Investigation of the Effect of Production Losses and Their Root Causes on Productivity Improvement

Case Study in National Tobacco Enterprise (Ethiopia)S.C

Berhanu Fufa Deressa

A Thesis Submitted to

The department of Mechanical Design & Manufacturing Engineering

School of Mechanical, Chemical and Materials Engineering

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Mechanical Engineering (Manufacturing Engineering)

Office of Graduate Studies

Adama Science and Technology University

August, 2022

Adama, Ethiopia

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Declaration

I hereby declare that this Master Thesis entitled "Investigation of the Effect of Production Losses and Their Root Causes on Productivity Improvement, Case Study in National Tobacco Enterprise (Ethiopia)S.C" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

Name of the student	Signature	Date

Recommendation

I the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled "Investigation of the Effect of Production Losses and Their Root Causes on Productivity Improvement, Case Study in National Tobacco Enterprise (Ethiopia)S.C" prepared under my guidance by Berhanu Fufa Deressa submitted in partial fulfillment of the requirements for the degree of Masters of Science in Mechanical Engineering.

Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

__________________________ _______________________ ________________

Advisor Signature Date

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Co-advisor Signature Date

Approval Page of MSc. Thesis

I, the advisor of the thesis entitled "Investigation of the Effect of Production Losses and Their Root Causes on Productivity Improvement, Case Study in National Tobacco Enterprise (Ethiopia)S.C" and developed by Berhaanu Fufa, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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Advisor Signature Date

We, the undersigned, members of the Board of Examiners of the thesis by Berhanu Fufa have read and evaluated the thesis entitled "Investigation of the Effect of Production Losses and Their Root Causes on Productivity Improvement, Case Study in National Tobacco Enterprise (Ethiopia)S.C" and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Mechanical Engineering.

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Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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School Dean Signature Date

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Office of Postgraduate Studies, Dean Signature Date

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ACRONYMS

ANOVA	Analysis Of Variance
AHP	Analytical Hierarchical Process
CED	Cause-And-Effect Diagrams
CPP	Cigarette Per Minute
CRR	Cigarette Rejection Rate
DMAIC	Define, Measure, Analyze, Improve, Control
FMHACA	Food, Medicine And Health Care Administration & Control Authority
FCTC	Framework Convention On Tobacco Control
GDP	Gross Domestic Product
JTI	Japan Tobacco International
JIT	Just In Time
LSS	Lean Six Sigma
NTE	National Tobacco Enterprise Share Company
OEE	Overall Equipment Effectiveness
PPM	Packet Per Minutes
RCA	Root Cause Analysis
SPC	Statistical Process Control
SPSS	Statistical Package for the Social Sciences
TQM	Total Quality Management
VSM	Value Stream Mapping
WHO	World Health Organization

ABSTRACT

Productivity is the quantitative relationship between what is produced and what has been spent to produce. Investigating the loses of product with root causes and remedies were analyzed. The main objective of this thesis was to analyze the root causes of production losses to enhance productivity in Tobacco factory. Various losses occurring in a manufacturing plant reduced productivity while increased costs. Minimization of cigarette rejection was one of the most important factors for an organization to Productivity improvement. Root-cause identification for machine breakdown, quality and productivity related problems were key issues for manufacturing processes. This research has been carried out in a of national tobacco enterprise (Ethiopia) S.C industry. Data would be collected; by data analysis structured interview questions, visiting recorded data in company, by visiting concerned machines in industry and recording existing rejection rate per month. Initially in this study pie chart and Pareto analysis were used to figure out the major contributors for losses due to machine breakdown. RCA using the CED and 5Why techniques were done so as to explain the reasons behind major machine breakdown. Statistical analysis tools were carried out in SPSS version 26 and SPC are used in the process to identify the existing wastes of the selected machines and to reduce them. According to the company's plan, the annual percentage plan was 4.09% and the loss by mid-2022 year was 6.66%. this when it converted to money 108,643,625.20 birr were a production loss. It was found that the rood break and incomplete cigarette pocket were the major root causes for this rejection. The factory's production and improvement related documents of different month and final annual reports were referred and analyzed. The outcome of this thesis was to reduce or eliminate rejection in cigarette manufacturing operation and obtain better product quality. The various methods have been discussed in detail with their outcomes on the productivity of organizations.

Key words*; production losses, productivity, rejection rate, quality parameters, root cause analysis, cause and effect diagram.*

CHAPTER -1

INTRODUCTION

1.1 Background of the study

Production loss analysis is identified of sources, calculates losses and analyzing their root cause. The analysis process accounting and categorize the losses, for effective actions to eliminate causes of losses. Production Loss Analysis Software focuses on the factory to compare the actual cost and the plan cost in the manufacturing process something traditional OEE cannot do. This unique process makes it easy to visualize how much your factory has lost. Various losses occurring in a manufacturing plant have direct bearing on reduced productivity and increased costs. Though some losses like asset failure can be measured using traditional methods, advance systems are required for root cause analysis. Then there are many miniscule losses which are very difficult to measure. Their frequency of occurrence can be high and hence their cumulative effect significant. These are referred to as ‘minor stoppages. Yet other types of losses occur due to lack of coordination between various departments (Industrial Internet in Action, 2018)

Productivity is the quantitative relationship between what is produced and what has been spent to produce. It is a measure of the ratio between the output of a process and the input of resources needed for it. Output could be in the form of goods produced or services rendered and may be expressed in physical quantity (where products or services are homogeneous such as number of customers served, quantity of goods produced) or financial value for example sales, production value or value added (Kanyoni et al., 2021).

Once the cigarette rod is created it goes to the tipping unit where the filter and tipping paper are added to the cigarette and they are cut to give them their final appearance. In this part the cigarette reject rate is considered, since the machine has different sensors that are measuring the characteristics of the cigarette. Some of these characteristics are circumference, loose end, ventilation, missing filter, leakage and weight. If any cigarette does not meet these specifications, the machine will not consider it and it will be thrown out of the process for rework.

Once the cigarettes are examined, they pass to the packing machine where the machine takes 20 cigarettes per turn and with the paper and aluminum builds the cigarette packet. Here also the cigarette reject rate is considered, because if a package contains a damaged or defective cigarette, the sensors in the packaging machine will reject the complete packet and all the materials involved in the process would be wasted.

1.1.1 Cigarette Making Process

The process of making the cigarettes is divided in two parts: Primary process and Secondary process. The primary process is where the tobacco leaf is processed to give the consistency and flavor depending on the cigarette brand. The secondary process is where the making and packaging of the cigarettes takes place. Once the tobacco has been processed and flavors are added it is taken in special bags that weight approximately 150 kg, to the feeding room where an operator takes the bags and place them on a conveyor that will transport the tobacco to the suction pipe line. The tobacco is transported by suction pipes that take to the maker machines; each machine can produce 4500 to 10,000 cigarettes per minute (U.S. EPA, engineering report on tobacco products processing detailed study 2006).

1.1.2 Primary Tobacco Processing

The tobacco processing stage that occurs prior to the manufacture of cigarettes is known in the tobacco products industry as primary processing. Figure 1.1 depicts the following steps generally involved in the primary processing operations:

- Various types of tobaccos (local, import and reconstituted) are sent through conditioning cylinders, in which steam is added to loosen and moisten the tobacco.
- The conditioned tobacco is sent to storage treasure in order to separate lamina and stem.
- The lamina and stem separately stored by case then send to silos where some blending occurs.
- Various blends of tobacco are flavored in cylinders, dried, and remoisturized. Any domestic tobacco used in the blend is processed separately (flavored and dried) prior to final blending.
- The final tobacco blend is cut, dried, and remoisturized.
- The cut tobacco is sent to flavoring cylinders for final flavoring.
- Expanded tobacco, a low-density tobacco, is added to the final tobacco blend during the final processing steps.
- The processed tobacco is sent to feeding room and then to the secondary process.

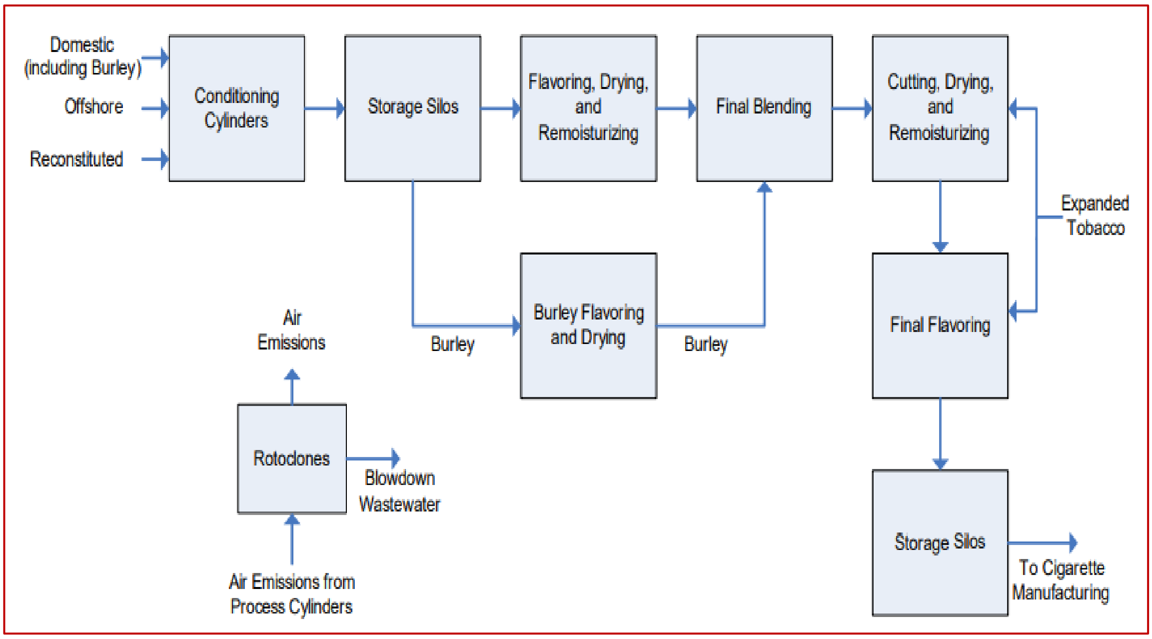

Figure 1.1 Primary tobacco process (U.S. EPA, engineering report on tobacco products processing detailed study 2006).

1.1.3 Secondary Process

Cigarette manufacturers use tobacco from the primary processing operations to manufacture cigarettes. Figure 1.2 depicts the following steps generally involved in the cigarette manufacturing process:

- Blended tobacco, which may include reconstituted, expanded, and other varieties of tobacco, is conveyed from the primary processing storage feeder room to the cigarette maker machines through pneumatic feeder. The maker machines place the tobacco onto cigarette paper as double rod, roll and glue the paper around the tobacco, and cut the rods to the correct length for cigarettes.
- The filters place between two of the cut rods, wrap the filters to the rods with filter tipping paper and cut the filters to create two cigarettes.
- Through tray filler the cigarette sends to packer machine by belt conveyor.
- The packer machines pack the cigarettes and place them in cases.
- Cigarettes that do not meet specification are cut open to reclaim the tobacco. The cigarette paper and filter are disposed of as trash. The reclaimed tobacco is returned to primary processing

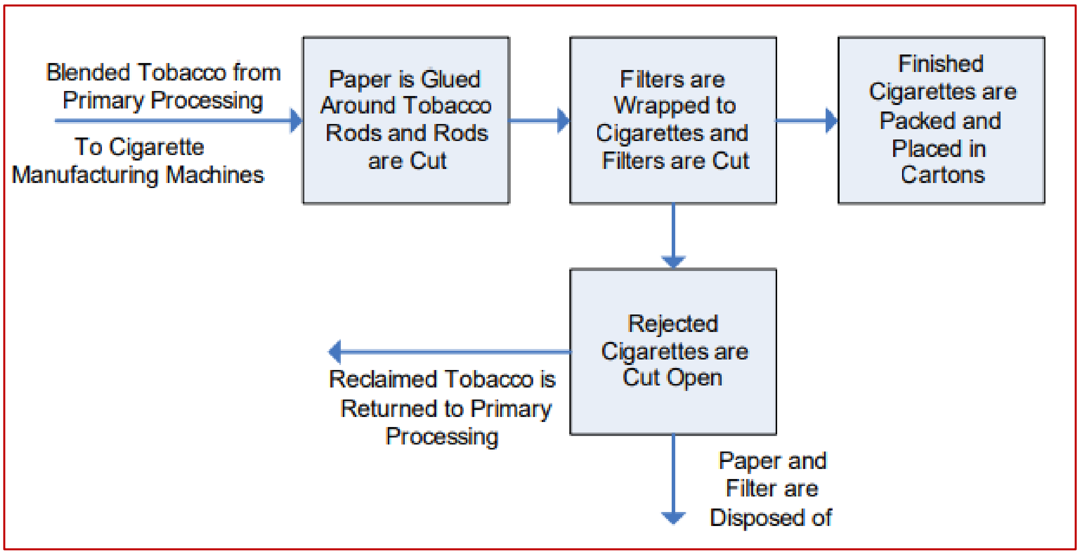

Figure 1.2 Secondary tobacco process (U.S. EPA, engineering report on tobacco products processing detailed study 2006).

1.2 Statement of the Problem

Cigarette Reject Rate is defined as all the cigarettes in the make, pack machines that do not meet quality requirements. This is a measure of the percentage of the cigarette throughout in the make/pack groups that is rejected. The company cannot meet demand from the market even with 24-hour production. In order to maintain a stable output level and meet market demand, the corporation must reduce production rejection. As companies' data records about 6% of cigarettes are rejection that is a big loss in material and tobacco yield that must be reprocessed. This rejection may add cost of (material, rework and tobacco reprocess) to the company per months. Maintenance is also a factor for productivity, high rate of machine failure is observed in the factory. The variation of Design capacity and current capacity of the machines also a factor for productivity, high speed loss of the machines is observed in the factory. Reducing production losses is essential to enhancing Efficiency of the entire equipment. it is important to know how wasteful your process is and use research-proven processes and techniques to eliminate the cause of the problem.

1.3 General Objective

The main objective of this thesis was to analyze the root causes of production losses to enhance productivity in Tobacco factory.

1.4 Specific Objectives

The specific objectives designed to solve the problems are:

1. Investigation of current production capacity and designed capacity
2. Investigation of production losses for three years
3. Analysis of root causes of product rejection
4. Propose the techniques in which cigarette rejection rate is minimized

1.5 Scope of the Research

This research work was focused on the cigarette Manufacturing industry (NTE) and the purpose investigation of the actual and feature method of reduction losses in cigarette making operation procedures. This study takes only secondar process in NTE member of JTI as a case study on investigation of production losses and their root causes toward productivity improvement. In this research only a two- and half-year data of a selected case study company has been analyzed since increasing the amount of data will makes the study complex and also difficult**.** The study was developing the current and future state study area, analyzing the area through and case study to assist decision making process and identification of the actual and future method of cigarette making operation procedures.

1.6 Significance of the study

This study was focused on cigarette manufacturing industry (National Tobacco Enterprise), and propose the alternative method of reduction losses in cigarette making operation procedures. Case study was conducted on the production losses of the company and to find out the root causes of these losses so as to eliminate them and to decrease the rejection caused due to machine breakdown.

1.7 Limitations of the study

Since the factory was confidential, data collection duration was prolonged. Advertising tobacco products is also prohibited. More over the study program was running in addition to my job and the distance limits my regular face to face contact with my advisor was a challenge.

1.8 Motivation to do the research

During the internship working in NTE it's found that, high cigarette rejection in their factory. The product of this industry is different brand of cigarette. Achieving the desired quality is a great importance of the functional operation. In the present work, it is motivated to reduce the rejection related to parameters of cigarette manufacturing operation, specifically the cause of rejection in the process. So, the cost of rejected products should pay attention.

1.9 Research questions

a. How to assess rejection in cigarette making and packing operations?
b. What is the method to find out causes of rejection and remedies in the process?
c. What are the techniques for controlling of losses in cigarette making operations?

CHAPTER-2

LITERATURE REVIEW

2.1 Background of the Company

National Tobacco Enterprise Established in 1935 as "Imperial Ethiopian Tobacco Monopoly" with a paid-up capital of 50,000 Maria Theresa dollars, NTE was re-established as a share. National Tobacco Enterprise share company (NTE) have been a monopoly company since there was not competitors in Ethiopia. Since 2016/2017 NTE a member of Japan tobacco international group. The industry is about to manufacture cigarette and distribute them to the demand all over the country.

National tobacco enterprise (Ethiopia)share company (NTE)was re-established as a share in 1942. NTE manufactures, distributes and salles nyala the leading domestic tobacco brand in country. The company provides direct employment to over 1200 Ethiopia and indirect employment to over 10,300 out growers. NTE is a Member of the Japan Tobacco International Group of Companies (JTI) – a leading international tobacco products company headquartered in Geneva, Switzerland. JTI owns 71% of the shares of NTE acquired from the Government of Ethiopia in 2016/2017 for USD 1 billion. This is the largest private sector investment by a Japanese company in Ethiopia to date. The country ratified WHO'S Framework convention on Tobacco control (FCTC). Based on the FCTC, a tobacco control directive is also issued by the Ethiopian Food, Medicine and Health care Administration & control Authority (FMHACA) (http://www.ethiotobacco.com)

Tobacco impacts the economy positively as seen as in many countries. In Ethiopia tobacco growing farmers are beneffited as the crop as cash crop is cash crop which can be sold relatively at higher price than the consumable crops and these farmers are estimated10,300. The tobacco industry is also a labor intensive industry which accommodate large size of employees which in turn support the economy by absorbing substantial amount of employments. Tobacco industry is also one of key sectors that bring sizable amount of income through multiple layers of tax. World bank study showed 1.16 billion birr 2016/2017 which is 0.07% of GDP. There is also a potential to export processed and unprocessed tobacco to forign markets that's untapped resource to support the national economy and over all GDP. As the global tobacco market size is vaunted at USD 931.11 billion in 2020.

2.2 Productivity

As M D Sreekumar (2018) mentioned productivity is the measure of the combined efficiency or integrated efficiency of employees, machines and other devices and equipment's, nature of raw material inputs, performance of the management, efficiency of the whole production system. Productivity can be computed and expressed as the ratio of average acceptable output per period by the total costs incurred through various resources (Labor, Input material, consumables, power utilized, capital, energy, material, personnel) consumed in that period. It is nothing but a measure of efficiency of the integrated system consisting of resources like Money, Men, Materials, Machines (4Ms of an industry) and time etc. Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labor and capital, are being used in an economy to produce a given level of output. One of the most widely used measures of productivity is Gross Domestic Product (GDP) per hour worked (Paul Krugman 1994). As Dirk Pilat (2014) has studied Every productivity measure, implicitly or explicitly, relates to a specific producer unit: an establishment, a firm, an industry, a sector or an entire economy.

As NTE organizations' the best way to control resources and materials were being used effectively in companies was with the use of KPI (Key Performance Indicators). Key performance indicators measure the performance of a process and yield of the processes so objectives can be achieved. In this organization there are four very important KPI's that measure productivity, efficiency and costs. These are None Tobacco Material (NTM), Overall Equipment Efficiency (OEE), Production Volume and Cigarette Rejection Rate (CRR)

2.3 Review of Related Research

According to Muhammad (2018) studied about Measurement & Analysis of Productivity and Finding Solutions to Improve Productivity in a Garment Factory there are many models and approaches for measuring productivity. In this study they used Kurosawa's structural approach of productivity measurement for measuring the labor productivity. In this approach, developed a structure of work hours. The low quality of the raw materials causes defects in the product. Low quality fabrics causes rolled out problems, distortion, improper thread tension, high stitch pressure etc. These are the causes of some of the vital defects that were identified based on the Pareto analysis. From the structure, he developed methods to calculate the productivity of the labors. From the response of the workers and the management personnel it was identified that the machine downtime and accidents due to machine failure are some of the problems that this department faces. The reactive maintenance of the department causes many unexpected breakdown and failure of the machine. Sometimes multiple breakdowns cause delay as the manpower is not enough to tackle too much breakdowns at the same time. Regular inspection of the machines and taking preventive maintenance measures will help to solve the breakdown related problems.

According to Karthik M (2019) has studied**,** in order to meet the customer demand better option is to make use of existing facilities, improving productivity, and reducing the rejections. Because there are lot of many new vehicles are coming to the market and for existing models demand is increased. Productivity improvement deals with achieving the more output from the less input within specified time. This can be done by improving basic process, improving existing methods and procedure and by controlling rejections and rework. Eliminating or minimizing the scrap is the main aim of any manufacturing unit. The outcome of his work is being suggestion to improve and change certain procedure in the process and to improve certain process, which is causing bottlenecks in the 5C line. By implementing certain changes in the process, the productivity is observed to be increased considerably by reducing rejection rate from 10.61% to 5.50% in 5C line. A methodology has been developed for reducing the rejection and for improving productivity of the company. It is known that some changes have taken for reducing the rejection and improving the productivity.

Kanyoni (2021) has studied about Productivity Improvement for a Manufacturing Company by Root Cause Analysis. Productivity measures the performance of an organization and can also be used by companies to assess their progress. In general productivity is the ratio of the output to the input of a production system. Productiveness increases the overall efficiency of a company such that the production capacity is utilized to the optimum level. All resources are used in an effective and efficient manner to get the best possible results. High productivity has the benefit of creating more outputs with the same or fewer inputs. Higher productivity can lead to lower average costs, improved competitiveness and trade performance, higher profits, and higher wages. Productivity is an essential component of an organization's performance hence its productivity improvement contributes positively to an organization's profitability. Nallusamy (2018) studied Toyota's production system, lean manufacturing can be defined as 'A systematic approach to identifying and eliminating wastes through continuous improvement by making the product at the pull of the customer in pursuit of perfection'. Waste can be eliminated and lean development can be achieved by various tools such as 5S, Kanban, Kaizen, Value stream mapping and Work standardization.

VSM is used as a main tool to identify the opportunities for various lean techniques. The variables influencing the chosen characteristics and then optimized the process in a robust and repeatable way were represented and focused on what six sigma is today and its roots in both Japan and in the west and what Six-Sigma offers the world today. Six sigma is a lean tool to improve the business policy which tries to develop the maximum efficiency and effectiveness of all the production processes to fulfill the customer requirements. By implementing Six sigma Define, Measure, Analyze, Improve, Control (DMAIC) a revolutionary approach with its statistical tools and techniques in different processes, quality along with the monetary savings can be achieved.

Patil et al. (2015) has studied about" Application of Six Sigma Method to Reduce Defects in Green Sand-Casting Process". In this case study, DMAIC based Six Sigma approach is implemented to optimize the process parameters of foundry. The stability of the casting process is also increased. Before the application of Taguchi and ANOVA, the parameters of the casting process were more arbitrary and difficult to control and hence the product quality suffered instability problems. Taguchi and ANOVA yielded optimized control factors, resulting in superior product quality and stability. The Sigma level of the company increased to a higher level than under the existing process and the rejection percentage declined. They concluded that use of the Six Sigma DMAIC approach was successful in identifying the problem, improving the process and controlling the defects. Also, Bambharoliya (2015) has studied that Increasing productivity and profitability are main objectives of any organization. Many tools and techniques are used to reduce rejections and defects of product. Most of the rejections and defects are occurred due to improper control of quality of product. So, use of 7 Quality control tools is best way to reduce rejections and defects of product after analyzing of manufacturing process. Another advantage is increasing customer satisfaction by use of 7 Quality control tools in today competitive market. Based on application of these tools will increase the level of standard products which they require as vision of an organization. From the review of mentioned research articles, he derived conclusions that 7 Quality control tools are very simple and easy to use for all majority industries, Quality improvement can be made by reducing rework and rejection rate using 7 Quality control tools, Reduction in rejection is indirectly improving productivity and profitability of the organization and Quality control tools have shown better results in quality improvement as referred many case studies.

Jacob (2020) studied about 'Investigation of defective products and how to reduce them' they reflect that the use of lean methodology and its tools can provide manufacturing companies with accurate information on what defects they have and the causes behind, in order to reduce the number of defects and improve the sustainability aspect. Jadhav (2013) has studied about ‘Investigation and Analysis of Cold Shut Casting Defect and Defect Reduction by Using 7 Quality Control Tools’ it is impossible to produce defect free castings. Occurrence of the defect may involve single or multiple causes. These causes can be minimized through systematic procedure. his paper represents the defect reduction by controlling alloy composition and pouring temperature. The seven quality control methodology was used to analyze and reduce defects which includes check sheet, pareto analysis, cause effect diagram, flow chart, scatter diagram, histogram and control chart. Here main focus was on improving the pouring practices and alloy composition for improving the flowability of the molten metal Cold shuts generally occur on wide casting surfaces in thin, difficult to fill sections which are farthest from the pouring cup, or where two streams of metal come together in the mold during filling.

Abdelrazig (2015) has studied about Using Lean Techniques to Reduce Waste and Improve Performance in Municipal Construction Project Delivery. He concludes that Waste in the construction process were defined and isolated as a controllable waste in which it was classified, recognized, and controlled. Also, Venkataraman (2014) says that various organizations are implement lean manufacturing in recent year for reducing and eliminate waste. In this article use the value stream mapping for reducing cycle time of crank shaft. Various type of tools is applied and get benefits, create a current state map of the crank shaft assembly line, and creates a future state map for improving process of crank shaft assembly, here is a three-assembly available for producing a crank shaft. And improve the process and reduce waste so that apply three type kaizens, and used the analytical hierarchical process (AHP) for decision making which process are apply and after than get result of the crank shaft assembly to reduce the inventory, and apply the single piece flow for crank shaft manufacturing and give quick response to the customer demand.

Sivaraman (2021) in his paper deals with the Productivity Improvement and Reduction of Lead Time in Manufacturing Industry Using Lean Tools, Productivity Improvement and Reduction of Lead Time in Manufacturing Industry Using Lean Tools’ A lean manufacturing initiative focuses on cost reduction and increases in turnover by systematically and continuously eliminating non-value-added activities. After achievement of fitting lean instruments, it was discovered that the all-out arrangement time was consolidated by around 180 minutes and process duration was dense by about 98 minutes which eventually decreases the lead time and builds the efficiency. In the wake of presenting the appropriate recompenses for each activity the Standard Operating Procedures (SOP) was made to do the cycle for fruition of the item. The created SOP was confirmed through appropriate channel for execution. During the cycle for a simple appraisal of the work by the specialists a reconsidered duplicate of the SOP was glued in each machine. Because of another sending of SOP it was seen that the lead time was decreased in the assembling line without influencing the required yield. According to Hari Lal Bhaska (2022) studied Lean Six Sigma is a systematic approach to reduce or eliminate activities that do not add value to the process. It highlights removing wasteful steps in a process and taking the only value-added steps. The lean six sigma method ensures high quality and customer satisfaction in the manufacturing. The main purpose of his studies was to explore the Lean Six Sigma (LSS) in the manufacturing sector as that study there was limited research on "Lean Six Sigma in manufacturing," and according to him, no standard work has been done for such a combination. As a result, his studies were to address such gaps in manufacturing and Lean Six Sigma (LSS) manufacturing that allow them to achieve the most benefits from this strategy.

Anna Lokrantz (2018) has studies about Root cause analysis of failures and quality deviations in manufacturing using machine learning**.** His aim of paper work is to describe a developed framework where machine learning techniques such as probabilistic graphical models and Bayesian networks are utilized for learning the causal relations in manufacturing processes. Root cause analysis (RCA) in the context of manufacturing is the process of identifying (causal) factors that cause errors or quality deviations in the manufactured product. A root cause is the most primary reason for, for example, an unwanted quality deviation in a final product or a decrease in overall equipment effectiveness (OEE) for a machine. In many cases, a problem can be solved in the short term by resolving either the symptom or the apparent immediate cause, but it will later reoccur because the treatment was not implemented to address the real root cause. In RCA one challenging issue is the problem of distinguishing between what is a symptom and what is the real root cause. The traditional approach to RCA is to utilize expert knowledge to define the causal factors existing in a manufacturing line.

Kumar and Mahto (2013) has studied about Productivity Improvement through Process Analysis for Optimizing Assembly Line in Packaging Industries. His aim of study was to minimizing workloads and workers on the assembly line while meeting a required/maximum output. Minimization of the number of workstations and maximization of the production rate are the most common goals. The paper presents the actual case different components manufactured at industries in which productivity improvement is a prime concern and there is a necessity for balancing the operations at various strategic workstations in order to apply group technology and minimize the total production cost and number of workstations. They conclude that from the analysis of data gathered from industry on assembly line balancing it is found that assembly lines are flow-line production systems, where a series of workstations, on which interchangeable parts are added to a product. Connecting all components of input, method, and process is most important part of process analysis. one way to analyze the frequency of problem in the system is utilizing a causal diagram that complies with what has been delivered by Krajewski et al (2016) in their book titled “Operation management”. Losses can occur in a manufacturing plant due to many reasons like asset failure, setup time, unavailability of raw material, operator inefficiency and many more. They impact Availability (A) and/or Performance (P) and/or Quality (Q) of production. In other words, losses impact Overall Equipment Effectiveness (OEE) (https://www.iiconsortium.org/case-studies/AIPL-Loss-Analysis-Case-Study.pdf). As Robert 2006 says Overall equipment effectiveness data (information) is used to identify and categorize major losses or reasons for poor performance. OEE provides the basis for setting improvement priorities and beginning root cause analysis.

Dibyojyoti (2015) has been studied Root Cause Analysis is a method to understand the actual reasons behind any undesirable effect, so as to address the problem at the grass root level. According to Mark Gershon has mentioned in “Choosing Which Process Improvement Methodology to Implement”, All the process improvement tools share many common features. They share the philosophy that processes can always be improved. They share the assumption of measurement and statistics being a key to improvement. And they share the faith in the power of the workers closest to a process to be able to improve it. Finally, he recommended but the combination of Lean and Six Sigma is proving to be the best approach developed yet. It adds more tools, looks at more situations, and achieves results faster than Six Sigma alone (http://t.www.na-businesspress.com/JABE/Jabe105/GershonWeb.pdf).

2.4 Research gap

To improve productivity of tobacco production in Ethiopia there is no research has yet conducted through investigation of product losses and their root cause analysis. As the government permission to run the industry for export the product despite of fact that tobacco has healthy effects, however no research has done to support productivity by analyzing product losses get in this industry. This research can be use full to give information on the production status capacity and productivity of tobacco in Ethiopia.

CHAPTER-3

RESEARCH METHODS

3.1 Introduction

To achieve the objective the study this research approach was utilized to prioritize the techniques and how to reduce rejection, obtain required results, and look for continuous production improvement. Therefore, case study line would be used to implement this methodology in a research design and study how to improve productivity by maximizing production rejection. The paper's goal was to improve a production process in an enterprise with the use of process improvement tools. The analysis was carried out in terms of identifying the most common problem that arise during a production process, which influence the final products Following that, certain activities were recommended in order to eliminate of them. Root cause analysis were used to analyze them. Ishikawa diagram and pareto chart are used for identify, the main problem that needed to be resolved and the causes of those issues were identified.

Following the classification of the factors according to how they affected the problem, then lean six sigma and 5 Why analysis was conducted, which led to the improvement of production process that may help enhance the manufacturing process in an organization. Kaizen workshops produced solutions that, if implemented, may enhance the organization's existing processes and get rid of flaws. The evaluation matrix of efficacy (degree of solution influence on problem) and mode of implementation (it is whether an enterprise may launch the solution itself or it must outsource to a different company) was also utilized to study the offered solutions.

As a research method a case study was chosen in regard of the usefulness of problems solving within processes management in enterprise as well as methods and tools used to make effective and sensible decisions (Piekkari and Welch, 2011).

Case study research can be used to develop new theories, expand on existing theories, challenge traditional theories, and conduct pilot research. Case study research is good for understanding complex issues in their real-life settings, and it is often used to understand the perspective of participants in those settings.

As Laura Lohman (2021**)** mentioned about case study design, Case study research is commonly described as a form of qualitative research. Qualitative case study research differs from quantitative research, which focuses on numerical data and uses statistics to answer a research question. In qualitative research, researchers use non-numerical data, such as answers to interview questions, to answer a research question. Case study research also differs from research conducted through experiments. In case study research, the conditions of the setting and context are integral to the research, and the researcher does not exclude or control for those factors, as in experimental research. According to Tools & Techniques for Process Improvement A useful way of mapping the inputs that effect quality is the Cause & Effect Diagram, also known as the Fishbone or Ishikawa Diagram. It is also a useful technique for opening up thinking in problem solving (www.dti.gov.uk/quality/tools).

3.2 Methods

This research paper is based on case study approach. This case study research has been carried out in a national tobacco enterprise (Ethiopia) S.C industry. This research approach is utilized to prioritize the techniques and how to reduce production rejection, obtain required results, and look for continuous production improvement. Several root cause analyses are used in the process to identify the existing rejection rate of the selected industry and to reduce them.

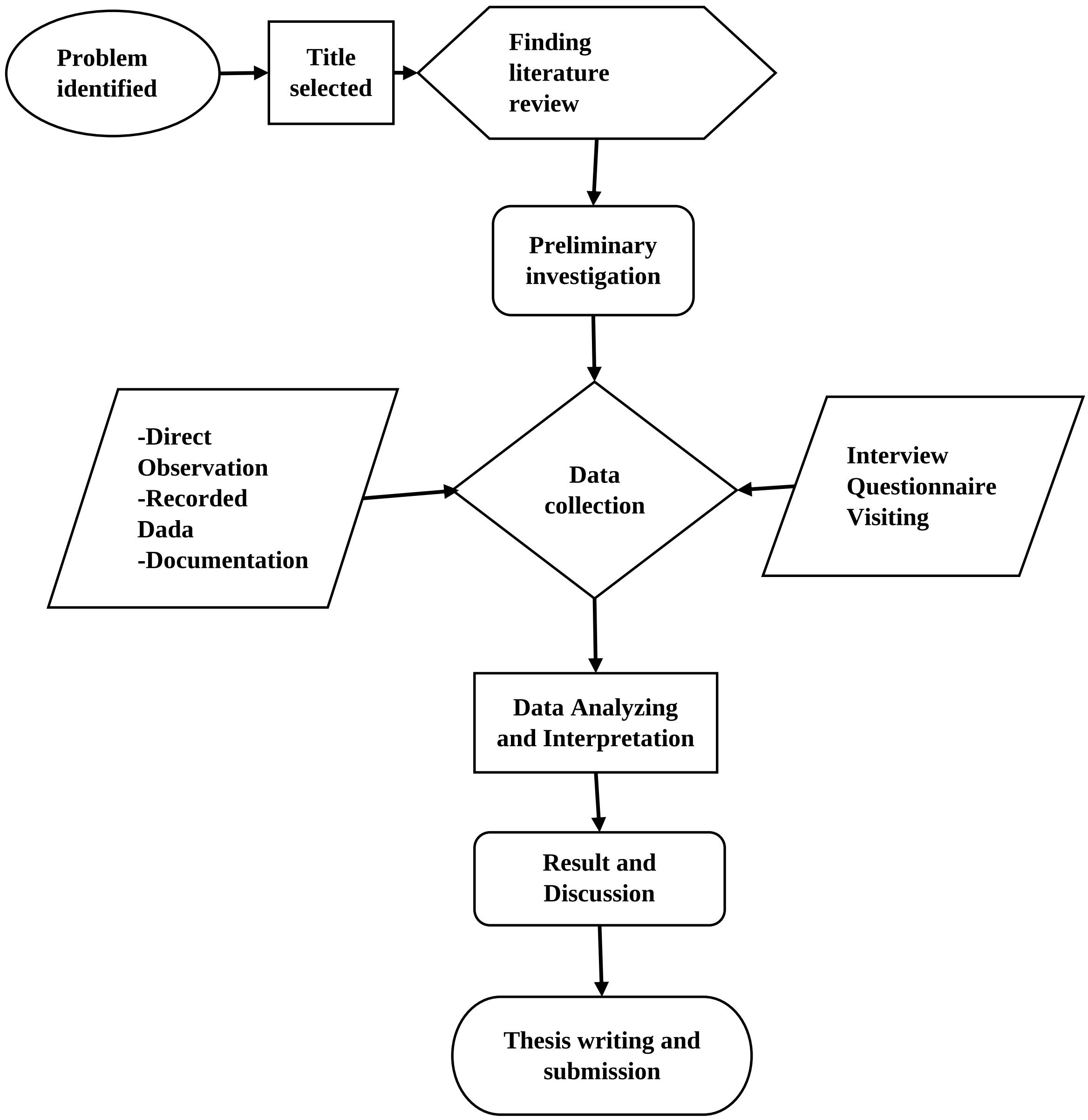

Figure 3.1 Flow chart of the research study

3.3 Data Collection

Data availability was one of the basic factors of the study. Data collected from both Primary and Secondary sources to obtain quantitative and qualitative information. In most cases the primary data have been gathered through direct measurement, recording and collection from the source of information on the time. Besides primary data, source of much study was from this type of source which were available by gathered by different organization for many years. In this research, secondary data was used for the analyzing the research.

3.4 Method of data collection

Data would be collected; by data analysis structured interview questions, visiting recorded data in company, by visiting concerned machines in industry and recording existing rejection rate per month. The factory's production and improvement related documents of different month and final annual reports has been referred and analyzed.

- **Observation of production process, machineries and techniques**
- **Survey questionnaire:** A separate questionnaires were developed for respondent. The questionnaire included production, maintenance, quality and top management. The reason for survey was to understand the magnitude and impacts of losses in different functions of the case company and indicate priority areas for planning of actions.
- **The Focus group discussion:** The focus group discussion was designed to identify the root causes for high rejection. Members of the focus group discussions were meticulously selected to ensure improve the data collected. To extract and organize data tools such as, fishbone diagram, cause and effect diagram and 5 whys were also used to identify the most significant root causes
- First hand data from production department, quality department and maintenance sections.

3.5 Data Analysis Method

Data analysis in statistical process control (SPC), cause and effect diagram (CED) methods 5why technique and 5Ws1H technique to problem solving techniques chosen for the procedures. The data collected by recording per shift were summarized for analysis. The outputs of the data were presented appropriately depending on statistical results and the result presented in a written form. Finally, presentation, analysis, and interpretation of data, conclusions and recommendations were drawn using analysis and data outcomes into a text format.

All collected data have been analyzed using different tools and techniques; tables, graphs, and charts have also been used to present the results on various variables in the study. To achieve the objective of this study root cause analysis techniques selected.

3.6 Data analysis tools

3.6.1 OEE Analysis

OEE (Overall Equipment Effectiveness), was initially used by Seiichi Nakajima in the 1980s. It aimed as a quantitative metric for measuring productivity of individual production equipment in a factory. Overall equipment effectiveness data (information) is used to identify a single asset (machine or equipment) and/or single stream process related losses for the purpose of improving total asset performance and reliability a trustworthy quantitative statistic, is utilized in the majority of manufacturing systems to regulate and track the output of production machinery. This performance indicator includes three crucial elements to assess how effectively (or poorly) the line is performing: availability, productivity, and quality. OEE can be defined as the percentage of time that a piece of machinery would need to operate at maximum speed in order to produce the machine's actual output. The three factors availability, performance, and quality rate of an items are multiplied to arrive at the figure. OEE analysis can be applied at several stages in the manufacturing sector, and its value can be utilized as a standard for additional production plant measures (Keegan 2014).

3.6.2 Pareto Analysis

A Pareto chart is a bar graph with lines to represent the total cumulative values and bars arranged in descending order of height, starting at the left. A crucial tool for performing pareto analysis is this chart. A pareto analysis is a technique which helps the identification of major problems, according to Pareto analysis, 80% of problems can be traced to 20% of the cause. Pareto analysis' key benefit is that by ranking them in descending order, it aids in identifying the core causes of flaws or other issues. Additionally, it offers a shared understanding based on facts rather than assumptions, which leads to winning the cooperation of all issues at hand. Therefore, in this study Pareto chart was chosen to identify the 20% predominant downtimes that caused around 80% of total losses so that it can be easier to study root cause of major problems causing a highest rejection level.

The Pareto Chart is a mix of a bar graph and a line chart. It’s used for demonstrating the 80-20 principle. Individual problems (or data points) are represented using bars, and these bars are arranged in descending order from the largest to the smallest. A curved line is used to represent the cumulative total of the data set. Furthermore, there is an 80% cut-off line that shows where the 80/20 principle applies. The 80/20 rule pretty much argues that 80% of the results are determined by 20% of the effort. Simply put, the Pareto Chart is a visualization tool that helps you pinpoint the most frequent complaint, defects, or other issues that can be easily categorized or counted. Also, the chart follows the Pareto principle 80% of effects are as a result of 20% of action or causes (https://tulip.co/blog/what-is-a-pareto-chart-definition-examples/).

3.6.3 Analysis of the five whys

Five Whys is an iterative interrogative technique used to explore the cause-and-effect relationships underlying a particular problem. The basic goal of the strategy is to continuously question "Why?" in order to determine the root cause of a problem or fault. The next question is based on each response. The number "5" in the name comes from anecdotal evidence about how many iterations were required to address the issue. Not every issue has a single underlying cause. The procedure must be performed with each new set of questions being asked in order to identify various root causes. (Olivier Serrat.2017)

A production team can concentrate on identifying the root cause of any problem with the use of the five why approach, which is known as the ultimate root cause analysis tool. This study is carried out during a brainstorming session where team members are exchanging solutions to stop difficulties and failures in securing a production line. This approach was created in Japan by the industrialist and inventor Sakichi Toyoda. It was first utilized in the Toyota production system and has since become an essential component of the lean philosophy. Many academics believe it to be a powerful tool when used as the first stage in a complicated production system's problem-solving process. The five why method is based on an iterative interrogative question to examine the cause-and-effect relationship underneath a specific problem. The fish bone (Ishikawa) diagram and tabular format are the two main methods for performing a five-why analysis. These two methods enable the study to be branched, allowing for the identification of various root causes. Production rejection should be the first area where OEE is implemented because they are what limit process throughput and prevent a production performance from becoming effective.

CHAPTER - 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter production rejection and operation were investigated causes of production loss problems.

4.2 Actual production and planned production data

The production plan for each year may vary due to a variety of variables, mostly because some tasks, such as brand change over, planned and unplanned maintenance and setup adjustments occur in every production year. The planned, actual and production performance data has been extracted from production data record sheet and since the packer machine counts the net actual production, packer counter has been taken as the source of actual production data. Under the table below the actual production, planned production and performance of different years are presented. Table 4.1 shows production performance of the company for fourteen years where the least performances were 2020 GC and 2012 GC which was due to poor maintenance strategy. It was confirmed that from Table 4.3 also the rejection rate of 2020 GC was higher than other production years.

Table 4.1 production performance of consecutive years.

(Source: NTE Planning department by Demise kifle,2020 'Factors Affecting Organizational Production Performances)

years	Plan in cases	Actual in cases	Percentage
2009	346,170	321,580	92.90
2010	375,480	347,062	92.43
2011	386,250	371,684	96.23
2012	453,485	352,929	77.83
2013	443,450	403,497	90.99
2014	454,085	417,938	92.04
2015	564,045	451,299	80.01
2016	562,050	477,821	85.01
2017	560,050	504,343	90.05
2018	580,000	574,002	98.97
2019	586,300	553,089	94.34

2020	509,400	349,233	68.56
2021	397,310	287,985	72.48
2022	361,258	145,207	80.39

Production performance of any manufacturing company is affected by many factors such as machine condition, maintenance strategy and quality of raw materials, input manpower efficiency which was highly dependent on experience and education of the works. In this research work as shown in Figure 4.1 production performances of the company was not uniform the planed and actual production variation was highly fluctuating due to many factors as discussed earlier and environmental factors. The good production performance was achieved in 2018 GC and 2019 while it was decreased till recent years of 2022 GC. The main factors to such problems were further investigated through questioners and cause and effect diagram in the next sections.

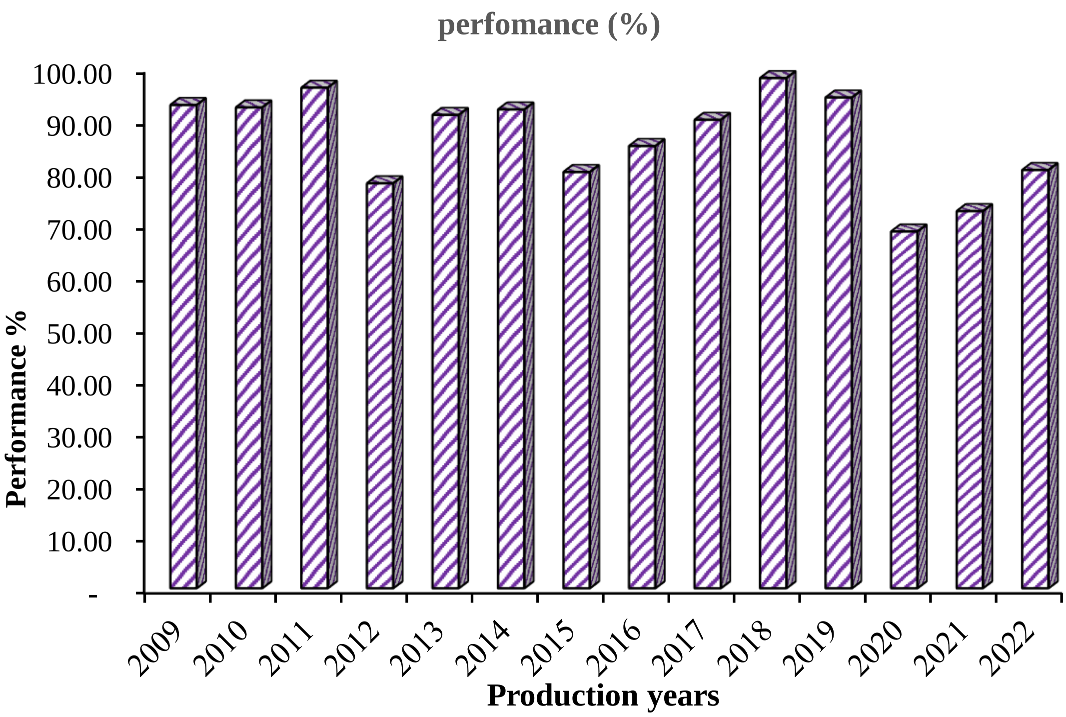

Figure 4.1 production performance (2009-2022)

4.2.1 production capacity of the machines

Table 4.2 shows designed and current capacity of the machines. This indicates the actual production capacity of maker 03 and maker 04 reduced by half of designed capacity.

Table 4.2 production capacity of the machines

Production line	Machine number	Designed capacity	Current capacity
Line 1 (GD03)	Maker 03	10,000cpm	5000cpm
	Packer 03	400 ppm	300 ppm
Line 2 (GD04)	Maker 04	10,000cpm	5000cpm
	Packer 04	400 ppm	300 ppm
Line 3 (GD05)	Maker 05	12,000cpm	6500cpm
	Packer 05	500 ppm	400ppm
Line 4 (GD08)	Maker 08	10000cpm	8000cpm
	Packer 08	500 ppm	400cpm

Table 4.3 Monthly rejection percentage of 2020 year

Months in 2020	Actual	Average	Target
January	8.17%		
February	6.96%		
March	7.69%		
April	8.26%		
May	6.85%		
June	7.93%	7.30%	6%
July	7.67%		
August	7.05%		
September	5.29%		
October	7.38%		
November	8.07%		
December	7.47%		

Table 4.3 shows the results of data collection from company's recorded document. It represented the actual, average, and target rejection rate for 2020 year. The rejection rate in the month of April 8.26%, January 8.17%, and November 8.07% were high percentage of rejection. Based on the this the average percentage of rejection was 7.30% that was greater than the target value 6.00% as shown in Fig. 4.2

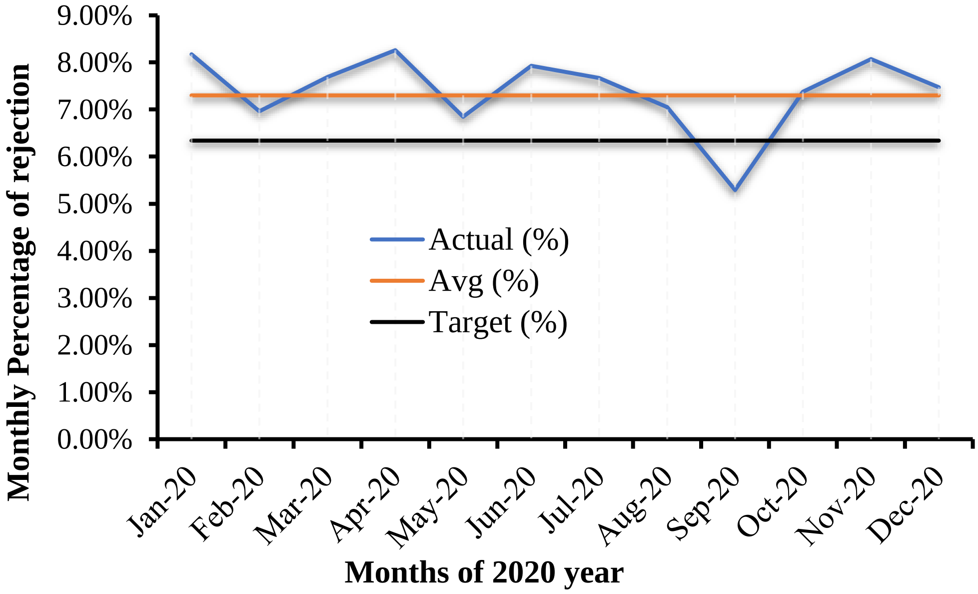

Figure 4.2 Rejection graph for the half year of 2020

Figure 4.2 shows the monthly average and actual rejection percentages were mostly out of targeted except month of September 5.29%. there were high losses due to high percentage of rejections. This shows us further investigation and process improvement needed. The data gathered from the company's recorded documents is shown in Table 4.4. It showed the rejection rate for 2021 in its actual, average, and target ranges. The rejection in this year meets as per company target plan except the month of January 6.60%. Based on the average percentage of rejection was 4. 71%.

Table 4.4 Monthly rejection percentage of 2021 year

Months in 2021	Actual	Average	Target
January	6.60%		
February	5.44%		
March	4.90%		
April	4.33%		
May	3.95%		
June	4.59%	4.71%	5.40%
July	4.20%		
August	4.20%		
September	4.35%		
October	4.90%		
November	4.41%		
December	3.59%		

As indicated in Table 4.5 the rejection rate in the months of April, May and June were 7.50%, 8.49%. and 7.86% respectively. The rejection in month of May 8.49% that was the highest record. From the above table, the rejection target 4.09% and actual rejection percentage was 6.66% this implies the rejection rate were beyond the target. The rejection percentage for 2022 year including its actual, average, target and the cost of rejection were shown in table below and when computed in money 108,643,625.20 birr.

Table 4.5 Rejection percentage of half year of 2022 year

Months of 2022	Actual rejection	Average rejection	Target Rejection	Converted to money
January	4.91%	6.66%	4.09%	10,262,440.10
February	5.39%	6.66%	4.09%	13,861,409.10
March	5.80%	6.66%	4.09%	15,339,434.00
April	7.50%	6.66%	4.09%	20,141,550.00
May	8.49%	6.66%	4.09%	27,363,270.00
June	7.86%	6.66%	4.09%	21,675,522.00
Total				108,643,625.20

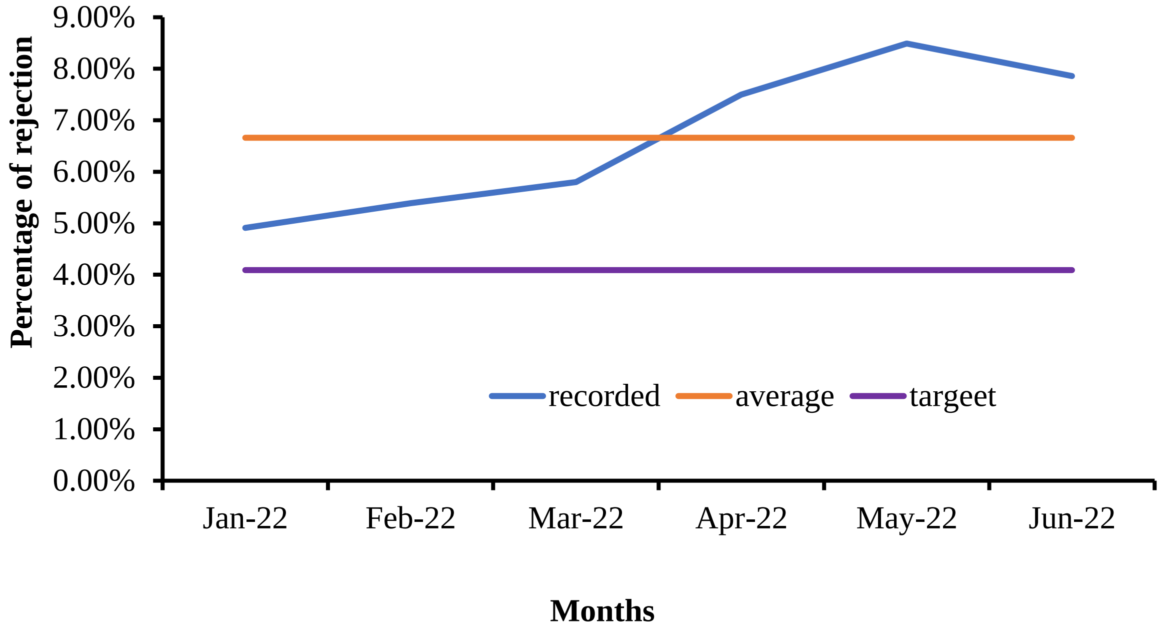

Figure 4.3 Rejection graph for the half year of 2022

Figure 4.3 illustrates planned and targeted rejection percentage of production, that there is a higher loss percentage for actual and average rejections compered to targeted rejections

4.3 Root Cause Analysis

According to BRC Global Standards studies, Root cause analysis is a problem-solving process for investigating an identified incident, problem, concern or non-conformity. Root cause analysis (RCA) requires the investigator(s) to look beyond the solution to the immediate problem and understand the fundamental or underlying cause(s) of the situation and put them right, thereby preventing re-occurrence of the same issue. This may involve the identification and management of processes, procedures, activities, inactivity, behaviors, or conditions. (BRC Global Standards (2012). Root Cause is the fundamental breakdown or failure of a process which, when resolved, prevents a recurrence of the problem. Every equipment failure happens for a number of reasons. There is a definite progression of actions and consequences that lead to a failure. An RCA investigation traces the cause-and-effect trail from the end failure back to the root cause (Kalantri1 and Chandrawat, 2013).

RCA "is a process of analysis to define the problem, understand the causal mechanism underlying transition from desirable to undesirable condition, and to identify the root cause of the problem in order to keep the problem from recurring by using a structured procedure (Kiran M et al, 2013)

The benefits of comprehensive root cause analysis include

- ✓ Identification of permanent solution
- ✓ Prevention of recurring failures
- ✓ Introduction of a logical problem-solving process applicable to issues and nonconformities of all sizes

The Root Cause Analysis is a five-step process involving the following:

- Step 1. Define the problem
- Step 2. Data collection
- Step 3. Cause charting
- Step 4. Root cause identification
- Step 5. Recommendation.

4.2.1 Analysis of the problem

The company cannot meet demand from the market even with 24-hour production. In order to maintain a stable output level and meet market demand, the corporation must reduce production rejection. Production may be stop because of numerous factors such as machine failure, maintenance tasks, labor issue, a lack of materials supply, and problem in production process, etc. excluding all other materials, methods, human factors, etc. it is essential to reduce production rejection by decreasing frequency of machine stoppage and down time. Waste and machine Breakdowns are the most common causes of productivity loss in manufacturing. frequent machine stoppages are one of the major causes of production losses and reduced productivity. Reducing production losses is essential to enhancing Efficiency of the entire equipment. it is important to know how wasteful your process is and use research-proven processes and techniques to eliminate the cause of the problem. Not only is it crucial to know how long your process takes to complete being able to not just experience but also attribute the length of time lost to a particular cause or source.

Case study was conducted on the production losses of the company and to find out the root causes of these losses so as to eliminate them and to decrease the rejection caused due to machine breakdown.

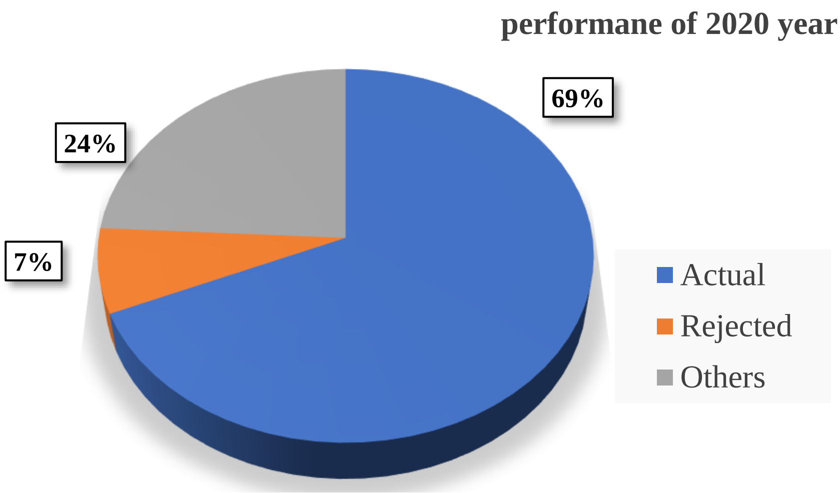

Figure 4.4 Pie chart of percentage performance of 2020 year

The rejection production data collected consists of all the rejects generated by cigarette maker and packer machines that was gathered as in shown Figure 4.4. However, this study focused on the rejection, which leads to rectify production losses. Since one cases of cigarette contain 10,000 pieces so 10,000 units will be waste when one case of cigarette rejected. When calculating the loss in Birr, the price of each finished product piece based on the brand and results in a loss of money ranging from 1.1 to 1.3 Birr. Data gathered on rejection shows that in 2020, 7.30% of the actual production was rejected. This means 25,494.01 rejected cases Loss of about 280,434,110 Birr by 2020 year.

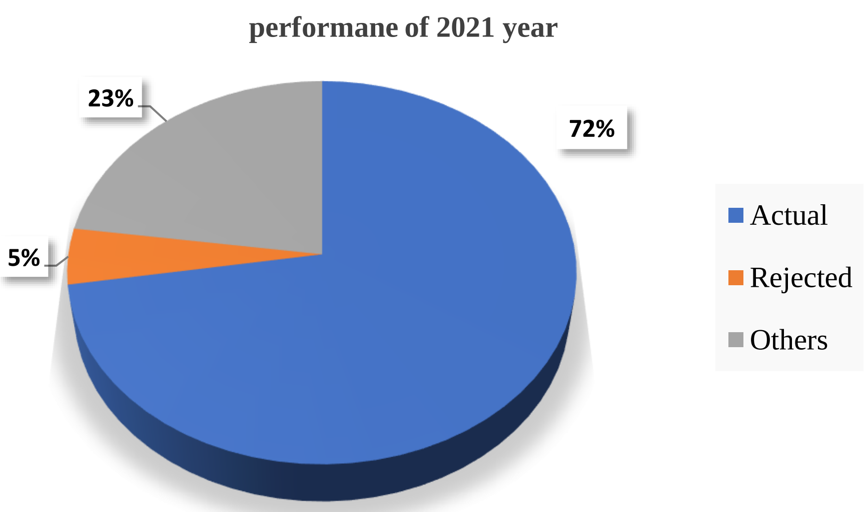

Figure 4.5 Pie chart showing percentage of production performance of 2021year

As shown in figure 4.5 around 5% of the actual output volume in 2021 year was rejected. Consequently, 13564.10 cases were rejected. Which means 13564.10 cases rejected. Converting a loss into money about 149,205,100 Birr through 2021 year

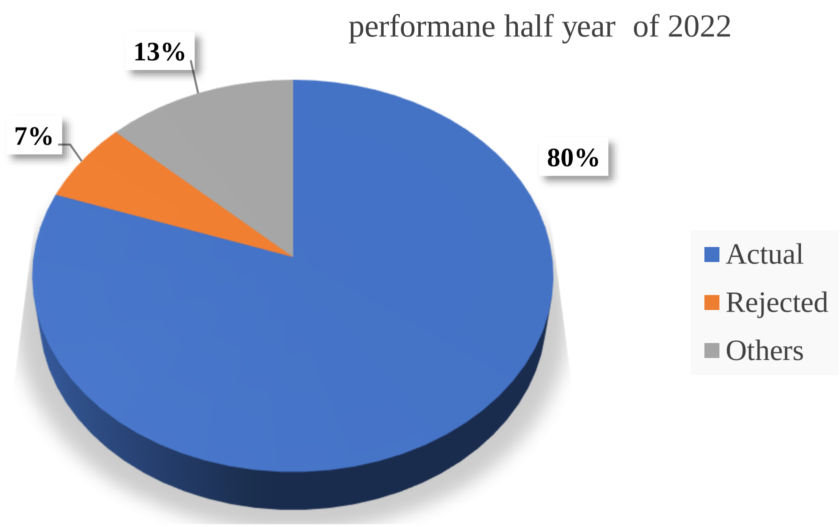

Figure 4.6 Pie chart showing percentage half year performance of 2022 year

Figure 4.6 shows that about 7% of the actual production volume was rejected, this decreases the productivity according on statistics on rejections from the half year of 2022 year. which converts to 10,162.39 cases equals 101,623,900. the loss would be around 111,786,290 Birr until the first half year of 2022

4.2.2 Data Collection and Analysis

Table 4.6 tabulates breakdown information that was gathered from a machine that had a high rejection rate history during all shifts for the month of May 2022. The breakdown statistics are listed as follows.

Table 4.6 Major causes of rejection and downtime on Maker 03 Machine

No.	Description/stoppage reason	Frequency	Downtime (hr.)
1	Rod break	1861	56.88
2	Maker service stop	748	33.15
3	Stop from tray filler	644	63.98
4	Tipper manual stop	433	18.97
5	Rolling block jam	357	13.70
6	Tipper cork break	224	14.00
7	Paper break maker	97	6.17

8	Feeder hopper empty	37	3.83
9	Tobacco down drop channel empty	11	5.67
10	Hopper filter jam	9	0.22
11	Torque limiter steam rejection roller	8	0.63
12	Mechanic	3	3.17
13	Maker air pressure	3	2.57

The breakdowns causing stoppages of production process were identified from the data collected and tabulated as Table 4.6 shown above. The main causes of breakdowns to rectify the rejection rate were also noted with GD03 machine. The major breakdowns causing production losses.

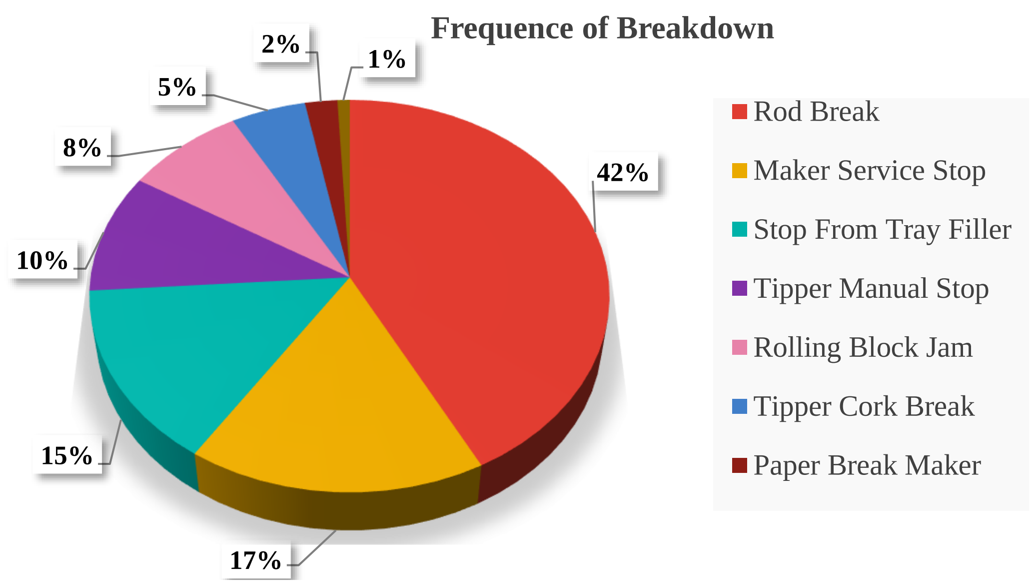

Figure 4.7 Pie chart Shows breakdown on GD 03 maker machine.

Figure 4.7 shows that rod break breakdown (42%) accounts for the majority of breakdowns that affect the company production on the GD03 Maker machine line. According to the data gathered, other significant breakdowns in the company include rejection at startup breakdown (17%) and stop from tray filler breakdown (15%).

The pareto chart in Figure 4.8 shows, the total cause of loss due to rod break on maker 03 machine was responsible for the 80% breakdown by others. The pareto analysis indicates that solving the root cause problem of rod break ensure a better and effective productivity improvement. Therefore, the result of this analysis will be taken as an input for the rejection reduction techniques.

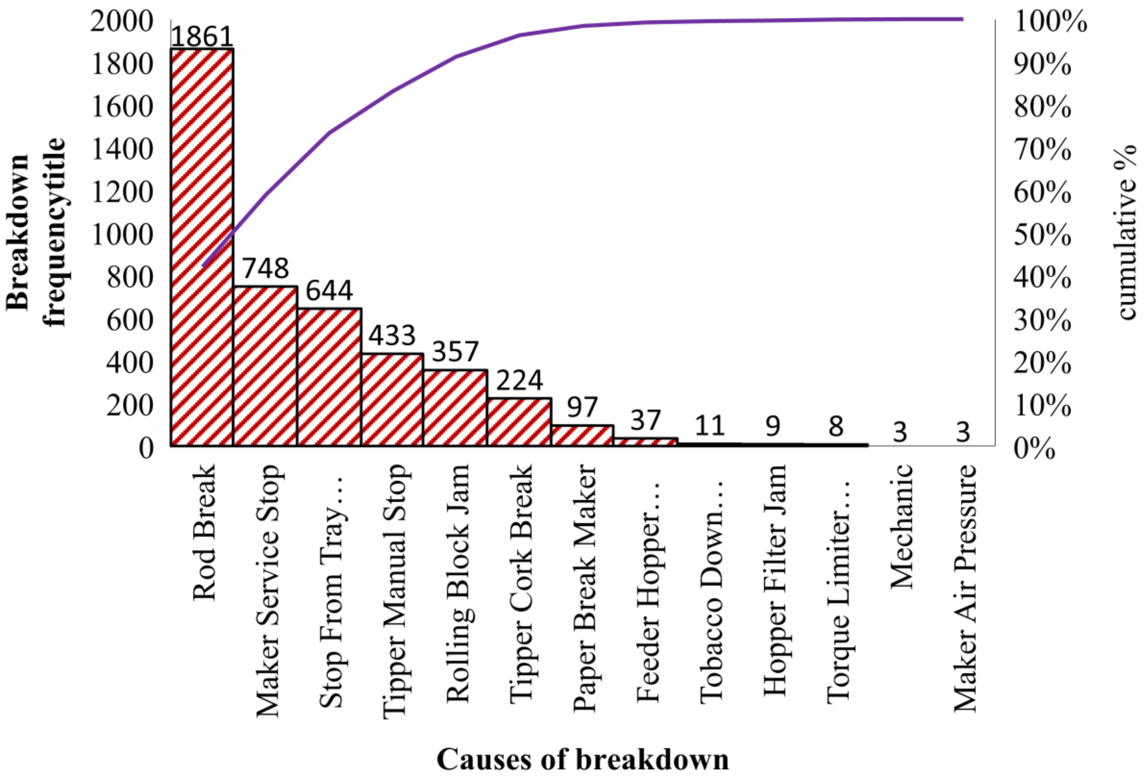

Figure 4.8 Pareto analysis of major breakdown causes on GD03 make machine

Table 4.7 Major causes of rejection and downtime on Maker 04 Machine

S/no	Description/stoppage reason	Frequency	Downtime (hr.)
1	Rod break	977	41.81
2	Stop from tray filler	886	103.27
3	Maker service stop	512	29.80
4	Tipper manual stop	350	21.35
5	Tipper cork break	130	10.45
6	Paper break maker	107	6.80
7	Feeder hopper empty	92	17.25
8	Rolling block jam	80	4.03

9	Tobacco down drop channel empty	26	10.72
10	Service stop	14	1.23
11	Maker splicing tape missing	13	0.62
12	Sensor fault tipper glue level	7	0.58
13	Exit jam	7	0.85
14	Maker air pressure	6	2.75

Table 4.7 illustrate the major machine stoppage, frequency and downtime that data gathered from GD04 maker machine. The breakdowns causing stoppages of production process were identified from the data. The time spend to rectify the breakdowns was also noted. Figure 4.9 shows, the primary cause of rejection was Rod break (31%) which responsible for the majority of the breakdowns that caused the company production on the GD04 Maker machine and as per the data gathered, rejection due to Stop from tray filler breakdown (28%), maker service stop (16%), and other considerable breakdowns rectify the CRR in the company.

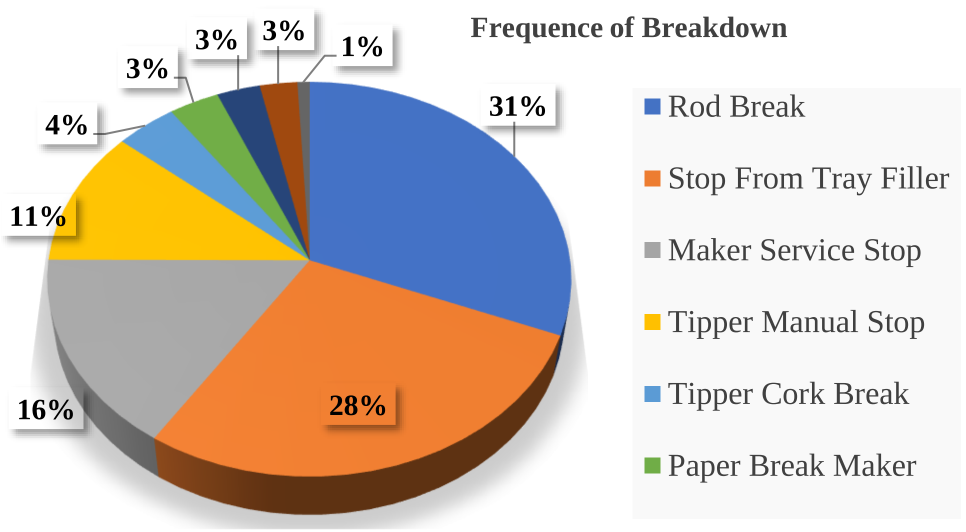

Figure 4.9 Pie chart machine breakdown on GD 04 maker machine

Table 4.8 Summary of major breakdown reason on maker's machine

No.	Description/reason	Frequency	Percentage	Cumulative %
1	Rod break	2838	37.48	37.48
2	Stop from tray filler	1530	20.21	57.69
3	Maker service stop	1260	16.64	74.33
4	Tipper manual stop	783	10.34	84.67
5	Rolling block jam	437	5.77	90.44
6	Tipper cork break	354	4.68	95.12
7	Paper break maker	204	2.69	97.81
8	Feeder hopper empty	129	1.70	99.51
9	Tobacco down drop channel empty	37	0.49	100

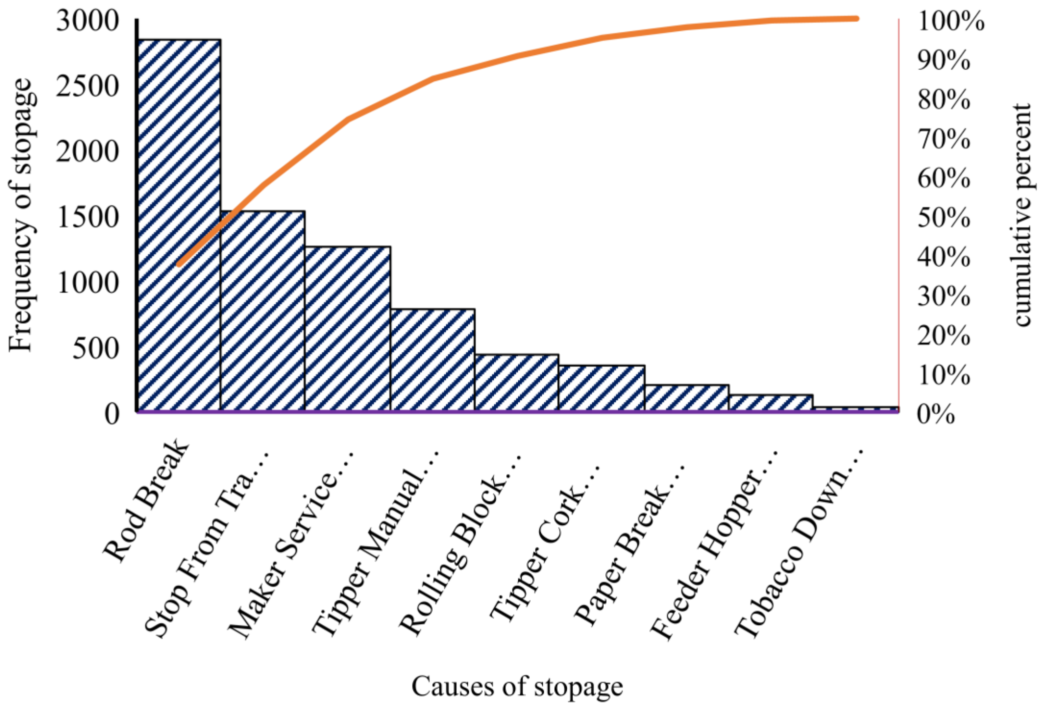

Figure 4.10 Pareto analysis of major breakdown causes for maker machine

A detailed overview of the problem seen in Figure 4.10 Pareto analysis due to frequent machine stoppage losses. Plotted along the main horizontal axis are the numerous causes of maker machine breakdown. The cumulative percentage was plotted against the secondary vertical axis, and the individual cause percentage is plotted along the primary vertical axis. From pareto analysis the factor contributing roughly eighty percent toward machine breakdown were found to be rod break, stop from tray filler and maker service stop. Out of these major losses recorded due to rod break was further studied. Table 4.9 shows the major machine stoppage, frequency and downtime that data gathered from packer03 machine. The major breakdowns causing stoppages Incomplete cigarette pocket, Jam on exit channel and No cigarettes in feeder x was identified from the data. The downtime due to the machine breakdown was also noted.

Table 4.9 Major causes of rejection and downtime on Pack03 Machine.

S/no	Description/stoppage reason	Sum of frequency	Downtime in hr.
1	Incomplete cigarette pocket	3561	61.35
2	Jam on exit channel	2231	69.38
3	No cigarettes in feeder x	1274	89.52
3	Hopper pusher guard open	847	10.82
5	Check fail; label presence on gluer	623	12.68
6	Service stop	557	17.30
7	No foil	455	4.22
8	Stop from cigarette reserve	420	13.00
9	Front guard open	85	3.73
10	No cigarette in hopper	76	2.58
11	Flexible wall jam	56	0.75
12	Packet jam on exit disc	43	1.02
13	Hopper guard open	41	0.85
14	Label jam at gluer exit	35	0.88
15	Hot melt not ready	29	0.22
16	Fail; 4th wheel packet exit check	20	0.17

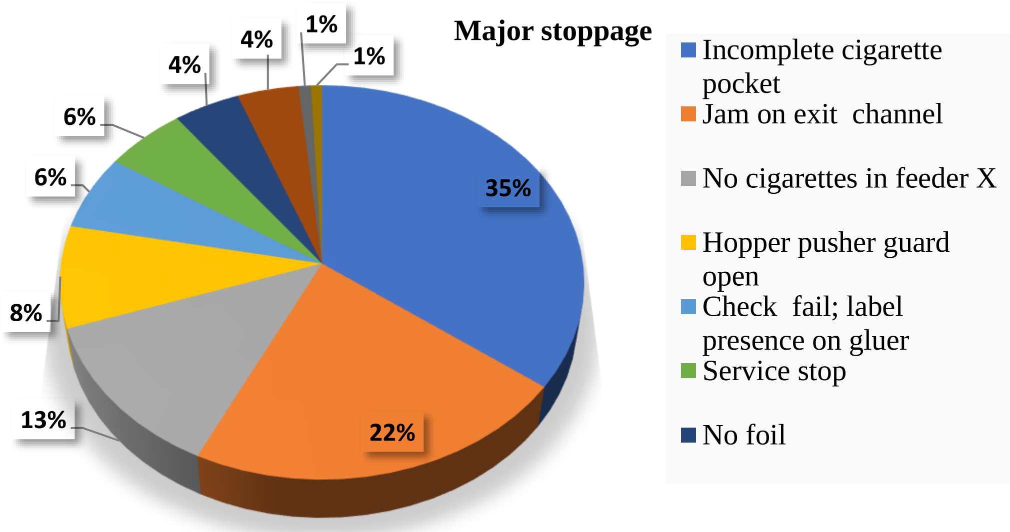

Figure 4.11 pie chart showing breakdown on GD 03 packer machine.

From the figure 4.11 above it is clear that incomplete cigarette pocket (35%) accounts for the most of the breakdown causing production loss to the company on Packer machine and Jam on exit channel breakdown (22%) are other major breakdowns in the company as per the data collected.

Table 4.10 shows the major machine stoppage, frequency and downtime that data gathered from packer04 machine. The major breakdowns causing stoppages Jam on exit channel, Incomplete cigarette pocket No cigarettes in feeder x was identified from the data. The downtime due to the machine breakdown was also noted.

Table4.10 Major causes of rejection on pack04 Machine.

S/no	Description/stoppage reason	Sum of frequency	Downtime in hr.
1	Jam on exit channel	2889	69.88
2	Incomplete cigarette pocket	2046	24.25
3	No cigarette in hopper	1211	20.88
3	No foil	1182	15.32
5	Stop from cigarette reserve	675	31.93
6	Flexible wall jam	670	6.10
7	No cigarettes in feeder x	642	41.40

8	Packet jam on exit disc	535	9.55
9	Hopper pusher guard open	519	10.55
10	Service stop	504	18.67
11	Check fail; label presence on gluer	144	5.02
12	Front guard open	80	7.63
13	Exist guard open	50	1.73
14	No cigarette in hooper	31	0.35
15	3rd wheel door open	29	1.03
16	Hopper guard open	27	0.38
17	No cigarette on feeder x	6	0.97
18	Fail; 4th wheel packet exit check	6	0.37
19	Hot melt not ready	5	0.17

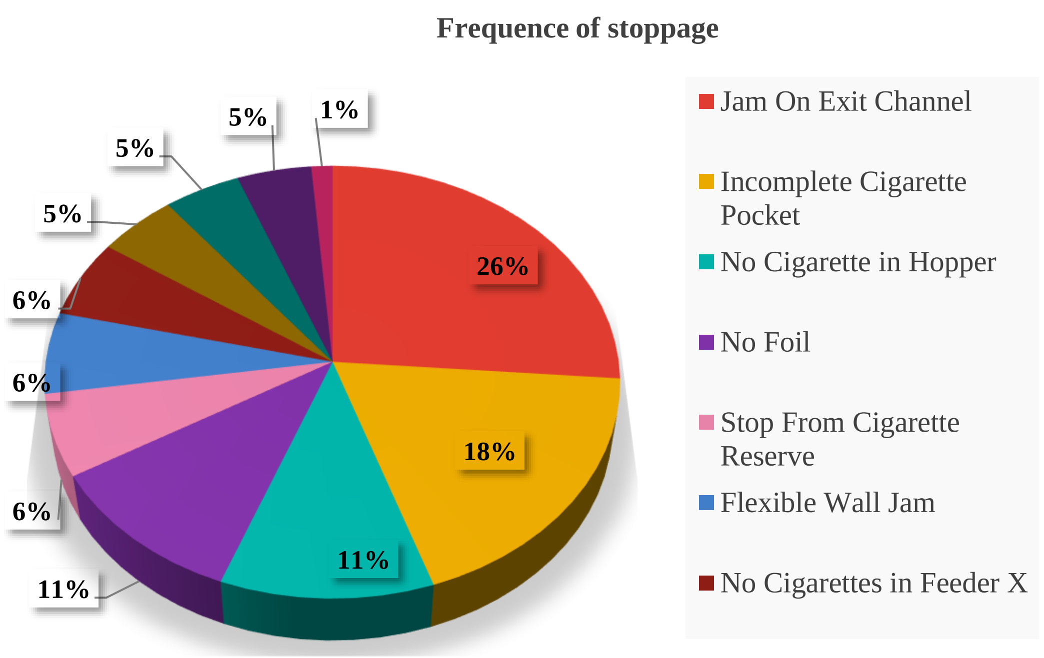

Figure 4.12 pie chart showing breakdown on GD 04 packer machine

According to the data gathered, Jam on exit channel breaks 26% account for the majority of breakdowns that result in production losses for the company on the 04 Packer machine, and Incomplete cigarette breakdowns 18% are other significant breakdowns in the company.

Table 4.11 Major causes of rejection and downtime on pack 05 Machine.

S/No	Description/stoppage reason	Sum of Frequency	Downtime in hr.
1	Incomplete Cigarette Pocket	2542	35.37
2	No Cigarette in Hopper	1668	21.52
3	Stop From Cigarette Reserve	1490	130.43
4	Service Stop	1204	24.97
5	1 Packet Transport Channel Jam	858	30.38
6	Fail; Label Check at Gluer Exist	158	5.48
7	No Label on Gluer	117	2.62
8	Check Fail; Label Presence on Gluer	115	4.40
9	No Cigarettes in Feeder X	57	0.45
10	5th Wheel Internal Half Ring Jam	53	1.73

Table 4.11 shows machine stoppage, frequency and downtime that data gathered from packer05 machine. The major breakdowns causing stoppages are Incomplete Cigarette Pocket, No Cigarette in Hopper and Stop from Cigarette Reserve were identified from the data. The downtime due to the machine breakdown was also noted.

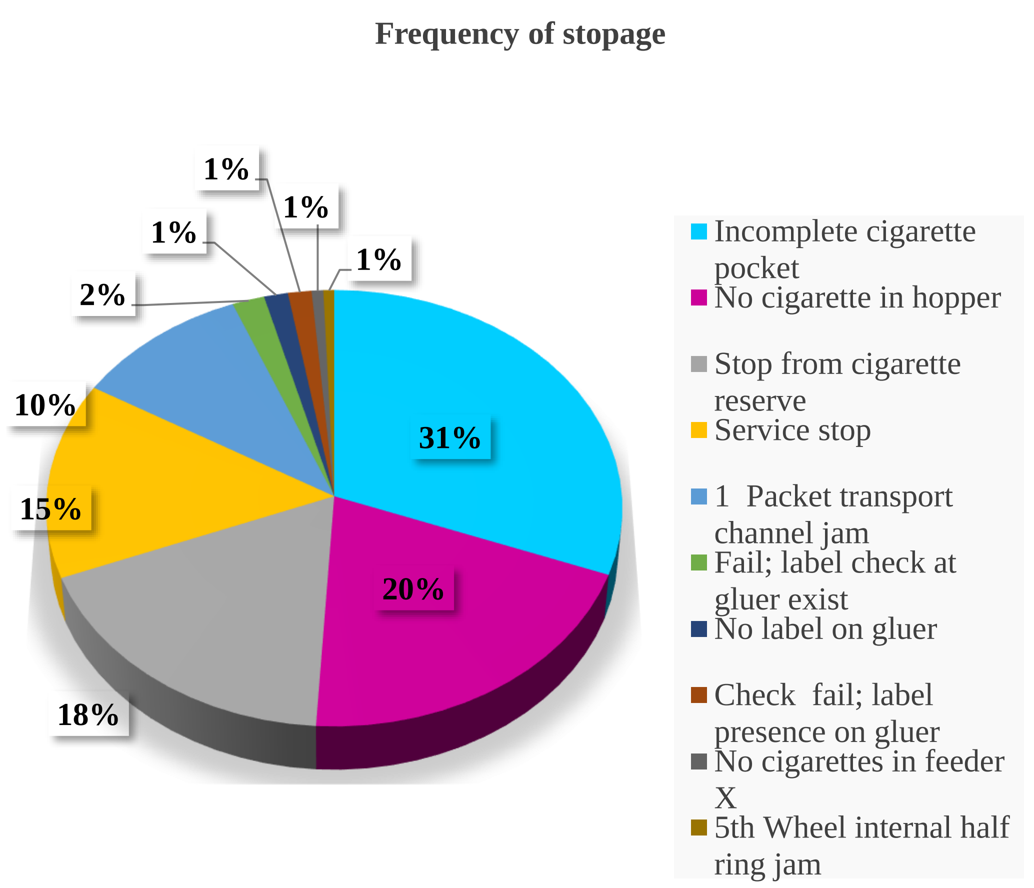

Figure 4.13 pie chart showing breakdown on GD 05 packer machine

Figure 4.13 shows major causes for breakdowns that causes product rejection. According to the data gathered, incomplete cigarette pocket breaks (31%) account for the majority of breakdowns that result in production rejection for the company on the 05 Packer machine, and no cigarette in hopper breakdowns (20%) are other significant breakdowns in the company. If company can comprehend what was going on and identifying the problems there should be a greater improvement.

Table 4.12 Summary of major breakdown on all packer machines for may

No	Description	Frequency	Percentage
1	Incomplete cigarette pocket	8149	27.24
2	Jam on exit channel	5120	17.12
3	No cigarette in hopper	2955	9.88
4	Service stop	2265	7.57
5	Stop from cigarette reserve	2165	7.24
6	No cigarettes in feeder x	1973	6.60
7	No foil	1637	5.47
8	Hopper pusher guard open	1366	4.57
9	Stop from cigarette reserve	1095	3.66
10	1 packet transport channel jam	858	2.87
11	Check fail; label presence on gluer	781	2.61
12	Flexible wall jam	670	2.24
13	Packet jam on exit disc	535	1.79
14	Check fail; label presence on gluer	259	0.87
15	Front guard open	85	0.28

Figure 4.14 shows Pareto analysis of major breakdown summary for packer machines. According to the Pareto Principle of Analysis, only "vital few" factors are responsible for producing the majority of the problems. A theory that can and is frequently used to improve quality to the extent that the great majority of problems (80%) are caused by a miniscule problem (20%). Therefore, if the connection can be made so companies can comprehend what is going on, detect and identify problems, and be able to take corrective actions, then there should be a greater probability of success.

In general, on all machines, issues that lead to product rejection were identified. According to the collected data, rod break has the highest percentile on makers machines and incomplete cigarette pocket is the top cause on packer machines. Therefore, the next task will be to investigate the causes of these problems and finding long term remedies. A Pareto chart, where the line represents the cumulative total and the bars indicate individual values in descending order. The frequency of occurrence is shown on the left vertical axis, while the cumulative percentage of all occurrences is shown on the right vertical axis. The Pareto chart's objective is to identify the most critical element among a group of components.

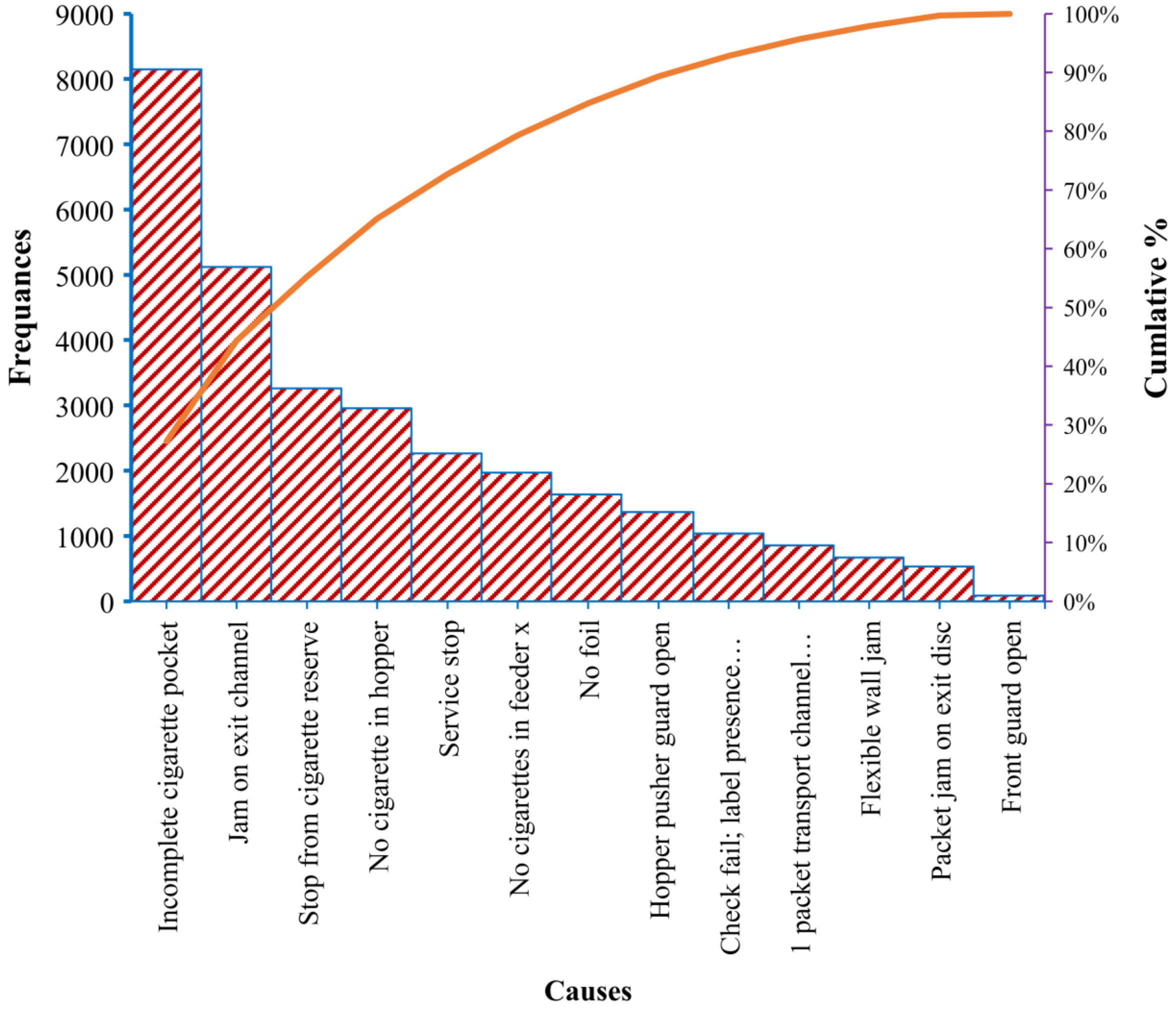

Figure 4.14 Pareto analysis of major breakdown summary for packer machines

From pareto analysis the factor contributing roughly eighty percent toward machine breakdown were found. As shown in figure 4.14 the principal factors to be incomplete cigarette pocket, jam on exit channel and stop from cigarette reserve. Out of these major rejections recorded due to incomplete cigarette pocket was further studied.

Table 4.13 Major downtime on maker machines

Reasons	Downtime in hr.
Rod break	98.69
Stop from tray filler	167.25
Maker service stop	62.95
Tipper manual stop	40.32
Rolling block jam	17.73
Tipper cork break	24.45
Paper break maker	12.97
Feeder hopper empty	21.08
Tobacco down drop channel empty	10.72

Table 4.13 shows total downtime of every cause in the maker line due to machine failure has been analyzed, and the following chart is used to compares the downtime of major causes.

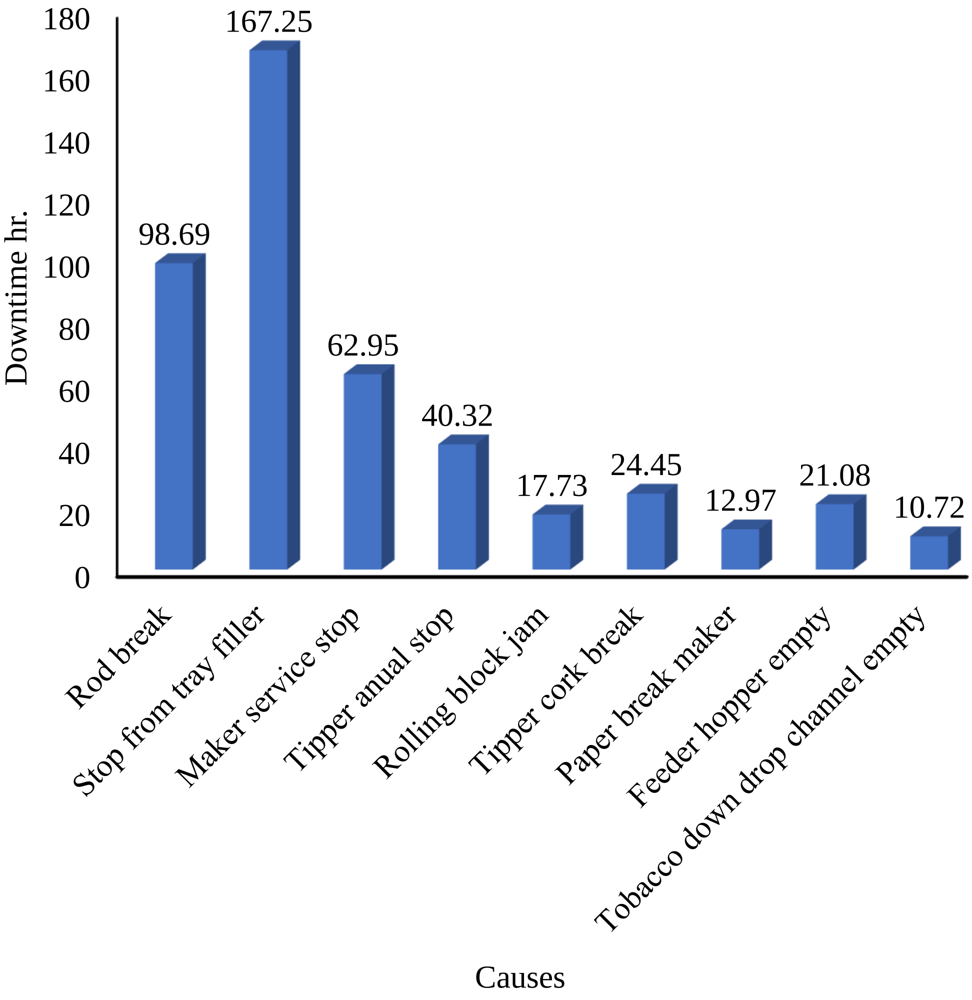

Figure 4.15 Downtime due to machine breakdown

From the downtime analysis in the figure 4.15 stop from tray filler was observed to have the highest downtime of all the causes with mainly because of lack of Tray.

4.2.3 Cause Charting and Root Cause Identification

Cause-and-effect diagrams (CED) or Ishikawa diagrams (Fish bone diagram) is one of the seven basic tools of quality, which is used to identify potential factors causing an overall effect (Kiran et al, 2013). A Pareto chart, where individual values are represented in descending order by bars, and the cumulative total is represented by the line. The left vertical axis is the frequency of occurrence, and right vertical axis is the cumulative percentage of the total number of occurrences. The purpose of the Pareto chart is to highlight the most important among a (typically large) set of factors. In quality control, it often represents the most common sources of defects, the highest occurring type of defect.

After the Fishbone diagram, we will analyze the main and secondary causes as well as the subcases, and in these analyzes we can use statistical, analytical methods, etc. After discussions, opinions, suggestions, the company's management will make the decisions to resolve the problem they are confronted with. (Ecobici Mihaela Loredana, 2017)
Fishbone diagrams, also known as cause-and-effect diagrams (CED) diagrams, are a tool for identifying and analyzing all or any of the potential causes of a specific effect in company operations or issues.
A Pareto chart, where the line represents the cumulative total and the bars indicate individual values in descending order. The frequency of occurrence is shown on the left vertical axis, while the cumulative percentage of all occurrences is shown on the right vertical axis. The Pareto chart's objective is to identify the most critical element among a group of (usually numerous) components.
The Pareto Principle of Analysis states that only “vital few” factors are responsible for producing the majority of the problems. A principle that can be and is often applied to quality improvement to the extent wherein that great majority of problems (80%) are produced by a miniscule only (20%) (https://tulip.co/blog/what-is-a-pareto-chart-definition-examples)

4.2.4 Root cause identification

From “Fact Sheet, December 2019” Fact Sheet Root Cause Analysis” Root cause analysis (RCA) is a problem-solving process for investigating an incident, problem, concern, or a non-conformity. The goal of a root cause analysis is to determine the missing or inadequately applied controls that will prevent the re-occurrence of a problem.
Six Basic Steps to Problem-Solving:

1. Identify the problem. Depending on the problem, this could mean stopping production, holding product, inspecting/sorting, removing or replacing, or even adjusting equipment settings.
2. Investigate. Look at the environment, personnel practices, equipment, etc.
3. Apply a corrective action (immediate & short term). Most operations stop here. However, repairing or replacing equipment or materials, changing procedures or methods, or conducting training may not be the true solution to the issue at hand.
4. Conduct a root cause analysis
5. Apply a proposed action plan and preventative actions (long term). This is determined through the root cause analysis above. Based on the outcome of the analysis, new procedures may need to be implemented, equipment may need to be fixed or modified and similar areas of the facility that could incur the same issues may need to be checked.

6. Verify the effectiveness of the preventative actions that are put in place. This is important to the preventative piece. Ensure that the controls are working and effective. If they aren't, return to step four as something may have been missed.

4.2.5 Root cause identification methods

There are many different methods that can be used when conducting a root cause analysis. Some popular options are "The 5 Why's + 2 How's", Cause and Effect Diagram (also known as Fishbone/Ishikawa), and Is/Is Not Matrix. The choice of which method to use may be a matter of personal preference, company policy, or even dependent on the type of non-conformance. Some methods may work better for different types of situations.

4.2.6 Root cause identification for rod break

By using five inputs of every process person, method, machine, materials and environment the major causes and place them under the general categories. Use brainstorming techniques as needed. List sub-causes and place them under the main causes. To determine sub-causes, ask why five times. Evaluate the diagram. Check that the branches on your cause-and-effect diagram are worded as possible causes and are arranged in a logical sequence

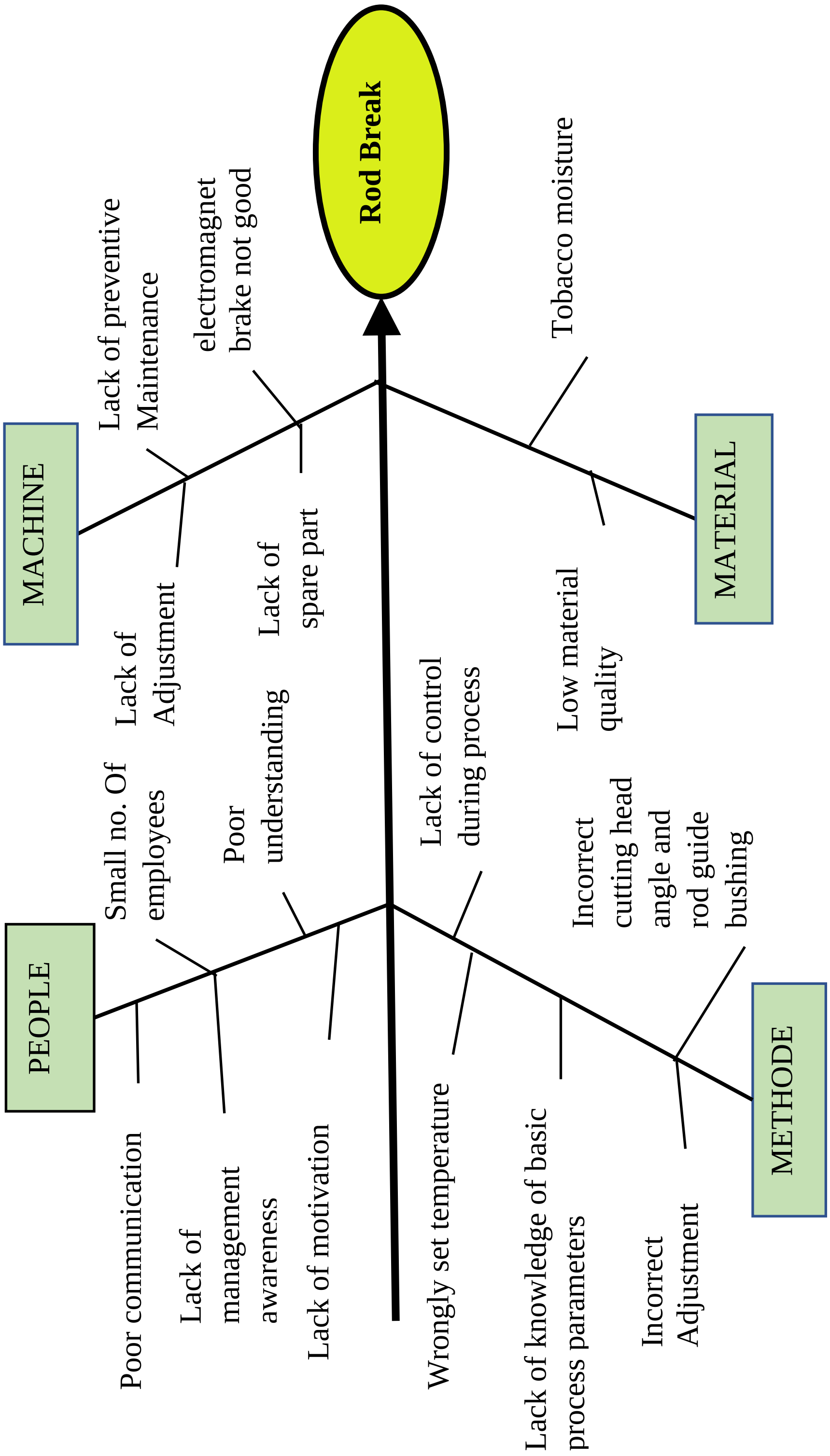

Figure 4.16 Cause and effect for rod break

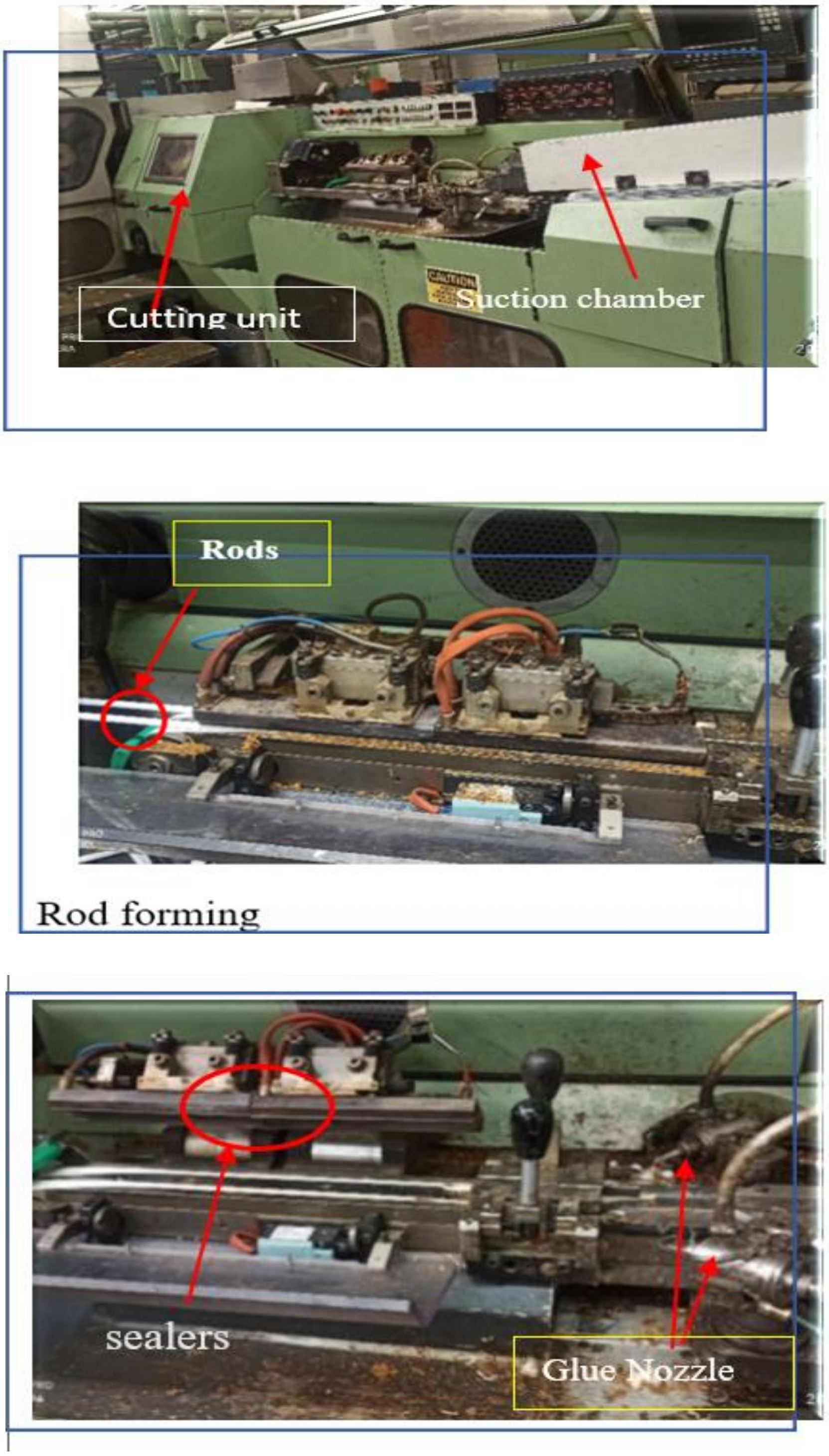

Figure 4.17 Machine parts which can be potential causes rod break failure

Figure 4.17 shows how rod is formed and the main factors that can be causes for rod break analyzed by 5whys techniques.

4.2.7 Root cause identification for incomplete cigarette Pocket

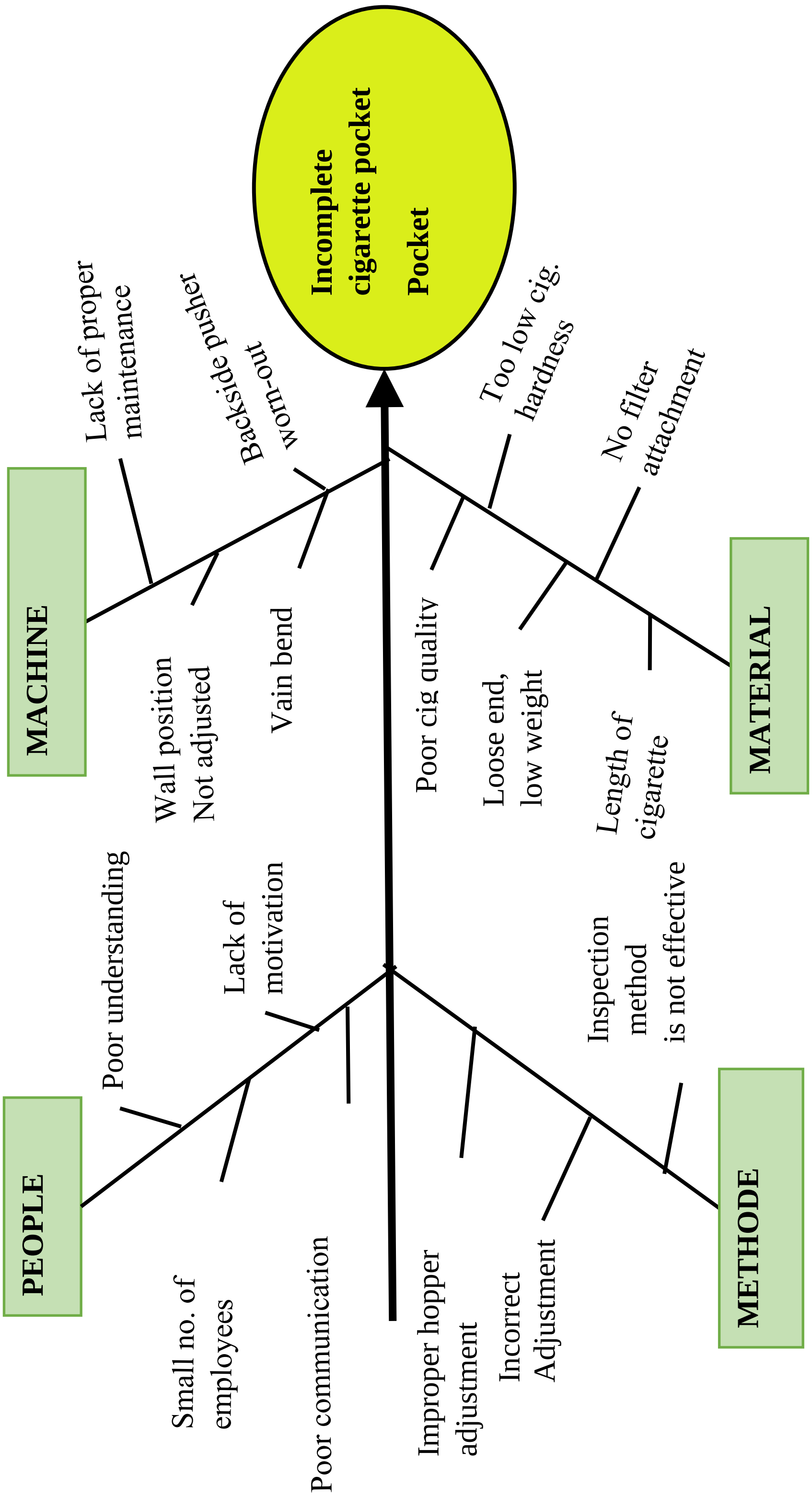

Figure 4.18 Cause and effect diagram of Incomplete cigarette pocket

4.3 Five Whys Problem Solving

The 5 Whys Problem Solving technique is a simple process to follow to solve any problem by repeatedly asking the question "Why" (five times is a good rule of thumb), to peel away the layers of symptoms that can lead to the root cause of a problem. This strategy relates to the principle of systematic problem solving. The next task was to identify the reasons for non-compliance based on how they impacted the problem that had been studied.

Table 4.14 5why analysis for the identified root causes of rejection

Main reason	Analyzed breakdown: for Rod Break				
	1 Why	2 Why	3 Why	4 Why	5 Why
People	Lack of control	Employees carry out numerous tasks simultaneously	Small no. of employees	saving	The management did not notice the cost of rejected product
	Poor communication	Lack of experience	Employees negligence	Lack of motivation	The management does not conduct meeting with employees
	Poor understanding of employees	Lack of employee skill	Lack of training	No focus on identifying employee skill gaps	Lack of management awareness
Machine	Paper gluing not good	electromagnet brake not good	Improper maintenance	Lack of control	The employee performs several

				during process	activities simultaneously
	Wrongly sealers set	Lack of basic process parameter	Lack of preventive maintenance	Lack of spare parts.	Lack of maintenance
Method	Incorrect adjustment of trimmer, paper folder, bed, heater, suction chamber, drum lining, rod cutting head, rod pick-up drum and glue nozzle	Manual instruction was not used	No sufficient jigs and tools and tools	Lack of management awareness,	Lack of standard at workplace
Material	Poor quality of material	Purchase of materials from the same supplier	Contract signed with the supplier on the product	The management is not looking for additional suppliers	Lack of management awareness

The 5 Why analysis was conducted for the reasons listed in area in order to determine the root cause real problems (Table 4.14).

The action plan will be implemented during the Improve phase of the project to attack the main causes stated in the analyze.

4.4 Analysis of questioner data

Table 4.15 The management is active in reducing production losses.

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	1	5.0	5.0	5.0
Agree	3	15.0	15.0	20.0
Neutral	7	35.0	35.0	55.0
Disagree	7	35.0	35.0	90.0
Strongly disagree	2	10.0	10.0	100.0
Total	20	100.0	100.0	

Table 4.15 shows the response from respondents regarding to management awareness on production losses/ rejection. Based on this 35% response disagree and 35% response neutral. From this it's clear that there is lack of management awareness regarding to production rejection which rectify rejection rate.

Table 4.16 Are the top level of management committed to reduce production rejection rate

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	3	15.0	15.0	15.0
Agree	7	35.0	35.0	50.0
Neutral	6	30.0	30.0	80.0
Disagree	4	20.0	20.0	100.0
Total	20	100.0	100.0	

As shown in table 4.16, 35% of respondents agreed on the top level of management committed to reduce production losses and 30% of respondents neutral. Based on these responses, its observed that top level management wants to reduce production losses.

Table 4.17 Based on assessment needs training and promotion are implemented

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	3	15.0	15.0	15.0
Neutral	4	20.0	20.0	35.0
Disagree	10	50.0	50.0	85.0
Strongly disagree	3	15.0	15.0	100.0
Total	20	100.0	100.0	

As table 4.17 above shows, 50% of the respondents said they disagree and 20% said they were neutral. this indicates that training and promotion are not based on evaluation and that a large proportion of employees have complaints.

Table 4.18 The maintenance plan for the machinery was carried out on time as planned

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	1	5.0	5.0	5.0
Agree	4	20.0	20.0	25.0
Neutral	4	20.0	20.0	45.0
Disagree	10	50.0	50.0	95.0
Strongly disagree	1	5.0	5.0	100.0
Total	20	100.0	100.0	

As Table 4.18 shows that 50% of the respondents answered disagree to the statement that the maintenance plan for the machinery was carried out on time as planned. This indicates that there was a problem with planned maintenance of machinery.

Table 4.19 Which types of maintenance are most commonly used in NTE

	Frequency	Percent	Valid Percent	Cumulative Percent
Reactive (run-to-failure)	9	45.0	45.0	45.0
Preventive maintenance	1	5.0	5.0	50.0
Corrective maintenance	10	50.0	50.0	100.0
Total	20	100.0	100.0	

As shown in Table 4.19, 50% of the people's responses were corrective maintenance and 45% were reactive (run to failure). This response states that pm is extremely low and that this factor was a significant contributor to machine failure.

Table 4.20 What are the main root causes for the production loss

	Frequency	Percent	Valid Percent	Cumulative Percent
Mechanical problem	6	30.0	30.0	30.0
electrical problem	8	40.0	40.0	70.0
Raw material problem	6	30.0	30.0	100.0
Total	20	100.0	100.0	

As shown in Table 4.20, the responses of 40% of the respondents indicated that there were electrical problems, 30% indicated that there were mechanical problems and 30% indicated that there were raw material problems. based on this response, it indicates that there were technical problems as well as row material quality problems.

4.5 Five Ws one H technique to problem solving

As Krzysztof Knop (2018) mentioned in his studies, after identifying the problem – inconsistent assessments during the visual inspection, it was decided to analyze it using the 5W1H method.

The acronym 5W1H referred to as the questioning method or the method of the Five Ws, stands for the questions what, who, where, when, how and why.

By analyzing all the factors, this technique enables a to analyze a case and identify an issue. According to Posted by David (Galiana,2019) 5W1H method on Project Management defined and applied, " The 5W1H method allows you to discern the information needed to better understand, encompass, clarify, structure, frame a situation; as this way of thinking allows you to explore all the dimensions from different perspectives".

While being used and implemented in various circumstances, this tool is very well-liked by journalists. It will help you ask the right questions, expand your enquiry and obtain the right information, which in turn helps you find the best solutions. This method allows you to guide all your team members and to gather all the factual elements needed for a complete and objective understanding.

The 5W1H method is an irreplaceable problem resolution tool because this allows you to understand a potentially problematic situation by asking the right questions

Table 4.21 5W1H analyses and method for problem solving

<table>
<tr><th>What</th><th>How</th><th>Who</th><th>when</th><th>where</th><th>why</th></tr>
<tr><td>Action to be taken</td><td>This element of technique is used to examine the sequence of things and triggers and how the resultant problem or issue unfolded.
(Specific steps)</td><td>Identifying people who may have direct or indirect involvement in causing or contributing to the problem.
(Responsible Persons)</td><td>time-stamping the occurrence of problem.</td><td>Specific location</td><td>Justification for implementation</td></tr>
<tr><td>Rod Break</td><td rowspan="2">-Discuss with maker machine technicians & Create maintenance plan.
-Upload routine causes to the Maintenance system</td><td rowspan="2">Production and operational manager, primary process manager, Maintenance supervisor, quality department, Shift supervisors, Technician and Operators</td><td rowspan="2">Initial and final Dates</td><td rowspan="2">Maker machine</td><td rowspan="2">There is Lack of management awareness so that no maintenance plan to control the issue</td></tr>
<tr><td>Stop from Tray Filler</td></tr>
</table>

Incomplete Cigarette Pocket	Discuss with maker machine technicians & Create maintenance plan. -Upload routine causes to the Maintenance system	Production and operational manager, primary process manager, Maintenance supervisor, quality department, Shift supervisors, Technician and Operators	Initial and final Dates	packer packer	There is Lack of management awareness so that no maintenance plan to control the issue
Jam On Exit Channel					
Incomplete Cigarette Pocket					

Table 4.21 shows 5W1H problem solving technique for identified major causes of production losses. According to this technique what action to be taken (identified main causes), where (identify all the places in the reading and make a list of them, when (Identify all the time factors in the reading and make a list of them), who (Identify responsible person and make a list of them), how (Identify the way events took place and make a list of them) and why (Identify causes for events of actions and make a list of them Draw connections between the sequence of events and additional information, when their relationship is explained.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study discussed the investigation of product losses and their root causes. Critical machines and stations on production line were identified, and were analyzed along with the critical parts. Also, the reason for the breakdown has been analyzed through root cause analysis by 5-why, fish bone diagram and SPSS were used to identify the root cause of the machine breakdown. The major causes for cigarette rejection were the rod break on makers and incomplete cigarette pocket on packer machine. This in turn indicated lack of maintenance schedule to improve maintenance technique. The fundamental root causes connected to production rejection were lack of proper maintenance and lack of management awareness. Many problems were revealed in the process belongs to people's machine, methods and materials. found the rood break and incomplete cigarette pocket were the root causes for this major.

5.2 Recommendation

- The impact of maker machine regarding to cigarette rejection rate were high, due to the lack of spare parts and frequency of machine stoppage, so the company should pay more attention to repair, replace and maintain the machines as per the maintenance schedule.
- On the packer machine specially, line two of packer 04 with high frequency of machine stoppage was identified, so the company should take action to minimize the occurrence of machine breakdown.
- Due to lack of planned maintenance in the company the frequency of failure machine components was high, so the company should consider to implement maintenance schedule.
- The management should find the way to provide related trainings and awareness to minimize product losses.

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APPENDIX A

Five why technique worksheet

Define the problem	Define problem here
Why is this a problem?	**Primary cause** Why is it happening? 1 It is happening because Why is that? 2 It is happening because Why is that? 3 It is happening because Why is that? 4 It is happening because Why is that? **Root cause** 5 It is happening because **Note: if the final "why" has no controllable solution, return to the previous "why."**
Corrective action to take	**Corrective action** Describe action here Party responsible Date action to begin Date to complete

https://www.smartsheet.com/sites/default/files/IC-5-WHYs-TEMPLATE-WORD.dotx

APPENDIX B

Questioner sheet

Adama Science and Technology University Master of Science (MSc)

Dear respondent:

I am currently studying for a Master degree in mechanical design and manufacturing engineering (MSc) at Adama Science and Technology University. I am undertaking a research project entitled "**Investigation of Production Losses and Their Root Causes Towards Productivity Improvement:** Case Study in National Tobacco Enterprise (Ethiopia) S.C"

This questionnaire is designed to solicit information for purely academic purpose. This is to enable the researcher complete the thesis in partial fulfillment of the requirement for the degree of master in mechanical design and manufacturing (MSc).

Your response is truly important to the success of this study. I would like to assure you that your response will be processed as Strictly Confidential. So please try to answer all questions included. I would like to thank you very much in anticipation for your kind cooperation. I look forward to receive your reply

Sincerely yours,

Note:

- No need to write your name in this questionnaire.
- Respond to the statement/question in this questionnaire based on your current level of knowledge and expertise.
- As you read each statement tick a box that corresponds to your level of agreement.

Thank you

PART I: **Respondent profile**

Instruction: this part of questions asks you about your personal and job-related information. Please mark (√) for each question in the space provided.

1. Sex: Male ☐

   Female ☐

2. Age

A. 18 - 30 ☐
B. 31 – 40 ☐
C. 41 - 50 ☐
D. 51 - 60 ☐
E. Above 61 ☐

3. Academic Background

A. High School ☐
B. Diploma ☐
C. First Degree ☐
D. Masters ☐
E. PHD ☐
F. Others(specify)__________

4. How long you have served in the organization?

A. Less than 1 year ☐
B. 1-5years ☐
C. B. 6-10years ☐
D. 11-15 years ☐
E. 16-20years ☐
F. Above 21 years ☐

5. What is your position or work group in the organization?

A. Management group ☐
B. Non-management group ☐

Part II: Information related to production loses/rejection.

1. In NTE factory is their rejection/loses of cigarette in secondary process?
   A. Yes ☐ B. No ☐
2. if your Answer to question no.1 is yes, in which level do you think it will be rejected?
   A. High level ☐ B. medium level ☐ C. low level ☐
3. What is the primary cause of the excessive cigarette rejection in NTE?
   A. as a consequence of frequent machine breakdown / stoppage. ☐
   B. The product doesn't meet to quality standards ☐
   C. as a result of sensor failures ☐
   D. as a result of the employee' carelessness ☐
4. What are the main root causes for the production loss? (You can tick more than one
   A. Mechanical problem ☐
   B. Electrical problem ☐
   C. Raw material problem ☐
   D. Production process problem ☐
   E. Environmental ☐
5. Which types of maintenance are most commonly used in NTE?
   1. Reactive (run-to-failure) ☐
   2. Preventive maintenance. ☐
   3. Corrective maintenance. ☐
   4. Predictive maintenance. ☐

Part III: Management and Employee's Opinion Measurement.

The following items are related to organizational performance as measured from investigation of cigarette rejection rate and their main root causes. It's based-on degree of agreement as related from 1 to 5 from strong dis agreement to strongly agreement.

please tick (√) marks in the cell provided accordingly. 5= strongly disagree, 4= disagree, 3= neutral, 2= agree and 1 =strongly agree.

NO.	Item	Measurement scale				
		1	2	3	4	5
1	The management is active in reducing production losses.					
2	Your company measures internal customer satisfaction levels.					
3	OEE is under target					
4	high level of management committed to reduce cigarette production losses					
5	Does Top Management assume active responsibility for the evaluation and improvement?					
6	There is few skilled man power to attend all machines so that machines may not produce always as needed.					
7	The few skilled man power are working excessive Over Time.					
8	The existing skilled man power is specialized for particular machines that can`t be used interchangeably					
9	The skilled man power is not well paid and not motivated to enhance the production					
10	Training and Development is not given for the right people at the right time to influence negatively on the production.					
11	Based on assessment needs training and promotion are implemented					
12	To improve production performance, no relevant training is provided.					
13	Production is impacted by the information/communication flow, which only occurs at the structure's top level.					
14	To maximize output, it is not appropriately addressed to ensure that everyone is aware of the same information.					
15	Production is affected by the incorrect information flow.					
16	Uses of modern and up-to-dated cigarette manufacturing machineries.					
17	the average number of rejection rate is yearly decreasing in NTE					
18	strict follow up of guidelines and other procedures by employees					
19	The maintenance plan for the machinery was carried out on time as planned					
20	Major elements of quality management structure are in place to facilitate the organization's quality strategy objectives					

21	The periodical and annual production volume always fulfils the targeted production plan.					
22	Changeover time between different products lines is as per the given pre-set time					
23	Reject ratio of production line is always as per the acceptable limit					
24	The down time of production machineries is kept always under the targeted plan					
25	Poor communication					

Part IV: open-ended inquiries

In the space provided, please respond to the following questions

1. write the main reasons you think production might be wasted
____
____
____
____
____

2. What kind of process improvement techniques are implemented in your organization?
____
____
____
____
____

3. Is TQM standardized in your organization? why?
a. Yes ☐ b. No ☐

____
____
____

4. Any other comments regarding cigarette rejection rate reduction in NTE

Thank you!

APPENDIX C

Response of questioner

Respondent Education Back ground

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diploma	9	45.0	45.0	45.0
	Degree	11	55.0	55.0	100.0
	Total	20	100.0	100.0	

Respondent Education Back ground

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diploma	9	45.0	45.0	45.0
	Degree	11	55.0	55.0	100.0
	Total	20	100.0	100.0	

In NTE factory is their rejection/loses of cigarette in secondary process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	18	90.0	100.0	100.0
Missing	System	2	10.0		
Total		20	100.0		

If your Answer to question no.1 is yes, in which level do you think it will be rejected?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	high	16	80.0	84.2	84.2
	medium	3	15.0	15.8	100.0
	Total	19	95.0	100.0	
Missing	System	1	5.0		
Total		20	100.0		