six Sigma are applied to isolate the implementation steps. Although highlighted in different surveys, the steps can be integrated to hypothesize a suitable model of implementation. Eretski (2013) indicated that Six Sigma is supposed to build higher products' perceived value and services to the company's products. Amin et al (2013) point out that integrating the business strategy to Six Sigma is the key to successful business. DuPont considers Six Sigma as a management culture towards long-term business transformation as opposed to a result-oriented methodology. Jasti and Kodali (2015) also pointed out that the main reason why Six Sigma fails because the management lacks commitment. The management should be committed to understanding the Six Sigma techniques, guide the process of implementation, and provide leadership. The following describes the main issues that lead to the failure of Six Sigma implementation.

a. Issues in Training for the Employees

Following the successful implementation of Six Sigma in Motorola and General Electric companies, it is clear that training is a critical success factor while implementing Six Sigma. Training should be an integral part that should never be ignored when introducing Six Sigma. The training program (belt program) should begin from the top and applied to the whole organization. The chosen curriculum in the belt program should reflect the needs and requirements of the organization. The curriculum must be customized to include managerial and financial benefits. The qualitative and quantitative metrics, management practices and skills, and leadership should also be covered in the training programs. Formal training should also be considered as part of the development agenda of producing experts at different belt levels. Furthermore, trainees should be made aware of the latest techniques, tools, and trends and be able to communicate using real-time data analysis.

b. Organization Strategic Issues

Hammer and Goding (2001) stated that Six Sigma has been a subject of dispute and criticism in the quality sector depicting it as "Total Quality Management on Steroid". The main criticism suggested that Six Sigma is simply refined traditional techniques associated with quality. Organizations fail to understand that Six Sigma is not the universal remedy to all types of business issues. Additionally, it may not necessarily be the most effective management approach that would make a company feel the determination to comprehend and implement. Organizations looking toward implementing Six Sigma should carefully analyze the strengths and weaknesses of the business and adequately apply the tools, principles, and concepts of Six Sigma. The strategic plan includes understanding the customer needs and requirements, effective training of employees, understanding the metrics and enhancing organization infrastructure.

c. Culture Issues

To enable a culture that would accommodate Six Sigma projects, the concept of quality should be embedded into the design stage which should then be transferred to the manufacturing stage. Transforming organizational culture involves the integration of quality into the planning. Addressing simple issues that are easy to deal with and announcing the success of Six Sigma is not reasonable at all. The organization should start with the root causes and afterward deal with the sub-causes in that order. A company without a clear empathy of the real obstacles or one that lacks comprehensive change management might fail in the Six Sigma implementation. The leadership, commitment, and support of the senior management are critical to dealing with cultural issues or variations related to the implementation of Six Sigma. If management commitment to supporting the implementation of Six Sigma is missing, any attempts to integrate Six Sigma will fail.

2.5 Six Sigma Tools

The fundamental tools in quality management, which are also referred to as traditional, classical, or elementary tools are used in solving the majority of quality problems, and the course and effect diagrams are one such tool. The tool's effectiveness relies on the skills, complexity, and knowledge of employees as well as the ability to interpret the results. The great seven tools are identified as Pareto Charts, Lorenz Diagrams, Check sheet, Correlation Graphs, W. Shewhart’s control charts, Histogram, Ishikawa Diagrams, and Block Diagrams. This study will focus on the implementation of Six Sigma DMAIC using Pareto Charts, Regression analysis (Correlation graphs), and Ishikawa Diagrams.

2.5.1 Statistical Regression Analysis

Stephenson (2010) defined regression analysis as a statistical technique mainly used to relate variables. The core objective of this method is to create a mathematical model that compares a set of independent variables to dependent variables. Three types of regression models have been used that include; Linear Regression model, Change-Point Models, and Variable-based Degree-Day Model (VBDD). All apply the full least squares when defining model coefficients. For every independent variable x, there is an associated dependent variable y. Discrete values of any registered variables in linear regression $x1, x2, x3, \ldots, xp$ value can be defined by;

$$\mu y \ = \ \beta 0 \ + \ \beta 1\, x1 \ + \ \beta 2\, x2 + \ldots + \beta p\, xp$$

The linear equation demonstrates how μy varies depending on the states of explanatory variables. The value of y changes depending on the variation of μy and assumes to have a similar standard deviation σ. Also, the values of $b0, b1$ ... bp dictates the parameters $\beta 0, \beta 1, \ldots, \beta p$ of any function of linear regression.

Inside the least square model, the best line of fit for the adjustment of data is found by minimizing the squared sum of the vertical deviation of every data point from the legend line (Vehkalahti 2014). For a data point that falls inside the range of adjustment, the variation is zero. Since the variances are squared before summed, there are no deviations between positive values and negative values. Least squares belonging to linear regression estimators of functions $b0, b1, \ldots, bp$ are customarily calculated using a particular statistical software.

2.5.2 The Fish-bone Diagrams (Ishikawa)

The Fishbone diagram is a Cause and Effect diagram used to check and analyze crucial factors in recognizing the features of output quality for a particular task or process. The name was derived from its resemblance to a fish with the head as an effect and illustrates the bones as causes of a particular problem. The root cause defines the inmost underlying cause of either a negative or positive impact within a particular processor which when dissolved would lead to elimination or significant reduction of the symptoms in question. The most profound causes are not the obvious, proximate, or immediate causes, but we must dig deep to uncover them. Finding a solution to one of the root causes can result in a significant reduction or even eliminate the symptoms within a process.

Ishikawa diagrams are basically used to identify the root causes of numerous phenomena such as irregularities, errors, and problems arising during the process of work organization. The fundamental principle of the Ishikawa diagram was to find a cause and analyze a process to find a way of eliminating the irregularity and initiate measures to prevent the repetition of similar problems. Solving problems using the Ishikawa diagrams is the responsibility of the whole team suing to brainstorm. In most circumstances, specific problems are dealt with by specialists with a specialty in particular areas of process organization. However, there are instances where the teams involve individuals with different specialties and conferring to the principal of quality circles. The success of the brainstorming process, the objective of which is to find the root causes of particular phenomena, depends on the participation and interest of the work team and the compelling desire to evaluate the reasons for non-compliance and the limits of the processes in question. However, using Ishikawa diagrams solely does not necessarily deliver a rapid elucidation of an existing problem. The diagram is supposed to produce a revelation of all the possible causes of irregularities, to consequently eliminate the least probable causes.

Success or failure of individual or company goals has its root causes (Slameto 2016). If we can uncover the roots related to our accomplishments, it is easier to develop strategies to advance our general processes. While dealing with particular problems, we can find symptoms. Symptoms are the most visible things that attract our attention to a particular problem. Zaman, Kumar, & Pattanayak (2013), described a system as an evident gap between what we expect and what the reality is and all tasks as a process. The most basic process contains not less than three elements. i.e., the input, added value, and the output. While dissolving the problem in hand, the best approach is to deal with the root cause, as opposed to using a patch to fix the symptoms. As long as the root is dealt with, the systems disappear automatically. Patches will only add complexity and delay the process of finding the solution, and therefore, the Fishbone diagram is the best while looking forward to processing improvement.

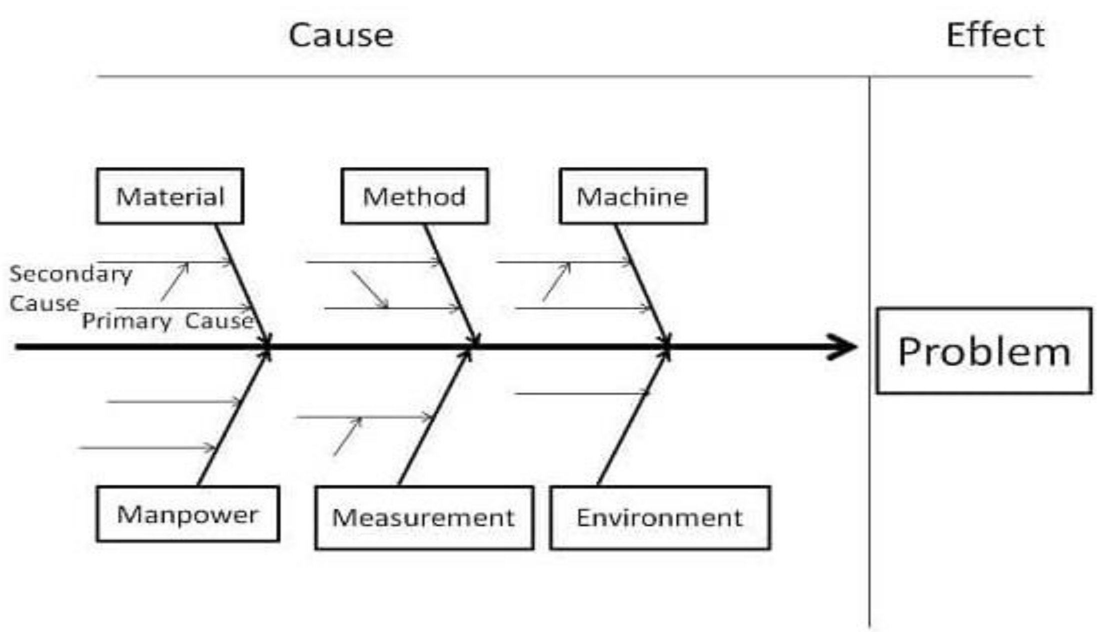

Figure 1, Shows the Fishbone diagram overview

Valles et al., 2009

2.5.3 Pareto Analysis

Named after Vilfredo Pareto, this method of analysis is the leading statistical tool applied in the decision-making process. Pareto analysis collects the things that possess a substantial overall effect. This methodology ranks items or data based on decreasing frequency order. Total frequency is usually added up to 100. All the antecedents form two categories, the useful many, and the vital few according to the 80/20 rule that was established by Vilfredo Pareto. Those antecedents holding the significant 80 percent are referred to as the “vital few”, while those with 20 percent are regarded as the “useful many”. The results are presented in the graphic form to clearly indicate the “useful many” and the “vital few”. Various data factors are presented in descending order with a clear pointer showing the line graph that separates 80 percent and also allows the rest 20 percent cumulative to be found.

Valles et al. (2009) while carrying out Pareto analysis based on Customer Experience antecedent obtained a comprehensive literature review where the antecedents of Customer Experience have been listed. It was noticed that the majority of antecedents related to Customer Experience with similar meanings are usually known by different names by separate researchers. All antecedents with similar names were grouped and accorded a collective name. After grouping, it was noted that from the 39 papers contained in the literature, 34 antecedents were identified having a frequency of 257. They were organized in descending frequency, and a Pareto analysis was completed. The Pareto analysis noted that 14 of the factors existed under the “Vital Few” which include Interpersonal services, convenience, employees, physical environment, trust, market mix, service process, customer incentives, challenges, affordability, emotional aspect, and usefulness. The “Useful many” included factors like telepresence, service quality, product variety, value addition, behavioral intentions, technology, novelty, involvement, problem resolution, courtesy, customization, facilities, novelty, security, age, lifestyle, tangibles, encouragement, and choice.

2.6 Summary

This dissertation focused on the integration of TQM and Six Sigma practices at Falcon Pack Company. Falcon Pack is an industrial company that has a wide range of product lines, but Six Sigma DMAIC will be implemented in the Paper bags production line. This will help in enhancing and developing the process performance and will encompass the whole process starting from order taking, the design, process, final merchandise, and customer. Additionally, the factors that influence the product's quality and performance, such as machine breakdown, employees, and the environment will be analyzed using Pareto analysis. The aim of using Pareto analysis was to help in identifying the main causes of defects that result in reduced performance, availability, and quality. This would help in categorizing the causes of defects based on the impact they have on the production line. The fish-bone diagram was applied to figure out the possible causes of defects that result in low quality and reduced performance. The fish-bone diagrams were analyzed step by step while the most probable causes of defects were noted. The less probable causes of defects were overlooked, although the data was kept for future references in case of future defects analysis. Furthermore, regression analysis was done to analyze customer satisfaction and predict the future trend of the same.

CHAPTER III

RESEARCH METHODOLOGY

This chapter describes all the steps involved in the collection and analysis of data. The methodology observed the Six Sigma DMAIC process of Define, Measure, Analyze, Improve, and Control. The data were collected within a month from different departments of Falcon Pack Company. The company didn't have any existing database, and therefore a manual collection of data was done.

3.1 Defining Process

Printing begins when machines that print on the rolls of paper are engaged while the cylinder is placed on it. Once the plate is fitted on the cylinders, the cylinder is fixed inside the three printing machines. The printing machine, also called the flexographic machine, has different printing stations for different colors summing up to eight colors. The number of plates installed depends on the number of colors that the customer needs for their block bottom paper bags. The printing is done on a thick roll of paper, and depending on the size of the bags required, the thick roll is taken to the slitting machine. The slitting machine reduces the width of the roll depending on customer requests regarding the size of the paper bag. Regarding the job order, the slit roll is fed into a suitable machine. There are two machine-types, for the flat bottom paper bag, and the block bottom paper bag. Since this dissertation is based on the block bottom type, the paper will be fed on three machines for the block bottom. For the flat-bottom variety, two machines are used. After bags have been made successfully, they are packaged inside standard cartons before they are moved to the store.

3.1.1 Steps of Producing Paper Bags

The operational foundation of the block bottom paper bag machine involves a simplified process of feeding raw materials, printing, slitting, sealing, and stacking. The simplified process is presented in Figure 2 and explained below; before the process of making paper bags begins, there is a discussion between the sales department and the customer concerning the specifications and size of the product. The company provides a paper with the details concerning the products they offer and the price for each. The customer will then provide the dimension and the specifications of the product that they would want. If the customer approves the quoted price, he/she gives the P.O as well as the artwork (product design) to the designer. The designer makes the sample of the artwork and sends it to the customer for approval. Sometimes, the customer will provide the artwork, and the designer will only need to make a sample and present it to the customer. If the artwork satisfies the customer, then an order can be placed at any time through written instruction. When placing the order, all dimensions such as thickness, quality, color, and width are specified. The artwork is then fed into three machines that make the plate. The plate must consist of all the details and all the requirements according to the customer demands. After the plate is ready, the company orders for the paper bag making raw materials from the distributors, about 25 tones. The plate mounting machine consists of sensors around its corners and is used to mount the plate on the cylinders.

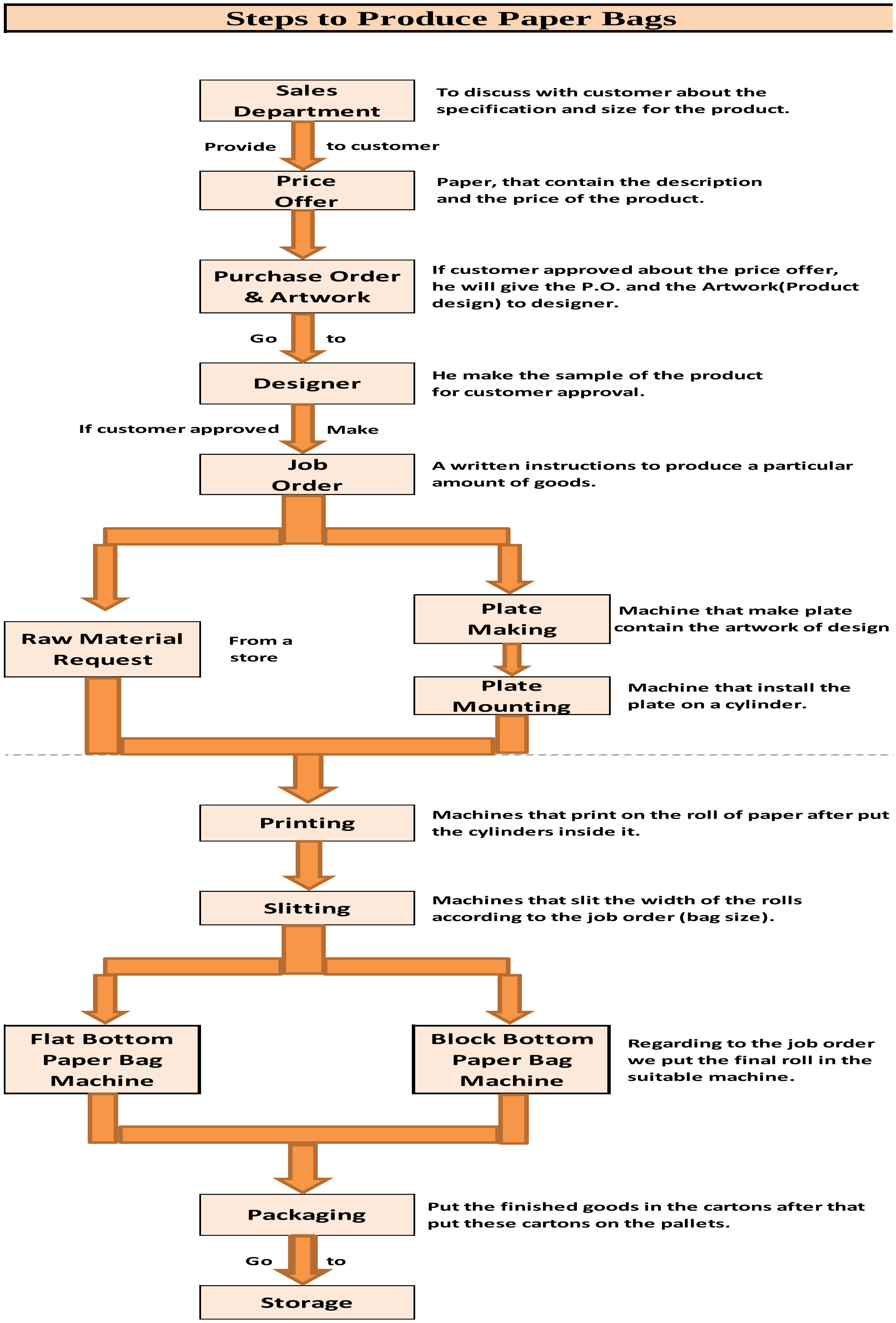

Figure 2, Steps to produce paper bags

a. Feeding the Paper Roll and Folding

The paper bag making process begins with feeding the paper roll in the unwind section. The unwinding unfolds the paper roll into the various parts of the machine. Unwinding occurs at a fixed tension as required. Too much tension may exceed the tensile strength of the paper roll, and this may shear the paper roll apart, damaging the paper. A lot of time might also be wasted while fixing the problem because the machine has to be halted before the process resumes. Friction brake or pneumatic brakes sustained the tension to the required amount. The paper film unwinds as needed to achieve the appropriate folding in the infeed stations. In this way, feeding can be described as a sporadic operation that goes on until the appropriate length is achieved in the rewind section.

b. Printing Paper

Printing begins when machines that print on the rolls of paper are engaged while the cylinder is placed on it. Once the plate is fitted on the cylinders, the cylinder is fixed inside the three printing machines. The printing machine, also called the flexographic machine, has different printing stations for different colors summing up to eight colors. The number of plates installed depends on the number of colors that the customer needs for their block bottom paper bags. The printing is done on a thick roll of paper, and depending on the size of the bags required, the thick roll is taken to the slitting machine. The printing machine prints the labels as per the customer's requirements. Here, the number of plates used for printing the labels depends on the number of colors contained in the artwork. For effective printing, the colors should match to ensure high-quality labels that would please the customer. The color mixture enables the machine operators to establish the perfect colors for the labels. The plates should also be aligned in such a way that each color is printed to its right position. Poor choice of color or incorrect alignment of plates can lead to a large amount of waste. Print mark panels contain a film registration device that acts on the graphics. The registration is necessary since it allows for slight adjustments for precise tip placement of sealing as well as bag cutting. The choice of printing machine depends on the type of material to be used as well as order specifications.

c. Paper Slitting

The slitting machine reduces the width of the roll depending on customer requests regarding the size of the paper bag. Regarding the job order, the slit roll is fed into a suitable machine. There are two machine-types, for the flat bottom paper bag, and the block bottom paper bag. The material is passed through cutters with sharp blades that move up and down as they cut through fabrics. The cutting process is very crucial and requires much accuracy to achieve the most accurate sizes and shapes. Additionally, one end should be left open while the other end is left sealed. When a paper is left open at both ends, it becomes waste.

d. Paper Bag Formation

As soon as the slitting process ends, the paper bag formation process begins. At this stage, slit film is transferred to the formation section. Fabrication of the paper material to form the paper bag takes place here with three machines being involved. The main activities here involve folding and sealing. The material is glued at regulated temperature and time to allow for perfect sealing of the bags. Effective sealing is provided by some heat-sensitive components, and the sealing time is controlled depending on the thickness and length of the material being used. This means that material with higher quality would require a higher temperature as well as longer sealing time. Automated hardware or accessory attached to the machine maintains the temperature and time for the sealing element. After heating, the paper bags pass through several cooling rollers along the chiller units to allow for perfect sealing. Most crucial is a machine that conforms to what is recommended for any particular bag design.

The application of glue follows cutting and folding processes. Attaching one of the open ends of the paper takes place here. The compartment with glue spreads it on edges of open. Attaching and combining of several cut pieces takes place here. The glue is applied both in a transversal and longitudinal manner whereby the material is passed over to the end folding stage. The end folding contains several rollers that press the almost finished paper bags to ensure they stick intact as well as ensure they are ready for packing. The bottom of the block bottom bags is folded appropriately such that several of them are grouped and packed.

e. Packaging the Finished Bags

When all phases have been completed, the bags are moved to the stacking section. Here, the bags are stacked together and packaged before being moved to the stores or delivered to the clients.

3.1.2 Producing Paper Bags Common Defects

This section reflected on the major causes of defects in the production line. The common defects include availability time, performance, and quality. The causes are explained in the following sections.

i. Machine Availability Time

At Falcon Pack, there are several defects that result in reduced availability. A lot of time is lost due to several reasons like maintenance time. In case of damaged belts or a belt replacement, it takes .5 hours to fix the problem. Another reason for time wastage is broken gear teeth that waste about 10 hours in every year. Additionally, defects in the glue pump take 10 hours to repair while nozzle problems in the machines consume 3 hours. Belt defects are recurrent as a result of the purchase of low-quality belts and the absence of maintenance. Additionally, it takes 4 hours on average to set everything when switching orders. This is contributed by time spend in fixing the plates, times spend in fixing the paper rolls, calibrating the machine parts, and finding the right color. After completing a job order, it takes 5 hours on average to clean the different sections of the machine before starting a new order.

Depending on different factors, a lot of time is wasted annually, which contributes to reduced performance of the machine. This is a big challenge because in such a big company, every minute counts, while every minute wasted affects the machine performance in a significant way. Wasting time also limits the number of orders that the company can take at any given time. For instance, a customer who needs a quick solution to packing bags may have to find a solution from other competitors if they cannot be served at the right time. Reduced availability limits the number of customers that Falcon Pack Company can take at any given time, and as a result, the company has lost some of the biggest and most reliable customers to their competitors. Therefore to improve availability, every factor that contributes to time wastage should be controlled for good business and reliable services.

ii. Machine Operating Speed

The high performance of any machine reflects high productivity for the company that owns it. Consequently, reduced performance reflects low productivity for the company. At Falcon Co., there are many reasons for reduced performance. One of the reasons is working at a slower speed than the ideal speed for the machine. The ideal speed is 60 meters/minute, but the company chose to operate the machine at 50 meters/minute to prolong the lifetime of the machine and reduce mistakes. Besides, different thickness of the material requires different speeds for better results. For instance, materials with very low GSM can only be operated at a reduced speed to avoid extreme tension that may result in the snapping of the paper material while operating. Also, the set speed for the machines should be lower to reduce wastage and improve observation. Using less speed also reduces the consumption of electricity and also allows the workers to count the pieces efficiently.

The performance is also affected by wastage while starting and during the end of the process of paper bag making. During that instance, the waste ranged from 10 to 50 meters. This means that if the machine is operated at a higher speed, the wasted during the setup and end of the process may increase. However, there are still some instances where the machine may be operated at the ideal speed. For example, in scenarios when the material has a higher GSM and can withstand the tension relative to the ideal speed. Additionally, when everything has been set up and ready, the speed can be adjusted to the ideal speed to improve productivity on any given day.

iii. Product Quality

The ability of any processing company to retain and win more customers rely on the quality of the products they produce (Izogo& Ogba 2015). At Falcon Company, they put more emphasis on quality, although there are several factors that affect the quality of paper bags they produce. Here, the problems that contribute to redundant quality were discussed. One of the factors is printing problems. If the output colors for labels do not match the customer's specifications, the customer might reject the bags and all the bags produced become waste for the company. This occurs when the color is either too light or too dark or when the labels are printed on the wrong spots on the packing bags. The fault might go to either the workers, the plate designers, or to the person who brought the order and failed to clarify specific colors to be used. When this happens, the customer might refuse to buy the product, and the company may have to repeat the process at their expense. While losses may be incurred, the time that could have been spent doing other orders is wasted as well.

Another thing that contributes to the redundant quality of packing bags is slitting problems. While slitting the material to different dimensions, the machine operator may make mistakes while taking the dimensions of different sizes of packing bags. When this happens, the dimensions of the bag may not match what the customer had requested. Depending on the amount of material that had been consumed before the problem was detected, a lot of material may become waste when the customer rejects the order and sends a request for the right product to be produced. Another defect that might occur in the slitting stage is the uncontrolled movement of the cutters. In such a scenario, the output of the slitting process may result in a material with irregular dimensions, and if used for bag making, the bags produced may have unnecessary dimensions and poor quality. The cutter movement is usually controlled by the operator, and any faults detected should be fixed to prevent further wastage.

Other defects may occur when the wrong material is used for a particular order. A thorough and careful test should be done on the material before it is subjected to designing and making of paper bags. Testing procedures vary depending on where the packages are to be used, and for what purpose. While testing the material, a chemical test should be done to assess the pH of different elements of the material such as sulphates, chlorides, compatibility with chemicals, as well as alkalinity. Additionally, a mechanical test should be done to examine the effect of too much tension, to fold, to crease, and so on. Furthermore, it is crucial to do an environmental test on the material to assess permeability, moisture absorption, as well as the effects of odors, gases, water, oil, and light transmission.

Apart from testing the material, failure to check packages may also result in some defects that diminish quality. The mechanical test may be performed mainly to protect the packages against different hazards of transportation. Some of the mechanical risks include shock, puncture, vibration, and compression. Environmental hazards include temperature, light, pressure, contamination, gases, and moisture. All the tests described certifies that the subsequent product complies with what the customer had specified. Other tests done to the equipment or the surrounding environment as well as those conducted on the production process are regarded as in-process control to improve quality.

There are several instrumental techniques that are employed for packaging control. Such techniques include; spectrophotometry to check light transmission, chromatographic methods to check color, thermal analysis to check effects of heat, Gas transmission examination, leak detection, physical test, and X-ray Fluorescence Analysis. All those tests are done to ascertain that the ideal requirements for goods packaging are met. The ideal requirements for an ideal packaging material include;

- The ability to hold the product without wastage by permeation, leakage, or wastage.
- It should protect the product from extreme conditions of the environment like moisture, air, and light during storage.
- Protect the product against harmful gases.
- The strength of the material should be able to endure shocks during storage, transportation, etc.
- It should allow safe, convenient, and efficient use of packaged content.
- Material that doesn’t interact with content in it.
- Must be able to enable easy identification.

- The closure must prevent leakage.

The other factor that tampers with the quality of the packing bags is the defects related to glue type. Sometimes the type of glue used might not be suitable, or the storage conditions might have changed its quality. This may result in poor gluing whereby some sections of the paper bag, especially the block bottom base might have some openings. A poorly glued packing bag might not be right for any product, especially contents that might leak. During the inspection of the bags, all poorly glued bags are separated from others, and gluing might have to be done manually, leading to poor quality bags. When considering the packages for pharmaceutical products, closure is an essential consideration. The packing bag must be designed in a way that would allow easy removal of the article contained in it. It should also deliver an adequate standard of protection, prevent contamination, and minimize content loss.

3.2 Process Measuring

The system output is the block bottom paper bag while the input is the paper that is input in the machine. The machine has several components that include belt and conveyor, MS frame, folding machine, electronic circuit, and motors. The paper is input in the respective machine that passes the paper sheet to the folding mechanism using conveyor belts. The lead screw applies glue to the folded paper. The three machines used are for lead screw, operating conveyor, and another for folding. This section explains the approaches as well as tools used to achieve the objective of this dissertation. All the elements which are relevant to this study, including the interview methodologies and empirical approaches have been evaluated and applied to establish a flawless structure and basis for this study.

Since the aim was to identify the causes of reduced performance, reduced availability, and reduced quality and suggest ways to improve the mentioned variables, an inductive tactic was followed to collect data. The reason is to have a better understanding of the findings and try to develop a long-lasting solution as opposed to just conducting the study. The inductive method will be derived from the observation, which will be analyzed and transformed to build a theoretical perception.

3.2.1 Measuring Areas

Availability data, performance data, and quality data were collected. Manual collection of data was done through observation, empirical method, and interviews from March 2019 to August 2019, since Falcon Pack did not have any existing database where data was available. At some point, data calculations had to be done since the formulas needed to change. Calculations for Availability percentage (E) involved planned production time (D), runtime (C), setup time (B), and available hours (C). Availability is usually calculated as a ratio of run time and planned production time:

$$Availability\ Percentage\ = \frac{Run\ time}{Planned\ production\ time} \times 100\%$$

$$Run\ Time = \ Planned\ Production\ Time - \ Stop\ Time.$$

Stop time includes all unplanned stops or breakdowns or planned stops like changeovers, which halts the manufacturing process.

Thus, $Run\ Time = Planned\ Production\ Time - Stop\ Time$

$$Planned\ Production\ Time = \ Total\ Available\ hours - \ Breaks$$

Or else,

$$Planned\ Production\ time = \ Run\ Time + \ Stop\ Time$$

The correct formula for calculating machine Performance is:

$$Performance\ \% = \frac{Ideal\ Cycle\ Time \times Total\ Count}{Run\ Time} \times 100\%$$

The set standard speed for the machine is 50 meters/minute. Whereas the ideal speed for the machine is 60 meters/minute, the company uses 50 meters/minute to protect the machine from mechanical wear and tear and to prolong the lifetime of the machine. To analyze performance, the ideal speed of 60meters/minute (equal to 1/60 ideal cycle time) was used to calculate performance,

The paper wastage quantity in tones across the three machines was found from the difference between the input quantity and the good product. The quality percentage was obtained using the formula:

$$Good\ product = Total\ input - quantity\ wasted$$

$$Quality\ \% = \frac{Good\ product}{Total\ input} \times 100\%$$

All quality factors were expressed in terms of percentage and total quality was the sum of the quality percentage contribution of the three machines. Wastage percentage resulted from printing, paper quality, slitting, and glue type. By doing the analysis, it was possible to find the contribution of each stage to the quality reduction and establish the stage with the highest wastage percentage.

3.3 Process Analysis

For this dissertation, the selected areas were put forward by considering the most relevant factor in relation to customer satisfaction. The Pareto analysis was used to identify the main causes of defects in the production line, and also to analyze customer satisfaction. The fishbone diagram was used in Falco Pack Company to gather and analyze data for workers to understand and interpret information correctly. This involved extensive planning and gathering relevant data concerning the end-users. The feedback from the customers was prudently monitored and evaluated to produce high-quality products. Feedbacks were carefully monitored to help in understanding the possible problems and the root causes. Concept Draw is a perfect Cause and implementation Diagram Creating. It allowed in identifying the possible causes of problems. Cause and Effect grouping into main categories assisted in identifying the causes of variation. The diagram in Figure 3 illustrates relationships among several factors.

The fishbone illustration, as shown in Figure 3, shows the elements of Equipment, Materials, Process, Environment, Management, and People, all that affect the overall problem. Regression and statistics, as well as Pareto analysis, were used to improve all the processes at Falcon Pack Company. The Pareto analysis was the major tool applied, especially in decision making. Regression analysis was mainly used to check for variations in customer satisfaction, before and after the process improvement.

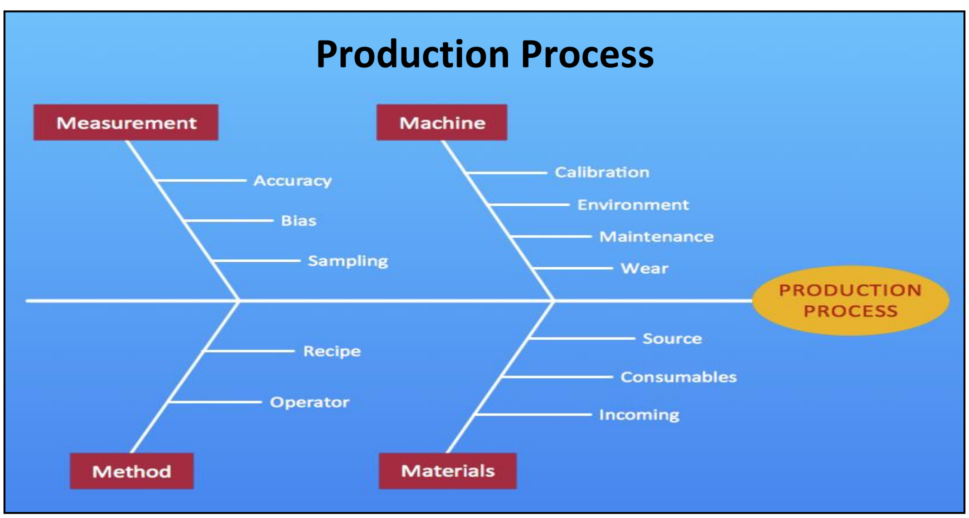

Figure 3, the fishbone model for the production process.

Slameto 2016

3.4 Process Improvement

Statistical Process Control (SPC) is the primary monitoring tool that was used during the phase of process improvement. The main goal of SPC is to monitor the process variations to reduce wastage and improve the performance of the process. The limits of quality and performance needed to be controlled first by measuring and then establishing acceptable standards of quality and performance. The brainstorming phase was carried out to try to identify the root causes and possible solutions. The other phase under improve was to regulate the process target by improving various factors that hinder performance and quality. After establishing the solutions, the causes of rejection were analyzed using the fishbone diagrams and Pareto Charts. The causes for low utilization percentage for the machines were analyzed while Total Productive Maintenance was established to improve availability.

3.5 Process Control Phase

This phase involves retaining the improvements that have been realized by the organization team. Additionally, the production team conducts periodic appraisals of various results as well as strict observance of the process return. Various strategic controls were executed by the members of the project through a progressive review of goals and targets progress. The members would meet periodically to assess the development of improvement steps and their influence on the overall goals of the company. The major challenge of implementing Six Sigma is not experienced while making process improvements, but when trying to sustain the attained results. Therefore in the control phase, Pareto charts will be employed periodically to monitor the quality, availability, and performance of the block bottom paper bag machines.

CHAPTER IV

RESEARCH RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the data that was collected from the Falcon Company. It also presents the analysis of the data to generate availability percentage, performance percentage, and quality percentage. The analysis also includes the used of cause and effect diagram to identify the possible causes of defects and suggest solutions.

4.2 Machines Availability Data

Analysis of availability data helped Falcon Company to maximize output using the available resources. This means improving productivity in the efforts to improve profit margins and business growth without cost increment. Availability data is presented in Tables 1, 2, and 3 for machines 1, 2, and 3, respectively. The runtime is the actual time of operation of the machine, which depends on the number of orders and the ability of the machine to remain functional. The setup time is the time taken to prepare the machine to start the printing and making bags. The data for availability was an instrumental tool that was used to benchmark, measure, and identify the possible improvement areas. With the manufacturing process being someway complex, Falcon Company had a bigger opportunity to apply Six Sigma to improve availability from order acquisition to finishing and packaging. By focusing on the main drivers of availability, it was possible to pinpoint weaknesses in operation, categorize their impact, find remedies, and track process improvement. The most probable thing that comes to mind when one takes availability to consideration is the downtime, whether scheduled or unscheduled. Downtime is a contribution of several sources but the most dominant is maintenance. The other key contributor to downtime is different forms of delays such as waiting for material, the lateness of workers, waiting to get customers, and waiting for plates to be processed.

Table 1: Availability data for Machine 1

Machine 1	**Available Hours (A) (Hours)**	**Set up Time (B) (Hours)**	**Run time (C) (Hours)**	**Planned production time (D)= B+C (Hours)**	**Availability % (E) =($\frac{C\times 100\%}{D}$) (%)**
18-Jan	546	115	334	449	74.48%
18-Feb	546	36	73	109	66.97%
18-Mar	546	72	221	293	75.43%
18-Apr	546	90	172	262	65.64%
18-May	546	86	314	400	78.50%
18-Jun	546	82	225	309	73.29%
18-Jul	546	92	237	329	72.04%
18-Aug	546	53	125	178	70.22%
18-Sep	546	67	164	231	80.00%
18-Oct	546	43	95	138	68.84%
18-Nov	546	62	129	191	67.54%
18-Dec	546	78	217	295	73.56%
Average	**546**	**73**	**192.1667**	**265.3333**	**72.21%**

Table 2: Availability data for Machine 2

Machine 2	Available Hours (A) (Hours)	Set up Time (B) (Hours)	Run time (C) (Hours)	Planned Production Time (D)=B+C (Hours)	Availability % (E) =($\frac{C\times100\%}{D}$) (%)
18-Jan	546	90	316	406	77.83%
18-Feb	546	15	45	60	75.00%
18-Mar	546	91	240	331	72.51%
18-Apr	546	90	361	451	80.04%
18-May	546	102	378	480	78.75%
18-Jun	546	49	192	241	79.66%
18-Jul	546	32	169	201	84.08%
18-Aug	546	25	97	122	79.51%
18-Sep	546	60	250	310	80.65%
18-Oct	546	56	152	208	73.08%
18-Nov	546	59	217	276	78.62%
18-Dec	546	100	227	327	69.42%
Average	**546**	**64**	**220**	**284.417**	**77.43%**

Table 3: Availability data for Machine 3

Machine 3	Available Hours (A) (Hours)	Set up Time (B) (Hours)	Run time (C) (Hours)	Planned Production Time (D) (Hours)	Availability % (E)= =($\frac{C\times 100\%}{D}$) (%)
18-Jan	546	57	349	406	85.96%
18-Feb	546	35	74	109	67.88%
18-Mar	546	88	341	429	79.49%
18-Apr	546	88	235	323	72.76%
18-May	546	84	301	385	78.18%
18-Jun	546	27	200	227	88.10%
18-Jul	546	48	164	212	77.35%
18-Aug	546	22	70	92	77.78%
18-Sep	546	43	276	319	86.52%
18-Oct	546	53	171	224	76.34%
18-Nov	546	48	235	283	83.04%
18-Dec	546	34	243	277	87.73%
Average	**546**	**52**	**222**	**274**	**80.09%**

Some of the causes such as waiting for customers to bring orders are unavoidable, although most of the causes can be addressed by proper scheduling and ensuring that all materials, plates, and aniloxes are made available, well prepared, and ready when needed. For example, for machine 1 data presented in Table 1, it is clear that the highest availability percentage (74.4%) was realized in January 2018 when the run time for the machine was 334 hours while the time wasted was very low. Contrariwise, the lowest availability percentage (66.97%) occurred in February 2018 when the run time reduced to 73 hours. Addressing time wastage can produce a positive result on availability. For example, the availability percentage for the three machines improved in June 2018 because the machines were operated at the minimum set-up time. The two ways of improving availability are lessening wash-ups and shortening the set-up time and changeovers. Faster set-up time is the key because it has a significant effect on the run time and the production rate. The make-ready time can be reduced by simplifying the set-up process. For instance, the aniloxes and the inkjets may be optimized to reduce the error rate. Machine operators can optimize the process by determining the correct volume of aniloxes and the ideal ink-carrying capacity. Even the slight differences can produce a bigger impact on the density of ink and therefore they should be avoided. The time wasted between different orders also led to reduced percentage availability. Standardizing as well as simplifying processes and materials can increase the productive period.

Further analysis was done using charts with the data that was collected for the three types of machines. The graphs are as shown in Figures 4, 5, and 6. The charts indicate several critical areas that affect availability and productivity overall, reducing the annual average availability percentage to 72.21%, 77.43%, and 80.09% respectively, for machines 1, 2, and 3. The findings suggest that the factors affecting productivity were in some way related to leadership, equipment failures, materials, rework employee’s motivation, dynamics, tools, and order availability. From the graphs derived, it can be seen that the availability percentage increased between February and May before it went down between June and August. During the February and May, the run-time for all machines was high while the set-up time was lower compared to June and August when the run-time went low while the set-up time remained high. Several factors increase the set-up time, which includes activities like rework, few machine operators, printing many colors, faults at various sections of the machine, and poor conditions of the environment. The run-time may also decrease as a result of few job orders, machine breakdown or shortage of paper material.

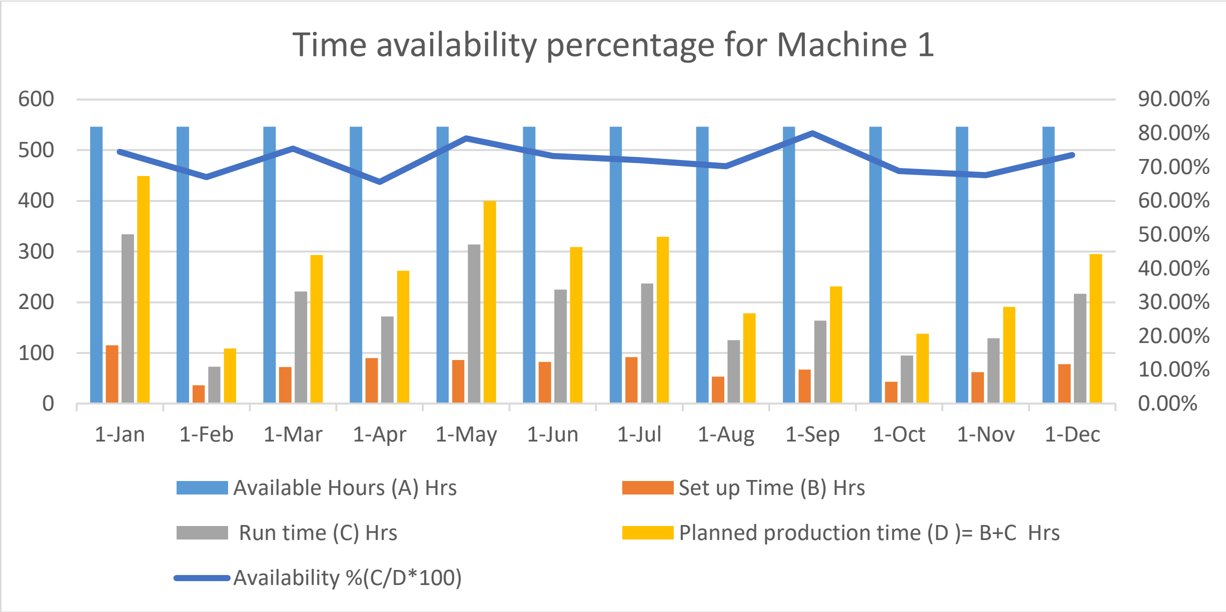

Figure 4, Time availability breakdown for Machine 1

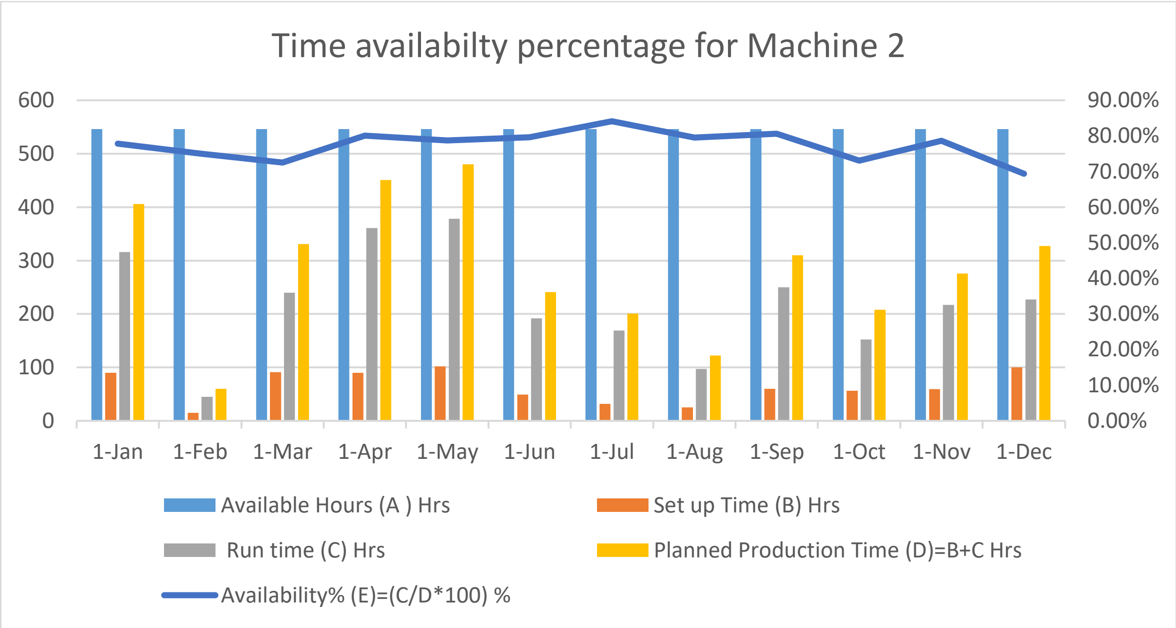

Figure 5, Time availability breakdown for Machine 2

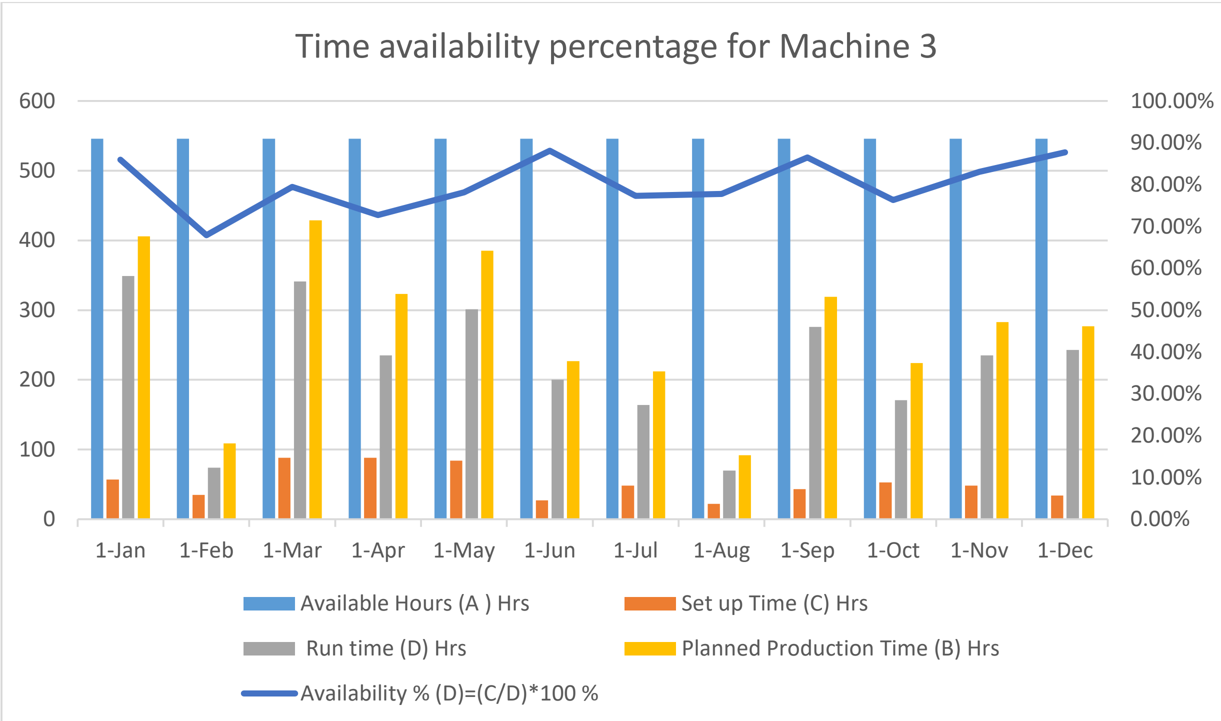

Figure 6, Time availability breakdown for Machine 3

A further analysis was done using a Pareto analysis to examine the root cause of reduced availability. The root causes of reduced availability are presented in Table 4. The data represent the time loosed within a duration of 546 hours, which is the typically available hours in Falcon Pack Company.

Table 4: Reduced time availability causes

Cause of reduced availability	Time lost (Hours)	Percentage of time lost (%)	Cumulative percentage
Long set-up time	27	25.47169811	25.47
Lack of orders	24	22.64150943	48.11
Unplanned downtime	19	17.9245283	66.04
Calibration	12	11.32075472	77.36
Planned maintenance	8	7.547169811	84.91
Rework	6	5.660377358	90.57
Shift changeovers	7	6.603773585	97.17
Power failures	3	2.830188679	100.00

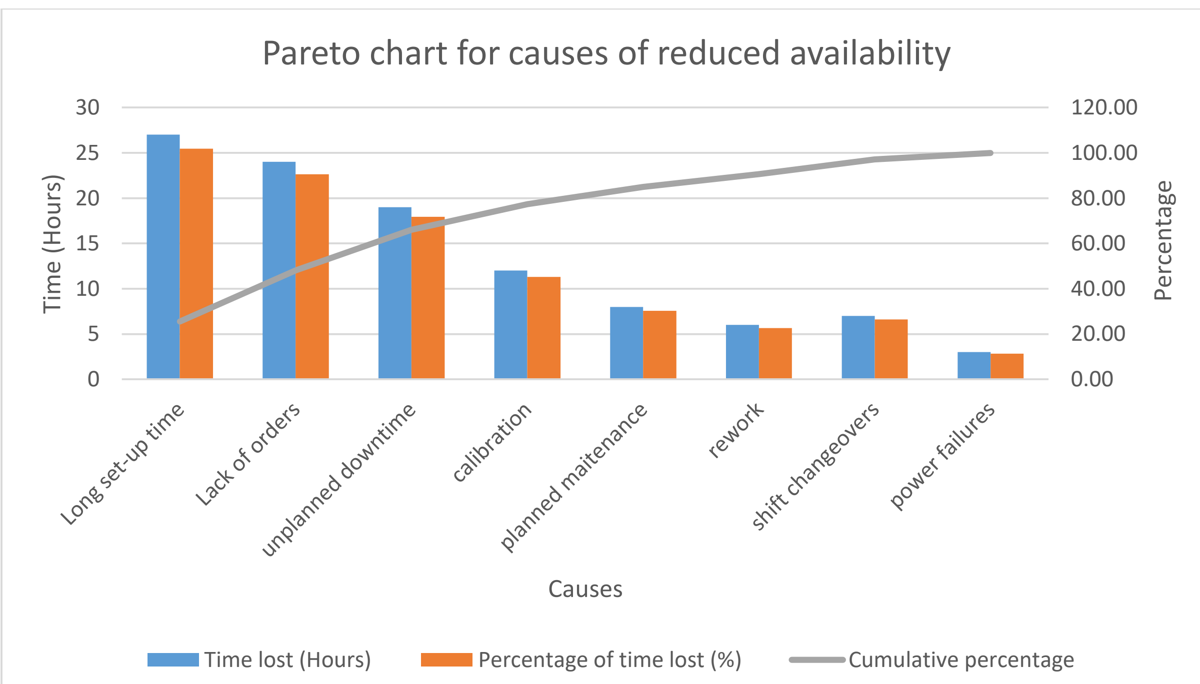

Figure 7, Pareto analysis for reduced time availability

The antecedents representing the vital few include long set-up time, lack of orders, and unplanned downtime. These three causes combined account to 37.7% of the causes. The useful many antecedents include calibration, planned maintenance, rework, shift changeovers, and power failures. To improve availability, all the causes of long set-up time such as untrained workers, few workers, and poor preparation and organization should be given much attention by the Company. Additionally, the company should facilitate its marketing plan and advertising to attract the new client that would bring more clients to the company. Unplanned downtime can also be dealt with by proper maintenance and replacement of defective parts of the machine. Furthermore, all causes of rework, power failure, and time wastage in shift changeovers should be addressed.

Presented in table 5 is the availability statistics of the three types of machines. The data shows the planned production time, run time, setup time, and availability percentage. Figure 8 shows a chart that compares the availability of machines 1, 2, and 3.

Table 5: Annual average utilization percentage for the three in-line machines

Annual Average			
	Machine 1	**Machine 2**	**Machine 3**
Planned Production Time (Hrs)	265.33	284.42	274.00
Run time (Hrs)	192.16	220.42	222
Setup time (Hrs)	73	64	52
Availability percentage (%)	72.21	77.43	80.09

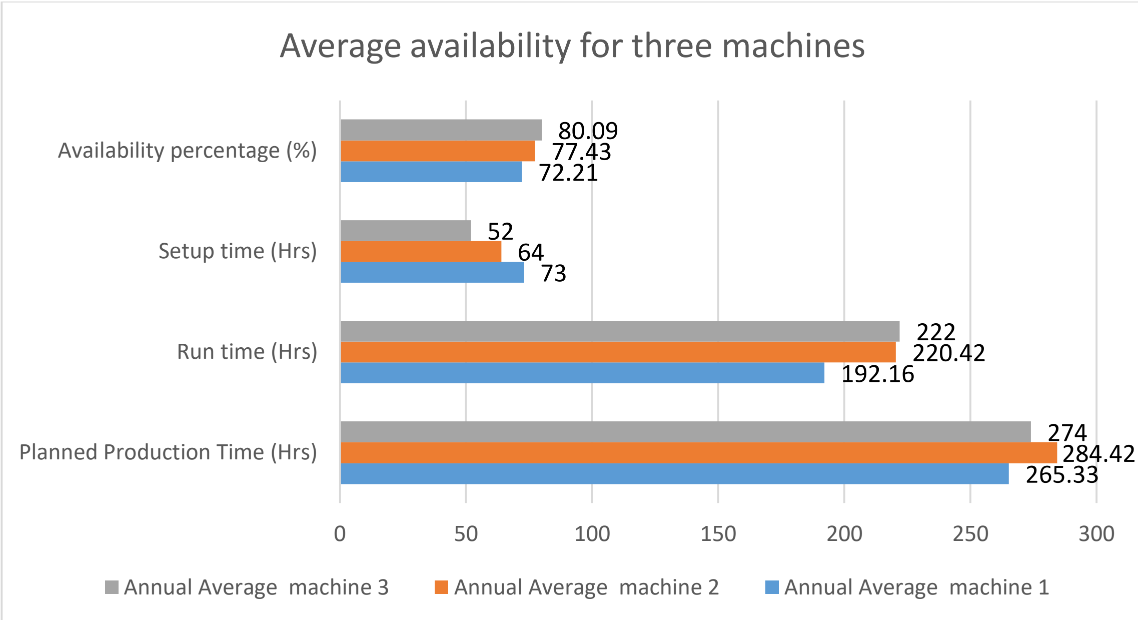

Figure 8, Comparison of time availability for the three in-line Machines

The scaled analysis shows that machine 3 had the highest availability percentage (80.09%) although more than 50% of the total available hours were wasted. The higher percentage of availability was influenced by a reduced set up time and higher run time. However, the availability percentage of machine 1 was very low (72.21%) because of the short run time coupled with a longer set up time. The chart reveals two ways of increasing availability; one way is by increasing the run time and the other way is by decreasing the set up time. Apart from that, the company should maximize the total available hours in a day by reducing both planned and unplanned stoppages.

4.3 Machines Performance Data

Performance defines the relationship between the ideal speeds of operation of the machine to the real speed applied in the production process. Alternatively, it describes the target duration to produce the required quantity of pieces compared to the actual duration. Performance covers minor stoppages like roll changes, web breaks, or plate cleaning of which some can be controlled while others cannot. Using the correct aniloxes and fingerprinting delivers the proper ink laydowns, which help in cleaning of plates, increasing the operating speeds, and getting rid of color problems and many other issues in the press stage. Machines at Falcon Pack Company are operated below the ideal speed of 60 meters per minute although there are several reasons for this. The dominant reason is to reduce the wear and tear of moving parts of the machine and to reduce the degree of errors. However, improving the production process, color consistency, and ink transfer allow production at faster rates. In a production process, a small increase in the speed of production improves machine effectiveness, utilization rates, productivity, and the most important, profitability.

Machinery resources in a company enhance the quality of its services while technological resources influence the efficiency of a processing firm. Machinery performance at Falcon Pack is somewhat low, which is resulted by a high level of material wastage and operating the machinery below the ideal speed. Tables 6, 7, and 8 show the performance data for three in-line machines used for the block bottom paper bag manufacturing. From the statistics derived, the Total Input was set as the independent variable and performance percentage as the dependent variable in the tables presented, the run-time means the actual duration that the machine operated. The actual meter is the total count length of the used material. The Ideal Run Rate is the ideal speed that the machine should be operated to give the maximum performance. An analysis was done using the graphs illustrated in Figures 9, 10, and 11 relating to machine 1, machine 2, and machine 3, respectively.

For the sake of efficient data analysis, the ideal run rate (60 meters/minute) was used to do the calculations and not the real speed (55 meters/minute) used to operate the machines. The reason is that the possible maximum speed of operating a machine is what gives the maximum performance of the machine. The performance loss for machine 1 is very low as illustrated in Figure 9. In 2018, the highest performance percentage (72.14%) was reached in December while the lowest performance percentage (52.21%) was realized in May. The average performance in 2018 was 54.92% which means that more than 45% of the performance was lost.

Table 6: Machine 1 performance

Machine 1	**Ideal Run Rate (A) (Meter/Min)**	**Run Time (B) (Minutes)**	**Total Count (C) (Meter)**	**Performance $(D) = (A * C * 100/B)$ (%)**
Jan-18	60	20,065	717,440	59.59%
Feb-18	60	4,375	153,040	19.20%
Mar-18	60	13,280	500,071	62.76%
Apr-18	60	10,300	402,368	35.58%
May-18	60	18,845	748,436	66.19%
Jun-18	60	13,485	489,967	60.56%
Jul-18	60	14,360	485,765	56.38%
Aug-18	60	7,635	279,956	61.11%
Sep-18	60	9,855	325,724	55.09%
Oct-18	60	5,680	225,622	48.58%
Nov-18	60	7,740	298,563	64.29%
Dec-18	60	13,020	544,614	69.72%
Average	**60**	**11553**	**430964**	**54.92%**

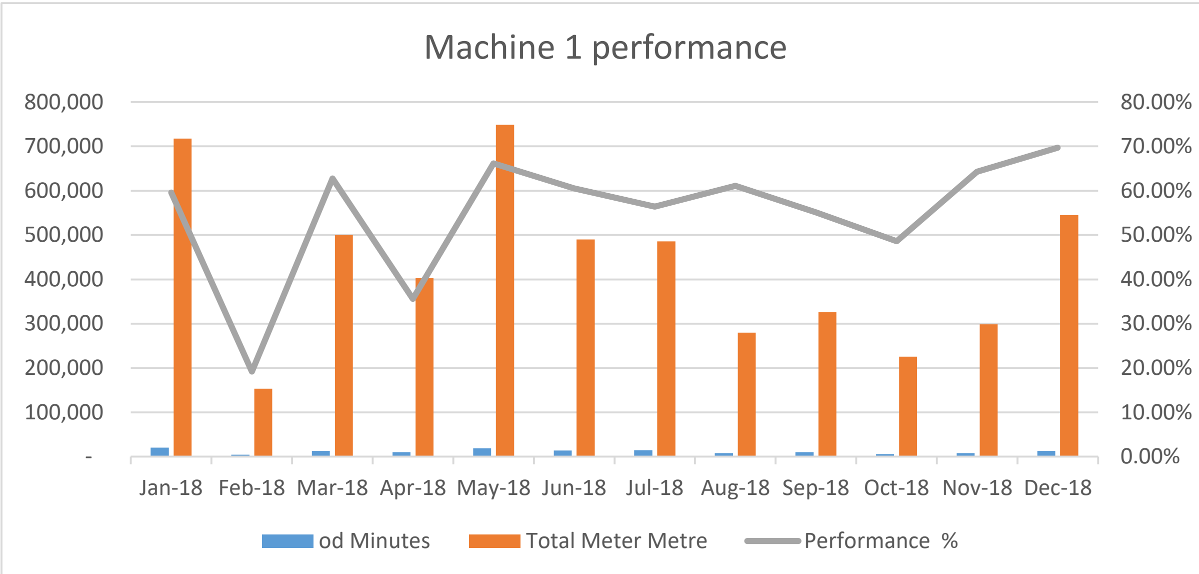

Figure 9, Performance analysis for Machine 1

Table 7: Machine 2 performance

Machine 2	**Ideal Run Rate (A) (Meter/Min)**	**Run Time (B) (Minutes)**	**Total Count (C) (Meter)**	**Performance (D)=(A*C*100/B) (%)**
Jan-18	60	18,985	679,107	59.62%
Feb-18	60	2,680	92,176	57.32%
Mar-18	60	14,420	566,985	65.53%
Apr-18	60	21,665	756,838	58.22%
May-18	60	22,655	709,755	52.21%
Jun-18	60	11,545	476,160	68.74%
Jul-18	60	10,120	410,267	67.57%
Aug-18	60	5,810	190,811	54.74%
Sep-18	60	14,985	598,703	66.59%
Oct-18	60	9,095	289,652	53.08%
Nov-18	60	13,038	559,906	71.57%
Dec-18	60	13,605	588,933	72.14%
Average	**60**	**13217**	**493274**	**62.28%**

The performance for machine 2 was highest in December (77.51%) while the lowest performance was in August (51.55%) as shown in Figure 10. However, the total count (meters produced) was highest in April (756, 838 m). On average, the performance for machine 2 was 62.28% in the year where 493274 pieces were produced.

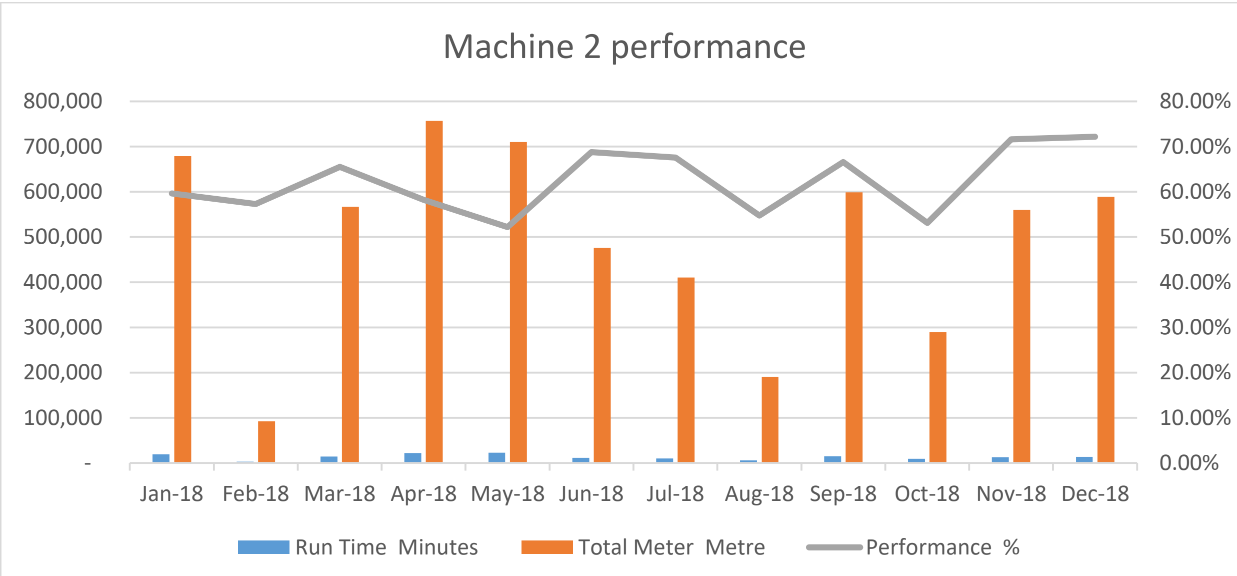

Figure 10, Performance analysis for Machine 2

Table 8: Machine 3 performance

Machine 3	**Ideal Run Rate (A) (Meter/Min)**	**Run Time (B) (Minutes)**	**Total Count (C) (Meter)**	**Performance (D)= (C*100/(A*B) (%)**
Jan-18	60	20,560	970,035	78.63%
Feb-18	60	4,465	172,565	64.41%
Mar-18	60	20,480	720,711	58.65%
Apr-18	60	14,100	529,816	62.63%
May-18	60	18,080	659,737	60.82%
Jun-18	60	12,010	501,328	69.57%
Jul-18	60	9,835	389,280	65.97%
Aug-18	60	4,175	129,145	51.55%
Sep-18	60	16,535	713,895	71.96%
Oct-18	60	10,230	360,596	58.74%
Nov-18	60	14,080	567,420	67.17%
Dec-18	60	14,575	677,850	77.51%
Average	**60**	**159,125**	**6,392,378**	**65.63%**

Table 8 shows the performance data for machine 3. The machine performance was maximum in January with 756,838 meters produced and 78.63% performance. In August, the performance decreased significantly leading to the production of 129 145 meters only, which means the performance reduced to 51.55%. On average, the performance for the machine was 65.63% in the year where 6,392,378 meters were produced. The information is well-presented in Figure 11

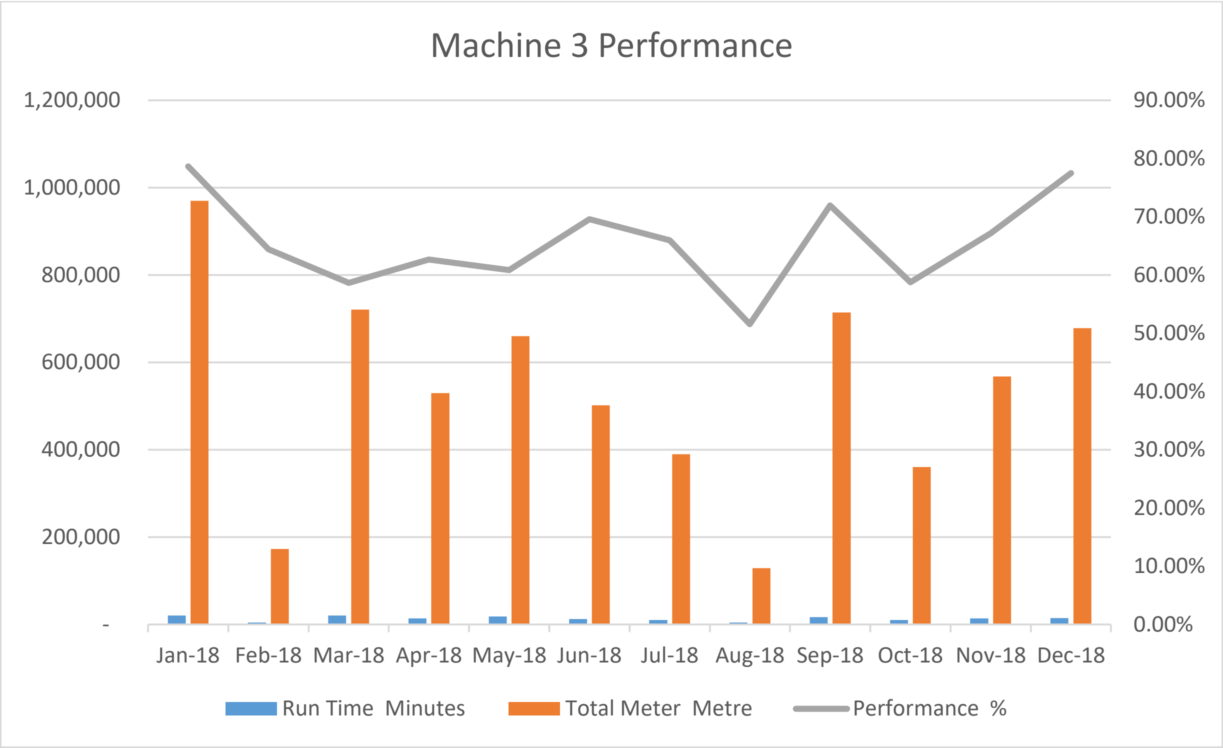

Figure 11, Performance analysis for Machine 3

The graphs reveal that there were some instances when machine performance went high, while in the majority of instances, the performance was narrow. The machine performance was also very low. The performance percentage was 54.92%, 62.63%, and 65.63% for machine 1, machine 2, and machine 3 respectively. The charts also show that performance increases significantly when the total count is high while the Run time is low. However, performance decreases when the gap between the Total Count and Run Time widens as illustrated in August for Machine 3 when productivity went as low as 51.55%. Further analysis was done to examine the causes of low performance as presented in Table 9.

Table 9: Low performance causes

Cause	**Percentage contribution**	**Cumulative percentage**
Employees not adequately trained	34	34
poor supervision	25	59
Lack of operation timeframe	15	74
inadequate resources and technology	14	88
poor communication between shifts	12	100

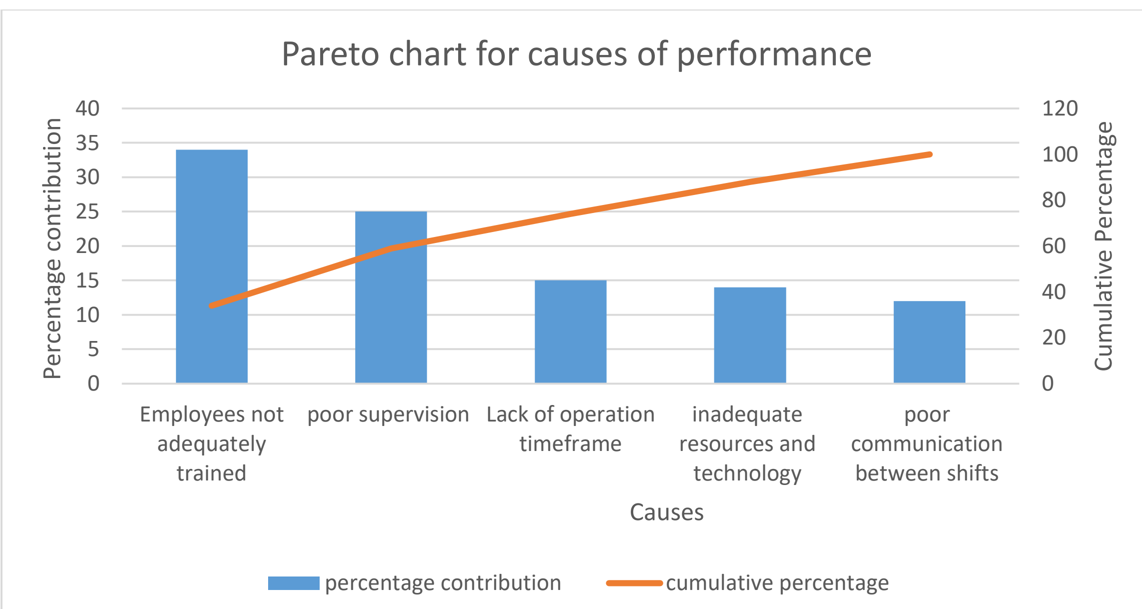

Figure 12, Pareto chart for low causes of performance

Several things resulted in the dip in the performance of the three in-line machines as shown in Figure 12. Firstly, the employees may have inadequate skills and training on the line of paper bag making. A lot of errors, coupled with a long set-up time, leads to a high wastage of the raw material. Secondly, the organization may not have the appropriate systems to back the managers in their lines of duty. The most basic of such a structure is an authority or an accountability framework that specifies the accountability of each employee and the authority they have in doing it. The absence of specified authority or accountability makes the process of achieving high performance very difficult.

Thirdly, the managers of the company might not have specified the exact timeframe of delivering the expected results. Managers are the hands of the organization owners and customers, and therefore, they should use the authority and resources they have to deliver excellent results. Additionally, the level of quality of the output must be clearly stated to ensure that every employee works towards that objective. Moreover, the expected output quantity must be clearly defined for every order in the hands. A high level of performance is impacted by conferring responsibilities to every subordinate manager and workers to ensure accountability for every mistake or success in the company. In general, the company should have the ability to deliver the expected quantity and quality to the customers and within the minimum possible duration of time (JIT) and avoid piling inventories in the warehouses.

4.4 Machines Production Quality

An analysis was done to determine the quality percentage of the three machines for the block bottom paper bags. The total input, wastage quantities, and good products were measured and used to calculate the quality percentage. The results were recorded in Table 10 for machine 1, Table 11 for machine 2, and Table 12 for machine 3. The results indicate that although the quality percentage was very high, the wastage in tons was still very high. To compare the variables, an analysis was done as presented in figures 13, 14, and 15 for machines 1, 2, and 3 respectively. The quality percentage is the representation of a good product compared to the input product. The quality of any output product is defined by the capability of the process to minimize production waste. At Falcon Pak Company, the total waste is a contribution of the production waste and the make-ready waste, either in printing or converting to the block bottom bags.

In January 2018, the total input in machine 1 was 13570.96 Tons, of which the good product after the manufacturing process was 13209.9 Tons. This means that 363 Tons of material was wasted in the process. The quality percentage might look high enough (97.32%), but 363 Tons of material running into waste is very huge when looking at it from a business perspective. Also on December 2018, the total input for machine 1 was 16485.46 Tons with the good product amount being 16148.4 Tons. In terms of percentage, the quality was 97.96% despite a waste amounting to 337 Tons. In general, 2739 Tons of material was wasted from the input of 176828.32 Tons. The data shows that despite a higher quality percentage, the wastage in tons is very high.

Table 10: Machine 1 production quality data

Machine 1	Total Input (A) (Tons)	Good Product (B) (Tons)	Wastage (Tons) = $(A - B)$	Quality Percentage $(\frac{B \times 100\%}{A})$
Jan-18	13570.96	13209.9	363	97.32%
Feb-18	2837.92	2726.9	111	96.09%
Mar-18	16649.3	16428.9	220	98.68%
Apr-18	11459.9	11266.4	194	98.31%
May-18	23047.2	22757.9	289	98.74%
Jun-18	14335.8	14107.1	229	98.40%
Jul-18	14952.6	14640.3	312	97.91%
Aug-18	9038.6	8863.1	176	98.06%
Sep-18	9379	9187.4	192	97.96%
Oct-18	6346	6240.4	106	93.34%
Nov-18	9704.5	9434.7	210	97.84%
Dec-18	16485.46	16148.4	337	97.96%

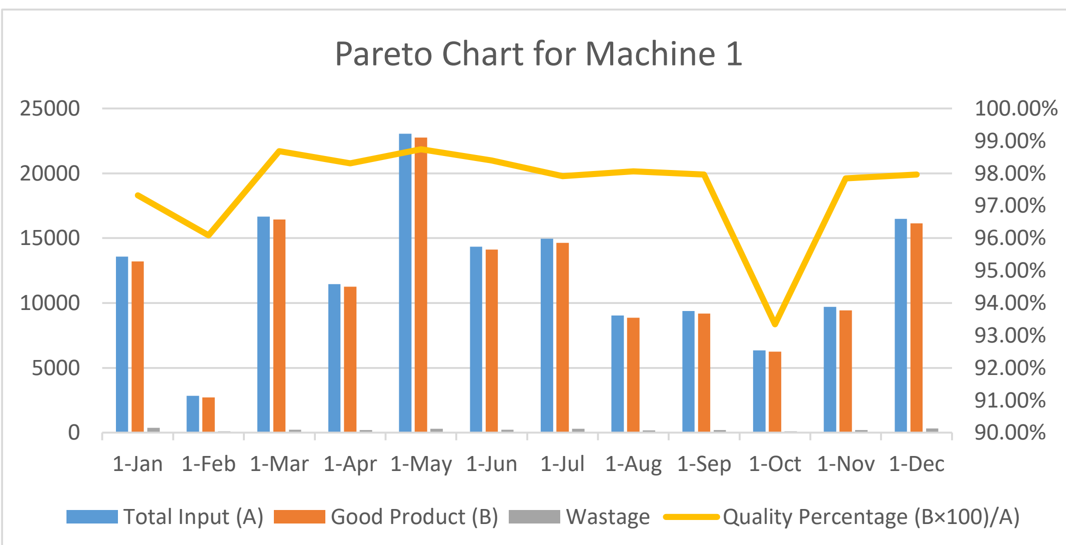

Figure 13, Machine 1 production quality percentage

Machine 2, on the other hand, processed 17979.61 Tons of material in January 2018 with 17684.1 Tons of Good product. This resulted in a quality percentage of 98.36 %. The wastage in tons amounted to 296 Tons. Similarly in December, 17085.5 tons of material were processed, with the process producing 16824.5 tons of good product and 261 tons in waste. Overall in 2018, 174214.32 tons of material was processed through machine 2, with a quality percentage of 98.52% and 2514 tons in waste. Again, the wastage for the year was very high despite the high-quality percentage.

Table 11: Machine 2 production quality data

Machine 2	**Total input (A) (Tons)**	**Good product (B) (Tons)**	**Wastage C (Tons)** $= (A - B)$	**Percentage quality =** $(\frac{B \times 100\%}{A})$
Jan-18	17979.61	17684.1	296	98.36%
Feb-18	2652.45	2620.3	32	98.79%
Mar-18	16996.86	16828.9	168	99.01%
Apr-18	23111.2	22837.3	274	98.81%
May-18	23275.3	22860.9	414	98.22%
Jun-18	13203.5	13013.2	190	98.56%
Jul-18	11764.3	11629.6	135	98.86%
Aug-18	5329	5205.4	124	97.68%
Sep-18	16907.3	16663.2	244	98.56%
Oct-18	9933.8	9754.5	179	98.20%
Nov-18	15975.5	15778.6	197	98.77%
Dec-18	17085.5	16824.5	261	98.47%

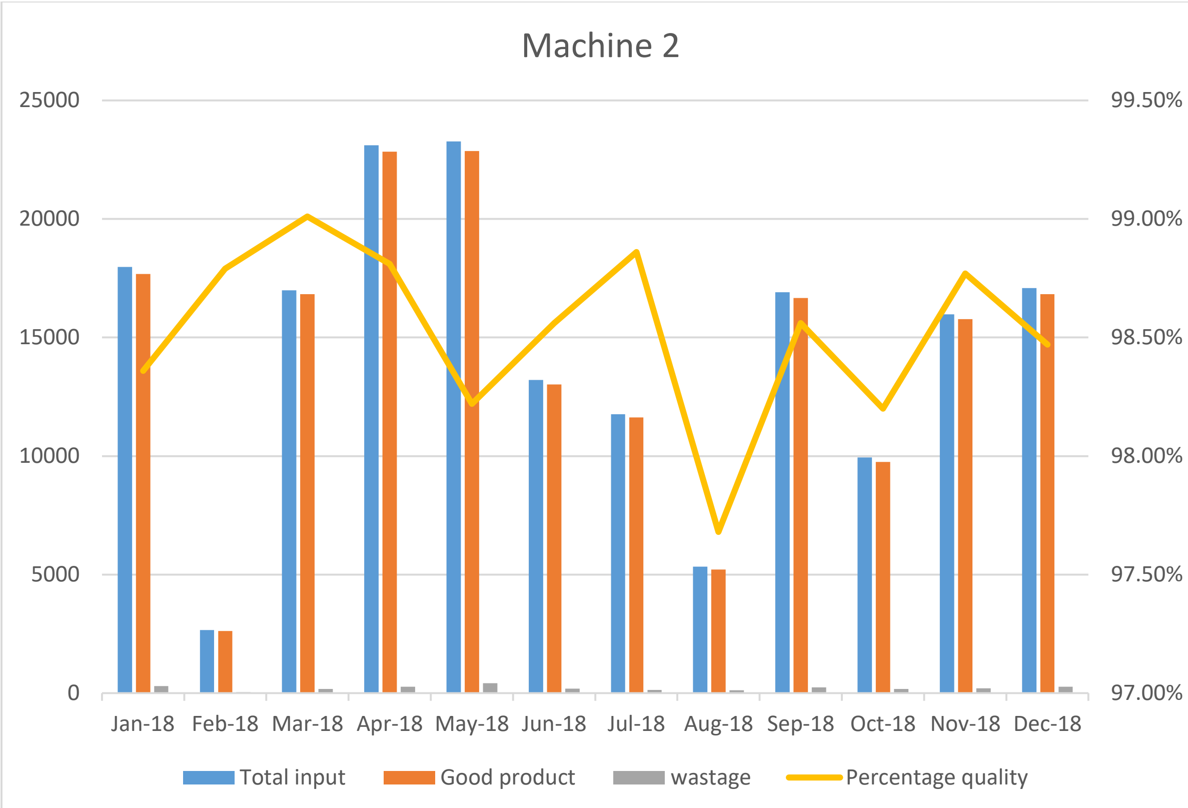

Figure 14, Machine 2 production quality percentage

Things were never different from machine 3 in which the total input for the year was 171,650.04 Tons while the good product was 169,120.59 Tons. This means that the wastage amount to 2501 Tons.

Table 12: Machine 3 production quality data

Machine 3	Total Input (A) (Tons)	Good Product (B) (Tons)	Wastage $(C) = (A - B)$ (Tons)	Percentage Quality = $(\frac{B \times 100\%}{A})$
Jan-18	6884.63	6647.2	237	97.61%
Feb-18	4880.09	4769.5	111	97.73%
Mar-18	24796	24487.4	309	98.76%
Apr-18	17746.1	17525.5	221	98.63%
May-18	20439.4	20128.1	311	98.48%
Jun-18	13833.2	13633.2	200	98.55%
Jul-18	11210	11092.3	118	98.95%
Aug-18	3564.5	3481	84	97.66%
Sep-18	19602	19388.4	214	98.91%
Oct-18	10797	10630.5	167	98.46%
Nov-18	20479	20203	276	98.65%
Dec-18	17418.12	17134.49	253	98.36%

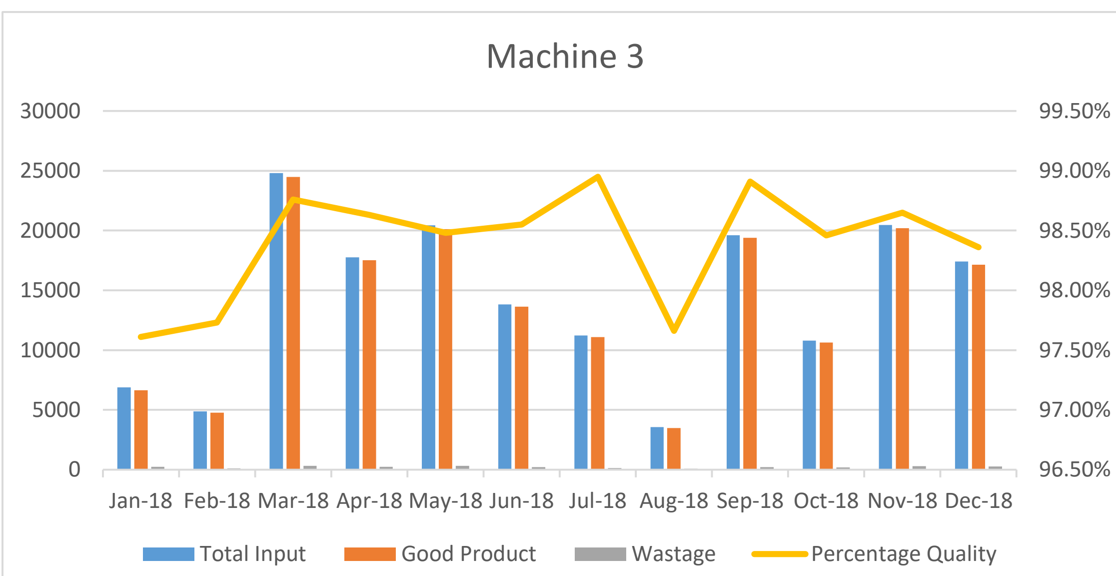

Figure 15, Machine 3 production quality percentage

In contrast, machine 1 has the highest variation between the total input and the good product (Wastage). The wastage quantity related to machine 1 reached 2739 Tons of material, whereas the quality percentage was 97.55%. On the other hand, machine 2 had a wastage quantity of 2514 Tons with 98.52% quality percentage. In contrast, the wastage associated with machine 3 was 2501 tons, which was the least compared to the wastage for machines 1 and 2. However, the quality percentage was 98.4% because the good product for machine 1 was the input for machine 3.additionally, the good product from machine 1 was the input product for machine 2. This explains the reason why the quality percentage for machine 2 appears higher than the quality percentage for machine 3 despite the fewer amount of waste in machine 3.

The charts in Figures 13, 14, and 15 show the quality data for the year 2018. Despite the high figures for quality percentage, the wastage in terms of tons is very high (Wastage= Total input-Good product). For example, the quality percentage in October was 98.33% but the wastage in tons was 150.47 tons, which is a very huge amount of waste, which means that measures must be taken to reduce the wastage. The reduction of quality as a result of paper quality is the leading cause of defects. Slitting also has a large contribution to quality loss. Additionally, glue type and printing losses are very huge for the company. Table 10 shows the data for the quality percentage for machine 1, which is the ratio of good product to the total input. Figure 14 analyzes the data in Table 10, which shows that the quality percentage increased when the total input was high and reduced when the total input was low. For example, the quality percentage remained low in January and February when the input quantities were low. Oppositely, the quality percentage was high between May and August when the total input was high. This means that the Falcon Company can increase the size of orders in the efforts to maximize quality. Small orders lead to high material wastage while quality remains low, and therefore, such orders should be avoided.

The main objective of TQM and Six Sigma is to enable an organization to improve the quality of its products to enhance customer satisfaction. At Falcon Pack Company, there are several activities that determine the quality of the output products. Those activities include printing, slitting, paper quality and glue type. The contribution of each of those activities to quality percentage was measured and listed, as shown in Table 13. The chart in Figure 16 was drawn to indicate the percentage distribution of wasted material as a result of a printing, slitting, material quality, and glue type. It can be seen from the chart that the main contributor of waste is paper quality. The immediate contributor is printing, which is followed by slitting, while glue type has the least wastage percentage distribution.

Table 13: Percentage defects in terms of printing, slitting, paper quality, and glue type.

Month	**printing**	**slitting**	**paper quality**	**Glue type**
Jan-18	23	19	44	14
Feb-18	13	18	53	16
Mar-18	17	16	48	19
Apr-18	23	19	46	12
May-18	21	14	55	10
Jun-18	15	18	53	14
Jul-18	19	17	52	12
Aug-18	22	13	51	14
Sep-18	19	23	47	11
Oct-18	22	20	45	13
Nov-18	18	25	41	16
Dec-18	27	20	38	15
Average	**19.91667**	**18.5**	**47.75**	**13.83333**

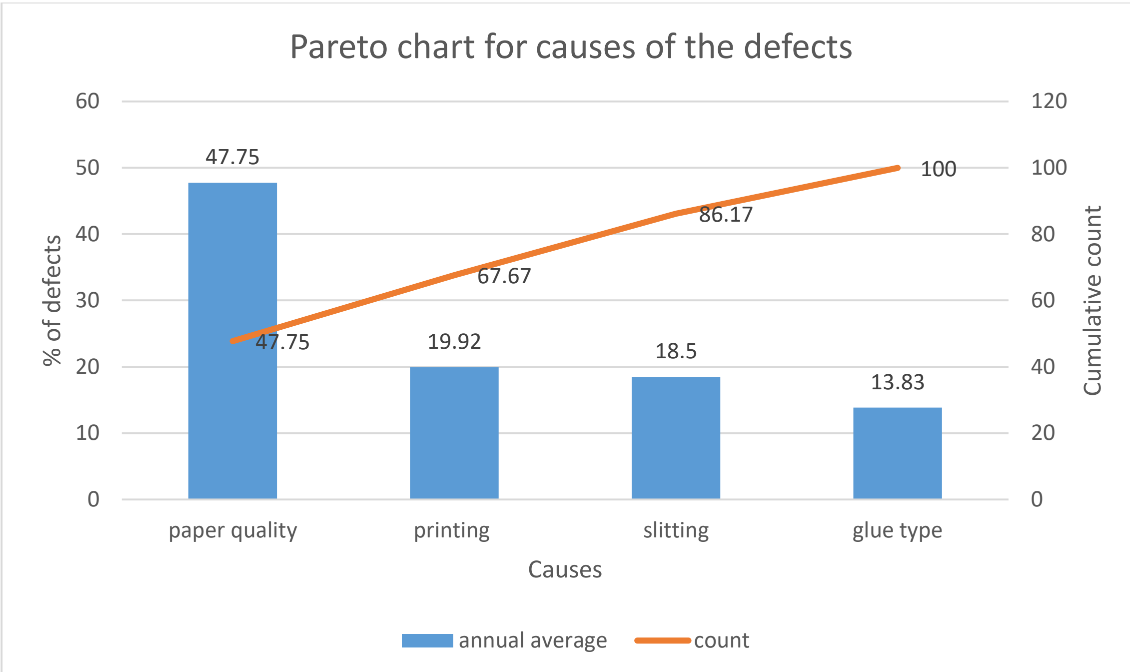

Figure 16, Pareto chart defect analysis percentage

The Pareto chart in Figure 16 proves the Pareto principle which states that 80% of the problems result from 20% of the causes. Printing and paper quality account to the highest percentage of defects while the rest of the defects result from slitting and glue type. From the chart, 80% of the defects result from Paper quality and Printing. Therefore when addressing the causes, paper quality and printing should be considered as the major causes while the slitting and glue type should be considered as the minor causes of defects.

4.5 Cause and Effect Diagram Analysis (The Fish-bone Diagram)

By applying the Fishbone Diagram in the Six Sigma methodology of TQM, the company was able to identify the possible causes of production problems and defects. When it is clear what is causing an issue, it will be possible to analyze the process and find a solution using the DMAIC approach. This will significantly influence the improvement of quality in products and services produces in the paper bag industry. Collecting and analyzing the feedback from customers is expected to have a significant impact on improving the products and services. Here, I prepared four main reasons for the wastage, and I have added some leading causes for each one. To analyze the roots, I derived four fishbone diagrams to represent each.

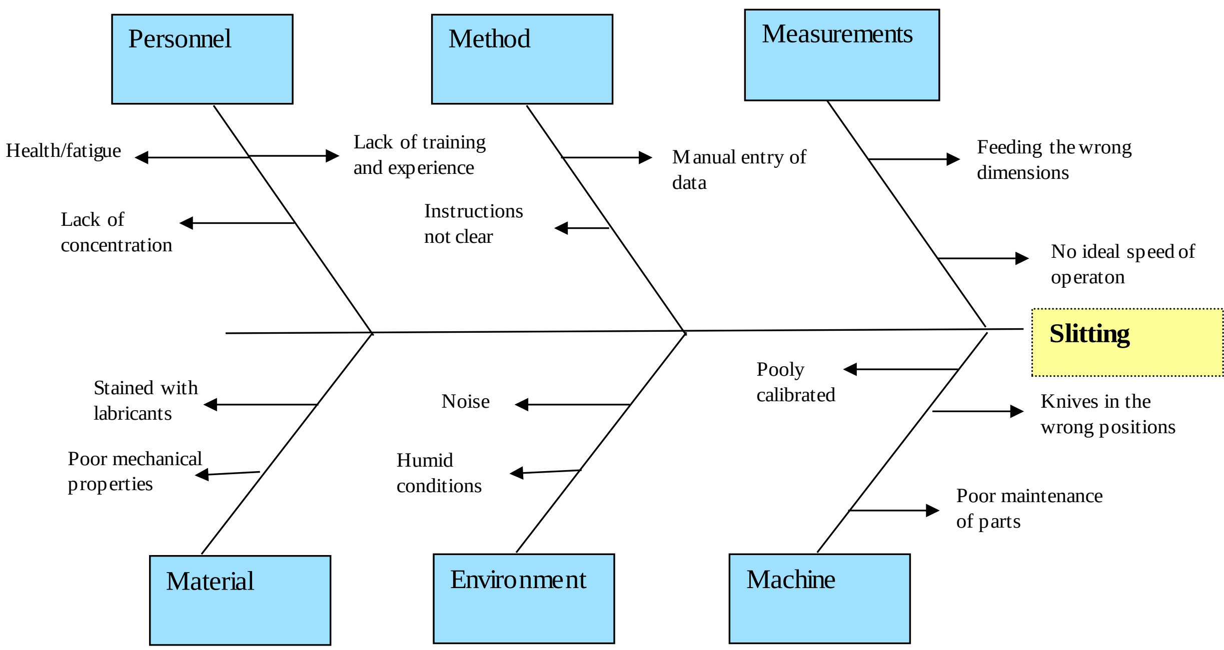

Figure 17, Fishbone diagram for paper slitting

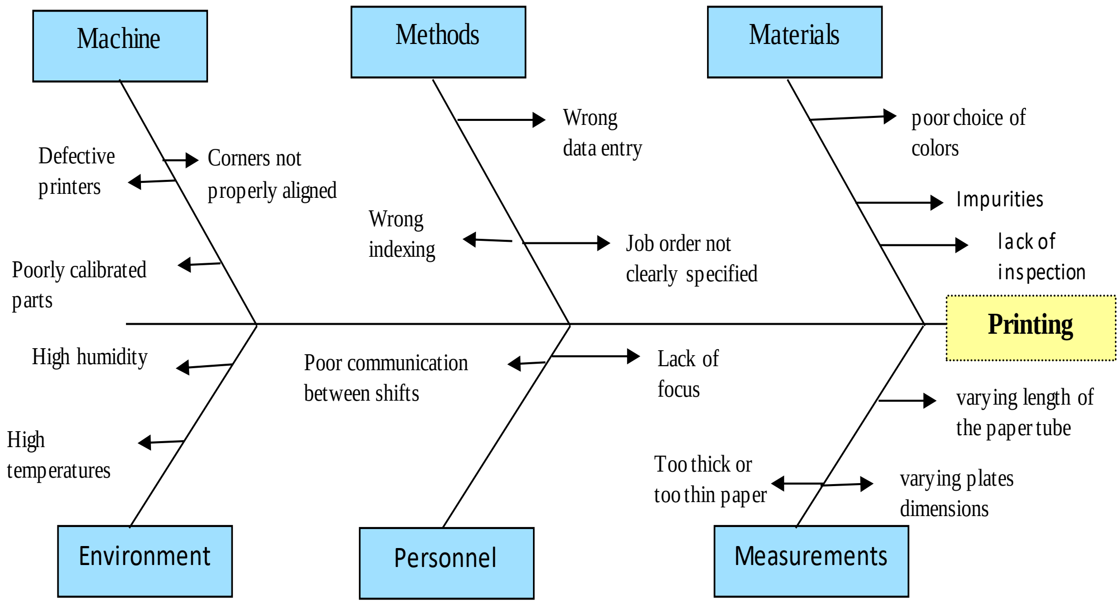

Figure 18, Fishbone diagram for paper printing

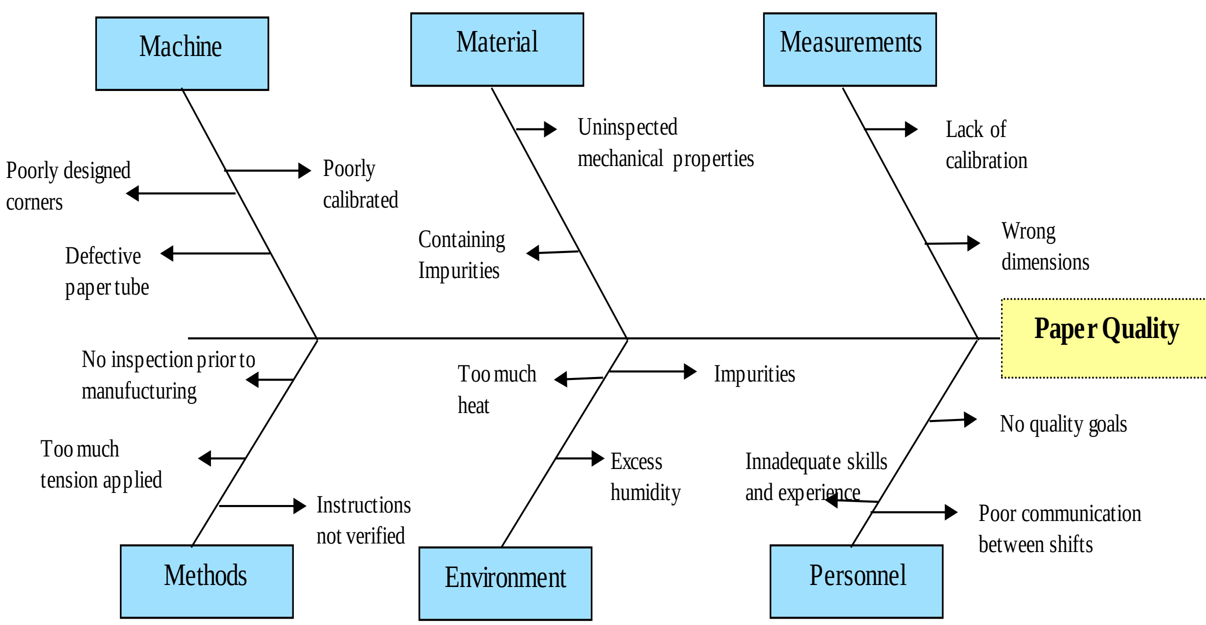

Figure 19, Fishbone diagram for paper quality

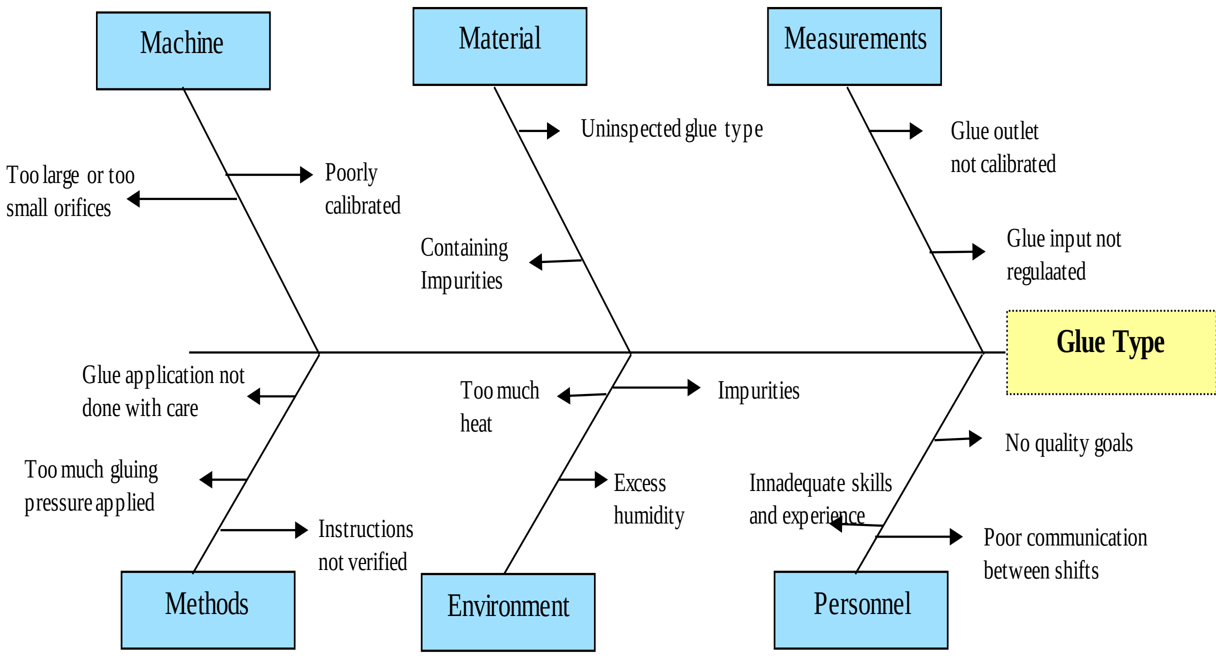

Figure 20, Fishbone diagram for paper glue type

4.5.1 Fishbone Diagrams Examination

There are several problems are Falcon Pack Company experience while using the paper bag making machines ranging from mechanical issues, electrical problems, calibration, printing, folding, and many others. This section is going to discuss ways of diagnosing, resolving, and analyzing the major issues that come up while dealing with the bag making machines. Some of the problems are easy to deal with, while some are complex and time-consuming. Again, some problems are caused by technical and mechanical failures. I have accumulated a list of common hitches usually experienced by machine operators in the company as well as detailed suggestions to enable operators to combat the problems.

a. Misalignment of the Paper Tube (paper roll)

Lack of parallelism of the roll can be the reason for printing defects and quality defects. Before launching the process, the paper roll alignment must be inspected to make sure that it is parallel and precise. The central insert wheels of the unwinding should be adjusted in the vertical direction to ensure that the paper tube is correctly aligned.

b. Poorly Designed Corners of the Paper Bag Making Machine

Where there is inappropriate designing of the corners, the distance accuracy between the two clamps should be appropriately measured and confirmed. The accuracy of the opening for the central clamp should also be verified. Besides, it should be established whether the integrated sizes of the sides are appropriate. Additionally, if the inserted knife is not in the right position, it should be reset at the correct position. It should also be ensured that the bottom clamp reaches the first line. Another thing is to ensure that the pressure produced at the mechanical figure is correct. Finally, it should be ascertained that the pressure generated by the middle finger is sufficient.

c. Paper Tube Wavering

If there is wavering of the paper tube, the first thing should be to confirm if tension at the unwinding is the correct one. Also, the positioning of the insert plate should be altered to ensure that it has the right opening inclination. Additionally, it should be verified that the friction wheel and pressure are suitable. Finally, the position of the paper tube creation mold should be verified and set at a suitable spot.

d. Poor Closing of the Manufactured Bag

Poor closing of the paper bag may be as a result of the absence of correspondence between the bag width and closing bars. This can be corrected by setting the closing bars and verifying that closing bars are correctly aligned. Also, the height of the bottom of the bag should baffle accurately. Cleaning the closing bars to remove dirt and glue can also help in preventing poor closing.

e. Broken Paper Bag Corners

The solution to the problem of broken edges of the paper bag is to ensure that the used dimensions along the sides are okay. Additionally, the positioning of the open bottom lock must be ascertained.

f. Gluing Orifices not Calibrated

Unnecessary gluing of the bag bottom occurs when the orifices are either too large or too small. If the bottom of the bag is continuously glued, a quick remedy has to be sought before more bags get damaged. If the opening from which glue is applied is too large, the size of the hole should be reduced and also assess whether the base gluing can be done using bottom glue.

g. Wrinkles Formation on the Bag Surface

Wrinkles make the paper bag appearance not to be attractive. The problem can be dealt with by regulating the pressure of the delivery belt. The positioning of the delivery tube should also be checked well and ensured that it is appropriate.

h. Irregular Bags Collection

If the collection of bags appears to change periodically, there might be a problem caused by pressure along the delivery conveyor. After checking the mechanism applied to transport the bags, one can adjust the pressure until the regular delivery of packets is realized.

i. Indexing Movement at High Operation Speeds

Ensuring the smoothest indexing Cam Profile reduces machine jerk as well as noise to prolong the lifespan of the machines (Kaura, Prasad, & Sharma (2015). Several techniques can be used to generate the smoothest indexing and movement in particular, as shown in Figure 21. Such techniques include;

- Correction of print mark and adjustment of the feeding angle.
- Tension control – monitoring the web tension at a high speed of operation ensures ideal conditions for various accessories.
- Seal temperature –a temperature control mechanism may be integrated along with the sealing unit. There should be a constant seal time that is independent of the speed of operation in the efforts to maintain the quality of bags.
- Machine performance – for material that can sustain high tension at high speed, the machine can be run at 60 meters/second to improve performance and availability. It should also be ensured that cutting accuracy is high and that print marks are in the right conditions.

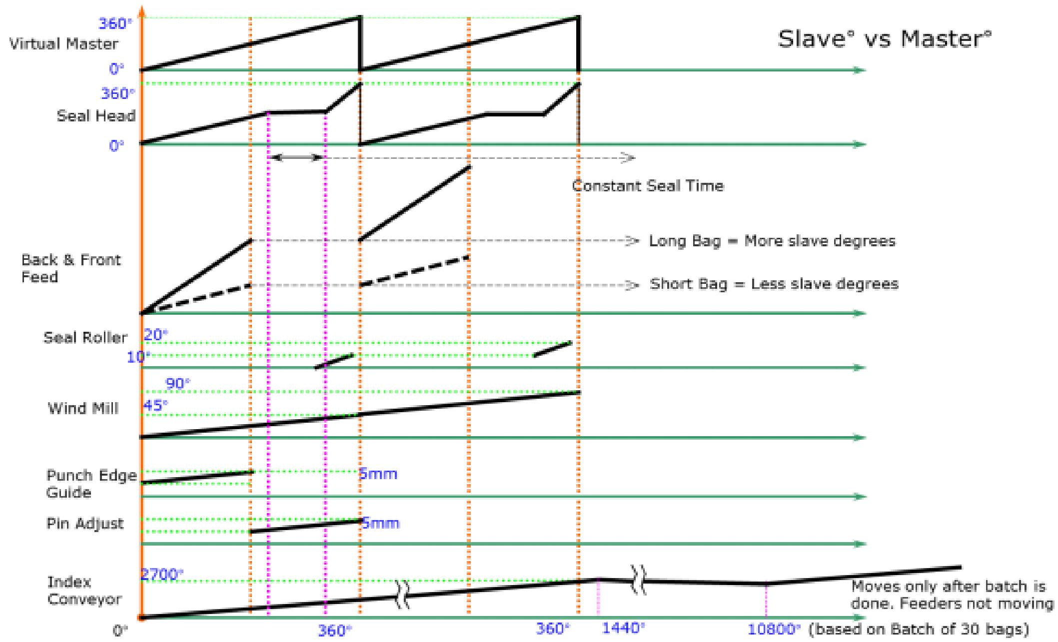

Figure 21, Paper smoothing indexing techniques

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4.6 The Implementation of Six Sigma Methodologies

Using the Six Sigma DMAIC method, the main performance indicators were measured and analyzed. The analysis helped in identifying the main causes of defects and low performance. Analysis using the fishbone diagrams helped in identifying the main causes of loss by the company, from which several solutions were implemented at Falcon Pack Company within three months. Fishbone analysis was the pivotal tool that was used to analyze all the possible causes of defects and eliminate errors within the shortest time period.

When considering the standard available hours, there are a number of factors that limit the possibility of optimizing the set hours. Such factors include downtime losses, cleanups, changeovers, and planned maintenance. At Falcon Pack Company, the 21 hours per day of continuous production is not achieved in daily production. There are some instances within the standard 21 hours when the machines remain unproductive. The company should maximize productivity by carrying out planned maintenance during the hours when no orders are running. Additionally, unplanned maintenance occurs when there is electrical or Pressurized Air Interruption, which causes machine stops. Electric interruptions cause material shearing and new preparations and cleanups have to be done as a result. Additionally, having to wait for materials such as papers, ink, glues, and plates delay the production process and cause stoppages. This is very common in daily productions because sometimes the materials may delay due to road traffic or last-minute purchase.

The standard available hours are also affected by set up and other tooling procedures. During the setups, the paper is set across rollers while molds are changed. Additionally, plates are set across different printing stations. The setup time includes all the time between producing the last mold to the launch of the next proof printing. In the slitting stage, new dimensions are set while the pressure is altered to prevent shearing in the process. Cleaning is also done at the beginning of shifts and during printing whenever necessary. For a certain period of time, the machines may produce poor quality output immediately after the start of each process, whether printing, slitting, or gluing. During this time, several settings are being inputted to the machine and the operators of the machine play a critical role in the process. Such settings may include color settings, plate alignment, fixing aniloxes during printing or arranging knives and setting the pressure during slitting.

Performance losses mainly occur due to speed losses. Speed losses arise when the machine is operated below the highest possible loop speed. The speed is increased towards the set speed limit and is stopped by reducing the speed gradually. The machines' actual cycle times are calculated by multiplying cycle time and a specific correlation coefficient related to deceleration or acceleration during the starting or stopping of the machine. Also, speed losses can happen as a result of momentary slowdown whereby the speed is decreased for a short while whenever a threat appears in the production process. For example, in the changing of the paper reel, the momentary slowdown may occur.

In the daily printing of paper, rolls of materials run into waste after the initial testing of labels quality. Machines are started after all the molds are fixed. Meanwhile, the detailed settings of each machine are set. After all the detailed settings have been completed, proofing printing is launched. After a while of producing a poor quality product, the machine produces the first good quality sample. The sample collection is done in the line of production before being approved and taken back to the production line. The samples are taken to the quality assurance team for checking and approval. If the samples are not good enough, they are included in the list of scrap loss. However, if everything is approved, the machine operators have given the go-ahead signal ad the broad production starts. The printing is stopped when the required number of pieces is reached. If the subsequent molds are prepared, they are connected to the machine and the same process as the first one is repeated until the present shift of production terminates.

Falcon Company has embarked on a fresh path of empowering their employees with resources. Thorough training has been done on workers to equip them with knowledge, skills, and technology that will help them achieve high levels of productivity. Workers have been trained to focus on the key performance areas and understand the vision and mission of Falcon Pack Company in relation to customer satisfaction. All holes in the availability of the resources have been filled so that their lack may not negatively affect productivity. The results have been positive since the levels of waste resulted from workers' mistakes have decreased significantly. Falcon Pack has also made workers feel that they are part of the business vision and mission. Teamwork has made employees work together as a unit, as they focus on fulfilling the set goals. If teamwork will continue to grow, the workers might even exceed the expectations of their managers. When workers are happy in their lines of duty, they tend to do more work and boost the business. Minding the health of workers through the provision of healthier food or flexible working can also boost productivity.

Pareto analysis and regression analysis have been also implemented along the production line to minimize machine downtime and increase productivity. Pareto charts have been used to check for defects and losses in the production process. The company has been able to reduce the set-up time as well as other contributors to downtime. For example, through the use of Pareto Charts, the company was able to identify the paper quality and printing as the main causes of defects while slitting and glue types were the minor causes of quality loss. With the help of Pareto Charts, the company can establish the run time that would lead to the highest availability of the machine. Additionally, fishbone diagrams have been used to identify the most common sources of defects and machine downtime. However, it has been proven costly to repair the defective parts of the machine, while some parts that nee automation have to be considered in the future.

Falcon Pack Company has been made to understand that poor relationship between the workers and the immediate supervisors leads to redundant productivity among employees. The senior management has encouraged workers recognition, encouragement, motivation, fulfilling promises, and no blame culture. Since implementing Six Sigma in the leadership, the productivity of workers has risen because they feel inspired, valued, and respected by the senior staff. Secondly, the absence of SMART goals has led to low performance and unsustainable defects. In the efforts to implement Six Sigma, the company has established SMART goals to increase productivity. The developed goals are specific, action-oriented time-bound, measurable, and realistic. For example, the company has since specified the quality goals that would lead to 3.4 defects per million opportunities.

The smart goals would lead to a 99.7% quality percentage and only 0.3% of wastage. That means that workers would be assessed based on the achievement of 99.7% quality percentage and only 0.3% of wastage. To make the goals attainable, workers training would be done on a weekly basis and they would be taught on measures to reduce wastage as well as the technology that would assist them to do that. The goals will also be time-based and the quality metrics would be assessed every week by the management for compliance. If the quality targets were not met, improvement measures were put in place before the following week's review. Such improvement measures include reduction of slitting defects, proper inspection of the material, proper calibration of the machine, and reduction of workers' faults.

4.7 Customer Complaints

The customers' complaints over the period between January 2018 and December 2018 were recorded as presented in Table 14. The results were used to identify the root causes of customer dissatisfaction using Pareto analysis. The results were presented in Figure 22. The results are contributed by 5 failures of which 80 % of the failures are contributed by quality concerns, lack of quick feedback, and lateness in-order delivery.

Table 14: The customer complaints data

Problem	Count	Percentage	Cumulative percentage
Quality concerns	35	36.08	36.08
Lack of quick feedback	29	29.9	65.98
Lateness in order delivery	16	16.49	82.47
Communication problems	12	12.37	94.84
Lack of cooperation	5	5.15	99.9

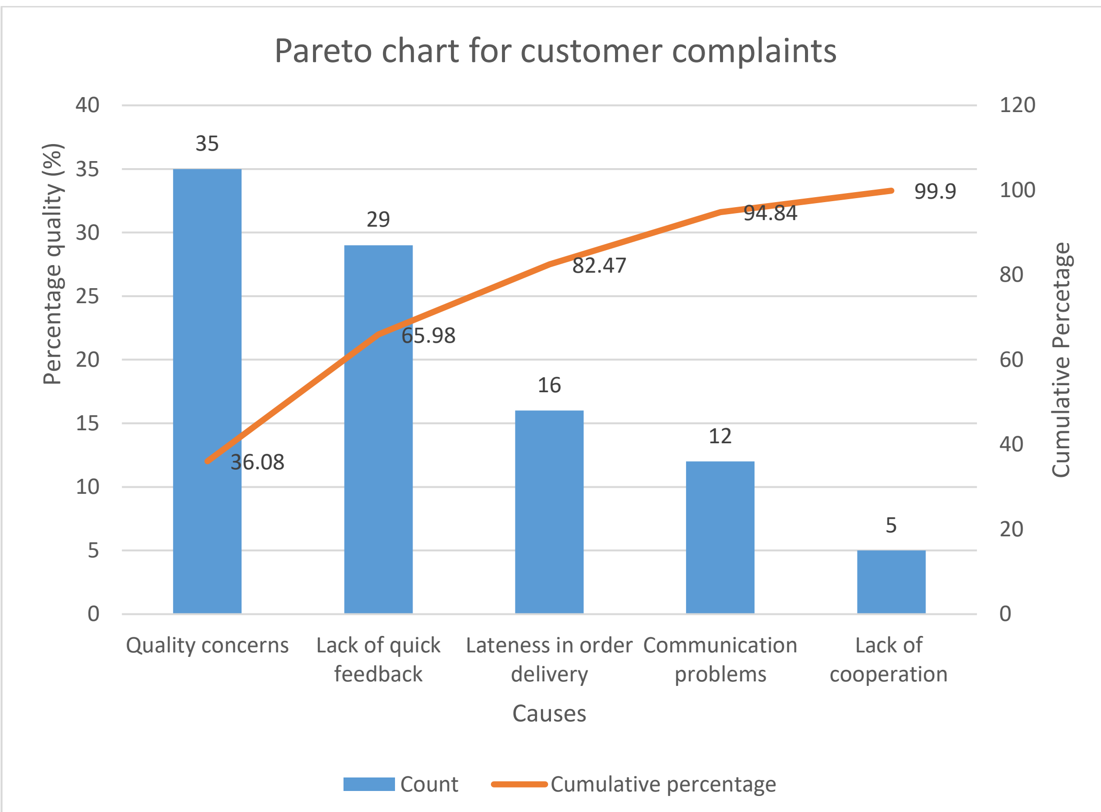

Figure 22, Pareto analysis for customer satisfaction

The first two causes, which are a quality concern and lack of quick feedback contribute to 65.98% of dissatisfaction among customers. This means that they can be considered the vital few while the rest of the factors could represent the trivial many. Thus, Falcon Pack could improve customer satisfaction to meet its goals by addressing introducing quality goals and facilitating such goals with improved technology, training its workers, and inspection of materials. Additionally, the company can increase the number of staff workers in the service center. Additionally, lateness in-order delivery can be addressed by reducing all machine downtime that could lead to delays in the production process, or by increasing the number of workers in the production line.

4.7.1 Regression Analysis

A regression analysis was conducted to develop a mathematical model that would compare the quality of the products to customers' satisfaction at Falcon Pack Company. In this case, a linear regression model was used since the customer satisfaction data is discrete. For every percentage quality x, there I an associated customer satisfaction index y. Discrete values of any registered variables in linear regression $x_{1,}$ $x_{2,}$ $x_{3,}$ …, x_p value can be defined by;

$$\mu y \;=\; \beta 0 \;+\; \beta 1\, x1 \;+\; \beta 2\, x2 + \ldots + \beta p\, xp.$$

The linear equation demonstrates how μy varies depending on the states of explanatory variables. The value of y changes depending on the variation of μy and assumes to have a similar standard deviation σ. Also, the values of b_0, b_1… bp dictates the parameters β0, β1,...,βp of any function of linear regression.

This section presents the analysis related to customer satisfaction with respect to product quality and performance. With respect to the techniques used for the questionnaire, the results used were derived from scale questions. The variables examined included requirements, evaluation, satisfaction, repeated purchase, recommendation, and comparison. Requirements state the extent of respondents' satisfaction with the fulfillment of what they expected their products to look like. Also, Evaluation states the extent of customers' satisfaction with the technical level (quality) of the product. Satisfaction, on the other hand, presents the level of satisfaction of the customers with the product delivered. Additionally, Repeated purchase predicts whether the customers would come back to buy the same product from the company. Likewise, the Recommendation express whether the respondents would suggest other customers but the product from the same company. Furthermore, Comparison tells how the product is performing in the market in relation to other products from other similar companies.

Table 14: The results of the evaluation of discrete variables related to customer satisfaction before six sigma

Variable	**Respondents**	**Mean**	**Minimum**	**Maximum**	**Variance**	**STD Deviation**
Requirements	50	5.12	4.53	5.64	0.1401	0.3743
Evaluation	50	4.48	4.21	5.01	0.0834	0.2888
Satisfaction	50	5.31	4.94	5.83	0.1114	0.3338
Repeated purchase	50	5.16	4.76	5.8	0.1902	0.4361
Recommendation	50	4.95	4.67	5.2	0.1707	0.4132
Comparison	50	5.79	5.17	6.2	0.2875	0.5362

Table 15: The results of the evaluation of discrete variables related to customer satisfaction after six sigma

Variable	Respondents	Mean	Minimum	Maximum	Variance	STD Deviation
Requirements	50	7.41	8.44	8.43	0.21	0.45
Evaluation	50	7.24	6.69	7.72	0.09	0.3
Satisfaction	50	7.57	6.9	8.34	0.13	0.36
Repeated purchase	50	7.49	6.33	8.64	0.27	0.52
Recommendation	50	7.44	5.88	8.28	0.29	0.53
Comparison	50	6.83	6.22	7.67	0.19	0.43

Firstly the average of the variables indicated in table 15 was determined. The responses were presented on a scale ranging from 0 to 10, whereby 0 represents the minimum value and 10 the maximum value as shown in table 16. The results indicate that the response to the questions asked averaged to a value close to 7, which represents a satisfactory level of compliance with the requirements of the product. Variable recommendation scored the highest while evaluation had the least score. Additionally, comparison reached the lowest mean.

Table 16: T-test analysis

Variable	Respondents	Mean 1	Mean 0	t-value
requirements	50	7.41	5.12	2.29
evaluation	50	7.24	4.48	2.76
satisfaction	50	7.57	5.31	2.26
repeated purchase	50	7.49	5.16	2.33
recommendation	50	7.44	4.95	2.49
comparison	50	6.83	5.79	1.04

The other step was to examine the statistical differences in the respondents' feedback. The score obtained after Six Sigma implementation was compared to the score obtained before Six Sigma. Table 17 shows the results obtained for the two-sample t-tests. Customer satisfaction increased by an index of 2.29 from 5.31 before Six Sigma to 7.57 after Six Sigma. Additionally, it can be seen that the evaluation had the maximum improvement (2.76) while comparison had the minimum improvement (1.04). In general, the performance of the company improved when considering all the variables reviewed.

CHAPTER V

CONCLUSION AND RECOMMENDATION

This chapter presents the summery of result of the dissertation as well as the recommendations for future process improvements. The limitations to implementation of Six Sigma have also been summarized in this chapter.

5.1 Conclusion

The enactment of TQM and Six Sigma at Falcon Pack Company has improved the availability of services, increased performance, and better quality of the block bottom paper bags. The process improvement with Six Sigma resulted to 99.7 % quality percentage which is 0.02% away from Sigma level. Moreover, there has been a significant waste reduction and operational efficiency, which has greatly reduced the cost of operation and better customer retention. On a scale of 10, Customer satisfaction increased by an index of 2.29 from 5.31 before Six Sigma to 7.57 after Six Sigma. Additionally, evaluation improved by a scale of 2.76 while comparison improved by a scale of 1.04. In general, customer satisfaction increased from 4.8 before Six Sigma to 7.5 after the Six Sigma implementation.

The results of the study reveal that continual improvement using Six Sigma enhances service delivery and the welfare of employees since all are allowed to participate in the process. Empowerment of employees by the management through training on Total Quality Management and Six Sigma has strengthened the freedom of workers as they are free to apply their initiatives in matters of quality, performance, and customer services. An environment that inspires the workers' efforts towards the realization of the company objectives and inspires responsibility, as well as the authority to create decisions, will only favor the business, rather than retract it. Emphasis on customer satisfaction has influenced the performance by increasing the market share and revenues, facilitated customer loyalty, effectiveness in resources management, and effective communication of customer requests.

The outcomes also indicated that leadership has positively influenced the performance through evaluation of activities, employees' motivation, ethical behavior, a clear vision, and the provision of common values. Implementation of Six Sigma has also penetrated strategic corporation with the business suppliers to ensure that there is a continuous performance of Paper bag making and that core processes are not interrupted. The company will also be frequently sharing vital information with suppliers to improve the proficiency and effectiveness of supplying the required raw materials and services. Six Sigma also has a provision to frequently communicate with the customers to get information about their needs and expectations. Effective communication with customers promotes quality cooperation in the efforts to improve the company's performance and customer satisfaction.

5.2 Constraints and Limitations

During the collection of data from Falcon Pack, several constraints were experienced and without which farther solutions could have been met for the company. Firstly, access to certain data was impossible because the company believes that such information is confidential and could not be shared. The company also believes that they are used in some situations, and they don't need any improvement on specific lines of production. Additionally, there are no existing databases with already existing data, and therefore, data collection had to be done manually. If there were existing databases with all types of information, more could have been achieved and probably the solution for more problems could have been realized.

5.3 Recommendation

Falcon Pack Company will need to implement a culture transmission to implement TQM and Six Sigma easier and quicker. Additionally, emphasis on continuous improvement as well as open communication across the organization needs to be supported. The senior management will also need to support the rest of the management team either financially, technically, or training to catalyze the effectiveness of Six Sigma in the company. Proper training of employees should also be supported to allow the employees to prepare towards managing TQM, which will also make it easier to identify and contribute to the progressive improvement processes of operational competence. Falcon Pack company will also need to establish achievable, clear, and measurable goals to set the spot-on direction for the company. Resources backup and supplements should also be set up to drive those goals and consequently upsurge the efficiency of operations and the profit margins. Strategies should be put in place to make suppliers part of the long term associates as they are partners of the company business activities while materials and outfits are usually the foremost cause of quality concerns. The integration facilitates and promotes communication, which is translated to customer satisfaction that craft value.

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Appendixes

Appendix A: Milestones

ACTIVITY	March	April	May	June	July	August	Sept	Oct
-Deciding which company to visit and identify the topic to pick.								
-Visited Falcon and identified the areas of improvement -Prepared a proposal for the dissertation. -Decided the method to use to improve performance								
-Data collection phase 1 -Data collection phase 2 -Data collection phase 3								
-Data analysis using regression analysis, Pareto Chart, and Fishbone diagrams -Writing dissertation								
-Implementation of the solutions at Falcon Pack -introduction of training workers lessons -Enhancement of SMART goals and quality targets. -Facilitation of fishbone analysis and regression analysis to improve performance								