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SCHOOL OF RESEARCH AND POSTGRADUATE STUDIES

FACULTY OF MECHANICAL AND INDUSTRIAL ENGINEERING

PRODUCTIVITY IMPROVEMENT IN TEXTILE AND GARMENT INDUSTRY, THE CASE OF YIRGALEM ADDIS TEXTILE FACTORY

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October 17, 2019

PRODUCTIVITY IMPROVEMENT IN TEXTILE AND GARMENT INDUSTRY, THE CASE OF YIRGALEM ADDIS TEXTILE FACTORY

By

EPHREM TADESSE

A Thesis Submitted to the School of Research And Graduate Studies of Bahir Dar Institute of Technology, BDU In Partial Fulfillment of the Requirements for The Degree of Masters of Science Degree in industrial engineering

(Production Engineering And Management)

In faculty of mechanical and industrial engineering

Advisor :

YitagsuYilma(PhD)

Bahir Dar ,Ethiopia

October 17, 2019

DECLARATION

I, the undersigned, declare that the thesis comprises my own work. In compliance with internationally accepted practices, I have acknowledged and refereed all materials used in this work. I understand that non-adherence to the principles of academic honesty and integrity, misrepresentation/ fabrication of any idea/data/fact/source will constitute sufficient ground for disciplinary action by the University and can also evoke penal action from the sources which have not been properly cited or acknowledged.

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THESIS APPROVAL SHEET

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The following graduate faculty members certify that this student has successfully presented the necessary written final thesis and oral presentation for partial fulfillment of the thesis requirements for the Degree of Master of Science in *production engineering and management*

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Abbreviations

JIT Just in time

TPM Total productive maintenance

TQC Total quality control

OEE Overall equipment effectiveness

PM Planned maintenance

CM Corrective maintenance

VIF Variance inflation factor

AM Autonomous maintenance

Abstract

Firm productivity is an essential indicator of the strength of firms to stay in operation in local and international markets. Managers coordinate the application of labor, capital, and intermediate inputs. Incapability to well control, coordinateas well as plan these resources significantly reduces plantefficiency and finally lower productivity.The purpose of the study was to investigate the existing system and improve productivity in Yirgalem Addis textile factory plc. In this study descriptive research design was adopted to identify the major determinants factors that significantly affect productivity at Yirgalem Addis textile factory plc.In terms of data, the study relied on primary data collected using structured questionnaires. The tool was pre-tested to ascertain its reliability and validity. Data collected was checked for errors and omissions and then coded before applying Statistical Package for Social Sciences (SPSS) analysis.The study results showed that out of 13 determinant factors, nine independent variables were found to have significant relationship with firm productivity. Insufficient skill gap training to technician, spare part scarcity, frequent machine downtime, poor preventive maintenance experience and inadequate skill of the maintenance personnel were among the major problems. Following thisresult, the appropriate productivity improvement technique that could address the major problem was selected and possible solution was suggested. After that TPM implementation plan was developedso as to address the problems and improve the productivity of the plant. Finally, as the result of regression analysis shown, Yirgalem Addis Textile factory, after successfully implementation of TPM,could improve the current OEE level of blanket plant (54.99%) to 82.7%.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

In the increasingly competitive global business environment, organizations are compelled in order to be more cost effective, productive, and generally more competitive (Awan&Tahir, 2015). Some of the sources of competitive advantage for these organizations include financial strength, tangible resources such as production facilities and intangible resources such as technical knowhow and the employees.

Textile industry has experienced an unprecedented degree of change in the last three decades, concerningradical changes in management approaches, product and process technologies, customer expectations and supplier attitudes as well. (Ahuja et al, 2006). In today's fast - changing marketplace, slow, steady improvements in production operations do not guarantee sustained profitability or survival of an organization (Oke, 2005).Thus the organizations need to improve at a faster rate than their competitors, if they are to become or remain productive in the industry.

Productivity refers to the volume of output produced from a given volume of inputs or resources. If firmbecomes more productive, then it becomes more efficient, since productivity is a measure of the efficiency of production (Samnani& Singh, 2014). Productivity has many benefits at various levels. Productivity is important to the firm because more real income means that the firm can meet its obligations to customers, suppliers, workers, shareholders, and governments (taxes and regulation), and still remain competitive or even improve its competitiveness in the market place (Chen, Hannon, Laing, Kohn, Clark, Pritchard & Harris, 2015). High productivity levels translate into lower unit costs and this is why Onyije (2015) terms productivity as one of the major drivers of success in the organization (Njururi, 2016).

Productivity improvement is one of the core strategies towards manufacturing excellence and it also is necessary to achieve good financial and operational performance. It enhances customer satisfaction and reduce time and cost to develop, produce and deliver products and service.Productivity has a positive and significant relationship with process utilization, process output, product costs, and work-in-process and on-time delivery(Naveen, *et al*, 2016).

There are number of techniques towards continuous productivity improvement, but one of each technique doesn't improve productivity comprehensively. The application of improvement tools and techniques, such as lean manufacturing, work study, ergonomics and TPM contribute significant improvement effort to solve productivity problem of textile industries. For instance ,Lean focuses on eliminating the sources of waste, aiming a continuous process flow while, work study carrying out different yet related activities such as to improve the efficient use of resources and to set up standards of performance for the activities to be carried out. On the other hand ergonomics is the interaction between people and their environment occurs in order to optimize well-being and overall performance(Bezaneh, 2017). TPM is also method of maintaining and improving the integrity of production and quality system through the machine and equipment and employees(Mulder, 2016).The aim of the TPMis then to improve both labor productivityand machine productivity in order to reduce maintenance cost (Manu, et *al*, 2011).

Though productivity improvement techniques can mostly bring technical improvement in the form of elimination, correction (repair) of ineffective processing, simplifying the process, optimizing the system, reducing variation, maximizing throughput, reducing cost, improving quality or responsiveness and reducing set-up time (Naveen, *et al*, 2016),other managerial related factors within institutionmust have to be given due attentions so that the optimal possible achievement could be attained.Assefa (2017) in his study identified that top management commitment and employee motivation as well as satisfaction is the basic factor affecting continuesproductivity improvement of any organization. This shows that productivity improvement is highly related with person's mentality and attitude.

For instance, there are simple factors that need to be involved for a workforce to have productivity. First, employees need to feel that they are part of the company and not just workers in the workplace (Skare, Kostelic&Jozicic, 2013). By giving them incentives and shares in the company, they will want to work harder and produce work of the highest quality. Their creativity levels will increase and ideas on how to grow the business will be numerous and productivity in the workplace will increase. Secondly, the relationship between the management and the employees needs to be professional with a hint of mutual respect (Cording, Harrison, Hoskisson&Jonsen, 2014). As the two groups merge together to form a corporation they are more qualified to meet the customers' needs (Terry, Myster, Davis &Wegleitner, 2014). As we all know, the customer is king and when the customers are happy, there is more productivity. It is achievable to have a productive workplace where the business grows and the workers, clients and management are satisfied. Productivity in the workplace is the key to any business succeeding (Ajala, 2012). Any effective and successful business or company understands the importance of productivity in the workplace. Being productive can help the firm increase and utilize the capacity of the human resources it has. Most productive companies have happy and healthy employees, which are the basis of a successful organization (Njururi, 2016).Therefore, labor productivity is one of the leading factors and plays very important roleto improve the productivity of any plant, beside all improvement techniques.

Yirgalem Addis Textile factory plc is capable of producing different items through new and modern machineries but according to information obtained from site observation and key informants therewere troubles related to some labor issues and maintenance management system.The maintenance system of the company basically focuses on the break down maintenance rather than prevention failure atthe source. Moreover, maintenance related activities are also given to the maintenance division and operators are not involved in minor restoration, prevention and deterioration measurement. Therefore, this thesis aims to investigate determinants factors of productivity, which could be both technical and labor factors, so as to enhance continues productivity.

1.2. Problem Statements and justification

Nowadays, the most important goals for almost all manufacturing company are to increase the productivity, which reflect to get better production efficiency. Blanket making process uses flow line production and product moves to one machine to another machine. But due to unplanned failure and repeated downtime, products are unable to move fastand accumulated in certain limited no of machines and finally decreased the rate of plant productivity. Therefore, in order to eliminate this problem and achieve the goal of the company, factors affecting productivity must be identified and then appropriate improvements techniques should also be applied so asto improve existing production process (Naveen, *et al*, 2016).

Though Yirgalem Addis textile factory Plc is one of well known Textile companies in Ethiopia, thefactory,especially Blanket planthas been operating under its planned capacity for years due to high rate of unplanned failure(Annual report, 2016-2018).As observed from annual report, the plant faced problem indecreasing the down time of equipment , controlling the performance of the equipment frequently, providing multi-skill development training and updating employees, taking a care of machines and equipments properly and decreasing idle time of operator and technician .

According to site observation and interview held with experts and employees, the blanket plant had difficulty on managerial functions related tocoordinating and directing production system. Moreover, it was observed that there is poor management –labor relationship due to claim associatedwithpayment, promotion and occupational heath safety.According to Rasul(2009), Alexander Mas (2008) and (Alazzaz and Whyte,2015) such problems could lead to labor dissatisfaction and poor performance then finally lower plant productivity.

1.2.1 Justification of Problems

In order to justify stated problems and develop solution, triangulation must be checkedfirst and the goal is usually cross checking information from different sources so as tomaximize the validity. But here, what was reported, what was informed by the key formant and employees and what was observed as problemsdid not confirm the reported problem. Therefore, it was found difficult to develop report based solution. For these reason, study should be conducted again to further investigate factory problem (determinant factors) using either quantitative or qualitative or mixed method approach (statistical approach).

Moreover, the report (2016-2018), as was described above in problem statement covered more of technical issue and didn't give much attention to labor related issue.Since labor productivity is one of the key factors for organizational success and competitiveness (Njururi, 2016), it is necessary to further investigate this labor issue in depth and identify the hidden factors using either quantitative or qualitative or mixed method approach (statistical approach)so that appropriate technique could be selected and then the right solution could be achieved.

In order for this statistical analysis, Questioner is developed based on the information obtained from review of literature , Key informants and site observation , this questioner contain set of independent variables that are supposed to affect the productivity of the plant.

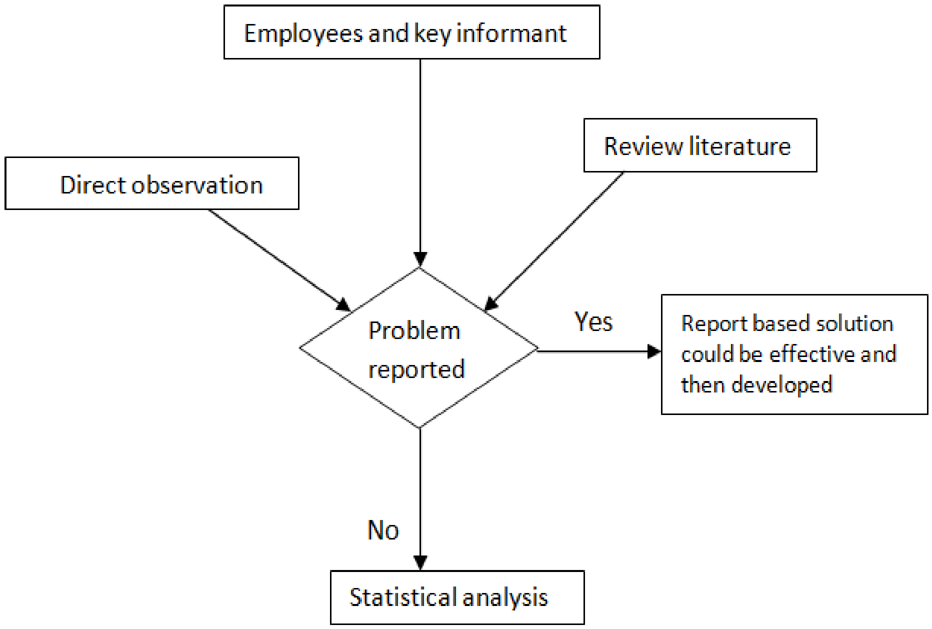

Fig 1.1 Triangulation of problem from different sources

1.3 Research questions

This study attempts to answer the following research questions

- What is the current level of machine productivity in blanket production process?
- What are the major determinant factors of productivity in Yirgalem Addis textile factory, blanket plant?
- What remedial measures/action can be developed to improve optimal productivity?

1.4. Objective of the study

1.4.1. General objective

- The thesis focuses on investigating the existing process so as to improveproductivity in Yirgalem Addis Textile factory plc.

1.4.2. Specific objective

The study has the following specific objectives:

- Investigating the current level of machine productivity in blanket production process
- Identifying the major determinant factors that significantly affect productivity and then:
- To develop a solution so as to improve productivity at Yirgalem Addis textile factory plc, blanket plant

1.5. Scope and limitation of the study

The study conducted on Yirgalem Addis textile factory wasbased on available data, questionnaire and interview and site observation. Due to repeated unplanned equipment failure, the study focused on blanket plant.Moreover, the study did not consider comprehensive productivity measures and limited to machine and labor productivity.

1.6. Significance of the study

The study will have significant contributions to the company to increase its profit through well established production system and also provide better services to its customer. In addition to this the study is likely to benefit various key stakeholders. These include not only the management of Yirgalem Addis textile factory but other similar organizations and researchers/academicians.

1.7. Organization of the Study

The study is organized into seven chapters. The first chapter gives an overview of the introduction, problem statement, research question, and including objective of the study whereas chapter two is all about literature review about productivity concept, measurement and empirical evidences. Chapter three deal with profile of case company and methodology to give a clear understanding about the organization and research design, data collection instrument and data analysis technique used in the study. The fourth chapter presents data analysis result; Chapter five proposes solution to existing problem observed in blanket plant .Lastly,chapter six consider conclusion and recommendation.

CHAPTER TWO

REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK

2.1. Definition of terms and concept of Productivity

The rate at which a factory produce good or service usually judged in relation to the number of people and the time necessary to produce them. Generally productivity is the measure of the efficiency of a person, machine, factory system etc., in converting input in to useful output.It is possibleto measure productivity of a factory according to how long it takes to produce a specific good.

Labor productivityis rate of output per worker per unit of time as compared with an established standard or expected rate of output.Basically, productivity is how much each worker produces per hour compared to what each worker is earning to perform the job. It can be measured by dividing total number of product produced by the total input labor hour (total output/ total hour).

Machine productivityis a technique used in factories to measure the productivity of the machines. The critical element of cost efficiency is termed as Productivity. It is calculated by dividing total number of product produced by total number of machines (total output/ total machine input)

Productivity improvement techniques are techniques that can be applied effectively in enterprise of any size, from one- Person Company to corporation with thousands of staff. KAIZEN is one technique which is a management supported employee driven process where employees make a great number of continues improvement effort (Jhamb, 2008). KAIZEN contains 5s, TPM, SMED and JUST IN TIME techniques.

Total productive maintenance (TPM)

TPM is keeping machine in a good condition through systematic maintenance of equipment so that they fail less frequently and production process continues without interruption (Jhamb, 2008).

2.1.2 Concept of Productivity

Productivity is defined a summary measure of the quantity and quality of work performance with resource utilization considered. Thus, though productivity may mean different things to different people, the basic concept is always the relationship between the quality and quantity of goods or service produced and the quantity of resource used to produce them. It can be measured at the level of the individual, group, or organization. From a manager’s perspective, productivity in all cases reflect success or failure in producing goods and services in quantity, of quality, and with a good use of resources. In short it is the ratio of output to input. This concept is expressed in the productivity equation (John R , 1993)

$$Productivity = \frac{out\ \ put\ \ value}{input\ \ value}$$

The equation shows the productivity rises, keeping other things constant, when the quantity of outputs increase, the quality of output increases, and/or the cost of resources (input) utilized decreases. The performance of an organization cannot be judged by the increment of the quantity of the output alone. The output may be raised without an increase in productivity. That means the rate of the increment of input cost may be higher or the quality of the output may be decreased.

Productivity can also be defined as the relationship between result and the time it takes to accomplish them. Time is often a good demonstrator since it is a universal measure, and it is beyond the human control. The less time taken to achieve the desired result, the more productive the system is(John R, 1993).

2.2. Productivity Measurement

Productivity is not a complicated concept as it is discussed above. It is the amount of output produced per unit of input. While it is easy to define, it is notoriously difficult to measure, especially in the modern economy. In particular, there are two aspects of productivity that have increasingly challenged precise measurement: output and input. Properly measured, output should include not just the number of product coming out of a factory, but rather the value created for consumers. In today's economy, value depends increasingly on product quality like appropriateness, customization, convenience, variety and other intangibles. Similarly, a proper measure of inputs includes not only labor hours, but also the quantity and quality of capital equipment used, materials and other resources consumed, worker training and education, Productivity is a comparative tool for managers, industrial engineers, economists and politicians. To be useful, measures must be as simple and as consistent as possible (Bailey and Hubert,1980).

2.3. Determinant factors of productivity

The first step towards improving productivity is to identify problem area within these factor groups. The next step is to distinguish those factors, which are controllable.The external factors that affect productivity are the economical, political, social, and other infrastructure factors, which influence the effectiveness and decision making process of management.The internal factors, which can be controlled in short run, are product, equipment, technology, materials, energy, people, organization and management style (Joseph, 1999).Each factor is discussed briefly below.

2.3.1. Product

Product as a factor of productivity means the extent to which the product meets the output requirements. The amount that the customer is prepared to pay for a product of given quality is determined by the product value. The value of the textile product can be improved by better design and specifications. The availability of the product at the right place, at the right time and at the reasonable price with the needed volume can also be important factors that affect the overall productivity (Miskir , 2013).

2.3.2. Plant and equipment

Plant and equipment productivity can be improved by: operating the plant and equipment in optimum process condition, good maintenance, eliminating bottle-necks, reducing idle time, and making more effective use of available machines and plant capacity. The productivity of industries, which produce perishable products or products that degrade unless continually processed, like textile industries, is highly dependent on their equipment. That means, the equipment used should be kept well and be available by proper maintenance to avoid the decomposition of the hide or skin on process (Joseph Prokopenko, 1999).

2.3.3. Technology

Increased volume of goods and services, quality improvement, new marketing methods, etc… can be achieved through increased automation and information technology. Automation can also improve material handling, storage, communication system and quality control. Thus the technology can be one of the important factors. For textile industry sector like Yirgalem Addis textile factory, the quality of the finished product highly depends on the technology used (Miskir, 2004).

2.3.4. Materials and energy

By reducing the amount of material used and energy utilization the productivity can be remarkably increased. These vital sources of productivity include raw materials and indirect materials like process chemicals, lubricants, fuel, spare parts, and engineering materials. Electrical or other source of energy must also be optimized to increase productivity (B. Naveen, 2015).

2.3.5. Organization and management style

An organization needs to be dynamically operated and led towards objectives and must be maintained, serviced and reorganized from time to time to meet new objectives. Management styles and practices also influence effectiveness through organizational design, personnel policies, operational planning and controlling, maintenance and purchasing policies and capital costs.

2.3.6. Work Environment

Employees need to have essential tools to carry out their duties. This consists of appropriate equipment, machinery and computer technology and also sufficient lighting, working space and ergonomically-correct seating (Akhtar, et al, 2015). Poor work conditions owing to physical components leads to low production levels and an overall job dissatisfaction. The second one particularly, if it is not considered it makes employees feel unappreciated and eventually they may quit (Alavi, et al, 2013). According to Tang (2012) work environment is also one of the main causes for employee turnover. Employees mostly want to be work in an environment that is favorable to them. This is the common reason that make employee move from one organization to another from time to time.A good environment is a place where the workers are at ease and feel appreciated; they are often happier and more productive at work. A bad work environment is a work environment where the worker is unsettled, feeling unappreciated and working in fear. Because of the nature of bad environments, there is often higher employee turnover rate or they typically fail to work to their full potential (Njururi, 2016).

2.3.7. Employee Rewards

According to Fitzgerald and Danner (2012) designing and implementing an effective reward system is a critical human resources activity which influences the attainment of performance targets and effectiveness of an organization to deliver on its mission and mandate. A reward system is a very important tool in managing the human capital and failure to reward the staff for their collective and individual efforts often leads to dissatisfaction manifested in various forms for example industrial strikes, go slows or the so called wild cat strikes and grievances against the employer (Moreland, 2013). This affects productivity and leads to loses in terms of lost man hours, high staff turnover and loss of profits or revenue. National Water and Pipeline Corporation is at the helm of conceptualizing effective reward strategy in place and the ramifications of that cannot be overstated (Tang, 2012). Hardworking staff or those who put in extra efforts in their work are not rewarded for their efforts and the level of dissatisfaction is phenomenal(Njururi, 2016).

2.3.8. Employee Motivation

Alazzaz and Whyte (2015) contended that motivating employees can be the biggest challenge to a manager. Motivating employees is the key to the overall effective performance in an organization. Organizational behavior which is the understanding of the applied psychology within the workplace can assist in achieving a highly motivated workforce in the organization. Legitimate staff promotion carried out on the basis of employees' performance at work, greatly motivates employees. However, failure by the organization management to carry out promotion on basis of performance can be a key de-motivating factor to employees(Njururi, 2016).

2.4. Productivity Improvement

Productivity improvement is not just doing things better; it is doing the right thing better. Productivity can be improved by utilizing the resources effectively. Thus the resources can be grouped in to human resource, capital resources and maintenance system.(Bailey and Hubert, 1980) .These three resources are discussed below.

2.4.1. Productivity improvement through Human Resources

The productivity issue of resource utilization includes another significant concern in today's world of strong social values- the way people are treated as human resources in the workplace. Human resource is the most important and potential area of productivity improvement (Joseph, 1999) ideally, productivity is achieved through high performance with a sense of satisfaction by the people doing the work.

2.4.2. Productivity improvement through Capital Resource

Significant productivity improvement usually comes from saving material and energy. On average, raw materials account for about 40 percent of total national production cost; if we include energy, this figure increases considerably (Ireland, 2003). Poor operator practice, bad layout and inadequate storage space can aggravate problems in handling materials and lead to excessive movement. A significant objective of any productivity improvement program should be to suggest method of maintaining the volume of production while reducing consumption of energy and materials and keeping the quality constant or better (Misikir, 2004).

2.4.3. Productivity improvement through Maintenance

It is not uncommon to find less machine utilization due to poor planning and lack of preventive maintenance. In one comparatively successful productivity improvement drive, downtime on critical production equipment should reduce in considerable amount. That means the availability of machines increases and so the productivity (Bailey and Hubert, 1980). As it is stated above, productivity increases when the quantity of output increases, other things being constant. Thus, proper maintenance makes the equipment to be available whenever needed. So the amount of output produced increases. Moreover, maintenance makes to keep the factory running in the best possible shape, making equipment reliable, productive, and secure to operate. Historically maintenance was considered as a necessary cost of doing business. However, new technologies and approach have positioned the maintenance function to be an integral part of the overall profitability of many businesses. Modern maintenance techniques and practical approaches have the potential for significantly increasing competitive advantages in the global market. Maintenance must work together to achieve true excellence, just as the finely meshed gears of machinery must work together for the machine to perform its function. Keeping our equipment and facility in optimal working conditions is not the responsibility of a small group of Engineers and Technicians, but every individual in the whole organization must take responsibility. All textile industries can benefit of this optimal condition and such optimal level of success is exactly achieved through the concept of TPM (Masaj,1992).

2.5. Empirical evidence

Though labor resources are the leading factor and playing vital role to enhance productivity, tool and techniques are also necessary to facilitate and bring a change in production system. For instance, TPM is designed to maximize the overall equipment effectiveness. The study conducted in India showed that out of 120 industries, most of them have remained successful implementing TPM and achieved 85%-95% OEE targeting zero accident, zero defects, and zero failure.As an example,Orient Cement Ltd., Andhra Pradesh has increased OEE form 83% to 94% , TATA Motor Ltd has achieved OEE from 70% to 80%, Tractor and Farm equipment Ltd., Chennai has achieved OEE from 65% to 82%. In addition to this Minda industries division has increased overall plant efficiency by 93% and reduced break down frequency and spare part maintenance cost by 85% and 72% respectively. Bajaj Ltd,Mahindra Vehicles Manufacturing Ltd, MVML & SKF Ltd and Toyota Motor Corporation has applied lean manufacturing and TPM and achieved OEE from 80% to 95%(Pardeep, *et al*, 2015).Koichiin Nissan Motors were acknowledged as 10% reduction in maintenance cost, 30%reduction in manpower and 140% increase in labor productivity applying TPM (Manu, et *al*, 2011).

The study conducted here in Ethiopia on Assela Melt industry (2015) also showed that OEE on boiler plant has shown a progressive growth up to 75% which is an indication of increase in rate of equipment availability and performance. As a result, overall productivity of industry showed increment. (Workneh , 2013).

3F furniture Ethiopia has also applied kaizen, mostly 5s principle and as the finding showed,kaizen implementation of the factory was improved from 34.84% to 84.96% though challenges were still there regarding labor claims and management commitment (Wubshet, 2018).

Moreover, The study conducted on Leather products industry of Bangladesh has showed that productivity had been improved by 12.71% applying method study and work measurement in the industry atproduction line-Surma for ladies bag (Md. Abdul Moktadir1 *et al*. 2017).

From the above empirical evidence, productivity improvement techniques can enhance productivity but, in order to achievedesired change in productivity, other productivity determinantfactor within institution has to be considered. All people, managers and workers, in the organization have a significant role to play in productivity. Moreover, productivity depends on the degree to which people's commitment to their work. According to Miskir (2004)People differ not only in their ability but also in their will to work. Therefore, motivation is one method to increase productivity. Managers coordinate the application of labor, capital, and intermediate inputs, poor management to lead to low-efficiency production operation (Bloom and Van Reenen , 2010). Poor human resource management practices like pay-for-performance schemes, work teams, cross-training, and unorganized labor-management and communication hinder firms productivity and lower profit (Rasul*et al*, 2009). Alexander Mas (2008) in his productivity study also showed how poor management-labor relations can affect productivity and industry profit, in addition to this institutional factors, employeereward (Fitzgerald and Danner 2012), satisfaction with working environment (Akhtar, et al, 2015) and motivation (Alazzaz and Whyte ,2015) could influence both employee and factory productivity .Therefore, unable to meet these condition could lead to loses in terms of lost man hour and profit. According to Miskir (2004), Productivity is achieved through high performance with a sense of satisfaction by the people doing the work. Managers are increasingly expected to facilitate productivity for the organization while maintaining the quality of work life for its members. For instance,as the study conducted at TikurAbbay shoe share Company (2017) showed, the implementation of Kaizen was challenged by gaps in capacity and ability of management body (Eden ,2017). Moreover, Almeda textile factory, Saba Dimensional stone and Addis pharmaceutical factory have implemented

Kaizen,particularly 5s principle but there was limited management commitment in motivating and creating awareness to employee through training. Due to these factors, theeffect of kaizen wasnot fully utilized. Finally, as it was mentioned in review of literature, labor is unquestionably important resource, unless due attention is given to labor to be more productive, applying only productivity improvement techniques could not bring the desired change in productivity.

2.6. Conceptual framework

The conceptual frame work in the figure 2.1 below summarizes what it was described in review of literature. Generally, the mission, vision, goals and objectives are designed in the way that they make the company to enable total productivity but, total productivity of the company depends on productivity factors/variables which could be technical and laborfactors. Achieving one of these factors can improve the existing system but, it does not bring desired change in productivity. Therefore, both factors should concurrently be considered. In order to identifyboth technical andlabor factors either one of or both of these productivity improvement techniques and statistical analysis could be applied so that the optimalsolution could be attained. Finally depending upon the nature of the problem identified, appropriate improvement techniques that could leads factory to higher productivity level will be selected and then applied so that the productivity of the plant could be improved.

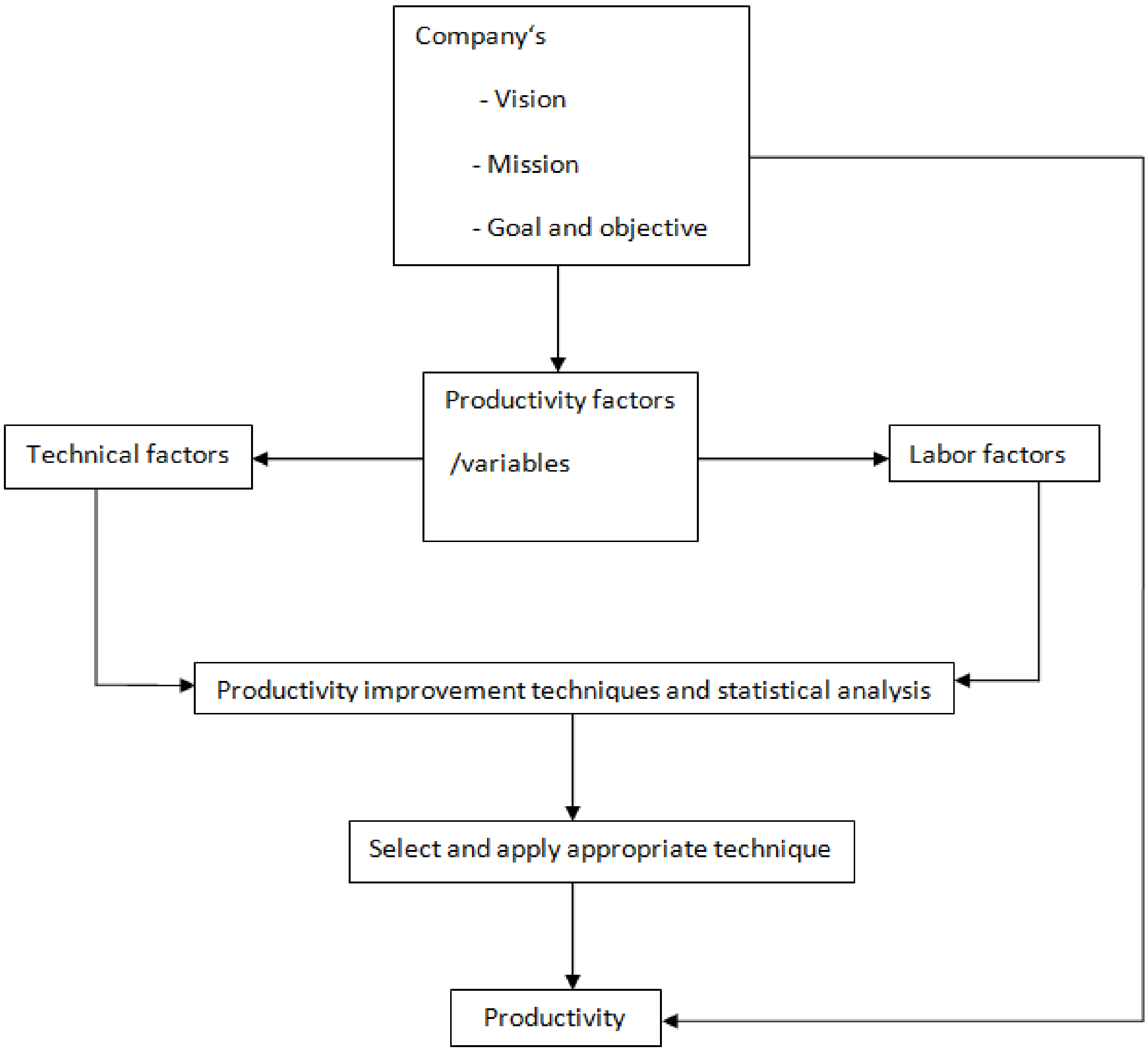

Fig 2.1 Conceptual framework developed on the basis of review literature

2.7. Overall Equipment Effectiveness

Overall equipment effectiveness plays a vital role where performance and quality of the product are of important to the organization. Moreover, it measures the availability rate of the machine, performance rate of the machine and quality rate of the product (Patel, 2016) so that the factory could improve efficiency of the plant. OEE is also a metric for the assessment of equipment effectiveness and identifying which machine performance is worst and, therefore, indicates where to apply possible action(Alorom, M, 2015).OEE is the gold standard for measuring manufacturing productivity. It identifies the percentage of manufacturing time that is truly productive. In addition, it takes into account all losses. An OEE score of 100% means you are manufacturing only Good Parts, as fast as possible, with no Stop Time .OEE measurement is combining all the factors; namely, availability, performance and quality that affect the equipment operation including the factors of time, speed, and quality. See figure 2.2.

OEE is the single best metric for identifying losses and improving the productivity of manufacturing equipment. By measuring OEE and the underlying losses, the case company will gain important insights on how to systematically improve their manufacturing system.

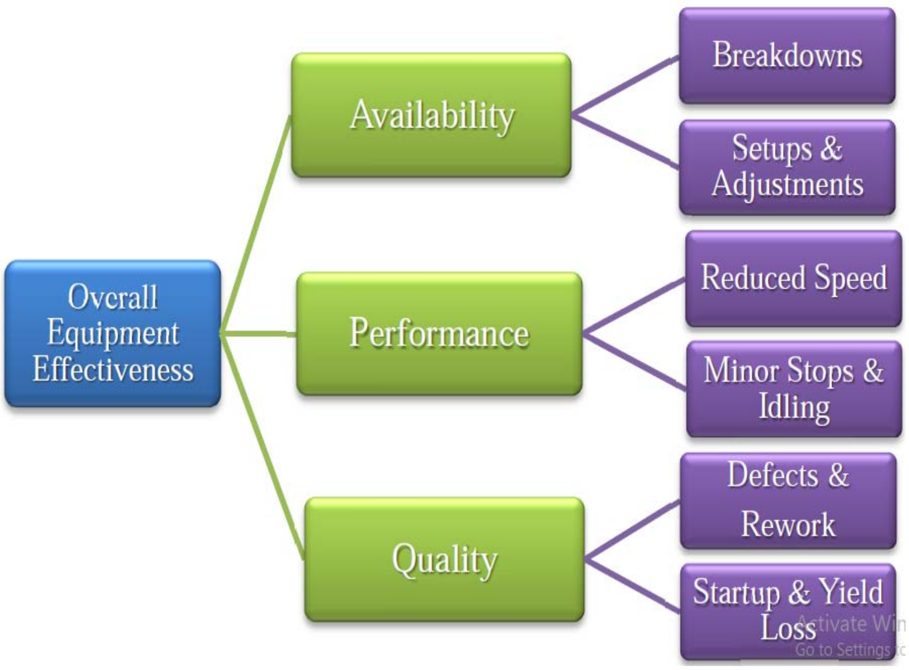

Fig 2.2 Overall equipment effectiveness factors (adapted from "The Implementation of Total Productive Maintenance in The Libyan Heavy Industry" by Alorom .M 2016).

2.7.1. Fundamentals of OEE

Overall equipment efficiency or effectiveness (OEE) is a hierarchy of metrics proposed by Seiichi Nakajimato measure the performance of the equipment in a factory. OEE is a really powerful tool that can be used also to perform diagnostics as well as to compare production units in differing industries. The OEE has born as the backbone of Total Productive Maintenance(TPM). By the end of the 1980's, the concept of Total Production Maintenance became more widely known in the Western world (Nakajima, 1988) and along with it OEE implementation too. The definition indicates how much the equipment is doing what it is supposed to do and it captures the degree of conforming to output requirements. It is clearly a measure of effectiveness.

2.7.2. Six big loosesanalysis

One of the major goals of TPM and OEE programs is to reduce and/or eliminate what are called the Six Big Losses, the most common causes of equipment-based productivity loss in manufacturing (Alorom, M, 2016).   Losses are activities that absorb resources without creating value. Losses can be divided by their frequency of occurrence, their cause and by different types they are (Nakajima, 2009).

Regarding divide losses by their causes, three different ones can be found:

1. Machine malfunctioning: Equipment or a part of this does not fulfill the demands;

2. Process: the way the equipment is used during production;

3. External: cause of losses that cannot be improved by the maintenance or production team.

Other causes such as shortage of raw materials, lack of personnel or limited demand do not touch the equipment effectiveness. These problems are the responsibilityof top management.Therefore, they are not taken into consideration through the OEE metric. To improve the equipment effectiveness, the following losses caused by machine malfunctioning and process has to be considered only (Raffaele, et al, 2012).

Availability (Downtime) losses

1. **Equipment Failure:-**Equipment Failure accounts for any significant period of time in which equipment is scheduled for production but is not running due a failure of some sort(Nakajima, 2013). Examples of common reasons for equipment failure in blanket plant include tooling failure, breakdowns, and unplanned maintenance.
2. **Setup and Adjustments:-**They account for any significant periods of time in which equipment is scheduled for production but is not running due to a changeover or other equipment adjustment. It may include cleaning and making adjustment to the equipment

to get stable quality in the product (productivity development, 2008). Examples of common reasons for Setup and Adjustments in blanket plant include setup, changeovers, major adjustments, and tooling adjustments material and manpower shortage. From the broader perspective of planned stops, other common reasons include cleaning, warm up time, planned maintenance, and quality inspections.

Performance (Speed) loss

3. **Small stops:-**It accounts for time where the equipment of blanket plant stops for a short period of time (typically a minute or two) with the stop resolved by the operator. It is the idling and minor stoppages. Examples of common reasons for Idling and Minor Stops in plant observed include misfeeds, material jams, obstructed product flow, incorrect settings, tool breakage in waving machine ,equipment design issues, and periodic quick cleaning. This category usually includes stops that are well under five minutes and that do not require maintenance personnel(Wireman, 2004).

4. **Reduced Speed (slow cycle) :-** They refer to the variance between machine design speed and actual operating speed (Bamber, Sharp, and Motara, 2006). The factors that impact the capacity of the machine are the speed and volume of the output (Wireman,2004). Reduced Speed accounts for time where equipment of the blanket plant runs slower than the Ideal Cycle Time (the theoretical fastest possible time to manufacture one part). Examples of common reasons for reduced speed in the plant observed includes dirty or worn out equipment, poor lubrication, substandard materials, poor environmental conditions, operator inexperience, startup, and shutdown. This category includes anything that keeps the blanket making process from running at its theoretical maximum speed when the manufacturing process is actually running.

Quality losses

5. **Process Defects:-**Process defect accounts for defective blanket produced during stable (steady-state) production. This includes different type of wastes that can be

recycled.Examples of common reasons for process defects in blanket plant include incorrect equipment settings, operator or equipment handling errors.

6. **Start-up losses (Reduced yields):-** Reduced Yield accounts for defective blanket produced from startup until stable (steady-state) production is reached. They are the losses due to low performance in the beginning of the operation of the equipment or the production line till reaching stability (Bamber, Sharp, and Motara, 2006). Examples of common reasons for Reduced Yield in the plant include sub optimal changeovers, incorrect settings when a new part is run, equipment that needs warm-up cycles, or equipment that inherently creates waste after startup.

2.8 Overall equipment efficiency (OEE) measurement

A model for OEE calculation aims to point out each aspect of blanket making process that can be ranked for improvement. To maximize equipment effectiveness it is necessary to bring the equipment to peak operating conditions and then keeping it there by eliminating or at least minimizing any factor that might diminish its performance. In other words a model for OEE calculation should be based on the identification of any losses that prevent equipment of blanket plant from achieving its maximum effectiveness. The OEE calculation model is then designed to isolate losses that degrade the equipment effectiveness(Overall equipment efficiency,2018).

OEE hereis calculated by multiplying three OEE factors; Equipment availability, Equipmentperformance, and Quality product being manufactured. It provides an accurate picture of how effectively the production process is running(Overall equipment efficiency, 2018).

1. **Availability**

Availability is the percentage of time that equipment of blanket plant is available to run during the totalpossible planned production Time.Equipment availabilityis calculated as the ratio of Run Time to Planned Production Time:

Availability = Run Time / Planned Production Time

Run Time is simply Planned Production Time of blanket plant and Stop Time is defined as all time where the manufacturing process of the plant was not intended to be running but not due to Unplanned Stops (e.g., Breakdowns) or Planned Stops (e.g., Changeovers).

Run Time = Planned Production Time − Stop Time

2. **Performance**

Performance in blanket plant takes into account anything that causes the manufacturing process to run at less than the maximum possible speed when it is running (including both Slow Cycles and Small Stops). Machine/equipment performance is the ratio of Net Run Time to Run Time. It is calculated as:

Performance = (Ideal Cycle Time × Total Count) / Run Time

Ideal Cycle Time is the fastest cycle time that the process can achieve in optimal circumstances. Therefore, when it is multiplied by Total Count the result is Net Run Time (the fastest possible time to manufacture the parts). Since rate is the reciprocal of time, equipment performancecan also be calculated as:

Performance = (Total Count / Run Time) / Ideal Run Rate, which is

= Total Count /(Run Time*Ideal Run Rate)

Equipment performance of the plant should never be greater than 100%. If it is, that usually indicates that Ideal Cycle Time is set incorrectly (it is too high).

3. **Quality**

Quality takes into account the produced blanket that do not meet quality standards, including parts that need rework. Remember, OEE Quality is defines good Parts as parts that successfully pass through the production process the first time without needing any rework.Quality is calculated as:

Quality = Good Count / Total Count

This is the same as taking the ratio of Fully Productive Time (only Good Parts produced as fast as possible with no Stop Time) to Net Run Time (all parts produced as fast as possible with no stop time).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research methodology

The collected data mainly aims at accessing the existing system and examining the factors that lower productivity of the blanket plant. Besides, the data is synthesized with literature for investigating the potential area of improvement. The research methodology section covers data source, research approach, and research design, sampling selection techniques and sampling determination. Finally, it discusses the method of analysis and selected models.

3.2 Research design and approach

3.2.1 Research design

Descriptive research design: -the research describes the situation and attempts to investigate/examine the existing problem in depth and finally propose possible solution and recommendation and possible solution to alleviate the stated problem.Descriptive researches test problems in more depth than exploratory research (Alorom, 2015).

3.2.2 Research approach

Mixed method research: - This approach has both qualitative and quantitative nature. Quantitative means anything that exists in a certain quantity and can be measured. The methodology has a quantitative nature, variables can be formulated and conclusions drawn from samples to populations. Some of the data are not inherently quantitative and do not necessarily have to be expressed in numbers therefore, it has also a qualitative nature. Qualitative data required for the study were collected from key informants, supervisor, employee and managers as well. These methods have been used to strengthen quantitative analysis also.

3.2.3 Data source

Relevant primary and secondary information was congregated to analyze and propose a solution to enhance productivity of the plant. The relevant secondary data was collected from the technical manual, monthly and annual report of the industry. Primary data was also collected using questionnaire and interview in structured way besides direct observation on site visit to enable to triangulate the responses.

3.3 Samplesize determination and selection techniques

3.3.1 Sample size determination

Yamane's formula for calculating sample size:

Yamane (1967) suggested formula for calculation of sample size from a employees which is an alternative to Cochran's formula. According to him, for a 95% confidence level and p = 0.05, size of the sample should be

$$\frac{N}{1 + N(e2)}$$

Where, N is the population size, in our case total number of employees.The study have participated73employees, from three different departments having direct relationshipwith blanket plant and e is probability of error which is 0.05. According to the formula

$$\frac{73}{1+73(0.05)2}$$

= 62 respondents

Adding 10% non response rate will make the final sample size 68.

3.3.2 Sampling technique

Stratified sampling technique: - Number of employees varies in each department. After identifying number of employees in each department, finally, employees will be randomly selected from each representative department by using probability proportional to size. These techniques will be used when if different employees with different qualification are there within these departments.

$$n(multipliyingfactor) = \frac{6\,8\,respondants}{totalnumberofemployee}$$

n = 0.93

Table 2: Stratified sampling technique:

.

employees	Department	Quantity	Respondent
Division head	Blanket plant	1	1
Supervision	Blanket plant	3	3
Quality control	Quality department	3	3
Operators	Blanket department	62	58
Maintenance man	Maintenance department	4	3
Total	3	73	68

3.4 Data reliability and measurement

The goal of reliability theory is to estimate errors in measurement and to suggest ways of improving test so that errors are minimized. Data will be checked for reliability using cronbach or coefficient alpha reliability estimation techniques (Endalework, 2016).

Cronbach or Coefficient alpha:- is used to measure reliability of data when the questioner has multiple choices (1-5), it is used for ordinal scale.

$$\alpha = k/\ k\text{-}1\ \ x(\ 1 - \frac{\sum s^2 i}{s^2 x})$$

Where

K= Total number of questions

$S^2 i$ = variance for each Q

$S^2 x$ = total for all variance Q

3.4.1 Data validity

Questionnaire was evaluated using both face validity and content validity byadvisors, friends and experts.(Endalework, 2016).

3.5 Data analysis technique

Data analysis in the research was conducted using appropriate tools in order to identify core problems in the specified company.

3.5.1 Regressions model

This model was adopted and estimated. It was used to examine and establish statistical relationshipk8s between the dependent variable (i.e., Productivity) and independent variables that are expected to influence productivity of the blanket plant. Multiple regression models will be specified to identify the determinants of productivity and to assess their relative importance in determining the probability of productivity at plant level.(used to predict/measure how one independent variable influence or affect the dependent one) (Gujarati, D. N, 1995).

$$Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n$$

Where

BO:- is an intercept

B1,B2 -------Bn:- are slopes of the equations in the model

X1 X2----Xn :- are relevant productivity characteristics (explanatory variables)

Zi--- dependent/outcome variable that is productivity

3.5.2 Econometric Tests and descriptive statistics

Descriptive statistics and econometric methods were employed for analysis purpose to meet the stated objectives. Econometrics test also measures how good the regression model fit with quantitative data (explanatory variable).

$$\text{VIF}_j = \frac{1}{1-R_j^2}$$

Before estimation of the model, in order to check the severity of multicollinearity among explanatory variables, the Variance Inflation Factor (VIF) was computed. Following Gujarati (1995), the VIFj is given as:

Where Rj is special coefficient of determination that results when the explanatory variable (xj) is regressed against all other explanatory variables. Contingency coefficients were calculated to see the degree of association between the both independent and outcome variables. They were calculated for each pair of independent variables using contingency coefficient procedure available in SPSS. Contingency coefficient is a chi-square based measure of association. A value of 0.5 or more indicates a stronger relationship where less than 0.5 shows week association between the qualitative variables (Gujarati, D. N, 1995).

CHAPTER FOUR

DATA ANALYSIS AND PRESENRATION

4.1 Production data Analysis of Blanket plant

The required data are collected to assess the overall performance and problem areas of the company.The chart below shows plannedand actual and waste produced. As it is observed from the chart the there is visible difference in planned and actual production. Blending and belling process produces pulled fibred in kilogram where as the carding stitching, Saurer and Raising produce finished length wise in meter. Finally, Pieces of blanket will be produced after cutting process followed by stitching and bailing.

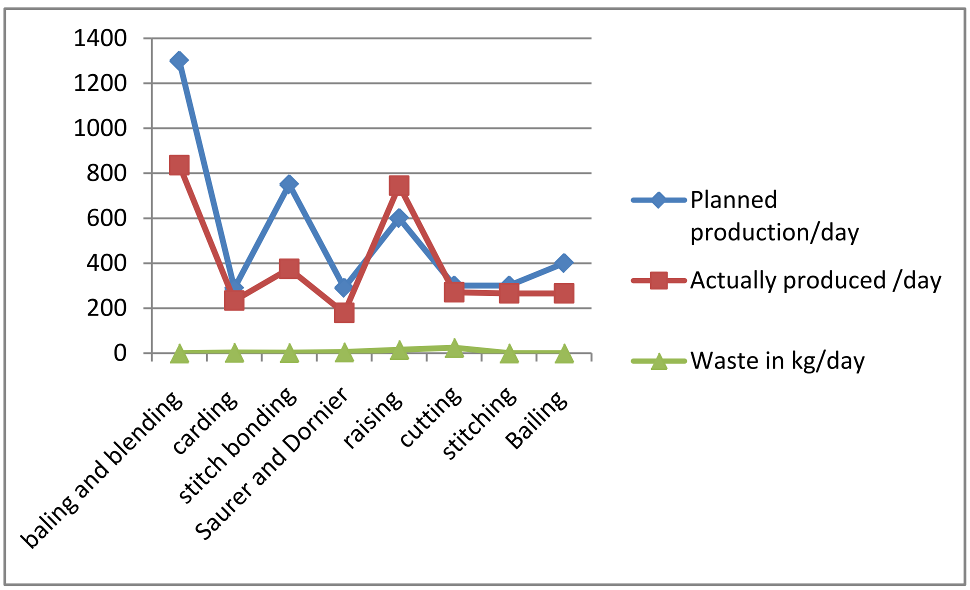

Figure 4.1 production and waste data

As it can be analyzed below,what was actually planned has experienced a difference with what it was actually produced(see appendix 3).One of the problems assessed is unplanned stoppages of machineries whichwerecaused by shortage of manpower and mechanical problem.

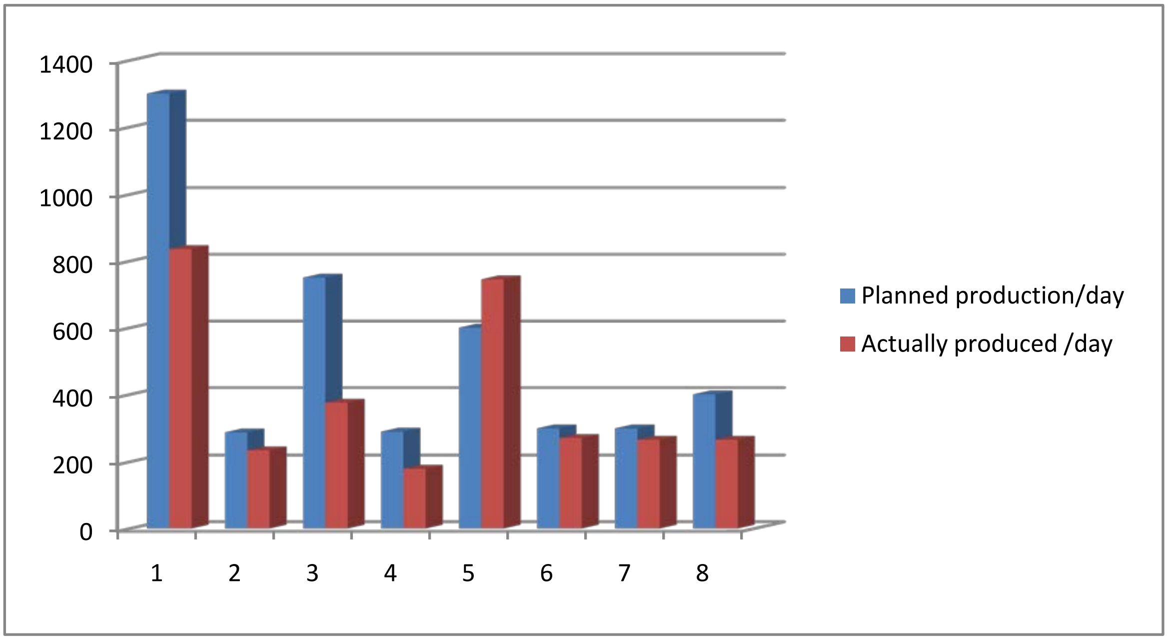

Figure 4.2 planned productions versus actually produced

Data collected and tabulated inAppendix 3 shows that there are four types of expected wastes in blanketproduction process. These are Salvage, return, Raising, and Cutting wastes. Oneinteresting thing here is that all types of wastes are usable. The pie chart below shows the types of defect and their share out of 100%. As it is observed, cutting operation has a major share 49.0% followed by raising waste which is 31% (Appendix 3).

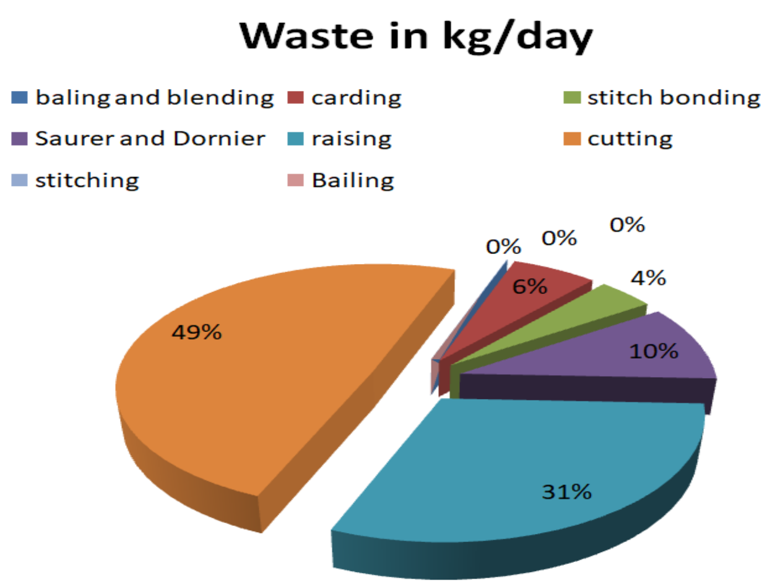

Figure 4.3 waste in kg for different blanket production process

The next line charts below shows the capacity of the plant. As it is observed from the chart, the company is operating under its designed and effective capacity due to machine downtime, as the result of both mechanical and other related productivity factors (see Appendix 4).

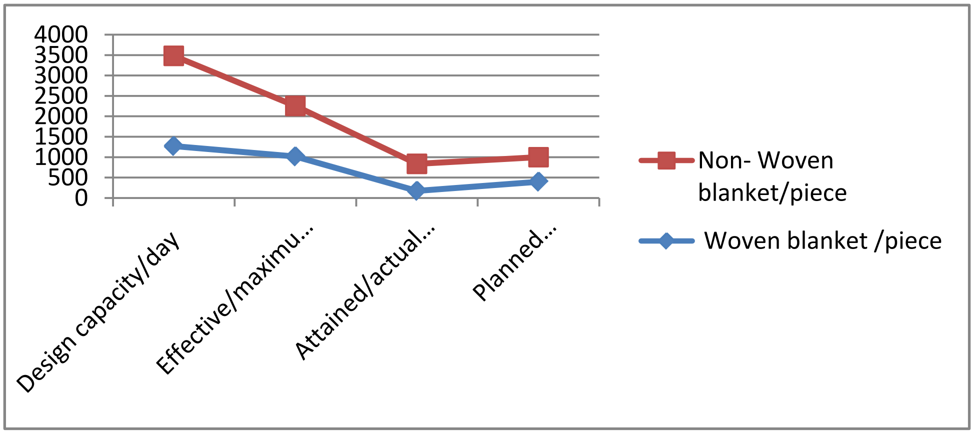

Figure 4.4 capacity of the plant

4.2 Invk8estigating the existing OEE level for blanket production process

Production related data relevant to OEE computation were obtained from onsite observation, interview and daily report. The production process data (Appendix 5) showed that cutting process with band knife produce 68 pieces of blanket per hour. Then the current OEE level for cutting process will be analyzed using the following data set.

Table 4.1 OEE data related to cutting process

Item	Data
Shift Length	(480 minutes)*2 = 960min
Breaks	(1hr (60 minute))*2 =120min
Downtime	1.65 hour (99 minutes),

Ideal Cycle Time	0.88 min(68/hr)
Total Count	271 piece
Reject Count/defective product)	25.4kg (10.16 piece) , 180x200(2.7kg) 160x200 (2.4kg) average 2.5kg

1. **Planned Production Time**

As described in the review of literature, the OEE calculation begins with Planned Production Time. So first, exclude any Shift Time where there is no intention of running production (typically Breaks).

Shift Length − Breaks

960minutes − 120 minutes = **840 minutes**

2. **Run Time**

The next step is to calculate the amount of time that cutting process was actually running (was not stopped). Remember that Stop Time should include both Unplanned Stops (e.g., Breakdowns) and Planned Stops (e.g., Changeovers). Both provide opportunities for improvement.

Planned Production Time − Stop Time

840minutes − 99minutes = **741 minutes**

3. **Good Count**

Total Count − Reject Count

271pcs **–** 10.16pcs = **260.84pcs**

1. **Availability**

Equipment availability accounts for when the cutting process is not running (both Unplanned Stops and Planned Stops).

Run Time / Planned Production Time

741minutes / 840 minutes = **0.8821**(88.21%)

2. **Performance**

Equipment performance accounts for when the process is running slower than its theoretical top speed (both Small Stops and Slow Cycles).

(Ideal Cycle Time × Total Count) / Run Time

(0.88min× 271pcs) / (741 minutes) = **0.3218** (32.18%)

Equipment performance can also be calculated based on Ideal Run Rate. Ideal run rate (Number of part per minute) is obtained by

60 minute / (Ideal Cycle Time × 60)

= 60 /(0.88x60) =1.13 parts/min

Therefore, (Total Count / Run Time) / Ideal Run Rate

(271pcs / 741minutes) / 1.13 parts per minute = **0.3218** (32.18%)

3. **Quality**

Quality accounts for manufactured blanket that do not meet quality standards.

Good Count / Total Count

260.84pcs / 271pcs = **0.9625** (96.25%)

OEE calculation

Finally, OEE of cutting process is calculated by multiplying the three OEE factors.

Availability × Performance × Quality

0.8821 × 0.3218 × 0.9625 = **0.2732** (27.32%)

Generally, losses can be viewed from three perspectives: the blanket plan had three major loss on cutting section which were

- Downtime loss(breakdown and setup and adjustment) was 11.79 %
- Speed loss(reduced speed and minor stops and idling) was 67.82%
- Quality loss (defect loss and start up) will be 3.75%

According to the above calculation, the OEE level for every other equipment or production process could be calculated in the same way and the computation result showed that the company is operating under capacity.See table 5.1

Table 4.2 Current level OEE level for blanket making process

Process	Machines	Unit	Production plan /machine	actually produced	Down time/hr/machine	downtime/min /machine	defect in meter &psc	Availability	Quality	Performance	
5	Carding	M	288	234	1.6	96	4.78	88.31	97.96	47.73	41.24
6	Stitch bonding	M	750	375	2.6	156	4.01	81.65	98.93	78.58	63.47
9	Saurer and dornier	M	290’	130	2.51	150.6	7.76	82.37	94.03	89.71	69.48
11	Raising	M	600	645	1.83	109.8	24	88.80	96.28	90.36	77.25
12	cutting	Psc	300	271	1.65	99	10.16	88.21	96.25	32.18	27.32
13	stitching	Psc	300	266	1.9	114	0.0125	86.29	100.00	59.36	51.22

As the result above showed , theaverage OEE level of blanket plant is poor**(54.99%)**and need much improvement , 85% OEE is referred world class and is based on 90% availability ,95% performance and 99% quality(Overall equipment efficiency, 2018). Therefore the researcher suggests TPM since it is applied productivity improvement techniquesaddressing OEE problem. As it was explained in review of literature, many companies have achieved significant improvements in OEE through TPM. On other hand ,successful implementation of TPM depends on some other productivity determinant factors ,keeping these factors constant, simple TPM program can have a significant positive impact on the Six Big Losses so that productivity could be improved (Nakajima, 2013) .

4.3 Productivity variables

In addition to OEE, there are determinant factors that limit productivity of the plant. For instance, Managerial related problems; as it was explained in review of literature have negative influence on plant productivity. This shows that implementing TPMand achieving OEE by itself does not assure total productivity. Therefore, it is necessary to study and analyze productivity determinant factors so that the best possible solution could be achieved. The regression analysis will dig-out and identifies the hidden factors which hindered productivity of the plant as well as confirm what was already described in the problem statement so that the suitable productivity improvement techniques could be applied. According to review of literature and information obtained from key informants, the main limiting factors that reduce the productivity of the plant are listed below.

- ✓ Machine downtime characteristics (V015)
- ✓ Satisfaction with working environment(V001)
- ✓ Satisfaction with the pay and reward(V002)
- ✓ Skill gap and other training(V005)
- ✓ Quality of raw material(V006)
- ✓ Administrative ability(V007)
- ✓ Workshop organization and well equipped(V008)
- ✓ Enough spare part and raw material availability(V009)
- ✓ Skill level of supervisor(V011)

- ✓ Preventive maintenance experience(V013)
- ✓ Workshop lay out(V010)
- ✓ Support by supervisor(V003)
- ✓ Skill level of maintenance personnel(V012)

Other firm productivity determinants, which are external to the firm, include firm infrastructure facilities, regulations, trade policies, development and access to finance, shortage of foreign currency and export behaviors.

4.4 Analysis of productivity determinant factors/variables

The descriptive analysis briefly explains the level and the characteristics of productivity variablesin terms of number and percentagewhere asthe regression analysis helps to identifythe major and significant problemsso that the right productivity improvementtechniques could be selectedand then applied.

4.4.1Data reliability analysis

Before the data has been analyzed, it was checked for internal consistency or reliability using the most widely used method called Cronbach or Coefficient alpha. The SPSS Package has shown that the data has no any internal consistency problem which is greater than 60%.

Table 4.2Data Reliability analysis

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.644	.658	7

As shown in the above tablethe data has the Cronbach alpha is 0.624(62.4%)

4.4.2 Determinants of Productivity: data analysis and Discussion

1.Productivity status

The descriptive table4.3 below shows the productivity status of the blanket plant. According to the result out of 62 respondents 36(57.1%) have replied that the plant is found in fair productive status where as 15(23.8%) replied the plant is found in low productivity status.

Table 4.3 Productivity status

	Frequency	Percent
Very low	11	17.7
Low	15	24.2
Fair	36	58.1
Total	62	100.0

2. Downtime characteristics

The table 5.8 below shows downtime characteristics of the plant. The result obtained shows that mechanical problem has the major share for machine downtime by 27.4% followed by manpower shortage, especially for night shift, and tool change with 19.4% and 14.5% respectively.The correlation coefficient and regression analysis shows that machine down time characteristics has relationship with the productivity of the plant and this relationship was found statistically significant determining productivity as less that 5% probability level (p =0.15 , r = -0.238).

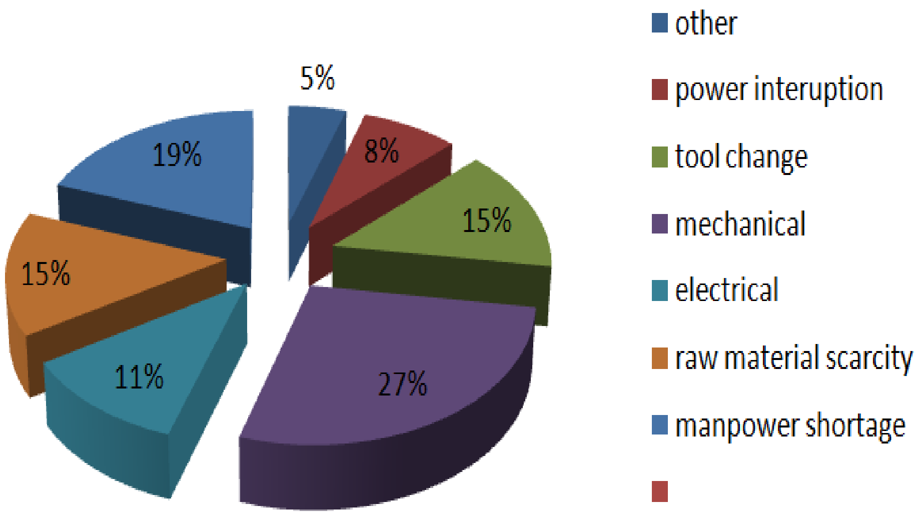

Figure 5.5 Downtime characteristics

3. PreventiveMaintenance experience

The descriptive table 4.4below shows that the blanket plant does not have good preventive maintenance experience. Out of 62 respondent more than 29 (47.3 %) replied that the plant had corrective maintenance experience. This method resulted high plants tools and equipment deterioration. The correlation coefficient and regression analysis shows that the maintenance has inverse relationship with the productivity of the plant and this relationship was found statistically significant determining productivityas less that 5% probability level (p =0.007 , r =0.109).Therefore, the absence of good preventive maintenance experience has made the plant to be unproductive.

Table 4.4 Preventive Maintenance experience

	Frequency	Percent	Cumulative Percent
Very low	6	9.7	9.7
Low	23	37.1	46.8
Fair	16	25.8	72.6
High	14	22.6	95.2
Very high	3	4.8	100.0
Total	62	100.0	

4.Quality of raw material

The quality of raw material influences the productivity of the plant. Since quality is conformance to standard and meeting customer expectation, it plays a gear role in productivity increment. According to the table 4.5 below medium quality of row material take share of 56.5% followed by high and low quality of raw material with 24.2% and 19.4% respectively. The correlation coefficient and regression analysis shows that quality of raw material has positive relationship with productivity of the plant but this relationship was not found significant determining productivityat less than 5% probability level ($p<0.05$). Therefore, the analysis reveals that this independent variable did not affect the productivity of the plant.

Table 4.5Quality of raw material

	Frequency	Percent	Cumulative Percent
Very low	8	12.9	12.9
Low	4	6.5	19.4
Fair	35	56.5	75.8
High	11	17.7	93.5
Very high	4	6.5	100.0
Total	62	100.0	

5. Employee satisfaction with pay and reward

The success of any business or manufacture sector depends on employee satisfaction. The higher satisfaction with the pay and reward will motivate the employee to work better for factory's productivity. Out of 62 respondent 44(70.9) were found unsatisfied where as18(29.0%) were found fairly satisfied. The correlation coefficient and regression analysis showed that employee satisfaction with the pay and reward has relationship with plant productivity but the relationship was not found statistically significant determining productivity`less than 5% probability levels ($p =0.00,-0.019$). Therefore, this independent variable could not be mentioned as a key factor forplants unproductively.

Table 4.6 Employee satisfaction with pay and reward

	Frequency	Percent	Cumulative Percent
Very low	17	27.4	27.4
Low	26	41.9	69.4
Fair	17	27.4	96.8
High	2	3.2	100.0
Total	62	100.0	

5. Employee satisfaction with working Environment

A Good working environment is a place where the workers are at ease and feel appreciated; they are often happier and more productive at work so that the factory productivity could increase. A bad work environment is a work environment where the worker is unsettled, feeling unappreciated and working in fear. Therefore, the higher satisfaction with working environment is positively relatedwith factory productivity. Out of 62 respondent 37(59.7) were found unsatisfied where as 11(17.7%) were found fairly satisfied. The correlation coefficient and regression analysis also showed that employee satisfaction with working environment has direct relationship with plant productivity but the relationship was not found statistically significant determining productivity at less than 5% probability levels.($p>0.05$). Therefore, this independent variable could not be mentioned also as a major factor for plants unproductively.

Table 4.7 Employee satisfaction with working environment

	Frequency	**Percent**	**Cumulative Percent**
Very low	5	8.1	8.1
Low	32	51.6	59.7
Fair	18	29.0	77.4
High	6	9.7	93.5
Very high	1	1.6	100.0

Total	62	100.0	

7.Administrative ability

It is obvious that the administrative functions,planningand organizingarevital for firm success and productivity improvement; the analysis result below has proved this. Majorities of the responded about 45.2% replied that there is fairadministrative ability followed by poor managerial and good managerial ability with 44.2% and 13.0% respectively. The correlation coefficient and regression analysis showed that there is relationship between administrative ability and productivity of the plant and this relationship was found significant determining productivity status at less than 5% probability levels.(p =0.023 r =0.475).

Table 4.8Administrative ability

	Frequency	Percent	Valid Percent	Cumulative Percent
Very low	11	17.7	17.7	17.7
Low	15	24.2	24.2	41.9
Fair	28	45.2	45.2	87.1
High	4	6.5	6.5	93.5
Very high	4	6.5	6.5	100.0
Total	62	100.0	100.0	

8. Skill gap and other training

Skill development training program enhances problem solving ability of the technician and operator and supervisor as well. Therefore, it is assumed to have a positive impact on productivity improvement. The result of correlation coefficient and regression analysis showsthat there weresignificant mean difference between training employee and productivity status at less than 5%probability level(p =0.014 ,r =0.275). According to the data analysis shown below out of 62 respondents more than 73% did not get skill development training.

Table 4.9 Training employee

	Frequency	Percent	Cumulative Percent
Very low	13	24.2	24.2
Low	30	48.4	74.6
Fair	12	19.4	91.9
High	5	8.1	100.0
Total	62	100.0	

9.Enough spare partavailability

The firm success is highly depends on the availability of enough spare parts. They are used to facilitate maintenance activity and decrease machine down time. Since machines are the heart of any production system, spare parts are quite necessary and play an important role in any production process. The study revealed that the plant had no enough spare part and raw material supply, Out of 62 respondents 36(58.1%) replied that the plant had low spare part supply followed by fair supply spare part supply by 30.6 %. The correlation coefficient and regression analysis also showed that there is relationship between spare part availability and productivity of the plant and this relationship was found significant determining productivity status at less than 5% probability levels.(p =0.05 , r =0.557).

Table 4.10enough spare part availability

	Frequency	Percent	Cumulative Percent
Low	36	58.1	30.6
Fair	19	30.6	88.7
High	7	11.3	100.0
Total	62	100.0	

10.Workshop organization and being well equipped

Workshop organization enables and motivates the worker to efficiently participate in production process. The study showed that 42.2 % of respondent had mentioned that the plant was both fairly organized and equipped whereas 38.7% replied unorganized and unequipped. The correlation coefficient and regression analysis showed that there is direct relationship between workshop organization and being well equipped and productivity of the plant and this relationship was found significant determining productivity status at less than 5% probability levels.($p<0.05$).

Table 4.11 Workshop organization and being well equipped

	Frequency	Percent	Cumulative Percent
Very low	3	4.8	4.8
Low	24	38.7	43.5
Fair	28	45.2	88.7
High	4	6.5	95.2
Very high	3	4.8	100.0
Total	62	100.0	

11.Workshop/Plant lay out

Good lay out results in comfort, convenience appearance, safety and profit. Out of 62 respondent 32(51.6 %) of respondents replied that the plant has fair lay out where as 40.3% replied that the plant has good plant layout. The correlation coefficient and regression analysis hasshown that the plant layout did not have any impact on the productivity status of the plant at significant level of probability (p = 0.038, r = 0.319).

Table 4.12 Workshop/Plant lay out

	Frequency	Percent	Cumulative Percent
Very low	2	3.2	3.2
Low	3	4.8	8.1
Fair	32	51.6	59.7
High	25	40.3	100.0
Total	62	100.0	

12.The skill of supervisor

The skill of supervisor is necessary to support and coordinate operators and the overall production system.   The analysis below shows that the plant supervisor has low skill to support and manage overall production system. Out of 62 respondent 30(48.4%) of respondent replied that the skill level of supervisor is fair sufficient to run the production system. whereas 16(25.8%) replied the high.The correlation coefficient and regression analysis showed that there is relationship between skill of supervisor and productivity of the plant and this relationship was found significant determiningproductivity status at less than 5% probability levels (p =0.00 , r =0.142).

Table 4.13. The skill of supervisor

	Frequency	Percent	Cumulative Percent
Very low	7	11.3	11.3
Low	9	14.5	59.7
Fair	30	48.4	74.2
High	16	25.8	100.0
Total	62	100.0	

13.Support by supervisor

Adequate follow up in production system enables to control wastes and facilitate any production system. 50.0% of Respondent replied that the skills of plant supervisors are fair,14.5% replied high. Whereas 19(30.6%) agreed that the company has to work on the skill of the supervisor to enhance their participation on production system. The analysis also revealed that supervisor support has slight statistically significant relationship with the plant productivity but this relationship was not found significant at less than 5% probability level ($p>0.05$). This confirms that the help of supervisor had positive contribution even for this insufficient productivity level of the plant.

Table 4.14 Support by supervisor

	Frequency	Percent	Cumulative Percent
Low	19	30.6	30.6
Fair	31	50.0	80.6
High	9	14.5	95.2
Very high	3	4.8	100.0
Total	62	100.0	

14.Skill of maintenance personnel

The skill and experience of the maintenance man surely prolong the life of machines and equipment .operators will also get chance to learn how take a care of their machine and equipment and perform minor maintenance tasks. According to descriptive analysis 14.5% of total respondent replied that the maintenance man has high maintenance skill whereas 29.0% replied fair and 19.4% replied low. The correlation coefficient and regression analysis also showed that there is relationship between skill of maintenance personnel and productivity of the plant and this relationship was found significant determining productivity at less than 5% probability levels (p =0.010 , r = 0.307).

Table 4.15 Skill of maintenance man

	Frequency	Percent
Very low	10	16.1
Low	12	19.4
Fair	18	29.0
High	9	14.5
Very high	13	21.0
Total	62	100.0

4.5 Interpretation of econometric and regression models

In total, thirteen independent variables were used for estimation. To identify determinant factor of productivity, regression model was estimated using a statistical package known as SPSS version 20. Types, codes and definition of the variables and estimates of the regression model are presented on Table 5.17and Table 5.18 respectively.

4.5.1 Econometric Analysis

Before fitting the regression model, it was important to check serious problem of multicollinearityamong the potential explanatory variables. The avoidance of multicollinearity problem enables the explanatory variable can separately contribute to the variation in the dependent variable. In order to handlethis issue, Variance Inflation Factor (VIF) and correlation coefficient tests were used.A value of VIF greater than or equal to 10 is an indicator for the existence of serious problem of multicollinearity.As can be seen in the table 5.16, the VIF of all variableswere found to be less than 10. Hence, the problem of multicollinearity was not serious among the independent variables.

Table 4.16 Variance inflation factor for ordinal variables

Variables	Tolerance	VIF
satisfaction with working environment	.501	1.994
satisfaction with the pay and reward	.650	1.539
support by supervisor	.234	4.271
skill gap and other training	.299	3.349
quality of raw material	.657	1.521
administrative ability	.386	2.591
workshop organization and well equipped	.540	1.852
enough spare part /raw material availability	.289	3.455
workshop lay out	.530	1.886
skill level of supervisor	.361	2.769
skill level of maintenance personnel	.456	2.191
preventive maintenance experience	.294	3.404
machine down time characteristics	.830	1.204

Table 4.17: Correlation coefficient for factor for explanatory variables

Correlation	V016	V001	V002	V003	V005	V006	V007	V008	V009	V010	V011	V012	V013	V015
V016	1													
V001	.350**	1												
V002	-.019	.052	1											
V003	.271*	.092	-.092	1										
V005	.275*	-.004	-.329**	-.199	1									
V006	.342**	.430**	-.057	.279*	.039	1								
V007	.475**	.078	.105	-.298*	.369**	-.036	1							
V008	.129	-.112	-.177	-.054	.071	.031	-.144	1						
V009	.557**	.177	.053	.454**	.089	.259*	.213	.193	1					
V010	.319*	.207	.036	.345**	-.344**	.220	-.006	-.014	.166	1				
V011	.142	-.453**	.095	-.057	.228	-.200	.257*	-.095	-.377**	-.089	1			
V012	.307*	.076	-.248	.476**	.282*	.116	.216	.021	.271*	.254*	.159	1		
V013	.109	.233	.185	-.095	-.553**	.163	-.087	.323*	-.048	.482**	-.226	-.076	1	
V015	-.238	-.093	-.059	-.005	-.131	.118	-.101	.047	-.177	.233	.025	.044	.184	1

Table 4.18 Types, codes and definition of the variables

Variable type	Code	Definition
Ordinal	V001	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V002	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V003	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V005	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V006	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V007	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V008	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V009	1: Very low 2:Low 3: Fair 4: high 5: Very high
	V010	1: very poor 2: poor 3: Fair 4: Good 5: perfect
	V011	1: very poor 2: poor 3: Fair 4: Good 5: perfect
	V0012	1: very poor 2: poor 3: Fair 4: Good 5: perfect
	V013	1: very poor 2: poor 3: Fair 4: Good 5: perfect
Discreet	V015	0: spare part shortage 1: power interruption 2: tool change 3: mechanical 4: electrical 5: other

4.5.2

4.5.2 Regression analysis

Finding the factors that contribute to productivity goes beyond the descriptive analysis and requires employing econometrics analysis as it was mentioned in the methodology. Based on the specification of the model in the methodology chapter, regression model was estimated to examine the effects of the expected determinant factors of productivity in the case company.The results are presented in Table 5.19. The magnitude of the coefficient obtained from the model shows the marginal effect of each explanatory variable.

Table 5.19 Regression analysis table

β_n	Independent Variable s included in the model	Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	β	
1	satisfaction with working environment	1.571	.381	.349	.000
2	satisfaction with the pay and reward	-.731	.342	-.160	.037
3	support by supervisor	.918	.583	.195	.122
4	skill gap and other training	1.218	.479	.280	.014
5	quality of raw material	.185	.276	.050	.506
6	administrative ability	.808	.345	.227	.023
7	workshop organization and well equipped	.088	.359	.020	.807
8	enough spare part availability	2.931	.589	.555	.000
9	workshop lay out	.696	.327	.176	.038
10	skill level of supervisor	2.094	.378	.554	.000
11	skill level of maintenance personnel	-1.230	.460	-.238	.010
12	preventive maintenance experience	1.121	.394	.315	.007
13	machine down time characteristics	-.289	.115	-.166	.015

4.5.3 Explanation of independent variables and regression model interpretation

Thirteen independent variables that are supposed to have influence productivity in the study area were included in the model, of which nine were found to be statistically significant even though the level of statistical significance and the sign of the significant parameters were different. The model output revealed that preventive maintenance experience (V013), machine down time characteristics (V001) ,,administrative ability (V007), skill gap and other training(V005), enough spare part availability (V009)workshop organization and well equipped (V008), skill level of supervisor(V011),support by supervisor (V003) ,skill level of maintenance personnel(V015)and satisfaction with pay and reward(V002) were found to be significant at less than 5 percent probability level and the rest four variables namely, Satisfaction with working environment(V001) , workshop organization and well equipped (V008) ,Quality of raw material(V006) and Workshop lay out(V010) were not significant at less than five percent probability level. Experts were interviewed to provide possible explanations and reason for each significant independent variable and those expert opinions were included and presented as follows:

Machine down time characteristics (V001):-

As it was already supposed, the descriptive part assured that there was statistically significant relationship between machine down time characteristics and productivity. The regression analysis has also shown that a machine downtime characteristic has affected the plant productivity. Productivity of the plant , holding other variables constant, decreases by a factor of 0.289 as machine down time occurrence increased by one level. The possible explanation is that machine down time, unless it is planned down time as change over and brakes, makes machine and operator idle that finally affects productivity of the plant and the employee as well.

Skill gap and other training (V005)

Skill gap and other training have negative statistically significant relationship with outcome variable plant productivity. The regression analysis has also shown that skill gap and other training have affected the plant productivity. Productivity of the plant, holding other variables constant, decrease by a factor of 1.218 as skill gap and other training problem increased by one level.(Productivity of the blanket plant was 1.230 times more likely to increase when there is enough skill gap and other training). The possible explanation is that training enables employee to acquire new knowledge, learn new skills and performs tasks differently and better than before. It trains employees how to perform particular activities or a specific job. Smooth and efficient running of any organization depends directly on how well employees are equipped with relevant skills.

Administrative ability (V007)

The descriptive part assured that there was statistically significant relationship between machine down time characteristics and productivity. The regression analysis here has shown that administrative ability has positive effect the plant productivity. Productivity of the plant, holding other variables constant, increases by a factor of 0.808 as administrative ability increased by one level.

Enough spare part availability (V009)

As it was already supposed, the descriptive part assured that there was statistically significant relationship between enough spare part availability and productivity. The regression analysis has also shown that enough spare part availability has significant relationship with the plant productivity. Productivity of the plant, holding other variables constant, decreases by a factor of 2.931as spare part scarcityincreased by one level(Productivity of the blanket plant, keeping other factor constant, was2.931 times more likely to increase when there is enough spare part availability) The possible explanation is that scarcity of raw material and spare part makes machine and operator idle that finally makes both the plant and the employee unproductive.

Workshop lay-out

As it was already supposed, this independent variable has positive statistically significant relationship with outcome variable productivity. Both the descriptive and regression analysis has shown that workshop lay-out has positive effect on plant productivity. Productivity of the plant, holding other variables constant increases by a factor of 0.696 as workshop lay-out condition improved by one level.

Satisfaction with the pay and reward) (V002)

As it was already supposed, the descriptive part assured that there was statistically significant relationship between satisfaction with pay and rewardwith productivity. The regression analysis has also shown that satisfaction with pay and reward has affected the plant productivity. Productivity of the plant , holding other variables constant, decreases by a factor of 0.731 as disappointment with pay and reward increased by one level. The possible explanation is that satisfaction with the pay and reward could motivate employee and make them work hard to enhance the productivity level of the plant.

Support by supervisor(V003)

As it was already explained in descriptive part, this independent variable has positive statistically significant relationship with outcome variable plant productivity. Both the descriptive and regression analysis have shown that support by supervisor has positive effect on plant productivity. Productivity of the plant, holding other variables constant, increases by a factor of 0.918 as support by supervisor increased by one level. The possible reason is that supporting employee from their supervisor encourages and makes them perform high in the organization as the result the productivity will increase.

Skill level of maintenance personnel (V011)

Skill level of maintenance personnel has negative statistically significant relationship with outcome variable plant productivity. The regression analysis has also shown that skill level of maintenance personnel have affected the plant productivity. Productivity of the plant, holding other variables constant, decreases by a factor of 1.230 as skill of maintenance personnel decrease by one level.The possible explanation is that skill level,whether the personnel are operator or maintenance technician, plays avital role in efficient employee's performance so that they can make their endeavor to enhance the productivity of the plant.Expert also noted that training the maintenance personnel creates awareness to have that their true task is not carrying out repairs only but eliminating failures. Maintenance men must become well trained about equipment functions and mechanism so as to analyze equipment failures and product losses and track down their causes.

4.5.4 Selection of appropriate productivity improvement techniques

It is difficult to address all identified problem using single productivity improvement techniques. Therefore;the suitabletechnique which could address the keyproblems wasselected.Other problems that could not be addressed,was recommended forward and unless they are given due attention, applying improvement techniques could not be fully utilized.

Finally, on the basic of major problem identified, TPM has been selected due to the following reason

- TPM is a program that can change the culture of the company maintenance policy byparticipatingall employees toward the maintenance system (Nakajima, 2013).
- It was previously noted that it reduces unplanned stoppage, breakdown accidents and losses obstructing equipment effectiveness (SachitVardhan,2015) so that it could improve OEE problem of the factory.
- TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. (Ejgayehu ,2008)
- It hasskill gap development training package for all employee so that they will be more productive.(Johansson B , 1999)

- In general TPM is highly structured approach, which uses a number of tools and techniques to achieve highly effective plants and machinery utilization (Eti et al., 2006).
- Through TPM process, both the cost and quality are improved significantly by reducing and minimizing equipment deterioration and failures. Cost of rework and repairs reduce to very limited products rejected. As a result, the overall equipment effectiveness level would show significant improvement. Additionally, equipment deterioration is eliminated as the equipment operated efficiently.

CHAPTER FIVE

PROPOSED SOLUTION TO EXISTING PROBLEM OF BLANKET PLANT

5.1. Introduction

Almost all industrial production process is carried out with the aid of machine, as the result of which each production – oriented organization is largely depends on its machineries. When a break down or long term disruption occurs, on machine, equipment or important tools, this will automatically have far-reaching consequence for the total production. TPM is method of maintaining and improving the integrity of production and quality system through the machine and equipment, employees and the supporting process.TPM can be of the great value and its target is to improve core business processes. It is specially meant for companies with a lot of machine that involves high maintenance cost (Mulder, 2016).

Total productive maintenance (TPM) program makes operator to participate in simple restoration and also give emphasis to involve the operators on activities to prevent and measure deterioration as they are always near to the machine. Since these activities are vital, it should be one of the necessary parts of daily work of the operator. The purpose is to achieve company goals through the implementation of operator initiated daily maintenance consisting of cleaning, adjustment, and regular inspections, as well as improvement activities. And the maintenance division also needs to participate in training operator and restoration of equipment which requires high skill and specialization (Ejgayehu, 2016).

5.2 Concept of Total productive maintenance (TPM)

One of the "Best Manufacturing Practices" defined by the U.S. government, TPM stands for “Total Productive Maintenance” and builds a close relationship between Maintenance and Productivity, showing how good care and upkeep of the equipment will result in a higher productivity. It certainly is a key element in Lean manufacturing as well. TPM is not only a strategy, but a new philosophy of continuous improvement and team work that creates a sense of ownership in the operator(s) of each machine as well as in their supervisor and the maintenance people involved (Venkatesh, 2005).Total Productive Maintenance (TPM) is maintenance activities that are productive and a continuous improvement strategy which involves everyone in the organization from operators to senior management in equipment improvement targeting ‘zeroaccidents’, ‘zerodefect’ and ‘zero failures’ in equipment lifecycle level through the activities of overlapping small groups in hierarchical system (Naveen, 2015).

2.8.1 Pillars of TPM

The basic practices of TPM are often called the pillars or elements of TPM. The entire structure of TPM is built and stands on eight pillars (Sangameshwran&Jagannathan, 2002). TPM paves way for excellentplanning, organizing, monitoring and controlling practices through its unique eight-pillar methodology.TPM initiatives, as suggested and promoted by Japan Institute of Plant Maintenance (JIPM), involve an eight pillar implementation plan that results in substantial increase in labor productivity through controlledmaintenance, reduction in maintenance costs, and reduced production stoppages and downtimes. Thecore TPM initiatives classified into eight TPM pillars or activities for accomplishing the manufacturingperformance improvements include autonomousmaintenance; focused maintenance; plannedmaintenance; quality maintenance; education andtraining; office TPM; development management; and safety, health and environment (Ireland & Dale, 2001; Shamsuddin et al., 2005; Rodrigues &Hatakeyama, 2006).The detailed maintenance and organizational improvement initiatives and activities associated with the respective TPM pillars are as follows:

Pillar 1:- 5s

TPM starts with 5S. It is a systematic process of housekeeping to achieve a serene environment in thework place involving the employees with a commitment to sincerely implement and practice housekeeping. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement. 5S is a foundation program before the implementation of TPM.It consists of five elements:

1. **Seiri (Sort)**:- Identification of the items those are not frequently needed. According to their frequency of use, priority must be provided and items with less frequency should beeliminated. And unnecessary item have to be kept in a red tagged area so that they can be found when they are required.
2. **Seiton (Set in order)** :- At first making sure that all the unnecessary items have been eliminated and keeping the necessaries in a way so that they can be easily picked up for

use. Certain places for needed items should be allocated and locations must be selected on frequency of use.

3. **Seiso(clean):-** Keeping workplace clean and free from dust, dirt and clutter. Engaging all the persons for cleaning their table, chair, machines etc.
4. **Seiketsu (Standardize)** Making the activities have been performed in first three stages standardize. Standard operating procedure and color coding can be used in the factory for this purpose.
5. **Shitsuke (Sustain**):- Providing various Trainings and incentives to the people so that they follow good housekeeping disciplines. It is raising awareness among people through using 5S poster and 5S slogan and well as arranging monthly meeting on 5S.

Pillar 2- Autonomous maintenance (AM)

This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technicalrepairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating. By use of this pillar, the aim is to maintain the machine in new condition. The activities involved are very simple nature. This includes cleaning, lubricating, visual inspection, tightening of loosened bolts etc.

Pillar 3-Kaizen

"Kai" means change, and "Zen" meansgood (for the better). Basically kaizen is for smallimprovements, but carried out on a continual basis andinvolve all people in the organization. Kaizen requires no or littleinvestment. The principle behind is that "a very large number of small improvements are more effective in anorganizational environment than a few improvements of largevalue". This pillar is aimed at reducing losses in theworkplace that affect our efficiencies. By using a detailed andthorough procedure we eliminate losses in a systematicmethod using various kaizen tools. These activities are notlimited to production areas and can be implemented inadministrative areas as well.Kaizen target are achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction.

Pillar 4-Planned maintenance (PM)

It is aimed to have trouble free machines andequipments producing defect free products for totalcustomer satisfaction. This breaks maintenance downinto four “families” or groups, preventivemaintenance, breakdown maintenance, correctivemaintenance, and maintenance prevention.With PMwe evolve our efforts from a reactive toa proactive method and use trained maintenance staffto help train the operators to better maintain theirequipment. In PMpolicy are set to achieve and sustainavailability of machines, optimum maintenance cost,reduces spares inventory, and improve reliability andmaintainability of machines.PMtargets arezero equipment failure andbreak down, improve reliability and maintainability by 50%., reduce maintenance cost by 20 %, andensure availability of spares all the time.

Pillar 5- Quality maintenance (QM):

It is aimed towards customer delight throughhighest quality through defect free manufacturing.
Focus is on eliminating non-conformances in asystematic manner, much like focused improvement.We gain understanding of what parts of the equipmentaffect product quality and begin to eliminate currentquality concerns, and then move to potential qualityconcerns.QMpolicy aims to create defect free conditions andcontrol of equipments, quality maintenance activities tosupport quality assurance, focus of prevention ofdefects at source, focus onin-line detection and segregation of defects,and effective implementation of operator qualityassurance. QMtargets are to achieve and sustaincustomer complaints at zero, reduce in-process defectsby 50 %, and reduce cost of quality by 50 %.

Pillar 6-Training

It is aimed to have multi-skilled revitalizedemployees whose morale is high and who has eager tocome to work and perform all required functionseffectively and independently. Education is given tooperators to upgrade their skill.The employees shouldbe trained to achieve the four phases of skill. The goal isto create a factory full of experts. The different phase ofskills is phase 1-do not know, phase 2-know the theorybut cannot do, phase 3-can do but cannot teach, andphase 4-can do and also teach.Training policy focuses on improvement ofknowledge, skills and techniques, creating a trainingenvironment for self-learning based on felt needs and training curriculum including tools/assessment etc.Training target are to achieve and sustaindowntime due to want men at zero on critical machines,achieve and sustain zero losses due to lack ofknowledge/skills/techniques, and aim for 100percentparticipation in suggestion scheme.

Pillar 7-Office TPM:

Office TPM should be started after activatingfour other pillars of TPM (AM, Kaizen, PM, and QM).Office TPM must be followed to improve productivity,efficiency in the administrative functions and identify andeliminate losses. This includes analyzing processes andprocedures towardsincreased office automation.

Pillar 8-Safety, health and environment:

In this area focus is on to create a safeworkplace and a surrounding area that is not damagedby our process or procedures. This pillar will play anactive role in each of the otherpillars on a regular basis.Safety, health and environment target arezero accident,zero health damage, and zero fires.

5.3TPM implementation stages and proposed implementation plan in blanket plant

5.2.1 TPM implementation stages

TPM has four implementation stages and this stages will be described as follows

Stage A-Preparatory stage

***Step 1-Announcement by management to all about TPM introduction in the organization*:**

Properunderstanding, commitment and active involvement ofthe top management in needed for this step. Seniormanagement should have awareness programmes,after which announcement is made. Decision theimplement TPM is published in the in house magazine,displayed on the notice boards and a letter informing thesame is send to suppliers and customers.

Step 2-Initial education and propaganda for TPM: Training is to be done based on the need. Someneed intensive training and some just awarenesstraining based on the knowledge of employees inmaintenance.

Step 3-Setting up TPM and departmental committees: TPM includes improvement, autonomousmaintenance, quality maintenance etc., as part of it.When committees are set up it should take care of allthose needs.

Step 4-Establishing the TPM working system and target: Each area/work station is benchmarked andtarget is fixed up for achievement.

Step 5-A master plan for institutionalizing:Nextstep is implementation leading to institutionalizingwherein TPM becomes an organizational culture.Achieving PM award is the proof of reaching asatisfactory level.

b) Stage B-Introduction stage

A small get-together, which includes oursuppliers and customer's participation, is conducted.
Suppliers as they should know that we want qualitysupply from them. People from related companies andaffiliated companies who can be our customers, sistersconcerns etc. are also invited. Some may learn from usand some can help us and customers will get themessage from us that we care for quality output, costand keeping to delivery schedules.

c) Stage C-TPM implementation

In this stage eight activities are carried whichare called eight pillars in the development of TPMactivity. Of these four activities are for establishing thesystem for production efficiency, one for initial controlsystem of new products and equipment, one forimproving the efficiency of administration and are forcontrol of safety, sanitation as working environment.

d) Stage D-Institutionalizing stage

By now the TPM implementation activities wouldhave reached maturity stage. Now is the time to applyfor preventive maintenance award.

5.2.2 Proposed implementation plan

An excellent way to get a deeper understanding of TPM is to walk through an implementation example. This section provides a step-by-step roadmap for a simple and practical TPM implementation (Lean production, 2018).

Step One – Identify Pilot Area

In this step, the target equipment for the pilot TPM program is selected. Since the company has limited TPM experience, the best choice is usually the Easiest to improve equipment method.The researcher had already selected blanket plant as a pilot area since the plant has registered major machine and equipment breakdown records.

Step Two – Restore Equipment to Prime Operating Condition

In this step, every equipment and machines within the blanket plant will be cleaned up and otherwise prepared for improved operation. Two key TPM concepts will be introduced:

- 5S
- Autonomous Maintenance

First, a basic 5S program should be initiated (including both operators and maintenance personnel). The goal of 5S is to create a work environment that is clean and well-organized.

In general, if there is clean and well-organized work environment within this company, tools and parts are much easier to find, and it is much easier to spot emerging issues such as fluid leaks, material fall and metal shaving from unexpected wear etc. but, In order to acquire these attainments, the blanket plant should implement 5s and perform the following major activities. After implementation of 5s and perform major activities, the plant should prepare check list so as to create standardization of 5s implementation process.

Table 5.1.5s implementation plan activities and description

Tasks/ activities	Description
Photograph	Take photographs that capture the initial state of the equipment and post them on the project board.
Clear Area	Clear the area of debris, unused tools and components, and any other items that are not needed.
Organize	Organize remaining tools and components onto shadow boards (boards containing outlines as visual cues).
Clean Up	Thoroughly clean the equipment and surrounding area (including residue from any leaks or spills).
Photograph	Take photographs that capture the improved state of the equipment and post them on the project board.
Checklist	Create a simple 5S checklist for the area (creating Standardized work for the 5S process) (table 6.2).
Audit	Schedule a periodic audit (first daily, then weekly) to verify that the 5S checklist is being followed. During the audit, update the checklist as needed to keep it current and relevant. Keep audits positive and motivational (treat them as a training exercise).

Table 5.2 5s check list

Name of operator:--------------------------- Date :________

Machine name/ Model/ Type:- ______________

No	Check list	Yes	No	Remark
1	Is the operator/employee properly trained in 5s?			
2	Is the machine tools switched off properly?			
	Is the machine clean and clear of tools and free from oil and grease			
3	Is the area clear of dirt, unused tools and components and any other tools that are not needed?			
4	Are the remaining tools organized well and placed on shadow board?			

5	Are the tools and the surrounding area clean thoroughly?			

Next, an **Autonomous Maintenance program** should be initiated. Strive to build a consensus between operators and maintenance personnel on which recurring tasks can be productively performed by operators. In many cases, light training will be required to bring up the skill level of operators. It places responsibility for routine maintenance, such as cleaning, lubricating, and inspection, in the hands of operators. How does this help the blanket plant?

- Gives operators greater “ownership” of their equipment.
- Increases operators’ knowledge of their equipment.
- Ensures equipment is well-cleaned and lubricated.
- Identifies emergent issues before they become failures.
- Frees maintenance personnel for higher-level tasks.

Allotment of minor maintenance activities to the operators can be achieved only when operators are trained to restore minor failure. This helps the plant to use the labor efficiently and to minimize the high rate of breakdown in the plant through improving operator’s skills. Furthermore, equipping the maintenance personnel with appropriate knowledge through training will enhance the repair efficiency of the industry which in turn reduces the down time of the equipment.The training provided to the maintenance men focuses on developing them as a teacher and leaders in the maintenance field. They must learn how to talk convincingly to operators and teach them about autonomous maintenance methods at every opportunity. Some of the skills that the maintenance men of the blanket plants should include:

- ✓ Ability to prepare and train operators in blanket plant.
- ✓ Ability to promptly discover causes whenever a failure occurs for machineries.
- ✓ Ability to make the repairs and checking of equipment before handing it over
- ✓ Ability to trace the causes of failure.

After implementation of autonomous maintenance and perform major activities, the plant should prepare check list so as to create standardization of 5s implementation process.

Table 5.3 AM implementation plan activities and description

Tasks/activities under AM	**Description**
Inspection Points	Identify and document key inspection points (all wear parts should be included). Consider creating a map of inspection points as a visual aid.
Visibility	Replace opaque guarding with transparent guarding in cases where inspection points are obscured (where feasible and safe to do so).
Lubrication Points	Identify and document all lubrication points. Schedule lubrication to occur during changeovers or other planned stops (in other words, avoid creating new sources of unplanned stop time). Consider externalizing lubrication points that are difficult to access or that require stopping the equipment (where feasible and safe to do so).
Operator Training	Train operators to bring any anomalies or emerging conditions to the attention of the line supervisor.
Create Checklist	Create a simple Autonomous Maintenance checklist for all inspection, set point, lubrication, and other operator-controlled maintenance tasks (creating Standardized Work for the Autonomous Maintenance process). See table 6.3 below
Audit	Schedule a periodic audit (first daily, then weekly) to verify that the Autonomous Maintenance checklist is being followed. During the audit, update the checklist as needed to keep it current and relevant. Keep audits positive and motivational (treat them as a training exercise).

Table 5.4 Autonomous maintenance check list

Name of operator:--------------------------- Date :________

Machine name/ Model/ Type:- ______________

No	Check list	Yes	No	Remark
1	Is the operator/employee properly trained in Autonomous maintenance?			
2	Is opaque guarding replaced with transparent Guarding?			
3	Are all wear parts identified and documented?			
4	Are all inspection points are safe to do so?			
5	Are all lubrication point lubricated and documented?			
6	Are lubrication schedule occurred during change over or other planned stops			

Step Three – Start Measuring OEE

After successfully implementation of 5s and AM ,a system is put into place to track OEE for the target equipment. This system can be manual or automated, but the scope of the system must include unplanned stop time.For most equipment, the largest losses are a result of unplanned stop time. Therefore, it is strongly recommended to categorize each unplanned stop event to get a clear picture of where productive time is being lost.

The plant should gather data for a minimum of two weeks to identify recurring reasons for equipment unplanned stop time, and to identify the impact of small stops and slow cycles. Review the data during each shift to ensure that it is accurate and to verify that the true causes of unplanned stop time are being captured.

Step Four – Address Major Losses

In this step, the most significant sources of lost productive time are addressed. The TPM concept of Focused Improvement (also known as Kaizen) is introduced. During this step, OEE data should continue to be carefully reviewed each shift to monitor the status of losses that have already been identified, as well as to monitor overall improvements in productivity. Fishbone diagram here is used to identify the potential cause of OEE problem so that the process could be improved.

Table 5.5 Description of activities addressing major losses

tasks/activities	Description
Select Loss	Based on equipment-specific OEE and stop time data, select one major loss to address. In most cases, the major loss that is selected should be the largest source of unplanned stop time.
Create Team	Create a cross-functional team to address the problem. This team should include four to six employees (operators, maintenance personnel, and supervisors) with the best equipment knowledge and experience…and that are likely to work well together.
Collect Information	Collect detailed information on symptoms of the problem, including observations, physical evidence, and photographic evidence. Consider using an Ishikawa (fishbone) diagram at the equipment to collect observations.
Organize	Organize a structured problem solving session to: a) identify probable causes of the problem, b) evaluate probable causes against the gathered information, and c) identify the most effective fixes.
Schedule	Schedule planned stop time to implement the proposed fixes. If there is an existing change control process, be sure to utilize that process when implementing fixes.
Restart	Restart production and determine the effectiveness of the fixes over an appropriate time period. If sufficiently effective, document any changes to procedures and move on to the next major loss. Otherwise, collect additional information and organize another structured problem solving session.

5.4 Technique addressing the major six losses

Addressing Equipment Failure

Addressing equipment failure (i.e., Unplanned Stops) is critical to improving OEE. For most companies, Unplanned Stop time is the single largest source of lost production time. A prerequisite to successfully addressing Unplanned Stops is to understand the nature of the problem.

Kaizen

A highly effective process for reducing unplanned Stop time is kaizen (sometimes calleda focused improvement activity). Ik2n a focused improvement activity a cross-functional team selects one type of loss to address (often from a top losses report). The team then applies a Root Cause Analysis or a 5 Why Analysis to identify potential causes and fixes. Once an issue is fixed, it is important to update related standardized work procedures to lock-in improvements (and avoid "same problem/different day" recurrences).

Addressing Setup and Adjustments

Another major source of lost production time for blanket plant is setups (also called Changeovers or Make Ready). The definition of Setup and Adjustments to cover all planned stops (e.g., including preventative maintenance) that occur during planned production time. After all, any time that could productively be used for manufacturing is an opportunity for improvement.

SMED (Single-Minute Exchange of Dies) technique

A well-established and highly effective way to address setup loss is SMED (Single-Minute Exchange of Dies). SMED is a collection of techniques for dramatically reducing the time it takes to complete a setup. The goal of SMED is to reduce setup times to less than 10 minutes (i.e., single-digit minutes). Here are several examples of changes that are often made as part of a SMED program:

- Put together setup carts with all tools and supplies necessary to complete the setup.

- Prepare parts in advance (e.g. preheat dies in advance of the setup)
- Use pinned or marked settings so that coarse equipment adjustments are no longer necessary.
- Eliminate bolts (e.g., use quick release mechanisms or other types of functional clamps)

Addressing Idling and Minor Stops/Reduced Speed

The root causes of Idling and Minor Stops and Reduced Speed are typically quite different, which is why they are independent elements of Six Big Loss analysis. This section does not make a distinction since many production operations within the plant do not have the capability of differentiating between Idling and Minor Stops (small stops) and Reduced Speed (slow cycles).

Analyzing the patterns of significant performance loss, for instance, performance loss may be more familiar: they could happen after a part or material change, after an environmental change, during a specific shift and over time (a consistent degradation over time)Once the plant identifies a pattern apply Root Cause Analysis or 5 Why Analysis can be used to identify potential causes and fix them. After a problem is fixed, it is important to update related standardized work procedures to lock-in improvements (to avoid "same problem/different day" recurrences). The blanket plant has to apply the following common countermeasures so as to improve performance loss

- Schedule preventive maintenance and lubrication activities.
- Introduce a 5S program to improve the condition of equipment.
- Train operators on standardized work procedures.
- Tighten material quality standards.
- Improve the precision of equipment set-points.

Addressing Process Defects/Reduced Yield

Process defects and reduced yield within the plant occur during different stages of blanket making process, which is why they are independent elements of the Six Big Losses:

- Process Defects (also known as production rejects) occur during stable production.
- Reduced Yield (also known as startup rejects) occurs during startup and is often a result of setups and warm up periods.

One of the most effective countermeasures to quality problems is to reduce variation (one of the central goals of Six Sigma). Variation is one of the reasons that there is often a higher rate of defects during startup. A very effective way to reduce variation is to pay close attention to equipment settings and materials:

- Equipment Settings (define and implement more precise equipment settings)
- Materials (run material tests on equipment to check for quality standard).

Note that these countermeasures are also often effective for performance loss (e.g., resulting in fewer jams).

SIC (Short Interval Control) technique

SIC (Short Interval Control) is a factory-floor process for driving production improvements during the shift. Each shift is split into short intervals of time (typically two to four hours) to identify and implement improvement actions. These improvement actions may be countermeasures to ongoing or emerging problems, or they may be actions to improve existing production. SIC can be very effective for all types of losses, because it dramatically shortens the time between a problem occurring and a countermeasure being proposed (Overall equipment efficiency, 2018).

Table 5.6Losses and their improvement mechanism adapted from “Lean production: lean made easy” by vorme, 2018)

Losses		Techniques to address
Availability loss	Breakdown	Kaizen and 5 why analysis
	Set up and adjustment	SMED
Performance loss	Speed loss	Root Cause Analysis or 5 Why Analysis
	Idle time and minor stops	
Quality loss	Start up loss	SIC (Short Interval Control)
	Defective products	

Step Five – Introduce proactive Maintenance Techniques

In this step, proactive maintenance techniques are integrated into the maintenance program (thus introducing the TPM concept of Planned Maintenance).The Planned Maintenance aims to increase mean time between failures (MTBF), reduce mean timeto repair (MTTR), and reduce maintenance cost. It is periodic inspection to detect conditions that might cause breakdowns andproduction stoppages and applied to eliminate,control or reverse such condition in their early stages. In other words, it is therapid detection and treatment of equipment abnormalities before they cause defects or losses. It ispreventive medicine for equipment. How does this help the blanket plant?

- Significantly reduces instances of unplanned stop time.
- Enables most maintenance to be planned for times when equipment is not scheduled for production.
- Reduces inventory through better control of easily wear and fail parts.

The table 5.8 shows planned maintenance implementation activities and description.

Tasks/ activity	**Description**
Components that Wear/Fail	Identify and document all components that undergo wear (these should have been established as inspection points in Step Two). Consider replacing wear components with low-wear or no-wear versions.
Wear/Fail Based	For wear/Fail components, establish a baseline replacement interval (in some cases replacement may be triggered early by an Autonomous Maintenance inspection in Step Two).
Time Based	Create a baseline Planned Maintenance Schedule that schedules proactive replacement of all wear and failure-prone components. Consider using “Run Time” rather than “Calendar Time” as the interval time base.
Component Log	Create a Component Log sheet for each wear or failure-prone component. Record every instance of replacement, along with information about the component condition at the

	time of replacement.
Monthly Audit	Perform a monthly Planned Maintenance audit: a) verify that the Planned Maintenance Schedule is being followed, b) verify that the Component Log sheets are being maintained, and c) review all new entries in the Component Log and adjust maintenance intervals when appropriate. Keep audits positive and motivational (treat them as a training exercise).

Additional TPM Activities

There are an additional four TPM activities. These activities support as well as facilitate TPM implementation journey therefore, blanket plant should apply and prioritizethese activities based on whatever is the most pressing and urgent need.

Table 5.9 supplementary TPM activities

TPM Activity	**Introduce When…**
Quality Maintenance	Quality is at the forefront issues facing the company. This may be a result of significant customer issues being raised over quality.
Early Equipment Management	New equipment is being designed or installed in a constraint/bottleneck area.
Safety, Health, Environment	The company a) has no substantive Safety, Health, Environment program, or b) the existing program would significantly benefit from being linked into existing TPM activities.
Training and education	Operators, maintenance personnel and managers must have to upgrade their skill and get training to maintain equipment and identify and solve emerging problems.
TPM in Administration	Administrative issues(process losses and communication loss etc) are one of the largest impediments to smoothly running production.

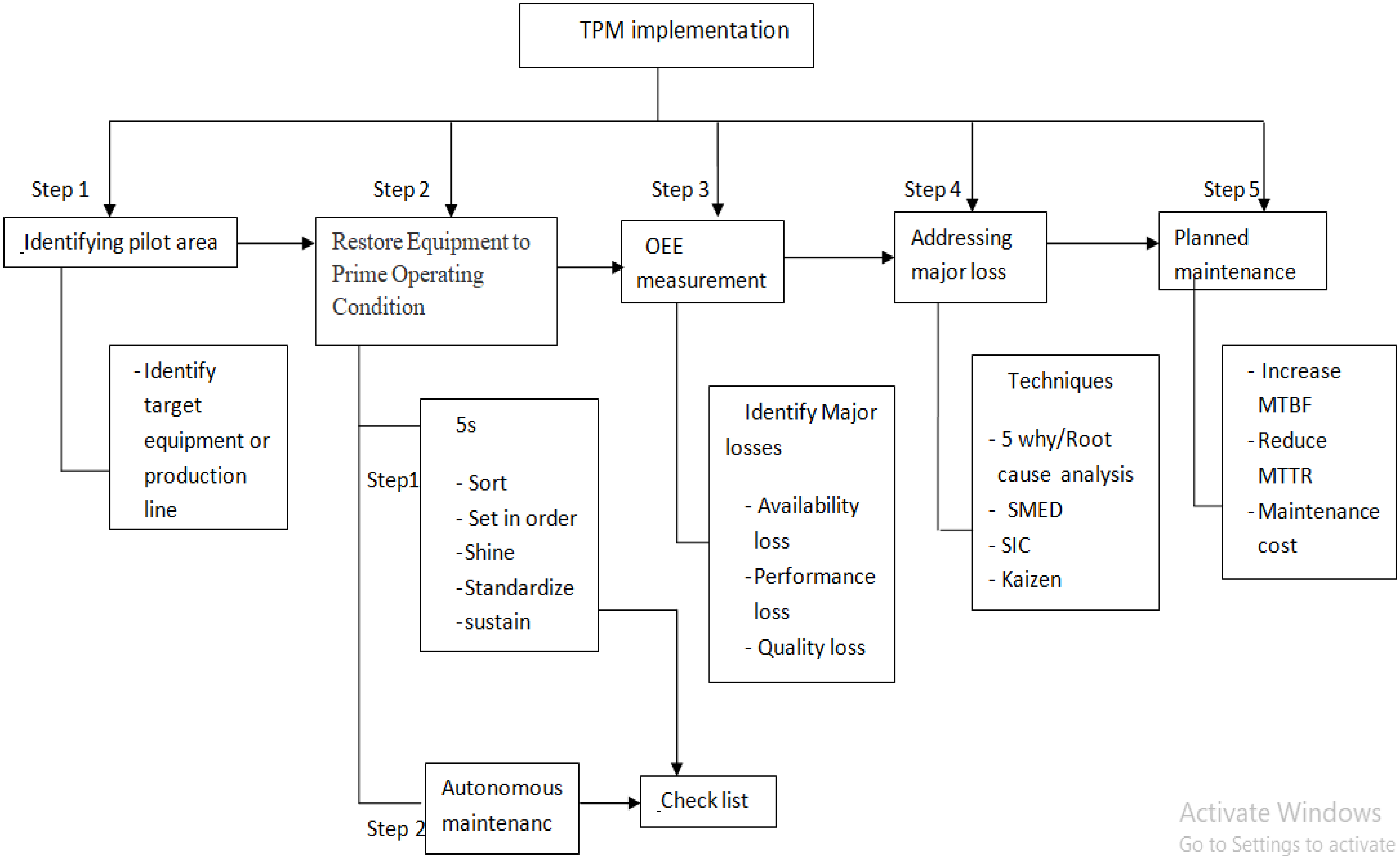

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Figure 5.1 TPM implementation plan summarization

5.5Major finding on productivity improvement

The purpose of regression analysis is not only to indicate which independent variable has significant relationships with outcome variable and which hasn't. But, it also predicts the probability of an event, which is plant productivity, to increase or decrease. The following equation shows how the plant productivity could increase after successful implementation of TPM.

$$R^2 = \beta_1 r_1 + \beta_2 r_2 + \text{--------} \beta_n r_n$$

Where β = standardized beta

r = Correlation coefficient

R^2 = Coefficient of determination

Therefore,

$$R^2 = \beta_1 r_1 + \beta_2 r_2 + \beta_3 r_3 + \beta_4 r_4 + \beta_5 r_5 + \beta_6 r_6 + \beta_7 r_7 + \beta_8 r_8 + \beta_9 r_9 + \beta_{10} r_{10} + \beta_{11} r_{11} + \beta_{12} r_{12} + \beta_{13} r_{13}$$

= 0.122 +0.003 +0.052 +0.077 +0.017 +0.107 +0.002 +0.309 +0.056 +0.078 -0.073 +0.037 +0.039

= 0.827

The regression equation above shows significant contribution of each independent variable to outcome variable, plant productivity. According to equation, the productivity of the plant will increase by a factor of 0.827 which is 82.7%. Other external factors that were not included in the study had influenced the productivity of the plant by 17.3% (Appendix 6).Table 6.9 below shows the contribution of each independent (explanatory) variable to outcome variable, plant productivity.

Table 6.9 contribution of each independent variable to outcome variable

Independent Variable s included in the model	Contribution to plant productivity	
	$\beta_n r_n$	%
satisfaction with working environment	0.122	12.2%
satisfaction with the pay and reward	0.003	0.3%
support by supervisor	0.052	5.2%
skill gap and other training	0.077	7.7%
quality of raw material	0.017	1.7%
administrative ability	0.107	10.7%
workshop organization and well equipped	0.002	0.2%
enough spare part availability	0.309	30.9%
workshop lay out	0.056	5.6%
skill level of supervisor	0.078	7.8%
skill level of maintenance personnel	-0.073	-7.3%
preventive maintenance experience	0.037	3.7%
machine down time characteristics	0.039	3.9%
Total (R^2)	0.827	82.7%

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATION

6.1. Conclusions

Based on the findings in the previous sections, OEE level and some productivity determinants factors need much improvement. The study result showed that there is high rate of machine down time. This can be attributed to the condition of equipment, mechanical and electrical and shortage of spare parts. Poor preventive maintenance system of the industry is also contributed to this effect. The line of investigation showed that the effect of not involving the operator in minor inspection and restoration of equipment results unexpected number of failures which challenges to maintain the preventive maintenance program. Rarely providing training to the operators, inspectors and mechanics also contributes to the deterioration of the equipment. In order to alleviate the current situations of the blanket plant, a typical TPM implementation plan has been proposed. The new proposed concepts rely on the continuous improvement, empowering the employee through training and standardizing every activity to minimize identified industrial problem. The study concludedthatlabor productivity and other management related factors has to be considered besides improving overall equipment effectiveness so that productivity of the plant could show optimal improvement. As the prediction of regression analysis showed, the productivity of the blanket plant will increase from current level (54.99%) to 82.7% after thoroughly implementing TPM.

6.2.Recommendation

Integrating combination of tool and techniques is vital to enhance productivitycomprehensively. Therefore, Yirgalem Addis Textile factory has to integrate lean manufacturing and TPM to reduce wastes, work in process andinventory, shorten production lead time, simplify the flow of materials and reduce non value addedactivities from the production process of waiting andtransportation, which make the factory meet customersrequirement quickly.

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Appendix 1

Blanket plant production process flowchart and production related data

1. Non –Woven blanket process flowchart

No	Input	Process	Output	Responsibility	Key performance indicator
	Material Requesting document	Raw material purchasing	Raw material Sample	Division head	30min to request
	Sample	Quality control and approval	Document	Quality lab	45min
	Multi color waste material	Sorting by color	Making ready by color	Sorting operator	Manual sorting 120kg/hr
	Cutting waste	Rag tearing	Making ready for pulling	Tearing operator	Pieces of fabric 140kg/hr
	Cutting waste and salvage waste	Pulling	Open fiber	Pulling operator	120kg/hr
	Open fiber	Balling	Pressed fiber	Puller operator	140kg/hr
	Rising return and open fiber	Blending	Blended fiber	Blended operator	210kg/hr ,25% raising return 75% pulled fiber
	Blended fiber	Carding	Lap form	Carding operator	39kg/hr
	Sample	Quality test	Polyester lap yarn	Quality control	As per order
	Polyester lap yarn	Non-woven	Gray fabric	Stitch bonding operator	40m/hr
	Gray fabric woven and non woven blanket	Inspection	Inspected fabric product	Inspection operator	157m/hr
	Gray fabric	Raising	Raised blanket	Raising operator	56m/hr
	Finished blanket length wise	Cutting	Piece of blanket	Cutting operator	68psc/hr
	Swing thread, ribbon and	Stitching	Seam finished	Stitch operator	35pcs/hr
	Parked blanket	Parking and bailing	Standard parked blanket	Parking operator	5.3 bale/hr

1. Woven blanket process flow chart

No	Input	Process	Output	Responsibility	Key performance indicator
	Material Requesting document	Raw material purchasing	Raw material Sample	Division head	30min to request
	Sample	Quality control and approval	Document	Quality lab	45min
	Polyster yarn	Warping	Waver beam	Warping operator	23kg/hr
	Waver beam acrylic yarn wastage salvage yarn	Waving	Woven blanket	Operator	11.44m/hr
	Process card and inspect	Inspection	Inspected fabric	Inspection operator	m/hr quality grade
	Gray fabric	Raising	Raised blanket	Raising operator	56m/hr
	Finished blanket length wise	Cutting	Piece of blanket	Cutting operator	68psc/hr
	Swing thread, ribbon and	Stitching	Seam finished	Stitch operator	35pcs/hr
	Parked blanket	Parking and bailing	Standard parked blanket	Parking operator	5.3 bale/hr

Appendix 2

Average waste in kilogram per day (blanket plant)

Types of waste	**Per kg**
cutting waste	50.09
salvage waste	34.86
raising waste	45.59
return waste	5.05

Appendix 3

Average daily production and waste data per machine (blanket plant)

Machines	Planned production/day	Unit	Actually produced /day	unit	Waste in kg/day
baling and blending	1300	Kg	836	Kg	0
carding	288	M	234	M	3.02
stitch bonding	750	M	375	M	2.03
Saurer and Dornier	290	M	179	M	4.9
raising	600	M	745	M	15.2
Cutting	300	Pcs	271	pcs	24.4
Stitching	300	Pcs	266	Pcs	0.025
Bailing	400	pcs	266	pcs	0

Appendix 4

Average daily production plan in 2017/2018 (blanket department)

Blanket plant	Woven blanket /piece	Non- Woven blanket/piece
Design capacity/day	1273	2209
Effective/maximum /day	1019	1237
Attained/actual capacity/day	175	662
Planned capacity/day	400	600

Appendix 5

Machine and average daily production related data for blanket plant

S.no	Machines	Qty	Functional	Product type	Unit	Production plan /machine	Actually produced /machine	Down time/hr/ machine	cycle time/hr	Defect/ day/machine
1	Tearing	1	1	Pulled Fiber	Kg	1300	836	2.15	152kg	
2	Pulling	1	1		Kg					
3	Bale press	1	1		Kg					
4	Blending	3	2		Kg					
5	Carding	3	2	Lap	M	288each	234each	1.6	39kg	3.02kg
6	Stitch bonding	4	3	Non woven	M	750 each	375each	2.5	40m	2.03kg
7	Sectional warping	2	1	Warp for woven	M	-	-		23kg	
8	Direct warping	2	1	Warp for non Woven	M	-	-		21kg	
9	Saurer	7	5	Woven	M	290 each	130each	1.51	12m	4.9kg
10	Dornier	2	2							
11	Raising	3	3	Both type	M	600 each	645each	1.83	56m	15.2kg
12	Cutting	2	2	Woven 180x220 160x220	Pcs	300 each	271 each	1.65	68psc	25.4kg
				Nonwoven 160x220	Pcs	300				
				Others	Pcs	Order				
13	Stitching	5	5	Woven 180x220 160x220	Pcs	200 each	266 each	1.9	36psc	.025kg
				Non woven 160x220	Pcs	400				
				Other	Psc	Order				
14	Baling	2	2	Woven 180x200 160x220	Psc	200 each	266each	2.15	5.3kg	
				Nonwoven 160x220	Psc	600				
				Other	Pcs	-				

Appendix 6 model summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.909[a]	.827	.780	1.779

a. Predictors: (Constant), machine down time charactestics, support by supervisor, skill level of suppervisor , workshop organization and well equiped, satisfaction with the pay and reward, quality of raw material, administrative ability, workshop lay out , satisfaction with working enviroment, skill gap and other training, skill level of maintenance personeel, preventive maintenance expereience , enough spare part /raw material availability

Appendix 7

REF: INTRODUCTION LETTER

I am a student at the Bahir Dar institute of technology conducting a research study as part of the course requirement. The study seeks to improve productivity at Yirgalem Addis textile factory plc.

You are kindly requested to respond to the required information in the questionnaire to assist in collecting required information. The information will be confidential, and will be only used for academic purpose and at no chance will your name or the name of your organization be mentioned anywhere in the report. Your honest participation will be highly appreciated, thank you for your co-operation,

Sincerely Yours.

PART 1: Productivity factors Questionnaires

In terms of the following productivity factors, how would you rate your performance as an employee in your organization? (Tick appropriately)

	Productivity variable	**Very low**	**Low**	**Average**	**High**	**Very high**
1	Satisfaction with the working environment					
2	Satisfaction with the pay and rewards provided					
3	Support by the supervisor					
4	skill gap and development training program to all employees					
5	Quality of raw material supply					
6	administrative ability to lead ,to control , to plan and coordinating activities					
7	Workshop organization and well equipped status					
8	Spare part/tools and row material supply					
9	General Level of productivity					
10	Other (Specify)					

Part II Maintenance related Questionnaires

1. Workshop layouts:

☐ Very poor ☐ poor ☐ fair

☐ Good ☐ perfect

2. The skill level of supervisor group is:

☐ Very poor ☐ poor ☐ fair

☐ Good ☐ perfect

3. The skill level of the maintenance work force is:

☐ Very poor ☐ poor ☐ fair

☐ Good ☐ perfect

4. The level of preventive maintenance in the plant

☐ Very poor ☐ poor ☐ fair

☐ Good ☐ perfect

5. Machine down time factors mostly happen in the plant

☐ Change over ☐ spare part shortage ☐ power interruption

☐ Mechanical ☐ electrical ☐ other