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**Investigation of Root Causes and Impacts of Defective
Yarn on Spinning Operation
A Case of Ayka Addis Textile Company**

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Declaration

I hereby declare that the work which is being presented in this thesis entitled **“Investigation of Root Causes and Impacts of Defective Yarn on Spinning, A Case of Ayka Addis Textile Company”** is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been accordingly acknowledged.

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

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Abstract

The main aim of this research is to investigate the root causes and impact of defective yarn on spinning operation, in case of Ayka Addis Textile Company. A preliminary survey was conducted at the company by taking a five month back data, the result shows a high defect rate of yarn was present in the company. Defects are still dominant in the manufacturing industry even though the attempts by companies to implement measures to eliminate them. Measuring the effects of these defects on their contribution to losses in monetary value is likely to assist the company to identify the major causes and then they take a measure to eliminate or minimize the root causes of these defects. An investigation of the root causes of the spinning department of Ayka Adis Textile Company was conducted using a root cause analysis technique also the impact of the yarn defects in monetary value is assessed, the assessment showed the company is suffering in financial loss of around 20,000,000 birr, in 2018 budget year due to production of defects. Pareto analysis, and why analysis tools were used to discover this root causes of defects which leading to monetary loss. Also the identified frequent defects were analysed to minimize their root causes.

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CHAPTER ONE

1. INTRODUCTION AND PROBLEM JUSTIFICATION

1.1 Introduction

The first step of textile manufacturing process starts from conversion of fiber in to yarn, this process is called spinning. Yarns are strands of fibers in a form ready for weaving, knitting, or otherwise intertwining to form a textile fabric. Yarns are made from different material but commonly are made of cotton, wool, or a synthetic fiber such as polyester. But most of the textile industries in Ethiopia produce yarns and fabrics from 100 % cotton fiber for domestic consumption (Amare, 2006).

Yarn faults are very important characteristics which affecting spun yarn ability process and fabric appearance. Not only affect the appearance of fabric but also create delay in spinning operation. So yarn faults are responsible for rejection and down grading of yarn and low productivity due to higher end breakage in further process. Quality of textile is determined based on quality of yarn used. So if yarn quality become poor then it is not possible to make good quality fabric (Bihola & Amin, 2018). So, maintaining yarn quality is very important for spinners to withstand in the market.

Different literatures shows that defects of yarns are arise by different causes. According to the study by Reazuddin et.al., (2016), The effect of spinning parameters such as rotor diameter and speed on thick, thin places and neps of yarn in rotor spinning process were considered as a cause for the defect of yarn. According to this research remarkable effect was shown in rotor speed and rotor diameter on some of the yarn defects those are thick places, thin places and neps in rotor spinning. The result shows that at constant rotor diameter of 43 mm, the yarn qualities were improved thick, thin places and neps were decreased with increase of rotor speed from 35,000 to 45,000 rpm. On the other hand, equivalent scenario observed due to increase of rotor diameter from 43 to 66 mm at constant rotor speed of 35,000 rpm. The yarn quality tends to deteriorate thick, thin places and neps were increased when the rotor diameter increases from 43 to 54 mm.

On the other side according to Neha Gupta, (2013), study the quality of the raw material used is more emphasized, on the managing of cotton fiber to minimize defective yarn during processing.

Also the study by Bihola and Amin (2015), showed that the yarn faults are divided into three based on the nature of yarn faults. Frequency of occurrence of faults, Type of faults, Size of faults. Based on the frequency of occurrence of these faults, the paper classified as frequent, seldom or special faults. Of these, the frequently occurring faults include thick place, thin place and neps. Also the study identified some of the causes for different defects. But he emphasized that optimum machine setting and proper housekeeping are the major causes that lead to breaks end in further process. Objectionable faults are more responsible for deterioration of yarn quality, breakages in further process and deteriorate the fabric appearance (Bihola & Amin, 2015).

Most of literatures written on this title related indicated that it is difficult to manufacture defect free yarn but it's possible to produce acceptable quality level of yarn by controlling different factors.

Thilagavathi and Karthik, (2016), the yarn faults which get in the woven or knitted fabric can only be removed at very high cost or cannot be removed at all. Therefore the yarn processing industry demands a fault free yarn.

The adopted industrial development policy of the government of Ethiopia focuses on transforming the agricultural led economy of the country to industry based, and for that strategic sector have already been selected and prioritized based up on the facts and findings of actual situation of the country and the global environment.

Accordingly, Ethiopia textile and clothing value chain roadmap 2016-2020, Textile Industry is considered as number one priority sector by the government's industrial development strategy. It is believed that the textile industry would play major role in the industry development strategy of the nation due to its advantages such as its labor intensiveness, ability to mobilize the masses up to the micro level, long chain characteristics of the sector which could pull many players along the value chain, linkage to the cotton agriculture for which Ethiopia has a big potential.

Also textile and clothing exports are an important source of hard currency, which is then used to buy technology for further development. According to data taken from the website of Ethiopian textile industry development institute (ETIDI), (web 1), Ethiopian Textile Products contributed 1.6% to the GDP (nominal) and accounted 12.4% of the Industrial output by value terms in 2010. Annual Production capacity of Textile and Apparel Industry include 102,000 tons of yarn, 207 million meters of woven fabric, 50 million kg of knitted fabric, 63 million pieces of knitted garments, and 28 million pieces of woven garments. 102 thousand tons of yarn, 207 million meter woven fabric. Also this data shows that the sector is an important source of income that provides employment for over 450,000 people (2013), up more than 200% from 2010/11. The export performance of the sector has shown an increasing trend, on average 50% per annum. The country gains USD 111.3 Million in the 2018 fiscal year from the sector.

1.2 Statements of the problem

As clearly stated in the introduction and problem justification part Textile Industry is considered as number one priority sector by the Ethiopian Government. But sources shows that even if this sector is supported by different government policies still it's challenging to generate planed dollars from the sector. According to Apparel insider news (2018), Ethiopia's textile and garment sector achieved less than half of their export target for the 2017-2018 fiscal year. The sector achieved an insignificant 46.3% of their export targets for the financial year. Also the Apparel insider news suggest that growth is being hindered by a range of factors, including very low productivity levels, poor product quality, high staff turnover, technical shortcomings and chronically low wages. But still the Government has pinned huge hopes on textile and garment exports and has been on a major attraction investors.

So the government attention toward the sector and the existing challenges of the sector invite the researcher to contribute a remedial solution for the successfulness of the plan.

As clearly elaborate in the above introduction part the first step of textile manufacturing process starts from conversion of fiber in to yarn. The yarn is then used to create textiles, which are then used to make clothing.

This processing step confirmed that quality of textile will be affected by the quality of yarn used. And also different literatures assured that quality of textile is based on quality of yarn used. So it is believed that investing more time on maintaining good quality of yarn processing will reduce the total textile processing faults. This idea is strengthened by Bihola & Amin (2015), the researchers confirmed that objectionable faults in textile are more responsible for deterioration of yarn quality. Because if the yarn quality is poor, there must be breakages in further process and even deteriorate the fabric appearance. This is the reason that this paper emphasized the yarn production department of the case company.

On the other hand preliminary survey on the case company (Ayka Addis Textile Company) spinning department shows the existence of yarn product quality problem. A 2017 fiscal year five month (April to August) quality control department data were taken to study whether the defects are exist or not and to identify their impact. The result from this survey shows that the spinning plant is suffering in production of faults yarn. For example the data from the company shows out of the produced 400,005 kilogram yarn with in the five month, around 27,201 kilogram is produced as a low grade quality and around 28, 117 kilogram as a hard waste. But the company specified that the spinning defect must be not more than 5%, also the objective of the company is to produce a high quality product which will be sailed for 100% export market. Also the preliminary survey identified that defects like Count Variation (cv), Thin places, Thick places, Neps, unevenness, are the most frequently happening faults in the case company.

Therefore, the intent of this study is to identify the root causes for existing defects in the case company from different perspective. Also to assess the impact of defects in terms of financial loss. And finally to develop and recommend the better way of managing the root causes of defect as per the study finding.

1.3 Research question

The intent of this study is to answer the following questions

- What are the key cotton yarn defects in spinning industry and in the case company?
- What are the impact of the existing defective yarn in case company in terms of cost and what are the root causes for those defects?
- How to minimize the root causes for defects of yarn?

1.4 Objectives of the study

1.4.1 General objective

The general objective of this study is to investigating the root causes of defects and impacts of defective yarn during spinning (conversion of fiber into yarn) and develop better way of managing the root causes.

1.4.2 Specific objectives

- To identify the type of cotton yarn defects in the sector & in case company.
- To identify the impact of the defects in terms of cost and the root causes for the defect
- To develop better way of managing the causes which is responsible for production of faults during spinning

1.5 Significance of the study

As this study is devoted to investigating the causes of defect, the existing impact of the defects and to develop a better way of managing the causes in the case company, therefore, the primary merits of the study goes to the case company (Ayka Addis Textile Company). Also this research paper contribute in filling the literature gap regarding considering the six major yarn defect contributing factor in a single research.

1.6 Scope of the study

The scope of this paper is to identifying the main root causes for defect of yarn, assessing the impact due to the defect and to develop a better way of managing the causes as per the finding of the research in Ayka Addis textile company plc. Specifically spinning department. As most of Ethiopian textile industries and specifically Ayka Addis Textile Company are mostly produce a yarn from a natural cotton, so this study is emphasize the cotton yarn.

1.7 Limitation

The researchers plan was to assess the impact of defective yarn in terms of opportunity cost and productivity. But the data related to break down of machine due to thick place, thin places and neps yarn defect is difficult to collect, due to this the impact of frequently happening defect on productivity is not covered. The machines stoppage is vary as per the fault length detected, and frequency, so it's really difficult to record relevant data for the calculation of productivity.

1.8 Organization of the research

This study consists of six chapters with different sections and sub-sections and it is structured as follows:

Chapter one presents the introduction for the main part of the study, statement of the problem, research question, and objective of the study, scope and limitations and significance of the study. Chapter two deals with the literature review of relevant previous studies, mainly research work performed in the areas of cotton yarn defect. Chapter three clearly elaborates the research design and methodology, and the population target. Furthermore, presents the methods and other related designs which give a direct way to the study. Chapter four presents about the technical view of textile processing operation in the case companies. Chapter five provides data analysis and presentation and interpretation, Chapter sixth finally presents the conclusion and recommendation of the study.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

Defects are still prevalent in the manufacturing industry despite the attempts by companies to implement measures to eliminate them (Zanele, 2016).

Quality management is an important area of practice and research. Managers and scholars have become increasingly interested in quality management, and the number of books and articles on the subject has grown radically as our knowledge has developed. Today it remains an interesting topic for managers and academics alike, and many organizations use quality practices, techniques, and tools to implement the quality management philosophy. Initially it was thought that quality had a cost and that if quality rose then costs increased correspondingly. This vision of quality has been changing and today it is considered that a commitment to quality enhancement can improve differentiation and also reduce costs. In addition, quality management has positive effects on improving the corporate image and promoting product/service quality, among other outcomes. Consequently, quality can have a positive effect on competitive advantage, through both differentiation and cost leadership. It is also important to create a quality culture to ensure that efficient management of quality issues translates into real benefits. The literature on quality has gone through a range of research themes and has principally examined how quality management practices should be adopted, how quality models should be used, and which techniques and tools are most effective in developing quality initiatives and what benefits can be achieved by organizations.

This chapter describe about these issues and describe both theoretical and empirical studies on quality practices, techniques, and tools. Also covers definitions of quality and quality management in yarn manufacturing industry and some definitions of quality and cotton yarn quality characteristics is discussed briefly. Also the major quality characteristics of cotton yarn are discussed respectively.

2.2 Definitions of Spinning

Yarn manufacturing (spinning) is a sequence of processes that convert raw cotton fibres into yarn suitable for use in various end-products (Wakelyn & Phillip, 2011). A number of processes are required to obtain the clean, strong, uniform yarns required in modern textile markets. Beginning with a dense package of tangled fibres (cotton bale) containing varying amounts of non-lint materials and unusable fibre (foreign matter, plant trash, grains and so on), continuous operations of opening, blending, mixing, cleaning, carding, drawing, roving and spinning are performed to transform the cotton fibres into yarn.

Spinning is the twisting together of drawn-out strands of fibers to form yarn, and is a major part of the textile industry (web 3). The yarn is then used to create textiles, which are then used to make clothing and many other products. There are several industrial processes available to spin yarn, as well as hand-spinning techniques where the fiber is drawn out, twisted, and wound onto a bobbin. Currently, over 85% of the world's yarn is produced on ring-spinning frames, which are designed to draft the roving into the desired yarn size, or count, and to impart the desired amount of twist (Wakelyn & Phillip, 2011).

2.3 Cotton yarn manufacturing and its quality management trend

Quality is an important factor to be considered in all industries. Quality of textile is based on type of yarn used (Bihola & Amin, 2015). So that, all manufactures of yarn concentrate more in quality so that they can withstand in the market. To be able to make agreements, accurate values which characterize quality are required. Quality of the products are provided by the testing instruments for example, for assessing the quality of fibres, slivers, roving's and yarns. Without the availability of such reliable values, it would be extremely difficult or even impossible to form the basis for a dialogue with the modern textile world (Srinivasan et al., 2013). Therefore, great importance is given to the accuracy and reproducibility of the quality determining values.

For successful quality monitoring, it is necessary to know the important quality parameters of yarn and the factors affecting them and their interrelationships. In most sector the quality of raw material is the most important feature in obtaining high quality products.

The same is true for yarn manufacturing, the quality of fiber (raw material for yarn production) can affect the quality of yarn. The yarn properties is changed with regard to raw material properties (Erdem, 2003). This researcher elaborate that the conditions for growing cotton have a significant effect on the raw material quality. When cotton types with different fibre characteristics are grown in various regions, the fibre quality properties also show differences with regard to growing conditions. The differences between regions, as well as the differences between cotton types, cause significant problems in producing the end-use products. This idea is strengthened by testtextile (2018), this study confirmed that no matter what processing system is used, the final quality of yarn is mainly depends on the selection of raw materials and the thoroughness of cotton opening, removing impurity removal and cotton blending testtextile (2018). So the strong argument of the researchers shows the spinners need to emphasize on cotton fiber (raw material) they used, for production of cotton yarn. The cotton fiber quality for textile manufacturing use characteristics are as listed in below.

2.3.1 Fiber quality characteristics

Fiber is a class of materials that are continuous filaments or are in discrete elongated pieces which is used to make yarns. Cotton fiber is one of the most widely used fibers in textile industries. Cotton fiber is a soft fiber that grows around the seeds of the cotton plant. The fiber is most often spun into thread and used to make a soft, breathable textile. The characteristics of cotton fibers vary based on varieties of cotton, growth areas, and climatic conditions from year to year. Some of cotton fiber quality characteristics are (Elliot & Grover, 1993 as cited in Amare, 2006).

Cotton staple length: It is a physical characteristic. Among all the tests that are made to evaluate the physical characteristics of cotton, probably none are more frequently used and in most cases more important than the length. Staple length is associated with not only spinning performance but also yarn properties and characteristics. Some factors that are influenced by length are spinning limit (how fine a yarn may be spun), yarn appearance, evenness, and strength. The accurate determination of staple length is important not only from a financial point of view, but also from the standpoint of processing and quality.

Cotton fiber Maturity: Maturity indicates ripeness or full development; whereas immaturity indicates lack of full development. Maturity of cotton fiber could influence the quality of the next product (cotton yarn). Immature cotton fiber has low strength.

Cotton fiber fineness: Fiber fineness and maturity seem to be associated closely not only from the physical characteristics themselves, but from some of the testing methods developed for their evaluation. Fiber fineness is the weight fineness of cotton fibers and is usually expressed in units of micrograms per inch that is the average weight of 1 inch lengths of fiber expressed in micrograms (0.000001 gram).

Moisture content of cotton fiber: Most textile fibers are hygroscopic; that is they have the ability to absorb or give up moisture. This moisture is picked up or absorbed by the hygroscopic material from the atmosphere if the relative amount of moisture in the air is greater than that in the material. Conversely, the material gives up the moisture if the relative amount of moisture in the air is less than that in the material. The moisture content of the cotton fiber is the percent weight of moisture based on its original weight.

$$\text{Moisture content of fiber} = \frac{(\text{Original weight} - \text{dry weight}) \times 100}{\text{Original weight}} [\%]$$

Non-lint content of cotton fiber: The determination of the non-lint content of cotton taken from the bale or at any stage in processing up through carding or drawing can be of value to mill management. The measurement on the raw stock gives an accurate estimation of the amount of trash in the bale, and the non-lint content of the cotton at different steps in the opening and carding areas is a good measure of efficiency of the cleaning equipment.

Fiber structure: It is the structure of fiber under microscope. Mature and immature cotton fiber could be identified using a microscope.

Strength of cotton fiber: It is a mechanical characteristic of a fiber. The importance of testing cotton fibers for strength and the best method to use in measuring the strength is considered very well. The strength of the fiber has a direct effect upon the strength of the yarn and fabric.

Cotton color: The color of cotton fiber is a physical characteristic and could be white, grey, and reddish. Cotton colorimeter is used to determine the color of cotton fiber. It is also possible to determine its color by visual observation.

Also the above idea is strengthened by different scholars, most of the literatures published on this title showed the main textile cotton fibre properties are length, fineness, strength and elongation, maturity, color, the amount of trash and the humidity that the cotton fibre retains are properties which affect the cotton quality.

So, to produce a good quality of yarn the raw material or the fiber should fulfil the minimum quality standard. According to Nilufen, (2003), the above fiber properties should be known in order to produce yarns and fabrics of appropriately high quality. Some of the quality characteristics of yarn are elaborated as below.

2.3.2 Yarn quality characteristics

Yarn is a long continuous length of interlocked fibers, suitable for use in the production of textiles (Wikipedia, contributor Merriam). Yarn can be made from any number of synthetic or natural fibers. The following are some quality characteristics of cotton yarn (Elliot B, et al., 1993 as cited in Amare 2006).

The important features of yarn, which are evaluated to determine its quality, are yarn number (count), strength, twist, appearance and evenness.

Yarn count (Yarn numbering): is a numerical expression which defines its fineness or coarseness. It also expresses whether the yarn is thick or thin. Count is a number which indicates the mass per unit length or the length per unit mass of yarn.

Yarn strength: Strength has been accepted by many, as one of the most vital characteristics of yarn. The factors which influence the yarn strength are: staple length of fiber- the longer the fiber the stronger is the yarn, fiber fineness- fine fiber gives greater yarn strength than coarse fibers, fiber strength, twist (as the twist value increase the strength of yarn also increase), and fiber length distribution in the yarn (variation in the distribution of fiber length will cause a variation in yarn strength).

Twist of cotton yarn: The cotton yarn twist is characterized by the number of twists or turns per meter of length and the directions of twist S-twist and Z-twist. Yarn twist needs continuous follow up during production process to minimize the variations.

Hairiness of yarn: These are protruding ends of single fibers or loops formed by separate fiber on the yarn surface.

The presence of fiber ends or loops on the yarn surface is called hairiness or fluffiness. The yarn hairiness depends on the kind of fibers, the degree of their straightening, methods of spinning and twisting, and other factors.

Yarn evenness: A deviations in linear density of spinning products (sliver, roving, and yarn) or man-made filament yarns in some portions on one or other side from the mean value determine their unevenness in linear density.

Cotton yarn tension: The tension of yarn should be constant during production or process. There should be a standard value (limit) of yarn tension for each type and count of yarn. When the tension of yarn increase, internal deformation takes place and leads to breakage.

Yarn abrasion: at any stages of processing in the textile industry the fibers and yarns often rub against each other and against the surfaces of the machines working parts.

So in considering yarns spun from staple fibers, there are many inherent variables that influence the final strength of the spun yarn. Also according to Salah (2014) and different studies emphasize that the following are the common yarn quality requirements for knitting. The below mentioned yarn properties should be considered in any fabric production otherwise it will not give a perfect knitting where the yarn's parameter is mandatory to be maintained. Evenness, Yarn Count, Breaking strength, Elongation, Twist, Yarn hairiness.

Yarn evenness: Yarn evenness is a measure of the level of variation in yarn linear density or mass per unit length of yarn. In other words, it refers to the variation in yarn count along its length. A yarn with poor evenness will have thick and thin places along yarn length, while an even yarn will have little variation in mass or thickness along length. While a yarn may vary in many properties, evenness is the most important quality aspect of a yarn, because variations in other yarn properties are often a direct result of yarn count irregularity. Twist tends to accumulate in the thin places in yarn, so irregularity in yarn linear density will cause variations in twist along yarn length. This preferential concentration of twist in thin places along a yarn also exacerbates the variations in yarn diameter or thickness, which often adversely affects the appearance of the resultant fabrics. An irregular yarn will also vary in strength along the yarn.

Yarn counts (tex) and twist (turns/cm): Yarn count refers to the thickness of a yarn and is determined by its mass per unit length. It is usually measured by the number of grams per one kilometer of yarn, a unit of measure called “Tex”.

Twist is generally expressed as the number of turns per unit length of yarn, e.g. turns per inch (tpi), turns per metre (tpm). The twist in a yarn binds the fibres together and helps to keep them in the respective positions. It thus gives coherence to yarn. Twist gives sufficient strength to the yarn.

Breaking Strength & Elongation of Yarn: Tensile property of textile yarns is a prime important parameter in determining the suitability for any particular application. It is therefore of utmost importance to determine this characteristic accurately.

Winding: Winding, which is the transfer of the yarn from the primary or 'spinners' package to a secondary conical package (cone) more suitable for weft knitting, provides an opportunity to monitor the yarn electronically for a number of faults, including: Knots, Thin places, Slubs or thick places, Weak places.

The tension employed in winding causes weak places to break and results in knots. Slubs and thin places are cut out by the electronic clearer and also replaced by knots. All knots, including those generated by the clearing process, are placed on the nose of the cone where they may be counted prior to packing. An agreed maximum limit of knots per cone will be set and any cone that exceeds this limit will be rejected.

Yarn Hairiness: Fibres extended out from the main body of the yarn are called hairiness. The number of hairs exceeding 3mm in length as a percentage of the total number of hairs is found to be linearly related to the count of the yarn.

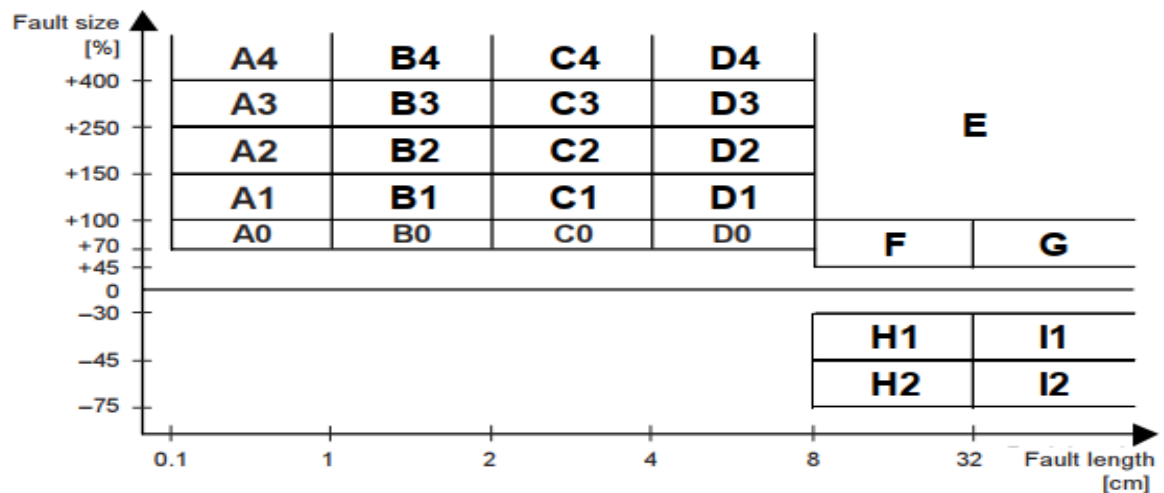
Another scholar Nilufen (2003), and different researchers, confirmed that the major yarn properties are the following:

Structural properties (yarn count, yarn twist), Unevenness properties (CV% values of unevenness, thin and thick places, neps, hairiness), and Physical and mechanical properties (strength, elongation). From the finding of researchers, it's possible to conclude that a yarn quality level is critical for production of a good or poor quality fabric (textile).

Also the researchers listed the quality characteristics that the cotton yarn should fulfil for use of fabric production. Even if the way the characteristics are differs but almost all researchers mention the same quality characteristics of yarn, like yarn number (count), strength, twist, appearance and evenness.

2.4 Globally Recognized Yarn Faults (Defects of Yarn) during yarn production

Bihola and Amin (2015), also different scholars confirmed that depending on the defect length and diameter on yarn there are totally 23 types of faults. Each fault is identified by an alphabet and a number. The alphabet 'A' to 'G' indicates the thick yarn faults while the letters 'H' and 'I' represent thin faults. The Number 1 represents a faults of size +100 to +150% over the nominal cross-section in the case of thick place and -30 to -45% in the case of thin places. Number 2 means +150 to +250% for thick places and -45 to -75% for the thin places and so on. The 'E to 'G' categories of faults are not followed by any numerical since they are fewer number.



As clearly mentioned in above, quality of the yarn produced can directly affected by the input of poor quality of cotton (raw material). Also others researchers finding shows the quality of yarn can be affected by the processing method throughout the conversion of fiber to yarn, the environment and etc. so, even if the formation of defect is differs by the causes, the length and diameter of the defect type but most of the literatures confirmed that the defects type present in yarn is classified in to five major categories (web 2).

1. **Count Variation:** Variation in diameter along the length of yarn beyond acceptable range.
2. **Unevenness or Irregularity:** It is mass variation per unit length (cm). This fault is expressed as U% or CV% and evenness tester is used to measure it.
3. **Frequently Occurring Faults:** These are the faults that occur in range of the 10 to 5000 times per 1000 m of yarn. Yarns spun from staple fibers contain imperfections, which can be subdivided into three groups:
 - Thin places: Cross sectional size -30% to -60% of normal yarn with fault length of 4 to 25 mm.
 - Thick places: Cross sectional size +30% to +100% of normal yarn with fault length of 4 to 25 mm.
 - Neps: Cross sectional size +140% to +400% of normal yarn with fault length of 1 mm. Neps are defined as small tight balls of entangled fibres on linear textile strands.
4. **Seldom Occurring Faults:** These are the thick and thin places in yarn which occur so seldom that for their determination at least 100,000 m of yarn must be tested. This faults may be classified into the following classes:
 - A. Short thick places: 1 to 8 cm and above +100%
 - B. Long thick places: Above 8 cm and above +45%
 - C. Long thin places: Above 8 cm and less than -30%
5. **Periodic Faults:** If any fault repeats after a certain length/time then the fault is called periodic or systematic fault.

2.5 Quality Control during yarn manufacturing

The quality control of manufacturing sector is important to ensure that the quality and cost of cotton yarn is optimized. In spinning (conversion of cotton to yarn) room, increased efficiency of operation and improved yarn quality are two major benefits to be derived from effective quality control throughout the preceding operations. Quality control is one method used to monitor and hence control the quality of yarn. In the cotton spinning process quality control involves the inspection of the; raw materials prior to entering the production line, products at every stage in the spinning process, and final product (yarn) prior to dispatch. Some of the important yarn quality characteristics measured to check the quality of a rotor spun yarn include: yarn count, tensile properties, evenness and imperfections.

Quality control is concerned with the operational techniques for detecting, recording, and taking actions to eliminate quality problems. It refers to all activities (processes) and technologies that are used to achieve or maintain the quality of a product or service. Quality control focuses on finding and eliminating of sources of defects and monitoring the manufacturing process. Under the notion of quality management, quality control should be concerned with the evaluation of test data and its application to the control of the textile process, raw materials, intermediate products, and final products.

To say a product is quality or not there should be an agreed technical measurement. In textile industry today laboratory testing instruments are developed to check the qualities of yarn in spinning department. This laboratory testing will provide different result which will help to categorize the product quality level. The data provided from spinning department laboratory includes assessing the quality of fibres, slivers, roving and yarns.

As justified in the above a quality management system requires reference values in order to assess quality levels for yarns and fibres. These will facilitate the devising of agreements via the boundaries of the textile chain. Reference values within the framework of the Uster Standard are available for the following quality characteristics, as indicated in Table 2.1. It helps to ensure that the machines in the entire mill are kept in good condition.

Table 1 Reference values for on-line and off-line control

Off-line values	On-line values
Count variation Mass variation (0.01m) Mass variation (0.01.... 100m) Mass variation between bobbins Index of irregularity Thin places Thick places Neps Hairiness Hairiness variation Hairiness variation between bobbins Tensile force Tensile force variation Elongation Work done to break Classimat values Nep content in cotton fibres	Ring Spinning Machine Actual efficiency value Production per spindle hour Yarn breaks /1000 spindle hr. Production loss due to yarn breaks Break-free yarn length Mean yarn break duration Exception spindles Rotor Spinning Machine Production per rotor hour Yarn break frequency Break-free yarn length Mean yarn break duration Yarn faults per 1000 km Cone Winding Machine Splice and knot frequency

Even if the quality management system is implemented in the spinning company but still the sector is suffering in different yarn quality defects. But recently a new technology is introduced on winding machine (on the final stage of yarn production), at this stage the electric scanners (uster) is introduced, which is used for checking (sensor) and elimination of yarn faults during winding process. This process is called Usterization of yarn. Such faults are called scan-cuts. This technology is helping the manufacturers to not deliver the defective yarn to their customer. But not protect them from loss due production of defect, loss of productivity due to stoppage of machine. According to (Bihola & Amin (2015), and different literatures findings showed that most of the manufacturers, since extraction of faults which is done at winding is a simple process, control of generation of faults does not get prime importance.

Scholars showed that yarn faults of various shapes and sizes can be introduced at all stages of spinning process. This occurrence of yarn defect does not only affect the productivity of the spinning department through frequent break down of machine due to the process of removing the produced defective yarn on winding machine, it also affect the knitting and fabric (textile) produced from. So, it's very important to control the defects of yarn at early stage. To control anything you have to identify the root causes and sub causes first.

2.6 Empirical literature review

According to Jamal et.al, (2011), Excessive high speed of carding machine can lead to fiber damage and higher neps generation which will downgrade the final product. Also this study recommend that it's good to find out the optimum speed which results best for both production rate and quality. Carding is the first and the only machine (in card process) which can eliminate neps, seed coat and the remaining impurities which cannot be eliminated by blow room section (Jamal et al., 2011).

Another researcher Nilufen (2003), mentioned that, fiber properties, preparation processes, process parameters and environment are the major factors which will affect the yarn quality. He also elaborate each factors as follows, Fibre properties (raw material), process parameters (method): yarn count and yarn twist; blend re-used waste fibres; waste that is removed (short fibre ratio). Preparation processes: machinery (types and adjustments); spinning systems (types and adjustments), and Environmental factors (temperature and humidity).

According to Ochola et.al, (2012) findings, fiber to yarn conversion process has been affected by several factors which include properties of raw material, level of technology, machinery and skill of machine operators. The intent of the article were to study the relationship between fiber properties and yarn imperfections in one of Kenyan textile factory. And the relationship between fiber properties and yarn imperfections were modeled using statistical and Monte Carlo techniques. The parameters of the fiber samples tested were: micronaire value, maturity, spinning consistency, fiber length, fiber uniformity, short fiber index, fiber strength, fiber elongation, trash content, fiber reflectance, trash area, trash grade and fiber yellowness. The yarn parameters tested were twist, linear density and imperfections (neps, thick and thin places).

Considering all the three factors (neps, thin and thick places), the factors which showed significant effect on yarn imperfections of ring spun yarn were; yarn twist, micronaire, fiber maturity, trash area, fiber length, fiber strength, and fiber yellowness.

According to Klein et al., (1987), cited in Edison Omollo et al., (2003), Raw material (fiber) is one of the most important factors influencing yarn quality. The researcher indicate that the quality of the cotton lint can be affected by the cotton growing conditions. Cotton neps can be caused by the growing season and conditions. For this study the cotton fiber and yarn samples were collected from a textile firm in Kenya. The cotton lint was tested using High Volume Instrument (HVI) for standard quality parameters, then its characteristics were compared to Uster Standards the result showed the cotton lint is reported good results. But the yarn produced from this raw material were tested for yarn count, strength, evenness imperfections and hairiness, then All the yarn characteristics were compared to Uster standards the result shows poor results especially for yarn evenness and hairiness. Finally the researcher conclude that Since the cotton lint reported good results the higher imperfections in the Kenyan yarn could be attributed to machine related causes. His recommendation is that the rotor spinning process adapted to spin the Kenyan yarn should be carefully evaluated to identify the sources of the shortfall in yarn quality.

Another researcher Khalilur et.al., (2015), studied the effects of some process conditions on ring yarn end breakage, Ends breakage rate are directly connected with poor quality production of yarn. In this study, eight statistically significant processing parameters of ring spinning that have an effect on the end breakage during the formation of ring spun yarn is studied by using the plackett burman experimental design. Then the effects of the significant parameters on the end breakage of ring frame were investigated. The eight selected independent processing conditions were mixing ratio, waste extraction% at blow room and carding, roving twist, break draft, spacer size, top roller pressure, spindle speed and yarn count. The result shows that the parameters that have most significant effect on the end breakage during the formation of ring spun yarn were obtained as waste extraction percentage at fiber preparatory stages blow room and carding, amount of roving twist, front top roller pressure and spindle speed of ring frame. An end break occurs whenever the spinning tension exceeds the yarn breaking force (Sayed, 2009 as cite in Khalilur et.al. 2015).

According to Bihola & Amin (2015), yarn evenness and yarn faults are very important characteristics affecting spun yarn ability process and fabric appearance. The occurrence of yarn defects has a major factor responsible for rejection and down grading of yarn and fabrics and low productivity due to higher end breakage in further process.

This researcher argue also in operational point of view, the end breakage rate is a symptom of how well a plant is running. It is well known that to control anything one should know the characteristic, the causes and the effect.

According to Khan & Hossain, (2015) research shows the productivity of a yarn manufacturing factory is affected by several factors including stoppage time losses, spindle speed, waste extraction percentage. So, the reduction of stoppage time is necessary to increase the productivity of ring frame in the spinning processing factory under discussion. The productivity of a spinning mill reduced due to unwanted stoppage of machinery. So it is necessary to reduce unwanted stoppage of machine to improve the existing productivity level.

According to nptel, (2014), frequently occurring faults are measured by yarn unevenness testers and expressed by the frequency of occurrences per km. Thick places (mass exceeds by at least + 50% of the nominal mass), Thin places (mass is lower than by at least - 50% of the nominal mass), Neps (mass exceeds by + 200% of the nominal mass with reference length of 1 mm).

According to Peter, (2003), as cited in Khalilur, (2015), a high end breakage rate points to a combination of machine, material and human faults. Yarn ends down rate have direct effect on fabric production and final product quality. Also higher the end breakage rate in spinning leads to higher the end breakage rate in weaving.

However, end breakage occur during spinning depends on various processing conditions of spinning. The rearrangement and combination of different processing conditions during ring spun yarn production can reduce the end breakage (Khalilur, 2015).

According to Testertextile, (2018), the yarn has a stable quality only when it formed by the fiber of close length and relatively uniform. In order to get such fibers. The fibers from different production areas and batches must be mixed together and Use cotton opener, cotton mixer and cotton cleaning machine to open, remove and mix all kinds of fibers.

In this process, most dust and impurities are removed by gravity and centrifugal force according to Narayana, (2015) there are two types of yarn faults, frequently occurring faults and Seldom-occurring faults. Frequently occurring faults: This type of faults includes thin, thick and neps as measured by evenness tester. These faults occur in the range of 10 to 5000 times per 1000 meters.

Seldom occurring faults: These faults refer to the thin places and thick places in the yarn, which are so seldom occurring for at least 100 km of the yarn. The seldom occurring faults can be grouped in three main types' Short thick, long thick and long thin faults.

According to Rengasamy et al., (2004), in ring spinning, from an operational point of view, the end breakage rate is a symptom of how well a plant is running. A high end breakage rate points to a combination of machine, material and human faults. Control of end breakage rate at the ring frame is the first step for improving the ring frame productivity. The end breakage in ring spinning not only reduces the production of the plant but also deteriorates the quality of yarn in terms of presence of piecing. End breakage during yarn winding in cons may lead to formation of lean cops. These lean cops will surely reduce the production of auto-coner machine. Yarn ends down rate have direct effect on fabric production and final product quality. Higher the end breakage rate in spinning leads to higher the end breakage rate in weaving. Finally the researcher insist that controlling yarn ends break down rate in spinning process will surely improve the running performance of subsequent processes and the quality of fabric. However, end breakage occur during spinning depends on various processing conditions of spinning. The permutation and combination of different processing conditions during ring spun yarn production can reduce the end breakage.

According to Muhammad, (2010), study shows the causes of yarn defects are due to efficiency of machines, the properties of raw material, lack of cleaning the machines and environment, lack of preventive maintenance, setting of machine, method of operation, operators, and speed of machine. So properly controlling and maintaining the above will minimize the production of fault.

Summary

The literature review section showed us even if the causes and types of faults are different but a yarn quality faults are common throughout the world spinners, also the covered literatures shows different method was used to minimize the volume of fault as per the type of defect exist in the selected case company. Also Almost all literatures have common understanding on its impossible to produce a yarn without fault because of different reasons. Due to poor properties of cotton can contribute to the formation of thick and thin places, due to fly in the ring department which is also one of the main reasons for short faults in the yarn and etc. most of the researchers confirmed the quality of raw material plays a great role for the defects of yarn production. Also literatures showed that the breakdown of machines for the purpose of removing (clearing) defects deadly affect the productivity of the department. Also the machines, methods and & environment is included as a contributing factor for formation of defect. Also the researchers emphasised that quality of yarn play a great role on the further process of textile quality. So maintaining the yarn quality is not only benefit the spinner but also the processes that are exist throughout textile production after production of yarn.

2.6.1 Cause and Effect Diagram Analysis

To solve a problem, one must first recognize and understand what is causing the problem. This is the essence of root cause analysis. So, we have to identify the major root causes of the defect. A Cause-and-Effect Diagram is a tool that helps identify, sort, and display possible causes of a specific problem or quality characteristic. It graphically illustrates the relationship between a given outcome and all the factors that influence the outcome. This type of diagram is sometimes called an "Ishikawa diagram" because it was invented by Kaoru Ishikawa, or a "fishbone diagram" because of the way it looks.

Since its inception, the cause and-effect diagram has gained enormous popularity for identifying root causes of a variety of problems (Shaw & Blundell, 2014).

A cause-and-effect diagram often called a 'fishbone' diagram can help in brainstorming to identify possible causes of a problem and in sorting ideas into useful categories. It is more structured approach than some other tools available for brainstorming causes of a problem (Ahmed & Ahmad, 2011 as sited in Jamal, 2017).

The root cause analysis is an analytical tool which is defined by Wilson et al., (1993), as cited in Tapoch et al (2018). He mentioned that this tool is very much effective which can be used to perform a corrective and comprehensive system-based review of critical defects. The cause effect diagram actually focuses on identification of the root for the specific defects and contributory factors.

According to Canadian Root Cause Analysis Framework (2005), cited in Dalgobind et al (2008), root cause analysis is an important component of a thorough understanding of “what happened”. The team begins by reviewing an “initial understanding” of the event and identifying unanswered questions and information gaps. The information-gathering process includes interviews with staff, who were directly and indirectly involved, examination of the physical environment where the event and other relevant processes took place, and observation of usual work processes. This information is synthesized into a “final understanding”, which is then used by the team to begin the “why” portion of the analysis. Joshi and Jugulkar (2014), summarized in their paper that the methodology cause effect diagram is easy to understand causes of defects of production. At first, it follows some easily possible main remedies and hence it reduces the defects as much as possible. Pareto analysis and cause effect diagram are used in a manual foundry to identify the defects and evaluate different defects and with causes for these defects, which are responsible for rejection of produced parts.

According to Siekannskiski et al., (2003) cited in Taposh (2017), summarised finding, the usage of cause and effect diagram help to identify the areas especially subjected to defect formation. Pareto diagram, a Statistical control tools, directs to irrevocable separation of main non-conformance in defects. Jadhav and Santosh (2013), represented the cause effect diagram as a systematic approach to find the root cause of one of the major defects is needed. According to Juriani (2015), Cause and Effect diagram is a powerful tool that aids in determining the control factors on quality output. He suggested various causes and remedial measure in his publication with the help of cause effect diagram. His study was highly useful for minimizing casting defects in foundries. Kamble (2016), drawn a cause effect diagram for the defect in a Medium Scale Foundry Industry. A defect may be the result of a single clearly defined cause or a combination of factors, in which case necessary preventive measures are vaguer.

Hence close control and standardization of all aspects of manufacturing techniques offers the best control against the occurrence of defects in castings. To overcome this problem the researcher is used Cause and effect diagrams are used to list systematically the different causes that can be attributed to a problem (Effect-Y). By carrying out systematic analysis of casting rejection using Pareto charts 80-20 principle a definite cause of defect can be known.

A cause-and-effect diagram can aid in identifying the reasons why a process goes out of control and once its cause is identified then it can be overcome by various remedies. Hossen et al. (2017), applied Pareto analysis and cause effect diagram (CED) for examining the stoppage losses in a textile factory in Bangladesh. They analysed and drawn the cause effect diagram for idling and minor stoppage, breakdown losses, and they also made a Pareto analysis where they have founded the major stoppage losses are idling and minor stoppages, breakdown, yield loss, reduced speed etc. They also provided some suggestion for the factory to minimize this loss. Similar to cause effect diagram, an important statistical quality control tool is Pareto analysis, which helps us to identify the top type of defect which contribute the most for occurrence of defects, which should be our main causes. Chandna and Chandra, (2009) as cited in Aniruddha, (2014), made a study on forging operation that produces cylinder crankshafts, which are used in buses and trucks. They used Pareto diagrams for finding and identifying critical areas and forging defects of crankshaft. In their study, the corrective measures reduce the rejection rate from 2.43% to 0.21%. Also according to Khekale et al., (2010), as cited in Aniruddha (2014), represented another case in 2010 of wastage reduction for a manufacturing industry which produce belt and located in the Virabha, India. This industry produce world class automotive belts and hoses. Pareto analysis was also used on casting defect analysis by Dabade and Bhedasgaonkar (2013) as cited in Tapoch (2017). They used design of experiments and computer aided casting simulation techniques. They found their result from their study that the reduction in shrinkage porosity approximately 15% and improvement in yield approximately 5%.

There must be many potential reasons, or “causes” which ultimately lead to create an adverse “effect”. Here, the ‘effect’ is the quality problem. Cause Effect (CE) analysis is a tool for analyzing and illustrating a process by showing the main causes and sub-causes

leading to an effect (symptom). It is sometimes referred as the “Ishikawa Diagram”, because Kauro Ishikawa developed it, and the “Fishbone Diagram”, because the complete diagram resembles a fish skeleton. The fishbone chart organizes and displays the relationships between different causes for the effect that is being examined. This chart helps organize the brainstorming process. The major categories of causes are put on major branches connecting to the backbone, and various sub-causes are attached to the branches.

2.6.2 Pareto Chart Analysis

Pareto chart is a simple statistical chart which is useful for quality control. Also known as Pareto diagram. It is a bar graph used to arrange information in such a way that priorities for process improvement can be established. It is used to identify the major causes of the defect and hence enables the manager to correct the high problem area. It ranks the data from highest frequency to lowest frequency of occurrences (Karuppusami & Gandhinathan, 2006).

In the early nineteenth century, the famous Italian Economist Vilfredo Pareto developed this. Now a days, it is widely used in quality management to identify the vital few and trivial many. Pareto analysis is a statistical technique in decision making that is used for selection of a limited number of tasks that produce significant overall effect. It uses the Pareto principle - the idea that a large majority of problems (80%) are produced by a few key causes (20%). Pareto analysis is a formal technique useful where many possible courses of action are competing for your attention. In essence, the problem-solver estimates the benefit delivered by each action, then selects a number of the most effective actions that deliver a total benefit reasonably close to the maximal possible one. This is graphical tool for ranking problems from most significant to least significant. It depicts a series of vertical bars lined up in a descending order- from high to low- to reflect frequency, impertinent, or priority.

The principle was developed by Vilfredo Pareto, an Italian economist, and sociologist who conducted a study in Europe in the early 1900s on wealth and poverty. It is a universal principle of the ‘vital few and trivial many’. According to this principle, the 80/20 rule has been formulated with the following meaning. For many phenomena, 80% of the consequences originate from 20% of the causes.

2.7 Gap from literature

Most of the study focus only on some of the factors that contribute for formation of defects, for instance setting of machine, raw material and production room temperature is mostly emphasized causes on literatures. But there is other factors which contribute for formation of defects that should be investigated. So, this paper try to see the cause of defects from six different perspectives (raw material, machine, man power, method, measurement, and environment). This makes different from the other research related to this topic.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Introduction

This section outlines the methodology on how data and information relevant to the research were gathered and analyzing tool is selected in order to achieve the objectives of the study. It discusses the description of study procedures and the methods employed in the study. Areas covered include the research design, sources of data, and instruments of data collection, population and sampling procedures, methods of data analysis.

3.2 Research Approach

There are two types of approach, qualitative and quantitative research approaches. The main distinction is that according to Silverman (2000), a qualitative approach tends to capture words and use them as the main factor for analysis while quantitative approach tends to use figures. The quantitative approaches is suitable to the numerical figures, in these research numerical values are collected and presented in expressive way even those the qualitative approaches were dominantly used due to the nature of the research purpose. So the study uses both qualitative and quantitative research approach.

3.3 Research Design

There are many definitions of research design; one definition that Kelliher (2005) uses is that "research design is the blueprint for fulfilling research objectives and answering questions where it aids the researcher in the allocation of limited resources by posing crucial choices in the methodology". Other definitions are that research design is an activity- and time-based plan and a guide for selecting sources and types of information to obtain answers to research questions (Blumberg, et al. 2005).

However it can be complicated in selecting an appropriate research design, Cooper and Schindler (2008) are of the view that, by creating a research design which uses a combination of methodologies, researchers can achieve greater insight than if they were to follow methods which used frequency or methods which have been mentioned the most in media.

This research is conducted in a descriptive method of research called survey studies to investigate the root causes and impacts of defective yarn in the factory under study. The descriptive research method helps to draw a valid general conclusion, and it is the most popular and widely used research method. This idea is strengthened by using a statistical quality control tools. It is an effective tool to address the quality issues.

3.4 Source of Data

This research uses both qualitative and quantitative data types. The main sources of data for this research were both primary and secondary data.

Primary data: Kothari (2006) describes that the collection of primary data is either through questionnaire or through interviews. Accordingly, for this study, the primary data has been collected directly from the respondents (quality, production and maintenance department workers) through the questionnaire question, interview, direct observation and group discussion.

Secondary sources: - Besides primary data, secondary data were obtained from the company report (data from quality department of the case company to get the volume of defective products and frequency of type of defects per year, also to get selling price of the defective product and quality product), different books, newspapers, magazines, thesis papers, articles. In addition to these, authentic and reliable online scholarly written literatures were used to supplement the information.

3.5 Instruments of Data Collection

The researcher collected data by administering a questionnaire, structured interview questions and group discussion. The questionnaire used structured questions, divided into five parts. Section A consisted the general background of respondents. Section B consist introductory question about the company operations. Section C discusses about the detail Causes for frequently happening Defects. Section D discusses about Production of poor quality in the company. Section E discuss about Training. Section F discusses about supplier's relationship.

Most of the structured questionnaire questions were the close-ended type and respondents were asked to mark the appropriate box matching the correct answer.

According to Sarantakos and Robson, (1993) definition “questionnaires are a written question, which can be self-administered by the researcher or could be sent by mails. Accordingly, Questionnaire is distributed to all of the 34 employees. This was used to investigate the causes of each type of defect from different workers experience. The composition of the respondent were quality, production & maintenance department workers of the company.

Interview: - it is verbal form of data gathering instrument. Interview is a form of verbal questioning and it is a principal means of data gathering. It is one of the most popular techniques in survey research. The structured interview questions were prepared to collect the data through interview, Most of the interview questions were similar to the questionnaire question, which is deliberately used to check the reliability of the respondent answer. The quality manager, the three shifts production supervisors, team leaders and maintenance supervisors was interviewed to gather information regarding the causes of yarn defects. The interview was carried out on the respondent's workstations. The interview was carried out on June, 4, 2019. The question was prepared as to answer the main causes of yarn defect and its impact on productivity. Around nine employees were contacted for this interview question.

Direct observation & group discussion: were applied for observing the manufacturing process of yarn in the case company and to discuss with key stake holders (quality, production & maintenance department workers) on the causes which contribute to the final defective product, specifically on thick places, thin places and neps defect type. The group discussion was carried out in quality manager office on June 07, 2019. The composition of the respondents were one employ from quality (the quality manager himself), two employees from maintenance (the maintenance supervisor and workshop machinist), and two employees from production department (the production supervisor and shift leader), totally five respondents were involved.

Desk review: were conducted to gate the actual defective yarn data from January 2018 to December 2018. The data source was the quality control department of the company.

Also desk review were used to get the sales volume of defective yarn (local quality or grade B yarn) and selling price difference between the grade A & B from marketing department of the company.

Literature review: were carried out in depth to understand the world practice toward controlling of the yarn defect. The literature source was different books relevant to the study, newspapers, magazines, thesis papers, articles. In addition to these, authentic and reliable online scholarly written literatures were used to supplement the information.

3.6 Research Population

Population refers to the group about whom the researcher wants to know more and from whom a sample will be drawn. This is often defined in terms of demography, geography, occasion time, etc.

Based on the information that the researcher got from the human resource department currently spinning department of Ayka addis Textile Company has 315 employees. But most of (around 195) the employees are engaged on a manual labor force task not professional task and around 86 employees are engaged in non-technical works. So researcher decide to take a target population from the professionals and employ which has direct contact with the quality and productivity issue. Due to this, the target population taken for this study is 34. Concerning the others worker as far as they don't have a quality and productivity concept, it's irrelevant to use them as data source for this research.

So, the researcher has taken 100% of the target population because of small population also in order to get more reliable data from different respondents. Accordingly the target population of this study involves the management staffs and core process employee of Ayka addis textile factory spinning department. For this study 34 respondents were involved in questionnaire question and 9 respondents for interviews question and 5 respondent for group discussion as per the availability of employees. The composition of the respondents was listed in table 2.

Table 2 Composition of respondents

Departments of respondents	For questionnaire respondents involved were	For interview respondents involved were	For group discussion respondents involved were
Production department workers	25	5	2
Maintenance department workers	7	3	2
Quality department workers	2	1	1
Total	34	9	5

3.7 Method of Data analysis

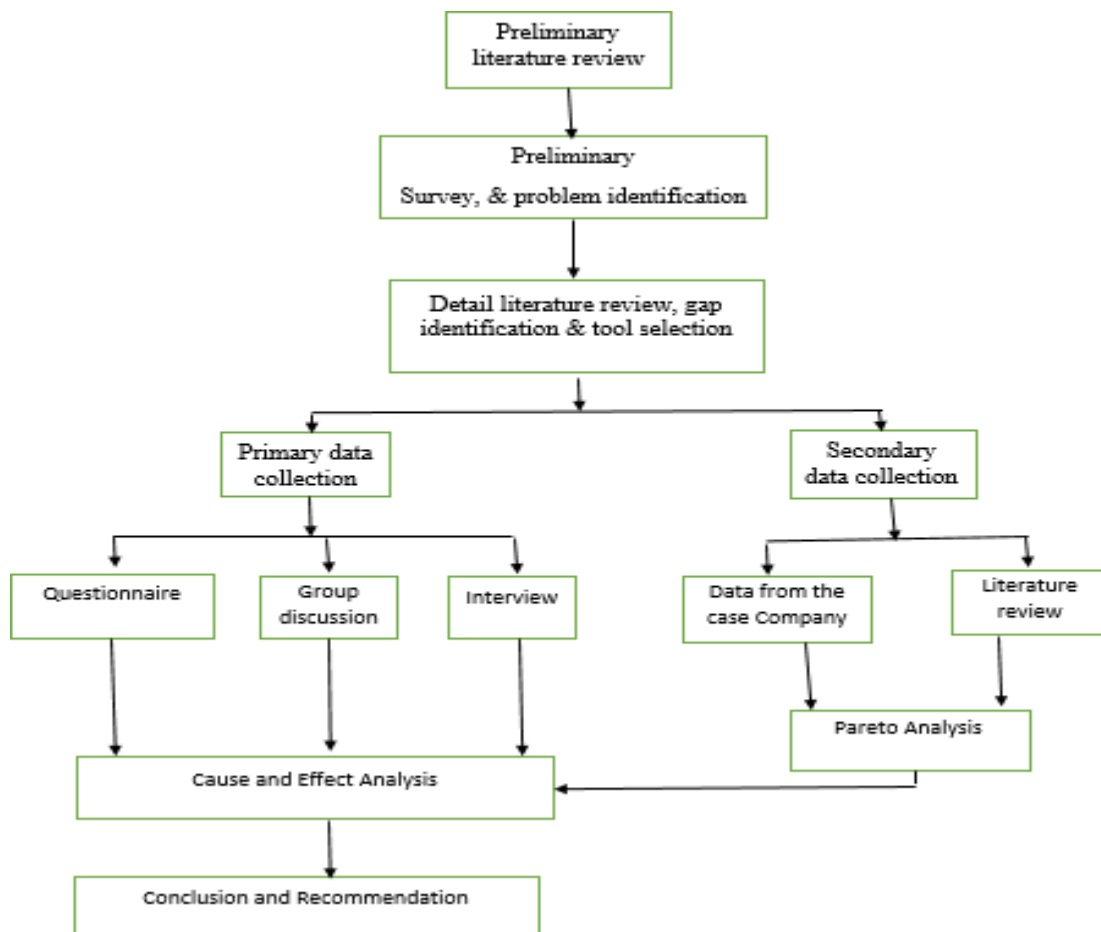
The data collected from the secondary source (the frequency and type of defect collected from the company) are analyzed through Pareto analysis, this is used to identify the top frequently happening defects which should have prioritize to take a corrective measure in the first place. And the data collected from primary sources (data gathered through questionnaire) was summarized, categorized and coded to suite for analysis through a statistical software program spss (version25), this is also used to identify the major causes of defect. The data collected from the questionnaire, interview and group discussion was triangulated to check the consistency of gathered information. Most of the information from the respondent on the three data collection tool method was similar. Finally the gathered data is analyzed through one of the statistical quality control tool which is cause and effect diagram. The outputs of the data were presented appropriately depending on the respondents' response and knowledge gathered from literature review. Also the end result is presented in a written form and in the form of diagram. Finally, interpretation of the output data, conclusions and recommendations is drawn in text format.

3.8 Ethical Consideration

At the beginning, the researcher has explained the purpose of the study to respondents. After that one questionnaire was given to each respondent. Respondents were guaranteed that no one will have access for an individual respondent's information except the researcher. Then, respondents have given their informed consent by completing and returning the questionnaire. Results of the study are reported in a complete and honest way without misinterpreting or intentionally misleading others with regard to the research findings. The study is the researcher's own work, and where researcher's ideas or words were used, Every person involved in the study was entitled to the right of privacy and dignity of treatment, and no personal harm was caused to subjects in the research. Information obtained was held in strict confidentiality by the researcher. Thus, only relevant information that helped in answering the research questions were included.

3.9 Structure of the Thesis

The study starts with the preliminary survey, then primary and secondary data was collected, followed by the analysis phase and ends with the solution phase. Supporting data are presented using a Pareto chart to priorities type of defect in order to be more focused for improvement. The Whys analysis is also performed to analyze the root cause of defect, to formulate corrective actions.



CHAPTER FOUR

4.1 Over view of the company

Introduction

Ayka Addis textile & investment Group plc is one of the largest Textile and Garment Company in Ethiopia as manufacturer and exporter of Textile and Garment product. Which was founded in 2007 GC by Turkish investors on a 200,000 square, meter land in Alemgena, 18km west from Addis Ethiopia. The company was under subsidiary of Ayka Istanbul which was founded in 1988GC In Istanbul/Turkey as a ready-made garment manufacture and exporter. Recently it's owned by development bank of Ethiopia. The company consists of four factories, which are spinning, knitting, dyeing and garment. These department lies in 100,000 squaremeter these departments depends each other which means the output of spinning department used as input for knitting and dyeing departments and also the output of Knitting and dyeing is input for Garment department. Data showed initially the company was started its intended activity with the capitals of \$140 million but now it has over \$1 billion capital. The company is fully operational in April 2010; it begins production state by its spinning department in 2009. In March 2011 launched second spinning factory which has a milling capacity of 25 ton/day and become operational since end of November 2012. Capacity of the company per day:-40 tons of yarn in two spinning factories, 35 ton of knitted fabric, 40 ton of dye fabric and 55 thousand pieces of different types of garment.

Main product of the company are a finished product like, Night wears, Pants, Tayit, Pyjamas, T-shirts, Bed shit

Main Customers of the Company

Tchibo - German Retailer

TESCO - American Retailer

Carrefour - French Retailer

RIKER - German Retailer

Baumhetter - German Retailer

4.2 Raw material used and the supplier of raw material

For the company the company uses organic (the cotton that growth without fertilizer and pest side) and inorganic (the cotton that growth with using fertilizer and pest side) cottons, viscose, polyester and Viscose rayon as main raw materials. These raw materials are purchased from local and foreign suppliers. Some of the local and foreign cotton suppliers are Middle Awash, Turkey, Burundi, Egypt, Burkina Faso and Zimbabwe. Viscose and Polyesters are supplied from China, Australia and Turkey. Other input of this company are coal, fuel, different spare parts, and packing material.

Process flow chart of yarn manufacturing in Ayka Addis Textile Factory

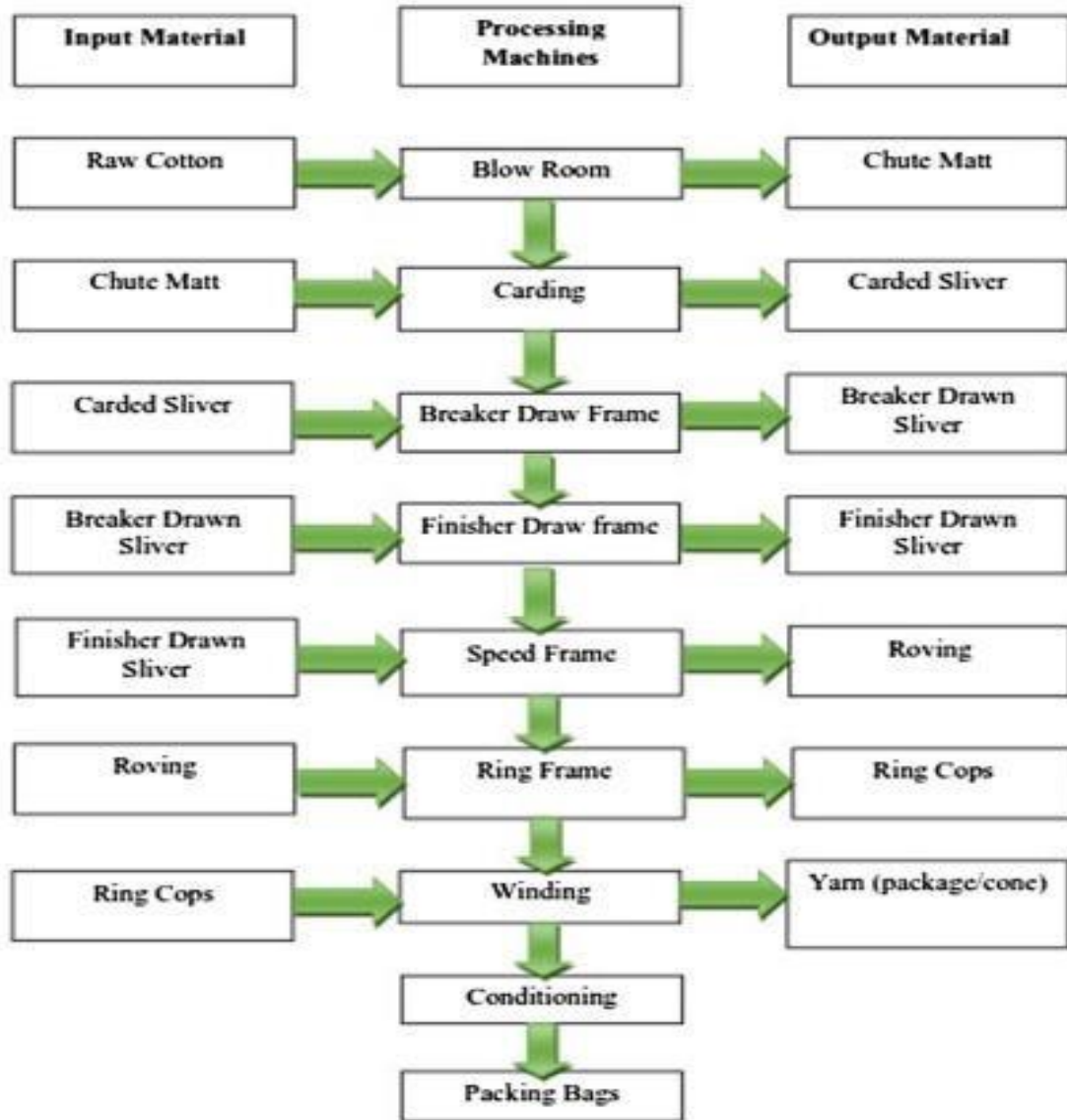


Figure 1 Process flow diagram of yarn production

CHAPTER FIVE

5 RESULT AND DISCUSSION

5.1 Introduction

This chapter present qualitative and quantitative data analysis for the investigation of root cause and impact of defective yarn. The chapter attempt to fully understand the production situation and identify the problems. In order to address the problems, production quality report were collected from the company. This data presents the type and frequency of defects in the case company, between January 2018 to December 2018. This data was analyzed using Pareto chart. Also data collected through questionnaires, interviews and group discussion are presented and analyzed in this chapter.

Accordingly in order to understand and evaluate the actual problems that the company facing, detailed statistical data is collected by recording monthly reports of defects from the spinning department (secondary data). This data consists of type of defect on each production months, from this we can distinguish the frequency per year of each type of defect by counting every recorded defect. The data are collected from the Quality control department that are recorded for one year (from January 2018 to December 2018 G.C) respectively.

Frequency of defects in one year period, from January 2018 to December 2018 G.C respectively.

Table 3 Type and frequency of defect from Jan 2018 to Dec 2018

No	Type of faults	Total frequency	Percentage (%)	(%)Cumulative frequency
1	Thick places	232,200	29.19	29.19%
2	Neps	192,600	24.21	53.40%
3	Thin places	169,200	21.27	75.10%
4	Unevenness	100,800	12.67	87.77%
5	Hairiness	45,000	5.66	93.43%
6	Count variation	30,600	3.84	97.27%
7	Foreign matters	25,200	3.16	100%
	Total	795,600	100	

Source: Quality control department of the company

Based on the above table, a Pareto chart is prepared, as given in Figure 5.1

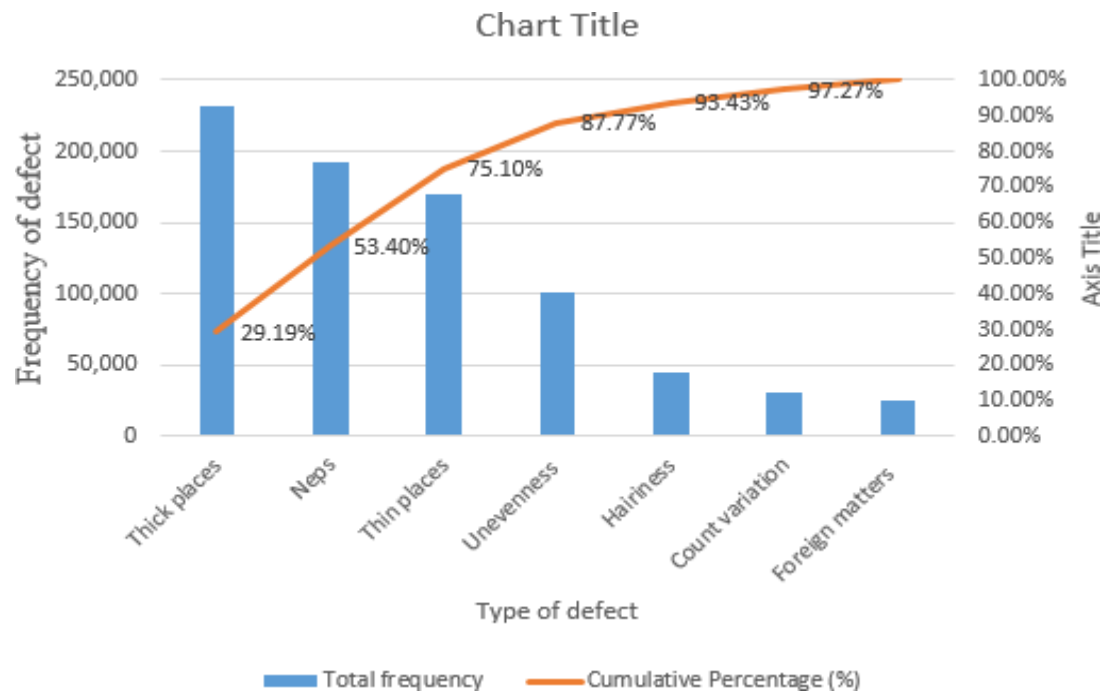


Figure 2 Pareto chart for defects of yarn

Observations from the Pareto Analysis

Among other defect type's thick places is the most frequent defect type with 29.19% of total yarn defect. Contribution of Neps is 24.21 %, and thin places is 21.27 %. So, the Pareto chart indicate that, the listed three defect types are responsible for about 75.10 % of the cotton yarn defects in the case company.

The effect of formation of thick place, thin places and neps in yarn create more rejected of yarn in the spinning, it create knitting, garments & Textile problem which will decrease the consumer, it leads to knitting fabric wastage, frequently yarn break in knitting, it create line mark, Neps spot in dyeing fabric, it create uneven dyeing of fabric, it create frequently yarn breaks. This all decrease the productivity and the customer. So, once a major problem has been identified, it needs to be analysed for possible causes. Based on this Pareto chart output, relevant primary data are collected through questionnaire, group discussion, direct observation and interview with key stake holders, to identify the root cause of the effect.

5.2 Qualitative Data Analysis (Questionnaires)

All of this collected primary data are qualitative data. Analysis of these qualitative data is as below. The questionnaire were distributed to all relevant worker of the department, the employees were 34, and out of this 31 of the questionnaire was collected. The composition of respondent were quality manager, quality laboratory employ, maintenance department employees, maintenance supervisor, production shift leaders and Machine operators these are assumed suitable to answer the survey questionnaires. Finally their responses were analyzed using SPSS (version 25) software. The result extracted from the spss is presented as below.

Table 4 Summarized form of Questionnaires response

Type of defects	Major Causes					
	Production machine	Raw material	Method	Man power	Measurement	Environment
Thick place	27	27	20	17	13	6
Neps	25	29	19	14	15	5
Thin place	28	27	23	14	8	6

As we can understand from the questionnaires analysis the most major causes for the thick, thin and neps defect type are machine, raw material method. As per the respondent respond machine problem is responsible for 87% of thick place defect of yarn, 81% for neps and 90% for thin place defect of yarn. Poor raw material is responsible for 87% of thick place defect, 93% for neps formation and 87% for thin place defect formation. Also the an appropriate yarn processing method in case company contribute 74% for thick place defect formation, 61% for neps defect formation and 64% for thin places formation.

Table 5 Education level of respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	12	38.7	38.7	38.7
	Masters	1	3.2	3.2	41.9
	TVET	18	58.1	58.1	100.0
	Total	31	100.0	100.0	

As per Table No 5. Around 38.9 percent of the respondents have bachelor degree. And 3.2 percent of them have masters, and 58.1 percent were TVET completed.

Table 6 Work experience of questionnaire respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	6.5	6.5	6.5
	3	6	19.4	19.4	25.8
	4	7	22.6	22.6	48.4
	5	3	9.7	9.7	58.1
	6	1	3.2	3.2	61.3
	7	5	16.1	16.1	77.4
	8	3	9.7	9.7	87.1
	9	3	9.7	9.7	96.8
	14	1	3.2	3.2	100.0
	Total	31	100.0	100.0	

According to Table 6, work experience of the respondent shows, an employ which has a work experience of less than five year is accounted 77.4 present of the total employ. And only 32.6 percent of the respondent has more than five year experience.

Table 7 Department of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	production	21	67.7	67.7	67.7
	quality	2	6.5	6.5	74.2
	maintenance	8	25.8	25.8	100.0
	Total	31	100.0	100.0	

From Table 7 we can understand the composition of respondents. Around 67.7 percent of the respondents were from production department. 6.5 percent were from the quality department and 25.8 percent of the respondents were from maintenance department respectively.

5.3 Qualitative Data Analysis (Group Discussion)

By taking the output from the questionnaire analysis as a major causes (machine, raw material, method, man power, measurement and environment), a group discussion question is prepared to investigate the root cause of each major defect.

General reflection of the respondents about the formation of defects (specifically thick, thin places and neps) were as follows, the detailed output of the group discussion is clearly shown on the cause effect diagrams. In the discussion period they point out that quality of raw material is one of the major cause (the company is using a raw material from local and import, so their assessment is when they use imported cotton the listed three defect rate get minimized, the justification they give is that Ethiopian cotton fiber quality is categorized as poor when they compare to the imported), also the cotton fiber characteristics data from the case company testin laboratory showed that local suppliers cotton is poor in stable length, trash content, maturity, and micronaire value when its compared with imports cotton. machine (the existing machines are given services for more than 20 years, due to this the cleaning efficiency are poor, the existing compressor machine capacity is too below the requirement which has a great contribution for thick and thin place formation, Also the machine setting, wearing of critical machine parts is one of the challenge), the ambient temperature and the humidity of the production and laboratory room not as per the spinning requirement so it has a contribution on defects of yarn. They also mentioned a laboratory testing equipment is calibrated before three year, due to this the testing data is not reliable, also they mentioned employee's skill toward material handling, and machine operation is poor, also they blame the cut sliver piecing method, during yarn operation there is a possibility of sliver cut because of different cause, so the existing piecing method use a man power which difficult to be consistent in the similarity of piecing. These points were addressed in the group discussion.

5.4 Impacts of production of faults in financial loss

The quantitative data collected from the marketing department as a secondary data source is used to calculate the opportunity cost that the company losses.

The data taken from the company shows a 43,206 kg of defective yarn was produced as a grade B quality level in a 2018 budget year. Also the data shows around 40,040 kg of yarn defect is produced as hard waste. Then this defective product price is compared with the good quality yarn of the company (export standard). For the comparison purpose the sales data from marketing department is collected, also this is used to identify the impact of money lost due to production of faults. The direct cost and opportunity cost is considered for this comparison.

Table 8 Comparison of export and local quality price (opportunity cost)

Defective products	Produced volume (kg)	Unit price for local quality yarn (per kg)	Price of hard waste (per kg)	Total price
Low grade quality product produced	43,206 kg	106.09		4,583,724.54
Hard waste	44,040		28.75	1,266,150.00
Grand total				5,849,874.54

Table 9 Export quality level price (opportunity cost)

Defective products	Produced volume (kg)	Unit price for export quality yarn (per kg)	Price of hard waste (per kg)	Total price
Low grade quality product produced	43,206 kg	295.58		12,770,829.48
Hard waste	44,040	295.58		13,017,343.20
Grand total				25,788,172.68

The price difference between the two product qualities is

$$25,788,172.68 - 5,849,874.54 = 19,938,298.14$$

This data shows the company lost around 8,187,102.53 birr due to production of low quality yarn or local quality level and lost around 11,751,193 birr due to production of fault recorded as a hard waste.

Hard waste is produced due to production of defective yarn in the late production operation. Then that faults is cut out on Uster machine (final stage of yarn production), so the cut out volume of defects is called hard waste.

Generally the company lost around birr **19, 938,298.14** because of production of faults recorded as a grade B quality and defect recorded as a hard waste.

So, the aim of this paper is to know the exact causes of the yarn defects and its impact in the case company. The impact is presented as loss of opportunity cost in the above part, but to identify the exact location of causes, cause and effect analysis is used in baleow discussion.

Different researcher showed that the yarn faults of various shapes and sizes can be introduced at all stages of spinning process. Also different researchers confirmed that in most of the mills, since extraction of faults which is done at winding is a simple process, control of generation of faults at the initial stage does not get prime importance. To control anything you have to know the causes.

So to minimize the impacts due to production of faults, it is critical to study the root causes and to take corrective action. In order to address this issue, a Root Cause Analysis was performed due its most familiar tool to study the causes of quality problems.

5.5 Cause and Effect Diagram Analysis

This chart helps organize the brainstorming process. The major categories of causes are put on major branches connecting to the backbone, and various sub-causes are attached to the branches. The method for using this chart is to put the problem to be solved at the head, then fill in the major branches.

According to the pareto analysis result about 75.1 % of the quality defects are due to Thick places, Neps & Thick places. The cause and effect of the above defects can be constructed by analysing the root cause of the defects related to Machine, raw material, man power, procedures, measurement & environment.

To eliminate or minimize production of defective product, it is very important to identify the causes, sub causes and their exact location in the system.

So, based on the output of group discussion carried out with the quality, production and maintenance department's employees and questionnaire analysis the cause and effect diagram for each defects of yarn is constructed as below diagram.

Cause and effect diagram for Thick places defect

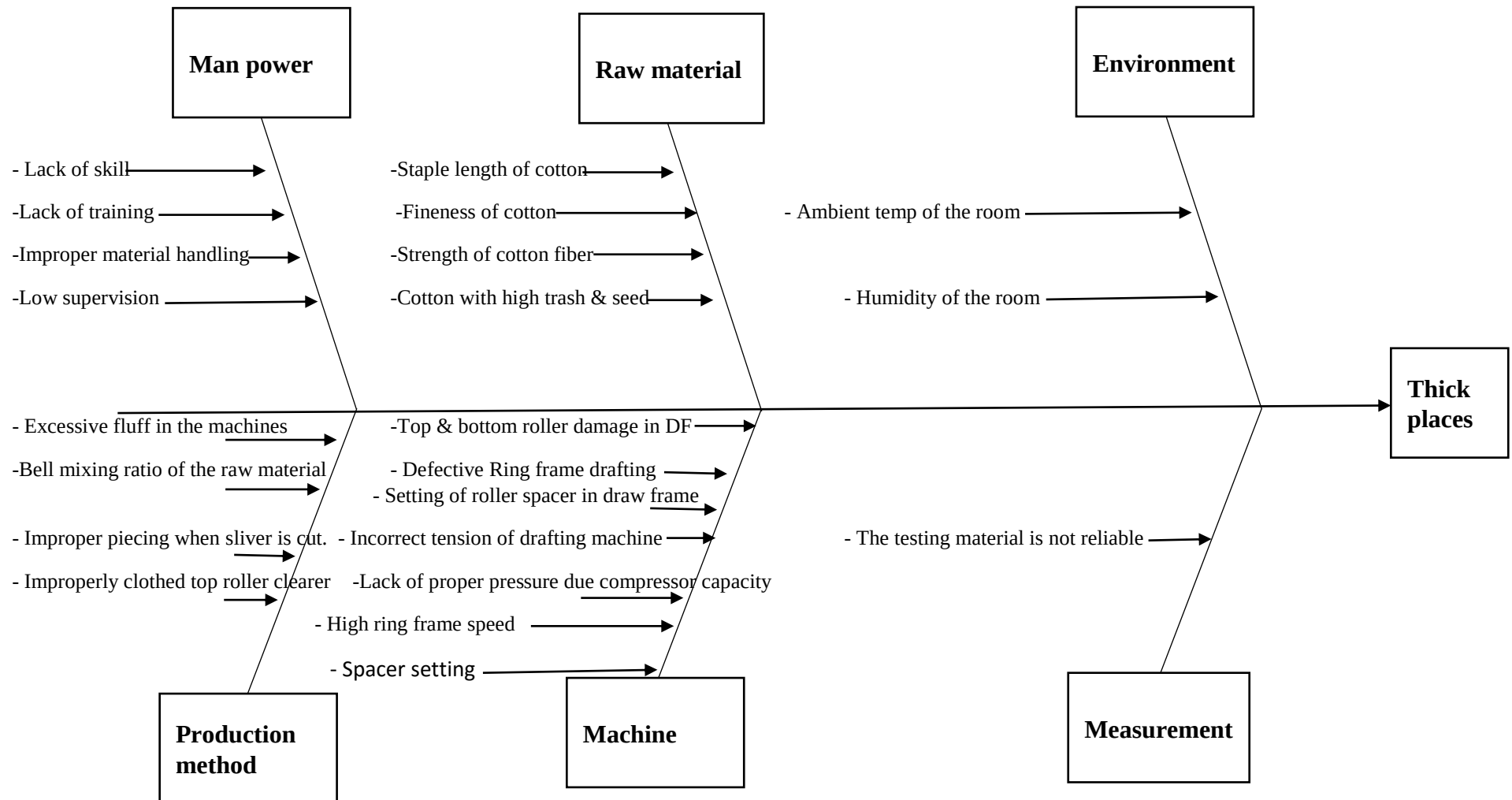


Figure 3 Cause and effect diagram for thick place

Cause and effect diagram for yarn Neps type defect

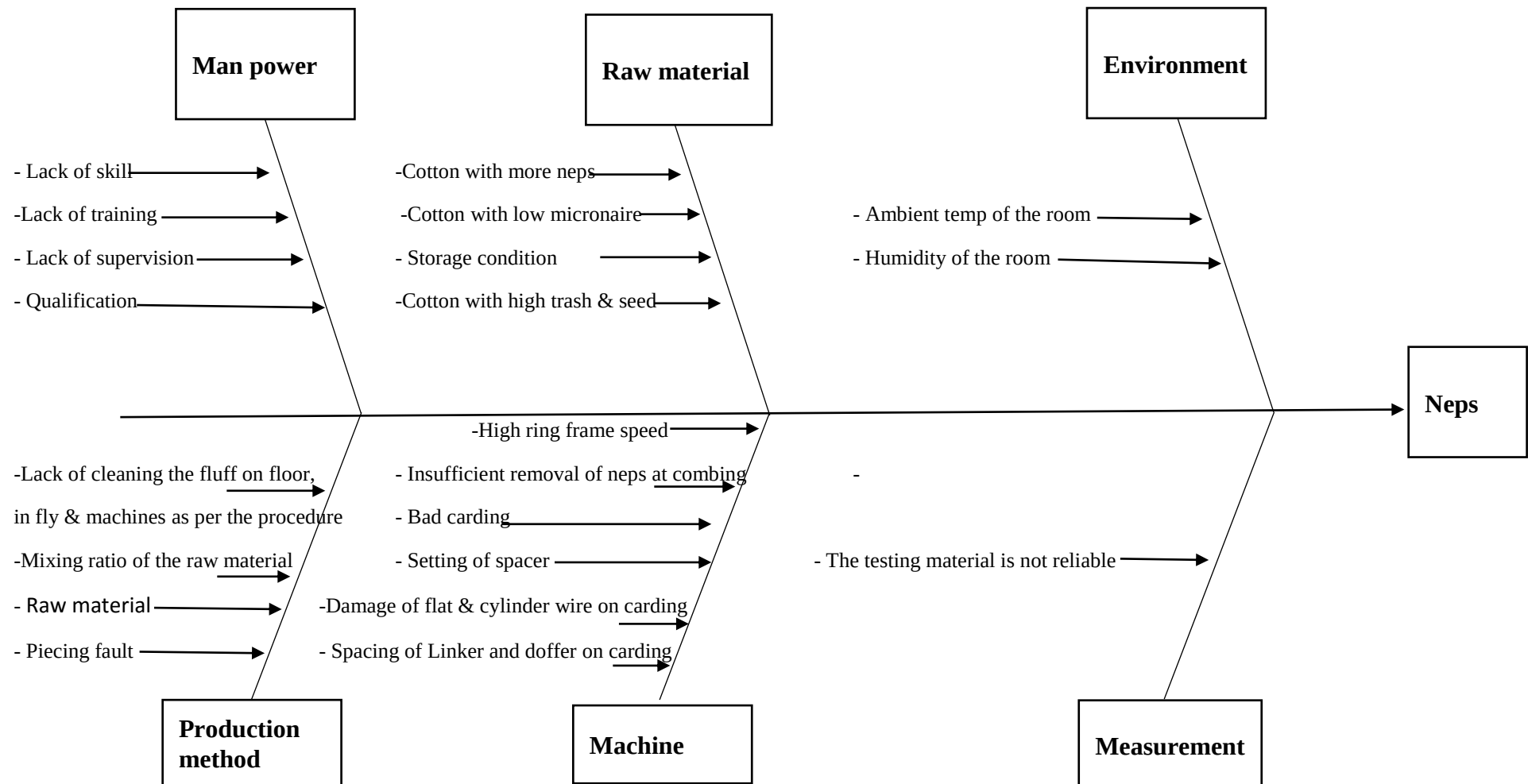


Figure 4 Cause and effect diagram of Neps

Cause and effect diagram for Thin places defect

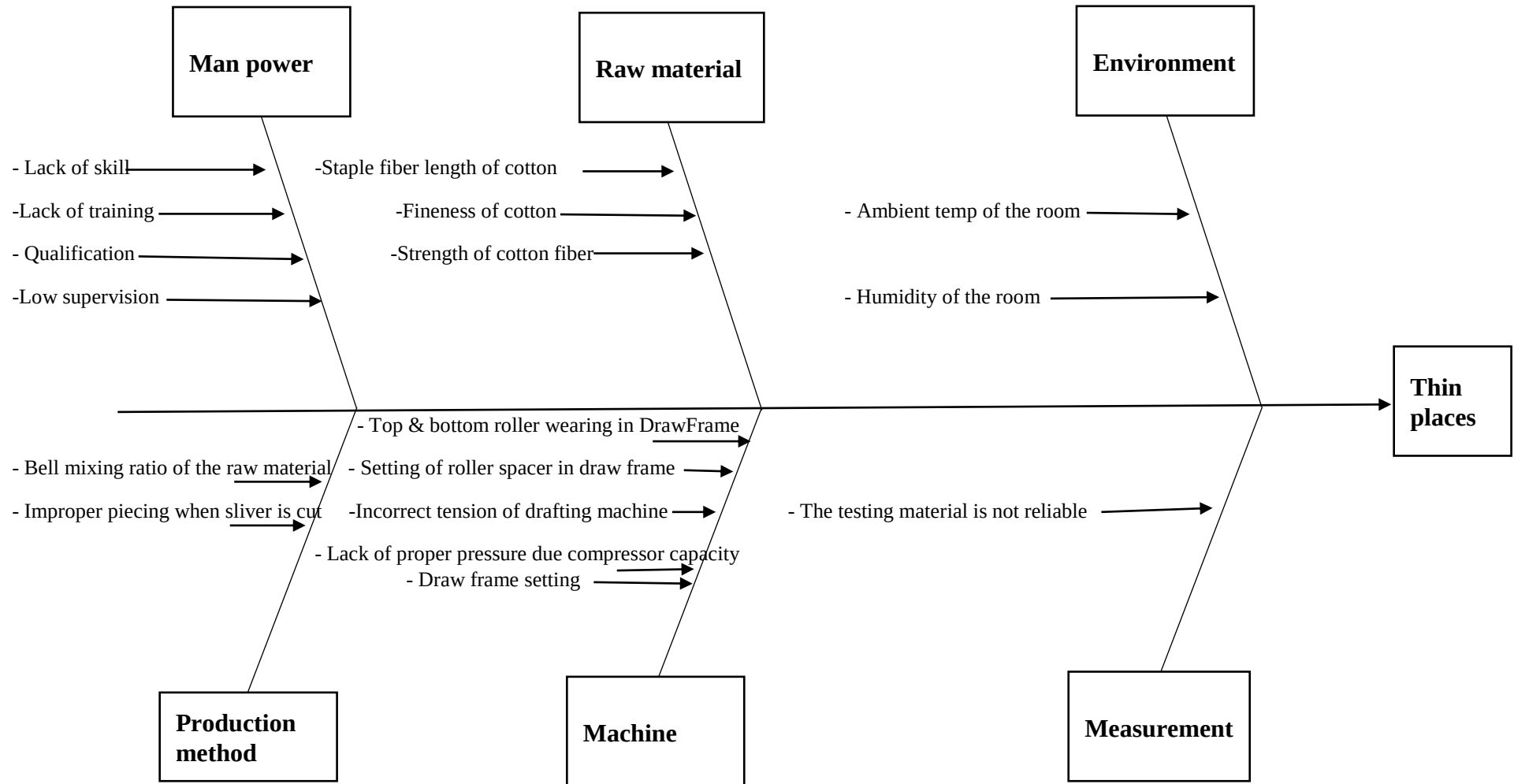


Figure 5 Cause and effect diagram of thin place

Also the causes of these defects need to be investigated to find out why they occur, and to implement preventive measures, so they can be minimized or eliminated. To identify the possible detailed root causes why analysis is used.

5.6 Why Analysis

The 5-whys analysis emerged as a result of Taichi Ohno's observation in his days in Toyota that when mistakes happen in the production or manufacturing environment people would always blame one another. He realised that mistakes are inevitable and the best approach towards mistakes is to identify the root causes of the mistakes and act upon it (Ohno, 1988 as cited in Samuel 2009).

As we can see from this Fishbone diagram man power, production methods, machine, raw material, measurement and environment are identified as a main causes for the defects. Based on this all contributors are analysed to obtain their root cause by asking the Whys as shown in Table 5.8. The question Why is asked until a root cause is identified.

Whys Analysis

Table 10 root causes of cotton yarn defect through whys analysis

Why	Why	Why	Why	Why
Man power	Lack of skill	Lack of training	Time constrains to give a training for new employees	The company need to deploy employs to start working as soon as possible
	Qualification of employees	Education back ground of most employees are not relevant to the job	People with textile academic background don't want to be hired in this company due the low wage.	So irrelevant study area are hired by giving certain training. Due to wage issue
		Work experience of employees are very low	Frequent turn over exist	Due to wage issue
Production method	Failure to follow procedures of cleaning the production area and mixing ratio of raw material	Procedures are not seen as important	No strong enforcement of procedures	Lack of supervision
		handling method is not considered as important for the quality	Lack of knowledge	Lack of training
		Fatigue	High frequency of similar work leads to fatigue	The nature of the task

Raw material	The purchased cotton from different regions suppliers has different properties	Depend on the geography and type of the soil. The quality level vary.	Even the Ethiopian Fiber properties is categorized as medium quality level	Staple length, trash content, micronaire value and maturity are the major poor properties of Ethiopian cotton
Machine	Drafting fault	Due to top and bottom roller wearing away on draw frame	Lack of replacing the part as per the machine service time	Lack of spare part in stock
		Incorrect setting in draw frame	Lack of skill of operators	Lack of training
	bad carding	Due damage of flat and cylinder wire	Lack of replacing the damaged part	Lack of spare part in stock
		Insufficient removal of trashes	Miss Space setting between cylinder & flat wire	Carelessness of operators
	Lack of proper machine speed, roller part spacing, and similar setting problem	Each operator using a technique they are familiar with to perform operations	No defined/ documented technique for performing operations	Lack of standardization

	Long thin fault	Stretch of roving at speed frame	Lack of appropriate and consistent pressure for transport the raw material throughout the value stream.	There was two compressor machine but one of them is damaged before 3 year but it's not repaired yet.
Measurement	The input raw material, on process and final product testing result is not reliable	The laboratory testing equipment's are not reliable	They are not calibrated for their reliability	It has a big cost for calibration. The management does not take as a priority.
Environment	The yarn processing environment is not as per the spinning requirement	The room temperature and humidity regulator systems is not functional	They were damaged before 3 years	Maybe it's because of some parts life time or lack of maintenance
	The raw material, on process and final product testing result is not reliable	The laboratory room temperature is not as per the spinning standard	The temperature regulating system is damaged	Maybe it's because of some parts life time or lack of maintenance

5.7 Remedies for cause and effect

These defects lead to loss of opportunity cost, minimize the productivity and minimize the profit of the company. Based on the finding, the following are some of remedial points which are suggested to the case company for minimization of defect rate.

For minimization of thick places defect

Concerning man power causes: The Company should train the employees to cover the existing gap of skill on machine operation, settings & maintenance, material handling, method of cut sliver piecing, and should have to strengthen the operation supervision.

Concerning production method causes: the company should improve the bale (raw material) mixing ratio, should have to maintain the consistent required pressure (by maintaining the existing or purchasing new compressor machine). The existing major problem for formation of thick and thin place in the company is identified as pressure (tension) inconsistency, due to damage of the one compressor.

Concerning raw material causes: the Ethiopian cotton fiber properties is ranked as a medium quality in the standard measurement, also literatures shows properties of cotton is vary as per the region and area they grow, So its recommended to buy a cotton which can fulfil the minimum properties also its recommended to mix the purchased bale for attaining the better quality in the starting operation of yarn production. Staple length, fineness, strength are the major properties of cotton.

Concerning machine causes: speed of machines should be appropriate as per the standard and should be consistent (stretch of roving at speed), incorrect tension of drafting machine problems can be solved by fixing the compressor machine. Miss lined setting of scanning roller can be solved by training the machine operators and by strong supervision, scanning roller wearing away can be solved by following the proper preventive maintenance based on the machine manual, and maintenance of machines is very critical so servicing and preventive maintenance of the machine should be adapted as a culture.

Concerning environment causes: the ambient temperature and humidity sensor of the production and laboratory room should be calibrated and the damaged part should be replaced.

Concerning measurement causes: the quality testing instrument should be calibrated to get a reliable reading.

For minimization of thin places defect

Concerning man power causes: The Company should train the employees to cover the existing gap of skill on machine operation, settings & maintenance, material handling, method of cut sliver piecing, and should have to strengthen the operation supervision especially during the night shift.

Concerning production method causes: the company should improve the bale (raw material) mixing ratio, should have to maintain the consistent required pressure (by maintaining the existing or purchasing new compressor machine). The existing major problem for formation of thick and thin place in the company is identified as pressure (tension) inconsistency, due to damage of the one compressor.

Concerning raw material causes: the Ethiopian cotton fiber properties is ranked as a medium quality in the standard measurement, also literatures shows properties of cotton is vary as per the region and area they grow, So its recommended to buy a cotton which can fulfil the minimum properties also its recommended to mix the purchased bale for attaining the better quality in the starting operation of yarn production. Staple length, fineness, strength are the major properties of cotton.

Concerning machine causes: speed of machines should be appropriate as per the standard and should be consistent (stretch of roving at speed), incorrect tension of drafting machine problems can be solved by fixing the compressor machine. Miss lined setting of scanning roller can be solved by training the machine operators and by strong supervision, scanning roller wearing away can be solved by following the proper preventive maintenance based on the machine manual, and maintenance of machines is very critical so cleaning, servicing and preventive maintenance of the machine should be adapted as a culture.

Concerning environment causes: the ambient temperature and humidity sensor of the production and laboratory room should be calibrated and the damaged part should be replaced.

Concerning measurement causes: the quality testing instrument should be calibrated to get a reliable reading.

For minimization of Naps defect

Concerning man power causes: The Company should train the employees to cover the existing gap of skill on machine operation, settings & maintenance, material handling, method of cut sliver piecing, and should have to strengthen the operation supervision especially during the night shift.

Concerning production method causes: the company should improve the bale (raw material) mixing ratio. The fluff (short size cotton) created due production should cleaned from the machine and production floor.

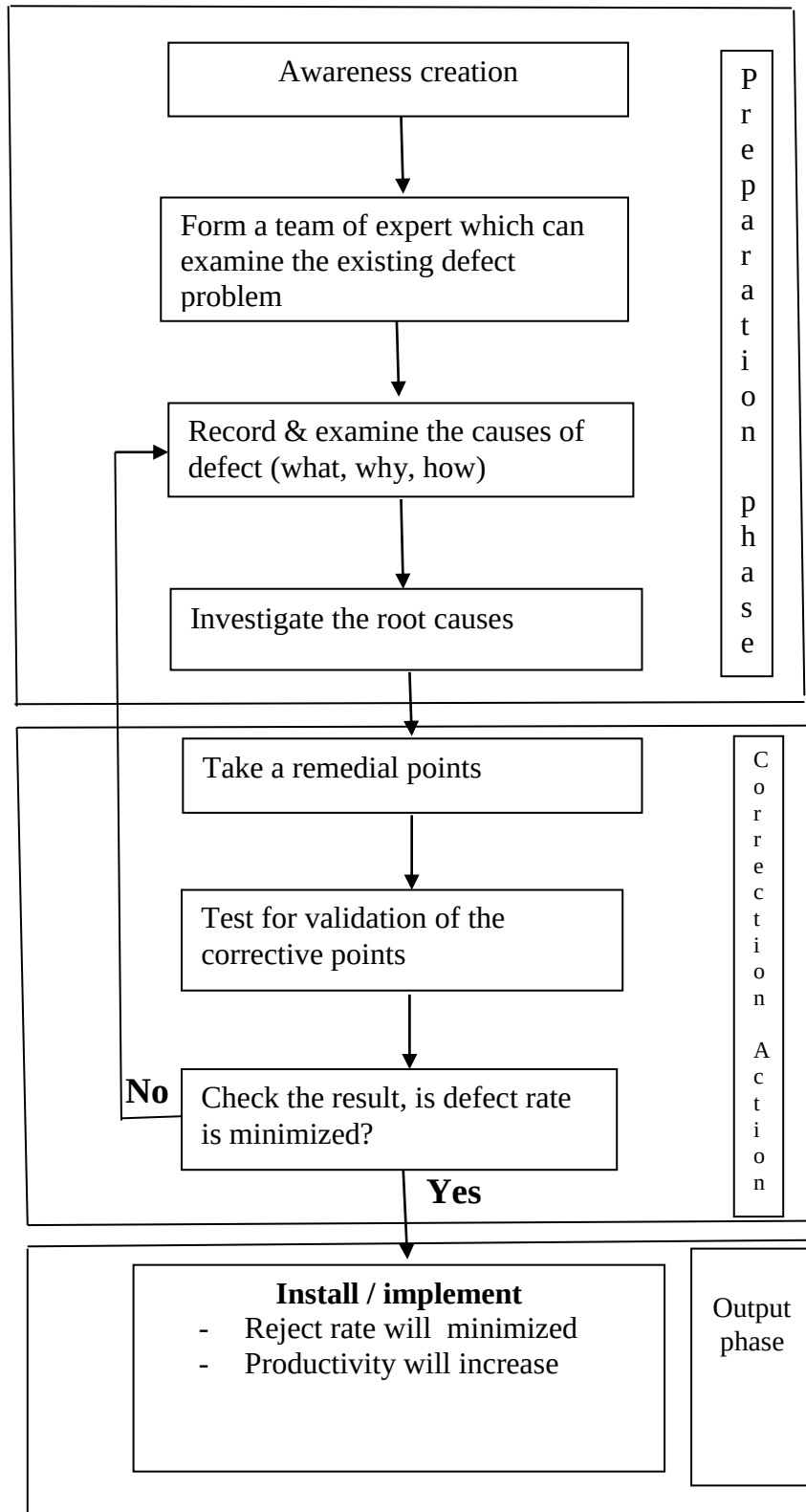
Concerning raw material causes: the Ethiopian cotton fiber properties is ranked as a medium quality in the standard measurement, also literatures shows properties of cotton is vary as per the region and area they grow, So its recommended to buy a cotton which can fulfil the minimum properties also its recommended to mix the purchased bale for attaining the better quality in the starting operation of yarn production. Staple length, fineness, strength are the major properties of cotton. (its recommended to not use a cotton with more neps, low micronaire, high trash and seed also its recommended to not use un immature fiber to minimize our final yarn from formation of neps)

Concerning machine causes: speed of machines should be appropriate as per the standard and should be consistent (in sufficient removal of neps at combing due to damage of flat and cylinder wire), due to lack of removing neps on carding machine this is due setting of the liker and doffer spacing, damage of flat and cylinder wire the machine problems can be solved by following the proper preventive maintenance based on the machine manual, and proper setting of the machine as per their function can minimize the occurrence of neps formation.

Concerning environment causes: the ambient temperature and humidity sensor of the production and laboratory room should be calibrated and the damaged part should be replaced.

Concerning measurement causes: the quality testing instrument should be calibrated to get a reliable reading.

Proposed Defect Rate Minimization Model



Awareness creation includes the policy development: Policy is the starting point for minimization of defect rate. Unless policy is available by which a quality yarn production is guided, it is difficult to control quality. A policy framework helps an organization to mobilize resources and disseminate research outputs.

After creation of awareness and having a policy framework, form a team of expert which can examine the existing causes of defects. The causes will be obtained by recording and examining the problems, and by raising critical questions like What, How and Why.

Then after identifying the root causes, take a corrective action (remedial point) and test for validity. If the defect rate is minimized install the process, if there is no improvement then go to record and examine the real cause of defect.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusions

This study has presented the results of the survey conducted on Ayka addis textile factory specifically spinning department. The purpose was to investigate the root cause & impact of defective yarn in spinning operation. Pareto and cause and effect analysis tool were employed for the investigation purpose. From the results and discussion, the yarn imperfections (thick places, thin places and neps) type of defects are identified as the major yarn defect which is responsible for about 75.10 % of the cotton yarn defects in the case company. Based on the identified three major defects, root cause analysis were conducted to identify the exact causes of the three defects. Therefore from the analyses the following conclusions are derived.

- The major type of defects observed in the case company spinning operation department are formation of thick places, thin places and neps.
- Some of the core causes for the above major defects are machine setting and parts ear out, lack of proper pressure for the yarn processing operation, lack of cleaning the machines and surrounding, lack of proper raw material mixing ratio, low training, low supervision, temperature and humidity level of the production and laboratory testing room, the raw material etc.
- The impact due production of defective yarn in the case company is converted into money. The data from marketing department shows, the company lost around 19,000,000 birr in 2018 budget year.
- Literatures confirmed the productivity of a spinning mill will be reduced due to unwanted stoppage of machinery.

6.2 Recommendation

Based on the finding the following points are recommended to the case company, to reduce the production of faults, specifically the identified three major type of defects in the case company yarn production operation (thick place, napes and thin places).

The machines and the production room must be cleaned every hour to minimize the flying fluff from the room. The company should give a training for employees especially concerning proper machine operation, material handling and all employees should have to aware what the impact of poor quality yarn mean. Proper training and awareness among workers is the best possible solution to reduce the defect numbers

Lack of proper pressure is identified as a major cause for the formation of thick and thin places, so to overcome this problem the existing compressor machine must be repaired or it should be replaced.

The temperatures and the humidity regulating system has an impact on the yarn quality. So the system should be repaired. The laboratory testing equipment's must be calibrated every year as per Uster standard recommendation.

Also different literatures showed that the breakdown of machines for the purpose of removing (clearing) defects deadly affect the productivity of the department. So it is necessary to reduce unwanted stoppage of machine to improve the existing productivity level.

Generally implementing the suggested remedial points in chapter five can minimize the defect rate and also can minimize the machine stoppage for the purpose of removing (clearing) defects. Which will maximize the productivity of the department through minimizing the machine stoppage.

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APPENDIX

APPENDIX I: QUESTIONNAIRE



Addis Ababa University School of Mechanical and Industrial Engineering

Industrial Engineering Stream

Dear respondents, this questionnaire is prepared to gather relevant data from the spinning department employees of Ayka addis textile company to study and identify the root cause and impacts of defective yarn in this company. The aim of this study is for the partial-fulfilment of Msc in industrial engineering from Addis Ababa University.

NB: Your responses are to be kept confidential and will be used for academic purpose only.

Instruction: Please Mark all that are applicable from the alternatives given and provide written answers where necessary.

Section A: General Background of the respondent and the company operation

1. Highest Education: Bachelor ☐ Masters ☐ Doctorate ☐ Other.....
2. Subject Area: Textile Engineer ☐ Textile Technology ☐ Industrial Engineer ☐, Other ☐ (Specify).....
3. For how long have you work in textile sector? Less than 5 years ☐, 6 -10 ☐, 11-20 years ☐, above ☐ (Specify).....

Section B: introductory question about the company operations

4. In which department are you working now?
Quality ☐, production ☐, maintenance ☐, other ☐
5. What is your position in this department

Shop floor level ☐ Supervisor ☐ Shift leader ☐ Department head ☐
Production and technique head ☐, other ☐ (Specify).....
6. For how long have you work in this position?
One year ☐ two year ☐ three ☐ four ☐ above ☐
7. What are the frequently happening defect of yarn in this department?
Thin places ☐, thick places ☐, napes ☐, count variation ☐, unevenness or irregularity ☐, seldom occurring faults ☐, Periodic Faults ☐, other

8. What are the general cause for defects of cotton yarn?
Raw material ☐ Machine ☐ the production method ☐ Operator ☐, Measurement tool ☐ atmosphere ☐
other ☐
9. What are the main raw material for your production.....
.....
10. Are the raw materials locally available or imported?
a. Local available ☐ b. Imported ☐ c. Both ☐
11. Do you observe any quality difference on local and imported raw materials?

Yes ☐ no ☐
12. Do you categorize the yarn based the produced quality level? Yes ☐ no ☐
If yes how many level is available: grade A & B, ☐, grade A,B&C ☐
13. What is the impact due to production of defective yarn?
.....

Section C: Detail Causes for frequently happening Defects

14. What are the major causes for **thin places** defect?
People ☐, machine ☐, raw material ☐, method ☐, environment ☐, measurement ☐, other ☐.....
 - a. What are Causes due to people or operators?
Carelessness of labors ☐, lack of skill ☐, low supervision ☐, improper material handling ☐, effect of shift work ☐, other ☐ _____
 - b. What are Causes due to the machine you used?
Improper break draft setting in draw frame ☐, lack of cleaning top roller in draw frame ☐, Lack of machine cleaning ☐ bc of miss lined setting ☐ machine breakage ☐ lack of spare parts ☐, Roving tension in roving mcu ☐, Improper piecing in roving ☐, lack of service and maintenance, Speed of machine in ring spinning ☐, Improper maintenance ☐, yarn fault clearer setting ☐, Splice appearance ☐, rotor diameter and speed ☐, cleaning efficiency of machine.
 - c. What are Causes due to **raw material**?
Steeple length of the cotton ☐ fineness of cotton ☐, Cotton Maturity ☐, Moisture content of cotton fiber ☐, Strength of cotton fiber ☐, other ☐
 - d. What are Causes due to production **process or method**?
Frequent product change ☐, Lack of cleaning the surrounding ☐ raw material (bale) mixing ratio ☐ lack of cleaning the machine ☐, electric fault during running of machine ☐, bobbin geometry ☐, bobbin unwinding behavior ☐, binding speed ☐, winding speed ☐,
 - e. What are Cause due to environment?
Ambient temperature of the production department ☐, Ambient temperature of the testing laboratory room ☐, insufficient lighting of the production department ☐, other ☐
 - f. What are Causes due to measurement? Laboratory equipment reliability ☐, other

15. What are the major causes for formation of **neps** in yarn?
- People [], machine [], raw material [], method [], environment [], measurement [], other [].....
- What are Causes due to people or operator?
Carelessness of labors [], lack of skill [], low supervision [], improper material handling [], effect of shift work [], other [] _____
 - What are Causes due to the machine you used?
Insufficient stripping on carding [], Dirty under casing (grid bar) on carding [], uneven flats setting on carding [], under casing choked with fly (waste) on carding [], high roller speed on carding [], Damage of flat wire [] damage of cylinder wire [] doffer wire [] linker wire [], other
 - What are Causes due to raw material?
To high or low moisture of cotton [], extremely fine cotton with high trash content [], Cotton with more nep [] maturity of cotton [], other
 - What are Causes due to production process or method?
Lack continuous inspection [], Frequent product change [], Lack of cleaning the surrounding [] raw material (bale) mixing ratio [] lack of cleaning the machine [], electric fault during running of machine [],
 - What are Causes due to environment?
Ambient temperature of the production department [], Ambient temperature of the testing laboratory room [], insufficient lighting of the production department [], other [].....
 - What are Causes due to measurement?
Laboratory equipment reliability [], other
16. What are the major causes for **thick places** defect?
- People [], machine [], raw material [], method [], environment [], measurement [], other [].....
- What are Causes due to people or operator?
Carelessness of labors [], lack of skill [], low supervision [], improper material handling [], effect of shift work [], other [] _____
 - What are Cause due to the machine you used?
Improper break draft setting in draw frame [], lack of cleaning top roller in draw frame [], Bottom roller damage [] top roller damage [] setting of scanning roller [] lack of machine cleaning, Roving tension in roving mcn[], Roving breakage [], Improper piecing in roving []
 - What are Causes due to raw material?
Steeple length of the cotton [] fineness of cotton [], Cotton Maturity [], Moisture content of cotton fiber [], Strength of cotton fiber [], other []
 - What are Causes due to production process or method?
Frequent product change [], Lack of cleaning the surrounding [] raw material (bale) mixing ratio [] lack of cleaning the machine [], electric fault during running of machine [], bobbin geometry [], bobbin unwinding behavior [], binding speed [], winding speed [],

- e. What are Causes due to environment?
Ambient temperature of the production department [], Ambient temperature of the testing laboratory room [], insufficient lighting of the production department [], other [].....
- f. What are Causes due to measurement?
Laboratory equipment reliability [], other

Section D: Production of poor quality in the company

17. Which division(s)/department(s) is/are responsible for quality? (Mark all that are applicable).
- a. Production and technical section. ☐
 - b. Quality control service. ☐
 - c. Quality control service & Production and technical section. ☐
 - d. Top management (General Manager). ☐
 - e. Purchasing department. ☐
18. What are the obstacles for improvement in the quality area? (Mark all that are applicable).
- a. The system (policy, rules, procedures, etc) ☐
 - b. The working environment. ☐
 - c. Lack of consistency in the action being taken. ☐
 - d) The management ☐
 - e) Lack of the knowledge ☐

Section E: Training

19. Does the company have a training program? Yes ☐ No ☐
20. Does the company :
- a- Identify training requirements? Yes ☐ No ☐
 - b- Provide appropriate training? Yes ☐ No ☐
 - c- Evaluate the training provided? Yes ☐ No ☐
21. Have you attend any training on how to manage quality of yarn? Yes [] No []
If yes, how much time do you trained within a year 1[] 2[] 3[] 4[]
22. Do all personnel receive appropriate training? Yes ☐ No ☐

Section F: Supplier's relationship

23. Does the company have a procedure for evaluating subcontractors or vendors? Yes ☐ No ☐
24. Has the company established criteria for removing vendors in case of unsatisfactory performance?
Yes ☐ No ☐

25. Who are the suppliers of raw materials?

26. Are there inspection & tests for incoming, in-process and final products? Yes []

No []

27. Are there procedures for inspection? Yes ☐ No ☐

28. Does the company calibrate the testing instruments? yes ☐ No ☐

29. Does the right person be placed in the right job? yes ☐ No ☐

30. How often calibration of instruments takes place? Ones in a year [], twice in year [], three times above [], other

Thank you for your time! It has been appreciated!

II. Group discussion points

The interview and group discussion questions were emphasized on the **detail** causes for frequently happening defects due to the below listed causes.

1. What are the major causes for thick places, thin places and neps defect formation?

People [], machine [], raw material [], method [], environment [], measurement [], other [].....