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COLLEGE OF GRADUATES STUDIES

APPLICATION OF TOTAL QUALITY MANAGEMENT ON GARMENTS MANUFACTURING IN SUDAN

تطبيق إدارة الجودة الشاملة في صناعة الملبوسات في السودان

ATHESIS

SUBMITTED IN FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTEROF SCINCE IN TEXTILE ENGINEERING (BY RESEARCH)

BY

MUY ALSHAZLY HABOB WEDAAALA

CHIEF SUPERVISOR: Dr MOHAMMED AHMED EBRAHIM ALI ELGALIB

CO- SUPERVISOR: Dr KHALID ABDESHAFEA ABDELKAREEM ABAKAR

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I would like to express my sincere gratitude and greatest thanks to the following:

Dedication

I wish to conferment this work to my dear parents.

I would also conferment this work to my sincere husband

Finally, I would also like to conferment this work to my brothers, sisters and to my spirit sister Dr. Salma and to all my friends.

Abstract

Abstract -This study aimed to use and attempted to apply total quality management TQM in the Sudanese garment manufacturing factories to improve productivity and profitability and product quality and solving the factory's problems to meet customer satisfaction and decrease the garment imported and determined the potential of competition of local factories in the local and global market. The study designed and employed two methods, one for local garments factories in Sudan and the second for Sudanese consumers. The first one survey conducted among a sample of the local garment factories in Sudan to determine the impact on company strategy, management practices and performance, to identify the weakness and strength and solving problems. The second survey was conducted and employed for Sudanese consumers, the purpose of this survey is attempted to explore and identify how the Sudanese consumers evaluate garment quality and determine all the factors influence perception of garment quality and selection. The study focus on all operations of garment manufacturing start from design to storage and this study used Just in time, 5S checklists, quality assurance, and six sigma. Also the research focus on time cycle for manufacturing one piece of shirt and trouser between three workers to calculate the average time and identified the waste of time reason and losses time at the factory and time cycle elongation, the factories does not have a standard operation time. Similarly, the study observed non-value activities such as unnecessary transportation and manual operations, waiting for raw material due to poor layout and there were also product defects due to poor applying of 5S system and unqualified the workers. After implementation lean tools, using process flow chart and check sheets, quality assurance, the cycle time analysis, the standard time operation was determined. Likewise, the non-value added activities were reduced, thus productivity was improved, the scrape, rejection and defect of production are reduced and the factory meeting the customer expectation in the time delivery and quality of the product and the factory have a good name and reputation in the market. This study proved the importance and greater advantageousness have been investigated of application of TQM in garments manufacturing in Sudan.

Keywords: Garment Manufacturing, TQM, New Systems, Tools and Techniques for Improving Product Quality.

المستخلص

تهدف هذه الدراسة إلي معرفة أهمية تطبيق إدارة الجودة الشاملة في مصانع الملبوسات الجاهزة في السودان وذلك من أجل التحسين المستمر للعملية الإنتاجية وتحسين الربحية وتلبية إحتياجات المستهلك الذي يعتبر المحور الأساسي للعملية الإنتاجية, وذلك لأن إدارة الجودة الشاملة فلسفة إدارية حديثة أنشأت كأسلوب عمل لتطوير أداء المؤسسات لكي تستطيع المنافسة في ظل المنافسة والنهضة الصناعية الكبري التي يواجهها العالم الان وبالأخص في قطاع صناعة الملبوسات الجاهزة لما يشكل هذا القطاع من أهميه بالنسبة للإقتصاد الوطني, حيث تأتي هذه الدراسة كدراسة حالة لمعرفة مدى تطبيق إدارة الجودة الشاملة في صناعة الملبوسات الجاهزة في السودان, وخلق الوعي حول أهمية تطبيق إدارة الجودة الشاملة في المصانع المحلية والإقتناع الكامل بتطبيق هذا النظام من قبل الإدارة العليا للمؤسسة وضرورة إعادة النظر بالهيكل التنظيمي للمؤسسة بما يلائم نظام الجودة الشاملة من أجل البقاء والنمو والإستمرار . إعتمدت هذه الدراسة على اتباع طريقتين،الطريقة الأولى تصميم استبيان لمعرفة مدي تطبيق إدارة الجودة الشاملة في صناعة الملبوسات الجاهزة في السودان وتحديد مراكز الضعف القوة في المصانع والوقوف على مراكز الضعف ومعالجتها,أما الطريقة الثانية صممت إستبيان لمعرفة مدى فهم المستهلك لجودة الملبوسات الجاهزة . شمل إستبان المصانع إختيار مصنعين أحدهما مطبق إدارة الجودة الشاملة والأخر غير مطبق إدارة الجودة الشاملة وتمت المقارنة بين تلك المصنعين في جميع المراحل التي تمر بها صناعة الملبوسات الجاهزة ابتداءً من مرحلة التصميم إلي مرحلة التخزين , كما شملت هذه الدراسة جميع المراحل التي تمر بها صناعة الملبوسات الجاهزة ، حيث أستخدمت بعض أداوت الجودة الأساسية . تم تصميم إستبيان المستهلك لمعرفة مدى فهم المستهلك لجودة الملبوسات الجاهزة ومعرفة أراء المستهلك في جودة المنتج المحلي وكذلك معرفة العوامل التي تقود المنتجين إلي فهم إحتياجات المستهلك وإنتاج منتج ذو جودة عالية وأيضاً معرفة العوامل التي تؤثر تأثيراً سلبياً في عدم فهم المستهلك لجودة الملبوسات الجاهزة. كما أثبتت هذه الدراسة الأهمية القصوى والفائدة الكبرى التي تعود من تطبيق نظام إدارة الجودة الشاملة في صناعة الملبوسات الجاهزة في السودان. حيث وجدت هذه الدراسة بأن المصنع الذي طبق نظام إدارة الجودة الشاملة حقق ربحية عالية ومنافسة كبيرة داخل القطر وخارجة وذلك بإستمرار النمو والتطورات المستحدثة كما وجدت هذه الدراسة بأن المصنع الذي لايطبق إدارة الجودة الشاملة هُدَدَ بعدم البقاء والإستمرار، ولكن بالتوصيات التي وجهت لهذا المصنع وإلتزام الإدارة العليا وتطبيقة لبعض أدوات الجودة الأساسية قام في النهوض من جديد.

Table of Contents

VIII

Abbreviations

PBS	Progressive bundle systems
WIP	Work in progress
UPS	Unit production system
R&D	Research and development
CAD&CAM	Computer Aided Design& Computer Aided Manufacturing
AATCC	American Association of Textile Chemists and Colorists
ASTM	American Society for Testing and Materials
ASQ	American Society for Quality
AAFA	American Apparel and Footwear Association
ANSI	American National Standards Institute
TC2	Textile Clothing and Technology Corporation
ISO	International Organization for Standardization
TPM	Total Productive Maintenance
MIT	Massachusetts Institute of Technology
TQM	Total quality management
5S	1 –Sorting, Phase 2 - Straighten or Set in Order: 3 - Sweeping or Shining 4- Standardizing: Standardized Phase 5 - Sustaining: Refers to maintaining and reviewing standards.
JIT	Just In Time
SMED	Single Minute Exchange of Dies
PDCA	Plan-Do-Check-Act
SQC	Statistical Quality Control
QRS	Quick Response System
QC	Quality Control
HRM	Human Resource Management
QA	Quality Assurance
QIPM	Quality Information and Performance Measurement
TPS	Toyota Production System
MRP	Material Resource Planning
MAS	Management Accounting Systems
GTA	Graph Theoretic Approach
SPSS	Statistical Package for the Social Sciences

List of Tables

List of Figures

Chapter 1   Introduction

1.1 Introduction

Garment manufacturing in nature is more complicated than many other industries. It involves a number of machines, hundreds of employees and thousands of bundles of sub-assemblies producing different styles simultaneously. In garment production, garment components are assembled through a sub-assembly process until they are gathered into a finished garment. The production process involves a set of workstations in each of which a specific task in a restricted sequence is carried out(Leung Patrick Hui and Fun Frency Ng, 1999). Many factors such as the properties of fabrics and human emotions will affect the performance of operatives that ultimately will cause variance on the task time. Delays can be broken down into work elements which can be readily measured as fixed or variable and these measurements are then combined into work standards. Today's, competitive manufacturing environment, companies are constantly looking for ways on how to improve. Because of this, many companies are striving to practice lean manufacturing, which is a difficult process. Productivity improvement is not a job for specialist only; it should be a part of every job in the organization. It requires the optimal use of all resources like manpower, machinery, money and methods. Also, this manufacturing is labor intensive, which is characterized by the low fixed capital investment; a wide range of product designs and hence input materials; variable production volumes; high competitiveness and often high demand on product quality(Scott, 2006, Hassler, 2003, Forza and Vinelli, 2000).The garment manufacturing process evolved as an art and underwent several technical changes. The technological advancements in the garment manufacturing include the use of computerized equipment (especially in design, pattern-making and cutting), 3D scanning technology, automation and robotics, integration of components and materials within the plant, which wearable technology helps in improving production efficiency. However, the apparel industry especially sewing technology has remained significantly less automated compared to many other manufacturing industries. There are wide varieties of clothing types that the garment manufacturers have to handle,

which can be broadly divided into two categories: outer clothing and inner clothing. Outer clothing includes work-wear and uniforms, leisure wear and sportswear(e.g. suits, pants, dresses, ladies' suits, blouses, blazers, jackets, cardigans, pullovers, coats, sports jackets, skirts, shirts short- or long-sleeved, ties, jeans, shorts-shirts, polo shirts, sports shirts, tracksuits, bathing shorts, bathing suits and bikinis).The underclothing (underwear) includes jersey goods and lingerie (e.g. underpants, undershirts, briefs, socks, stockings and pantyhose). These products are manufactured in a wide range of design and style variations, to stay competitive, companies facing today's levels of unprecedented global competition must design and offer better products and services and improve their manufacturing

Chapter 2   Literature review

2.1 Introduction

There have been numerous studies which were conformed the suitability of the importance of application of TQM in garment manufacturing in propose of rise the quality of production and productivity and enhance the profitability.

2.2 Production systems use in garment manufacturing

Production system is the framework within which the production activities take place. A production system comprises attributes with the function to transform inputs into desired and predicted outputs (Jacobs and Chase, 2017). The attributes can be human labor, machines, or tools. For the apparel industry, the production system is defined as "an integration of material handling, production processes, personnel and equipment"(Kincade and Kanakadurga, 2013).There are two types of Garment Production Systems: complete whole garment production system (Kincade and Kanakadurga, 2013, Solinger, Babu, 2006) and assembly line production system. In the complete whole garment production system one individual makes the entire garment from cutting the cloth to sewing and pressing the garment. In assembly line production system there are three types such as (Progressive bundle systems (PBS), Unit production system, Modular system).The different types of production systems are distinct and require different conditions for working. However, they should meet the two basic objectives, that is, to meet the specification of the final product and to be cost-effective in nature. The main aim of any production system is to achieve a minimum possible total production time. This automatically reduces in-process inventory and its cost (Oliver et al., 1994)

2.3 Factors evaluating production system

The choice of best garment production system will depend on the product and policies of the company and on the capacities of manpower. The main goal of all the production systems is to decrease the total production time which leads to reduction in inventory cost. The appropriate selection of a suitable garment production system for an industry is influenced by the product style and policies of the industry and on

the labor capacity. The cost of inventory decides the choice of a production system in most circumstances in an apparel industry. When material, labor, space and interest costs are high, a synchronized subassembly system, which gives the minimum possible in-process inventory, is more suitable.

1. Processing time: It is the total working time of all the processes involved in assembling a garment.

2. Transportation time: It is the total time consumed for movement of semi-finished or finished garments from one workstation or department to another

3. Waiting time of unfinished garments: It is the idle time of a work bundle when it waits for the next operation.

4. Inspection time: It is time taken for in-process inspection of semi-finished garments or final inspection of finished garments before packing.(Babu, 2006)

2.4 The main processes and Steps of garment manufacturing

2.4.1 Planning of garment manufacturing

Planning is the important step in each phase of garment manufacturing and is a key phase of the management process and the overall development of the organization and the safety in performing tasks depend on the quality of plan. Production planning is important aspects of the garment manufacturing. Precision in planning equates to on-time shipments, the best use of labor, and assurances that appropriate supplies and equipment are available for each order. Production planning involves everything from scheduling each task in the process to execution and delivery of products. In most cases the production of garments is very time sensitive in order to ship goods to stores and boutiques for the upcoming season. Each function is explained briefly, just as an overview of the task. The planning process is a team effort by a number of people involved from a number of departments in an apparel organization. The initial step of this process is planning a line of products for a particular season or particular time period, depending on the company's selling seasons or selling practices. The planning development team is generally comprised of several people from designing, merchandising, research and development (R&D) and raw material development, technical design or product engineering, sales and marketing, finance, graphic design, sourcing, operations, planning, and quality assurance .The planning team

uses the information from research on trends, colors, materials, previous successes or failures, past sales records, experience from previous lines, and mark-down reports, etc. to brainstorm a plan for the new line. The information from this effort will assist the designers and the team to formulate a plan for the new line with a positive (brand) image to influence the consumer segment that the company is targeting for its sales (Stone, 2007).planning (following a decision as to 'what' to produce, 'how' to produce it, and with 'what' tools and equipment) is to adapt the manufacturing process to the available means of production, and shape it so as to ensure optimal production regarding time, costs and quality, building corrective and clearly layout before starting any activity and process which including (quantity of raw material require in process manufacturing quality of raw material (fabric, accessories, others) , the time of reach the raw material the place of production if the raw material don't available in the company , the time spent of manufacturing, the time delivery for receive the customer, understanding customer specification and achieving it, planning the sequence of work by select the first task should be done regular in orderly in all processes organizing allocating and assessing and determine time of each process, know the qualify and level of employees, know the capacity of organization, Treatment all the short coming in the organization planning is the sequence of work by select the first task should be done regular in orderly in all processes organizing. Allocating and assessing and determine time of each process, determine the average production day, monitoring the production, reviewing the results, determine the time delivery for the customer. Planning and coordination of the manufacturing process, as a basic process that transforms material inputs into products or services.

2.4.2 Design and Pattern making

After planning, the process Pattern making begins with the first step in manufacturing of garment is the creation of design and construction of patterns for the components of design. This requires determination of geometrical shape of the body surface in order that appropriate shell structures can be produced. Constructing garment patterns is a complex process that is performed, for particular types of garments, on the basis of (Eberle et al., 2008) (body proportions, body measurements garment, sizing systems and size designation of clothes, back and chest widths, main body measurements, construction measurements and additional

measurements) , design which is a critical component in the development of fashion products. The design process begins with a line concept, which explains the mood, theme, and other key elements that contribute to the identity of the line(Keiser et al., 2017). To develop the line concept, the designers obtain their inspirations for designs by conducting research. This involves market research and fashion research, from which they interpret findings into styles considering the brand and the target consumer. The market research provides information that helps the company to understand consumer demands. This it could be done by investigating the target consumers and their behavior (through consumer research), their preferred product designs and characteristics (through product research), and the general market trends through market analysis). The fashion research provides trends for the season as silhouettes, design details, colors, fabrics, and trims(Burns et al., 2016). Textile and graphic designers play a vital role in bringing the textile design ideas. Because of the fabric choice can play a substantial role in the aesthetics and performance of the designer's fashion ideas (McKelvey and Munslow, 2011). Textile designers gets their inspirations from mood boards from the design team, catwalk reports, print suppliers, and observing other fashion manufacturers or retailers (Goworek, 2010). Patternmaking requires a range of equipment including hardware and software to incorporate both the manual and the CAD domains. For manual pattern construction the components of a patternmaker's tool kit consist of an array of essential equipment items to accurately draft the flat pattern shape. If starting by constructing basic blocker foundation pattern according to a preferred construction method as previously discussed (Davis et al., 2008, Aldrich, 2015, Aldrich, 2012)the starting point is a set of measurements, measured either from a body directly or from a setoff standard measurements. Thus, no distortable tape measure to take accurate measurements is the foundation of any patternmaker's tool kit. For mass production, having mannequin and or fit model that represents the required size and shape of the target market sample size is an essential resource for verifying garment fit of digital patternmakers. Within the contemporary context, pattern construction is a complex process dependent on a range of design sources and manufacturing modes. Thus, being able on a range of design sources and manufacturing modes. Thus, being able to develop and evolve according to the interaction of the three domains of body, design and material allows for successful pattern shape according to the desired

outcome. The patternmaker is no consideration of the most appropriate method for creating longer simply a design interpreter or convertor, working in support of a creative designer. The process of patternmaking can itself be a creative technical design source. Therefore, the capacity to identify and dissect the elements and components and considers them as variables allow for a methodological approach to creating patterns for apparel. In addition, consideration of these elements is also embedded within the 3D CAD future, which in turn is developing a new digital tradecraft for patternmaking.

2.4.3 Spreading and cutting

Spreading is the process of stacking the material one layer on top of another to create a lay. The lay can be a single ply of fabric or several hundred plies. Various factors that can affect spreading should be checked, such as ply alignment, ply tension or slackness, bowing and splicing(Solinger, 1988).Spreading is a preparatory operation for cutting and consists of laying plies the composition of each spread, the number of plies of each color is obtained from the cut order plan. Number of plies depends on:

1. Capacity of the cutting machine,

2. Volume of production,

3. Type of fabric itself (rough or slippery)

4. Thickness of fabric.

Spreading fabric for cutting may be done in a variety of ways. These spreading modes describe the way in which the face of the fabric will be oriented, and what the nap direction is from ply to ply. The choice of spreading mode will affect the cost of spreading and the quality of the finished product (the result of the cutting). Spreading quality is achieved when any flaws in the face of the fabric can be identified by the spreader (even if the fabric was pre-inspected), and removed (either during the process of spreading or marked for removal after spreading). The highest levels of spreading quality are, therefore, achieved with spreading modes that permit the face of the fabric to be 'up' and visible to the spreader at all times. In laying and cutting procedures, layers of fabrics are superposed on a table to be cut simultaneously into garment components for further processing. During these operations, it is essential that each layer of fabric is laid in an unrestrained state in order that the dimensions to which various parts of the garments are cut are stable dimensions of the fabric. The fabric properties that govern this are extensibility in laying direction decides the ease

with which the fabric can be laid in an unrestrained state. It is essential that the fabric should not be too extensible at low loads. The coefficient of friction helps to make multiple layers more or less stable. Stretch in fabric layers produced by in-plane or lateral stresses on superposed fabric layers will affect the stress-free dimensions of the garment patterns. The numbering of cut components during the numbering process, every component is given a sequential number. This corresponds to the number of the fabric ply from which the component was cut. In the subsequent sewing process, the components with the same sequence number will be joined to make one article. This numbering helps to eliminate any confusion of the components and prevent the joining of components with different color shades. The sorting of cut components the sorting and bundling of cut components are the final work operations during which the following actions are taken: a full set of components of each cut style is formed; the cut articles are grouped by size, and also by color if several different colored fabrics were laid in one spread.

2.4.4 Sewing

According to (Kunz and Glock, 2000), sewing garment pieces together with thread forming stitches and seams is the most used method of garment production. Seam is the join between two or more plies of pieces of material, whereas a stitch is formed by one or more threads or loops of threads. Both the seam and stitch type affect the quality of a sewn garment which is characterized in terms of strength, durability, elasticity, security and appearance. Seam is the line where two or more layers of fabric are held together by stitches. It joins two or more pieces of fabric together, often leaving a seam allowance with raw edges inside the joining. During this operation, the fabric should be kept under the control of the operator and the sewing-machine feed dog. This requires a degree of in-plane fabric stability. Adequate tensile strength, shear rigidities, and fabric-to metal coefficient of friction are basic requirements for seaming.

2.4.5 Sewing-room problems

Sewing damage is a problem in apparel production, causing minor appearance problems which may have several causes (Carr et al., 1994).

2.4.5.1 Seam pucker

Generally, a seam is expected to lie flat in the fabric. The experienced sewing technician knows that in some types of fabrics, especially light, weight fabrics, this is rather difficult to achieve. Often the fabric gets rippled or undulated along the seam line. In most situations, this is a purely aesthetical defect of a seam, which may have several causes.

2.4.5.2 Differential fabric stretch and feed pucker

Differential fabric stretch, or feed pucker, occurs when different fabric plies being sewn are fed in dissimilar conditions by the material feeding system of the sewing machine. This causes the individual plies to be stretched differently, thus causing seam distortion when the materials recover from the suffered extension.

2.4.5.3 Dimensional change of the fabric

Conversely, if the fabric shrinks more than the thread, the stitch may become loose and the seam may undulate, although in a different manner. This is very common when sewing stretch fabrics. In order to avoid this problem, sewing machines used for stretch fabrics are normally equipped with differential bottom feed in this system; the presser-foot is split into two parts, whose movement amplitudes may be adjusted distinctly. If the rear feed dog (called the main feed-dog) has a longer movement than the front feed-dog (called the differential feed-dog), then the material will be stretched. This is called negative differential bottom feed. On the contrary, if the differential feed-dog has a longer movement than the main feed-dog, a non-elastic material would be gathered near the needle (Carvalho et al., 2015).

2.4.5.4 Sewing defects caused by needles

(Carvalho et al., 2015) Another main problem found in the sewing room is the defects caused by the interaction between the needle and the fabric. This can cause different types of damages in the fabric, namely:

7

• Rupturing of fabric yarns due to the collision with the needle tip.

• Friction between the fabric yarns and the needle.

• Thermal aggression of the needle on the fabric yarns.

• Friction between the fabric yarns and the sewing thread

2.4.5.5 Problems in stitch formation

The main problems that arise from the actual stitch formation include skip or slipped stitches, staggered stitches, unbalanced stitches, joint stitch, variable stitch density and needle, bobbin or looped thread breakage (Carvalho et al., 2015) presented the problems related to stitch formation: such as stitch imbalance, stitch distortion and skipped stitches as described below

2.4.5.5.1   Stitch imbalance

When a machine is set with the right ratio of thread pre-tensions on the threads being processed into the seam and with an absolute value of tension adequate to the materials and objectives of the desired seam type, a stitch is balanced. Stitch balance is fundamental for a quality seam, both from the aesthetic as well as from the functional point of view. Requirements on thread tension may vary according to the team's final use. A joining seam, for instance, requires higher tension than a seam for edge finishing ('serging' seam), because it has to hold the joined fabric plies firmly together. A seam on a stretch fabric uses lower tension than on a non-stretch fabric, because it has to provide some elasticity. It is up to the operator or technician to setup the machine for each type of sewing condition in order to assure optimal seam balance and tension setting. To achieve optimal balance, the interlacing points of the different threads intervening in a particular stitch type should occur according to the ideal stitch geometry that can be found, for instance, as described in the ISO 4915standard. For example, a balanced 504 stitch type has the lopper threads crossing at the center of the edge of the material being sewn and the needle thread holding the seam efficiently, assuring the necessary resistance and elasticity the stitch balance is directly related with the pre-tension values set during machine set-up. An indicator for correct stitch balance and tension are the resulting thread consumption values for each thread. Expected values of thread consumption values

for each thread. Expected values of thread consumption can be computed from the geometrical parameters of the seam, that is, material thickness, stitch length and width. Incorrect adjustment results in deviation from the predicted consumption values. When the needle thread loop is too loose, the joined fabric plies are not adequately held together, which may be acceptable in some situations (serging seams) and unacceptable in others (joining seams). If any of the interlacing spots of the threads do not match the pre-defined positions, there is an imbalance between the thread tensions. This will normally influence the team's performance negatively, and should thus be avoided (Carvalho et al., 2015)

2.4.5.5.2   Stitch distortion

(Carvalho et al., 2015) mentioned that the Stitch distortion is a problem especially in knitted garments, which affects the size stability of the garments. They stated that the distortion may have several causes, such as thread irregularity, improper handling by the operator, sharp speed variations. They mentioned also that this kind of defect is often very difficult to detect.

2.4.5.5.3   Skipped stitches

(Carvalho et al., 2015) stated that One of the most obvious, serious and sometimes difficult-to-detect defects are skipped stitches. A skipped stitch represented a weak point in the seam, and occurs when one or more of the interlacements between sewing threads fail to happen.

They mentioned that one of the causes for skipped stitches include is sewing threads with inadequate twist amount or direction, affecting the formation of loops necessary for the interlacement of the sewing threads. Others causes may occur due to inadequate needle diameter thread linear density or a combination of both. In addition to machine incorrectly threaded and damaged or wrongly positioned needle. They also, stated that the Needle and loopers at inadequate distance, damaged or not synchronized are also causes for skipped stitches.

2.4.5.6 Sewing Thread breakage

Thread breakage can be an annoying problem in the sewing room, although it is often quite easy to avoid. Constant thread rupture not only causes productivity quite easy

to avoid. Constant thread rupture not only causes productivity loss due to the time needed to re-thread the machine: in some situations, the whole seam has to be remade, and in other, the interruption of the seam is an unrepeatable defect (e.g. top-stitching a shirt collar).As seen before, thread breakage may result from overheated needles due to thermal aggression. Also, bad-quality or worn-out needles may cause problems due to excessive friction. Very often the problem lies in the machine. Incorrect threading or defects in the machine thread guides cause the thread to weaken and fail. The correct setting of in the machine thread guides cause the thread to weaken and fail. The correct setting of the synchronization and distance between needles and loopers, or other elements, are also important. Stitch formation thread breakage is more likely to occur at high speeds and when using higher thread tensions. Reducing these two factors certainly minimizes the problem, but due to productivity or functional requirements it cannot always be done. Most often, the problem resides on the quality of the sewing threads. The appeal to save on thread costs does not normally pay off. The cost on thread in garment typically does not exceed a few percent of the total price. Productivity loss due to thread breakage, besides non-repairable defects, is potentially more costly. Moreover, a good-quality thread is an asset for strong, stable and durable seams. High shrinkage potential of fabrics is another source of seam pucker. Threads made of cotton and other natural fiber often shrinks when wet. This may cause seam pucker when fabric shrinkage and thread shrinkage differs. This problem can largely be overcome with the use of synthetic sewing threads. These threads are normally dry heat stabilized to withstand up to 110°C. They may also cause seam pucker during pressing, if the pressing temperature is above heat-set temperature. Must be avoid problem of thread by testing the Yarn diameter, Yarn number of a sewing thread, Yarn ply, Strength and elongation, Shrinkage, Length per thread holder of sewing thread (Carvalho et al., 2015)

2.4.6 Fusing process

(Behera, 2015) stated that the Fusing of interlinings in garment manufacturing is a very important process. Fusing process is carried out by applying temperature and pressure over a period of time. The electric heating elements of the press cause the rise in temperature at the glue line which is the interface of resin and outer fabric. Interlinings are the accessories used between two layers of fabric to keep the

different components of garment in a desired shape or to improve the aesthetics and performance. Generally, interlinings are soft, thick, and flexible fabric made of cotton, nylon, polyester, wool and viscose or their blends, which may be coated with some resins. There are two types of interlinings in use in the garment production: fusible and non-fusible. The interlinings are carefully selected so that they can withstand the conditions during the fabric care and maintenance without any damage during the useful life of a garment. Once the garments are finished and inspected; they are packaged and transported to the retailers or the point of sale to the consumers(Behera, 2015).

2.4.7 Pressing

Pressing operation plays a major part in creating finished garments. The aesthetic appeal of the garment is increased with pressing. In the garment manufacturing process, the fabric is subjected to a lot of stress during cutting, sewing process. Due to the processes, crease formation and crushing of garments take place and it happens during handling and transportation also. The look of a garment is increased manifold times due to proper pressing of garments thereby attracting the public to buy the garment (Surjit and Rathinamoorthy, 2015)

2.4.8 Storage and packaging

After pressing, the garment should be free from wrinkle and creases, and have a good shape. Garment needs to be stored and packed for delivery to the potential customers. Nowadays, there are semi automation packaging machines available in the industry, but careless or inappropriate storage and packaging will cause deterioration in the appearance of the final product (Thilagavathi and Viju, 2013).

2.5 Quality assurance and quality control in garment manufacturing

Quality assurance and quality control are the important, unique, and complex area of the garment, and accessories industries. Quality assurance is not quality control, but quality control is an aspect of quality assurance. Quality assurance focus on process and quality control focus in product, quality assurance prevent defect and quality control find defect. Quality needs to be incorporated into every aspect of a product from the original design concept to the marketing and selling of a product (Kadolph, 2007).

(Kadolph, 2007) reported that the quality is assessed in the garment manufacturing during preproduction, production, and post-production operations. In the preproduction phase, fabric, accessories, closures, interlinings, sewing threads, and other design elements are tested prior to the construction of garments. The production of garment products includes cutting, assembling, pressing and other finishing procedures, and final inspection. At each step of the production phase, garments are assessed for quality. Companies develops various sampling plans to inspect products during the final inspection. Postproduction quality evaluation includes wear testing and testing with a simulation.

(Kadolph, 2007) stated the different between the concept of Quality assurance and Quality control. He stated that the Quality assurance is the "process of designing, producing, evaluating, and assessing products to determine that they meet the desired quality level for company's target market". Quality assurance looks at a product from the first design concept until it is sold to the consumer. Quality control is generally understood as assessing for quality after products have already been manufactured and sorted into acceptable and unacceptable categories. He also, mentioned that it is costly for companies that do not take a quality assurance method, but only look at quality in terms of quality control. Quality is a multifaceted concept that describes how well a service, process, material, or product possesses desired intangible or physical attributes.

However, several organizations have created standards and specifications to help in assessing consistent quality. Major organizations include the American Association of Textile Chemists and Colorists (AATCC) and the American Society for Testing and Materials (ASTM). These organizations account for the majority of test methods written for the apparel industry. Other organizations include the American Society for Quality (ASQ), American Apparel and Footwear Association (AAFA), Textile Clothing and Technology Corporation (TC2), American National Standards Institute (ANSI), and the International Organization for Standardization (ISO). These organizations publish industry-wide standards or "commonly agreed on aid for communication and trade; a set of characteristics or procedures that provide a basis for resource and production decisions; a product that meets all specifications and company or product requirements".(Kadolph, 2007)

These written standards assess fabrics and apparel products usually in terms of characteristics such as pilling, frosting, or color transfer. Individual companies write their own specifications or "a precise statement of a set of requirements to be satisfied by a material, product, system, or service that indicates the procedures for determining whether each of the requirements are satisfied" based on their target market's expectations (Kadolph, 2007).

2.5.1 Preproduction inspection and testing of raw material

2.5.1.1 Inspection and testing of fabric

Fabric, accessories, closures, interlinings, sewing threads, and other design elements are all tested prior to the garment manufacturing in the preproduction quality control phase.

(Keist, 2015) reported about the important of preproduction inspection. He stated that each component of a garment is tested prior to assembling. Fabric is assessed for major and minor defects and Closures, interlinings, sewing threads, and other design elements are tested for their quality and durability. Fabric with too many defects or closures that do not work properly can be detected prior to construction, which saves time and money in the long run. (Keist, 2015) reported also, about the Importance of Testing and inspection of fabric in the clothing industry to increased competition in the world market which have encouraged consumers to expect high-quality garments at affordable prices. However, the quality of a garment, as normally perceived by a customer, depends on its aesthetic appeal, its ability to drape gracefully, its 'handle' and durability. These depend largely on the quality of the fabrics used and the making-up process.

Knowledge of a fabric's behavior during its transformation from a two-dimensional plane into a three-dimensional article of clothing, and characteristics of the materials involved, are of prime importance for efficient production. It is, therefore, necessary to be able to identify and understand the natural characteristics and the mechanical and physical properties of fabrics.

2.5.1.2 Inspection and testing of accessories

(Keist, 2015) reported about the important of Garment accessories inspection. He stated that the Garment accessories are in the same manner as other textile and garment products. Accessories are checked during preproduction, production, and postproduction with a final inspection. Various fashion accessories include closures, interlinings, sewing threads, elastic waistband, and other design elements. These accessories should be able to withstand the care and maintenance procedures devised for the clothing.

2.5.2 Quality control and inspection during production

(Keist, 2015) reported also, about the important of Garment quality control and their inspection during steps of production which includes design and pattern making, cutting, numbering component of cutting, sorting components of cutting ,assembling, pressing and other finishing procedures and final inspection. He stated that each step in the production process is vital to the overall quality of garment products.

2.5.2.1 Spreading and cutting inspection

Cutting is an important phase of the production process. Precision is needed to cut accurate pieces that will fit together during the assembly process. Cutting defects which will be inspected include frayed edges; fuzzy, ragged, or serrated edges; ply-to-ply fusion; single-edge fusion; pattern imprecision; inappropriate notches; and inappropriate drilling (Keist, 2015)

Proper care should be taken to avoid any mistakes during spreading; otherwise, it will result in improperly cut components. The major parameters such as ply alignment, ply tension, bowing, and splicing should be done with a great care. Not enough plies to cover the quantity of garment components required should also be taken care. Misaligned plies will result in garment parts getting cut with bits missing in some plies at the edge of the spread. Narrow fabric causes garment parts at the edge of the lay getting cut with bits missing. Incorrect tension of plies, i.e., fabric spread too tight or too loose, will result in parts not fitting in sewing, and finished garments not meeting size tolerances. Not all plies facing in correct direction (whether "one way "as with nap, or "either way" as with some check designs), may

create in pattern misalignment or mismatch. This happens when the fabric is not spread face down, face up, or face to face as required.

2.5.2.2 Assembling inspection

After the pattern pieces have been cutting and they are assembled. Many issues and defects can arise during the sewing process. Defects in assembling include defects with both stitches and seams. Possible stitching defects include needle damage, feed damage, skipped stitches, broken stitches, wrong or uneven stitch density, balloon stitches, broken threads, clogged stitches, hangnail, and improperly formed stitches. Possible seam defects include seam grin, seam pucker, incorrect or uneven width, irregular or incorrect shape, insecure back-stitching, twisted seam, mismatched seam, extra material caught in seam, reversed garment part, wrong seam type used, slipping seam, and wrong thread used (Keist, 2015)

2.5.2.3 Sewing inspection

Sew ability is defined as the ability and ease with which fabric components can be quantitatively and qualitatively seamed together to convert a two dimensional fabric into three dimensional garment. The quality and serviceability of a garment not only depends on the quality of the fabric, but also on the quality of the seam. Quality characteristics of the seam can be measured by seam parameters such as seam strength, seam pucker, seam slippage, seam damage or needle cutting and seam appearance. Each of these parameters is influenced by various materials and machine variables, and can be quantitatively measured and inspected (Jana, 2015)

2.5.2.4 Pressing and finishing inspections

After garments are constructed, final preparations are completed. These final preparations include pressing garments to help set seams and finish garment shaping. Defects during pressing and finishing include burned garments, water spots, change in original color, flattened surface or nap, creases not correctly formed, fabric of

finished garment not smooth, edges stretched or rippled, pockets not smooth, garment not correctly shaped, and shrinkage from moisture and heat (Keist, 2015)

2.5.3 Final inspection

After materials have been tested for quality and the products have been manufactured, products are tested for their performance requirements, overall appearance, and sizing and fit. Proper sizing and fit can be measured as per the size of the garment or they can be tested by putting the garments in manikins or even live models. They are also checked visually for any faults during the production process. Hence, the quality of stitching, joining of garment components and accessories are inspected. Although each component of a garment is tested individually, in preproduction quality control, products are tested for a final time to assess the compatibility of materials used together and any noticeable fault. Garments are inspected for off-grain fabric, poor or uneven stitching, mismatched plaids or stripes along seams, puckered or extra material caught in seams, and uneven seams along hems, among many other problems that can occur in the apparel industry (Keist, 2015)

2.6 Garment cost

According to (Langfield-Smith et al., 2017), cost refers to any resources that are given up to achieve a goal. So, the cost is measured in monetary terms in accounting to show up on a balance sheet. The cost can also be defined as an economic value, spent to produce a product. The cost has a direct relationship with the economic activities used to add the value to a product from the raw material through to the finished commodity.

According to (Brown and Rice, 2001), the garment cost can be defined the process of approximation of the total cost to produce a garment, from a buyer's perspective, including raw materials, labor, and other expenses.

2.6.1 Cost elements

According to (Singh and Nijhar, 2015),the cost is classified as fixed or variable according to the behavioral aspect. The total cost in garment manufacturing on the basis of behavior is thus the sum of fixed cost and variable cost. They stated also, cost is also, classified as direct and indirect on the basis of traceability.

2.6.1.1 Direct material cost

According to (Jeffrey and Evans, 2011),the direct material cost is the cost of material that after value addition is converted into a finished garment. The direct material cost is approximately 45 to 60% of the garment's cost, depending on the types of the garment and the automated sophistication used to produce the garment.

So, raw material is still a major cost driver. Even a little reduction in direct material cost significantly impacts the total cost of a garment. The major reason to select an appropriate supplier, using supplier selection criteria, is to bring the total cost down. The fabric, as a raw material for the garments, is a major cost component, so optimum utilization of fabric is vital at the planning, laying out and cutting stages. An example of direct material manufacturing may include yarn, fabric, zippers, buttons, fabric fillings, hooks, labels, and cost in apparel etc. The price paid to bring the material from the supplier to them manufacturing unit is also accounted as a direct material cost, which is transportation cost and also called 'inbound logistics cost'.(Jeffrey and Evans, 2011)

2.6.1.2 Direct labor cost

Labor cost is the most essential component in the overall cost of garment. According to (Fiallos, 2009), labor cost can be divided into direct labor (either who involved in making a garment) and indirect labor, where direct labor is skilled and indirect is unskilled labor. Thus, direct labor cost means the wages given to the workers who are directly involved in manufacturing of the garments and the cost that can be traced per garment. So, the wages cost may include the salaries for cutters, sewers, press operators and packing operators as well. Lang field-Smith et al (Langfield-Smith et al., 2017) mentioned that the 'Labor on cost' is an additional cost that is paid to the employees managing payroll tax, employer contribution to superannuation funds, workers insurance, etc. they stated that also, Some companies treat these costs as manufacturing overheads.

2.6.1.3 Direct expenses

The proportion of direct expenses is not very significant, but this is the cost involved in assisting garment manufacturing. An example would be a company purchases any license to run a machine or process or any royalty paid by the company to another company as a part of business. Also, any small contract work involved ,such as embroidery, special finish to a garment, etc., is treated as direct expense (Singh and Nijhar, 2015)

2.6.1.4 Indirect cost or overhead

According to (Jeffrey and Evans, 2011), the element of cost is indirect cost, the cost that cannot be traced to a garment in an economic way. Indirect cost is the cost to run a company, which is otherwise referred to manufacturing overhead or simply overhead. Manufacturing overhead covers all other cost not associated with direct material and labor cost. The overhead contributes around 30% to the total cost of the garment.

The cost to move the garment batches from one process to another may be regarded as an indirect cost. Other overhead costs may include machinery depreciation, factory insurance, electricity, overtime and the support department. The support departments are not directly involved in production but assist in production. Idle time is also an overhead when machine and labor are not being utilized due to machine breakdown, schedule maintenance or machine set-up time. Apart from manufacturing overhead there is administrative overhead, selling overhead and money spent in research and development. Cost of the operators who help in manufacturing the garment; and finally, the overhead cost is the cost to run the business (Jeffrey and Evans, 2011)

2.6.2 Garment costing sheet analysis

The process of approximation of the total cost to produce a garment, from a buyer's perspective, including raw materials, labor, and other expenses, can be defined as costing (Brown and Rice, 2001). A costing sheet is used to trace the costing components. It is quite useful and handy to understand the percentage share of cost

for each constituent of the apparel supply chain, including material used. The allocation of the cost depends upon multiple variables (Singh and Nijhar, 2015)

The 'cost to the factory' where the garment is manufactured include types of fabrics used, dyeing cost, trims and accessories used (such as labels, hangers, threads, fusing, buttons, zippers, etc.), cutting cost, stitching hangers, threads, fusing, buttons, zippers, etc.), stitching cost, trimming cost, packaging cost, company overhead, labor cost, administration cost, etc. A reasonable mark-up is added on the finished garment to cover expenses incurred by the manufacturer and to earn profit (Singh and Nijhar, 2015)

Once the garment is manufactured, road/rail transportation cost is added to deliver the garments to a port of loading. At the port of loading, the cost of freight forwarders and stevedoring is added. Normally, the garments are transported by sea unless the lead time requirement is very tight that demands air transport. The landed cost of the garment in the buyer's country includes the FOB (free on board) price, shipping cost, clearance cost, custom duties and maritime insurance in the case of sea freight. The cleared garments from customs are road/rail transported to the buyer's warehouse, where the cost of inventory holding is added onto the garment price. Margin Is added to this final price (which is cost paid until the warehouse), which largely covers any mark-downs, expenses like salaries, sales promotion, rent, administration cost, insurance, taxes, etc., and finally the profit for the store (Singh and Nijhar, 2015)

2.7 New systems and tools for garment manufacturing development

2.7.1 Lean production

The use of lean production is now being practiced by organizations which aim to increase productivity, improve product quality, reduce cycle time, determine standard time and eliminate manufacturing waste.

2.7.1.1 Introduction

Garment manufacturing in nature is more complicated than many other industries. It involves a number of machines, hundreds of employees and thousands of bundles of sub-assemblies producing different styles simultaneously. In clothing production,

garment components are assembled through a sub-assembly process until they are gathered into a finished garment. The production process involves a set of work stations in each of which a specific task in a restricted sequence is carried out (Leung Patrick Hui and Fun Frency Ng, 1999). Many factors such as the properties of fabrics and human emotions will affect the performance of operatives that ultimately will cause variance on the task time. Delays can be broken down into work elements which can be readily measured as fixed or variable and these measurements are then combined into work standards (Gunesoglu and Meric, 2007) In today's competitive manufacturing environment, companies are constantly looking for ways on how to improve. Because of this, many companies are striving to practice lean manufacturing, which is a difficult process.

According to (Hoang et al., 2010) presented a comparative study on the relationship between implementing total quality management (TQM) and organizational characteristics (size, type of industry, type of ownership, and degree of innovation). They found that there is a clear difference in TQM practices by company size, industry type, and degree of innovation. Also, they stated that the TQM practices were statistically more significant in manufacturing companies compared to service companies.

 Productivity improvement is not a job for specialist only; it should be a part of every job in the organization. It requires the optimal use of all resources like manpower, machinery, money and methods (Wilson, 2010).A lot of studies have been focused on the lean concepts, principle, importance and benefits.(Nunesca and Amorado, 2015, Kumar et al., Kumari et al., 2015, Alukal and Manos, 2002). Many studies were focused also on the implementing lean tool is to increase productivity, reduce lead time, improve poor line balancing, reduce WIP, improve quality, and increase flexibility in design, and reducing cost, in addition to TQM impact to product innovation and on business strategy, and all management practices and performance. They reported that there are significant differences in both quality management practices and performance and there is positive impact of lean operations on the performance of garment manufacturing sector (Kumari et al., 2015, Malmadana Kapuge and Smith, 2007, Taj and Morosan, 2011).

To achieve these, the lean production philosophy uses several concepts like Kaizen, Kanban, 5S, Just in Time (JIT), Value Stream Mapping (VSM), etc.(Rahman et al.,

2013). As stated by (Farhana and Amir, 2009)"the key to competing in the international marketplace is to simultaneously improve both quality and productivity on continual basis." In today's competitive and changing business world, lean production philosophy has brought changes in management practices to improve customer satisfaction as well as organizational effectiveness and efficiency. Customers are now demanding a wide variety of products at a lower cost but with fast delivery (Farhana and Amir, 2009). They also expect more innovative products at competitive price as customers have more opportunities to choose from a variety of products. Lean manufacturing can be defined as "as systematic approach to identifying and eliminating waste through continuous improvement by flowing the product at the demand of the customer (Farhana and Amir, 2009, Silva, 2012, Nicholas, 2018). To achieve these, the lean production philosophy uses several concepts such as one-piece flow, kaizen, cellular manufacturing, synchronous manufacturing, inventory management, workplace organization, and scrap reduction to reduce manufacturing waste, shortening the cycle of production, reduction of required number of workers (Russell and Taylor-Iii, 2008, Munyai et al., 2017). As stated by (Kilpatrick, 2003), lean manufacturing makes an organization more production and services less expensively than a non-lean organization. There are studies that have been undertaken bearing on the relationship between lean practices and manufacturing performance of the firms (Farhana and Amir, 2009) also have shown the improvements in manufacturing through lean practice. The garment industry has numerous opportunities for improvement using lean principles. Many countries have started to practice lean manufacturing tools in the garment industry and observed tremendous improvement (Farhana and Amir, 2009)

2.7.2 Total Quality Management (TQM)

The Total Quality Management is regarded as a new access and managerial philosophy established mainly as a manner of work and a means for developing the performance of organization in order to achieve high quality. Total quality management don't focuses on product quality only it also consider act comprehensiveness versified focuses in performance quality in variation phases in organization. All the authors defined TQM as manufacturing good product in the first step. (Steingard and Fitzgibbons, 1993) (Vuppalapati et al., 1995)

2.7.2.1 Quality

Good Quality does not necessarily mean high quality. It means a predictable degree of uniformity and dependability at low cost, which suits to the market. The definition of quality depends on the role when they see it. The difficulty in defining quality exists regardless of product and this is true for both manufacturing of the people defining it. Most consumers have a difficult time defining quality, but they know it and service organizations. Today, there is no single universal definition of quality. Some people view quality as "performance to standards." Others view it as "meeting the customer's needs" or "satisfying the customer."(Chowdhury et al., 2007)

Figure 2.1 Dimensions of Quality

2.7.2.2 Basic quality tools

These seven tools are very important for quality measurement to achieve good quality of product by identify and analysis main causes of problem to prevent occurring of it

2.7.2.2.1   Cause-and-Effect Diagrams:

Cause-and-effect diagrams are charts that identify potential causes for particular quality problems. They are often called fishbone diagrams because they look like the bones of a fish. The "head" of the fish is the quality problem, such as damaged

zippers on a garment or broken valves on a tire. The diagram is drawn so that the "spine" of the fish connects the "head" to the possible cause of the problem. These causes could be related to the machines, workers, measurement, suppliers, materials, and many other aspects of the production process. Each of these possible causes can then have smaller "bones" that address specific issues that relate to each cause. For example, a problem with machines could be due to a need for adjustment, old equipment, or tooling problems. Similarly, a problem with workers could be related to lack of training a problem with workers could be related to lack of training, poor supervision, or fatigue. Cause-and-effect diagrams are problem-solving tools commonly used by quality control teams. Specific causes of problems can be explored through brainstorming. The development of a cause-and-effect diagram requires the team to think through all the possible causes of poor quality.(Syduzzaman et al., 2014, Kenett, 2014).
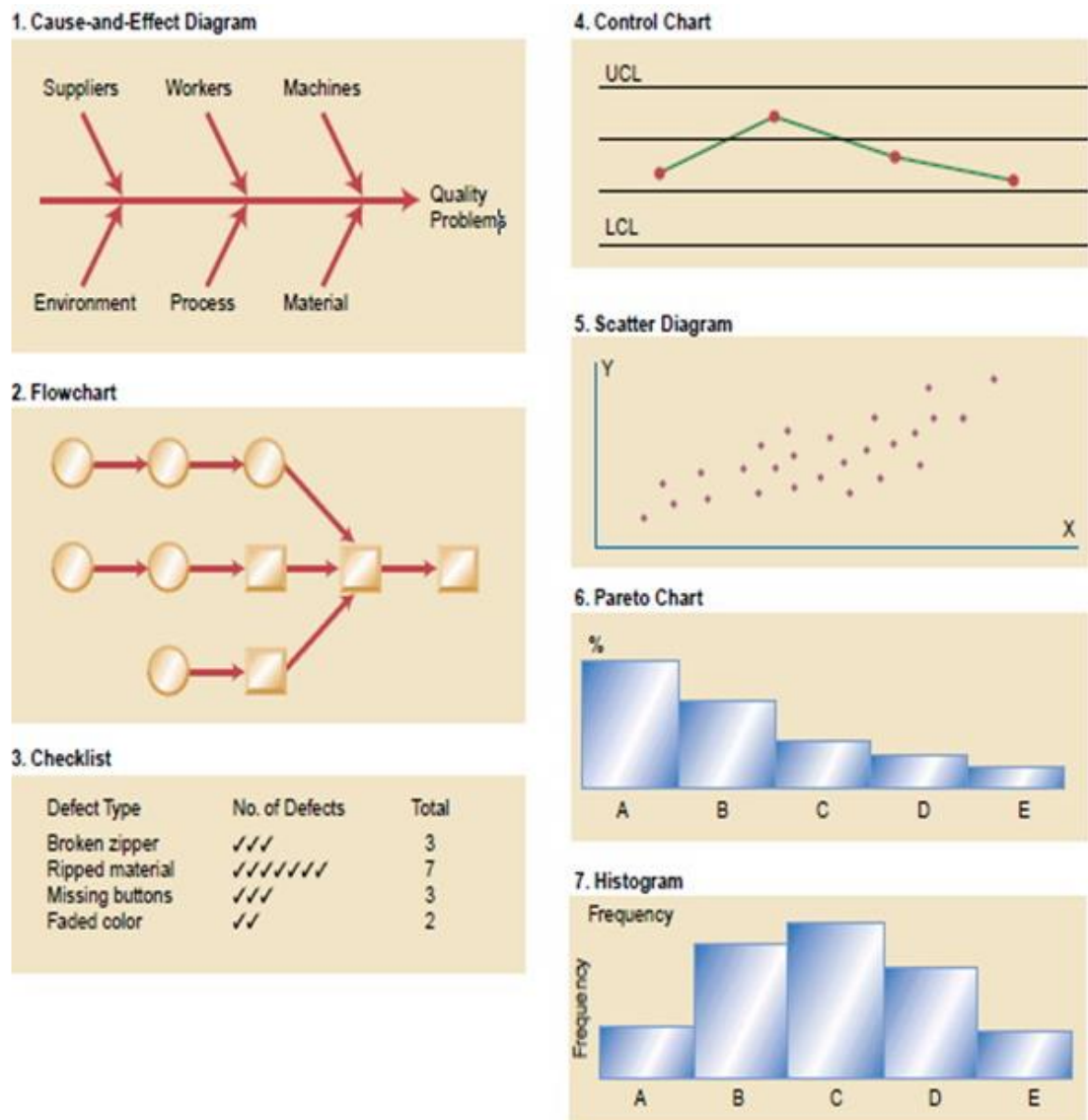
Figure 2.2 basic Quality Tools

2.7.2.2.2   Flowcharts:

A flowchart is a schematic diagram of the sequence of steps involved in an operation or process. It provides a visual tool that is easy to use and understand. By seeing the steps involved in an operation or process, everyone develops a clear picture of how the operation works and where problems could arise(Syduzzaman et al., 2014)

2.7.2.2.3   Checklists:

A checklist is a list of common defects and the number of observed occurrences of these defects. It is a simple yet effective fact-finding tool that allows the worker to collect specific information regarding the defects observed. For example, if a defect

is being observed frequently, a checklist can be developed that measures the number of occurrences per shift, per machine, or per operator. In this fashion we can isolate the location of the particular defect and then focus on correcting the problem (Syduzzaman et al., 2014, Ishikawa and Ishikawa, 1982)

2.7.2.2.4   Control chart:

Control chart are a very important quality control tool. These charts are used to evaluate whether a process is operating within expectations relative to some measured value such as weight, width, or volume. For example, we could measure the weight of a sack of flour, the width of a tire, or the volume of a bottle of soft drink .When the production process is operating within expectations, we say that it is "in control." To evaluate whether or not a process is in control, we regularly measure the variable of variable of interest and plot it on a control chart. The chart has a line down the center representing the average value of the variable we are measuring. Above and below the center line are two lines, called the upper control limit (UCL) and the lower control limit (LCL). As long as the observed values fall within the upper and lower control limits, the process is in control and there European Scientific is no problem with quality. When a measured observation falls outside of these limits, there is a problem(Syduzzaman et al., 2014, Ishikawa and Ishikawa, 1982)

2.7.2.2.5   Scatter Diagrams:

Scatter diagrams are graphs that show how two variables are related to one another. They are particularly useful in detecting the amount of correlation, or the degree of linear relationship, between two variables. For example, increased production speed and number of defects could be correlated positively; as production speed increases, so does the number of defects. Two variables could also be correlated negatively, so that an increase in one of the variables is associated with a decrease in the other. For example, increased worker training might be associated with a decrease in the number of defects observed. The greater the degree of correlation, the more linear is the observations in the scatter diagram. On the other hand, the more scattered the observations in the diagram, the less correlation exists between the variables. Of course, other types of relationships can also be observed on a scatter diagram, such as an inverted. This may be the case when one is observing the relationship between two variables such as oven temperature and number of defects, since temperatures

below and above the ideal could lead to defects (Syduzzaman et al., 2014, Ishikawa and Ishikawa, 1982)

2.7.2.2.6   Pareto Analysis:

Pareto analysis is a technique used to identify quality problems based on their degree of importance. The logic behind Pareto analysis is that only a few quality problems are important, whereas many others are not critical. The technique was named after Vilfredo Pareto, a nineteenth-century Italian economist who determined that only a small percentage of people controlled most of the wealth. This concept has often been called the 80–20 rule and has been extended too many areas. In quality management the logic behind Pareto's principle is that most quality problems are a result of only a few causes. The trick is to identify these causes. One way to use Pareto analysis is to develop a chart that ranks the causes of poor quality in decreasing order based on the percentage of defects each has caused. For example, a tally can be made of the number of defects that result from different causes, such as operator error, defective parts, or inaccurate machine calibrations. Percentages of defects can be computed from the tally and placed in a chart. We generally tend to find that a few causes account for most of the defects (Syduzzaman et al., 2014, Karuppusami and Gandhinathan, 2006)

2.7.2.2.7   Histograms:

A histogram is a chart that shows the frequency distribution of observed values of a variable. We can see from the plot what type of distribution a particular variable displays, such as whether it has a normal distribution and whether the distribution is symmetrical (Syduzzaman et al., 2014, Ishikawa and Ishikawa, 1982)

2.7.2.3 Definitions of Total quality management:

TQM can be defined as a set of techniques and procedures used to reduce or eliminate variation from a production process or service-delivery system in order to improve efficiency, reliability, and quality(Steingard and Fitzgibbons, 1993). (Vuppalapati et al., 1995) stated that TQM is an integrative philosophy of management for the continuous improvement of product and process quality in order to achieve customer satisfaction. According to (Dean Jr and Bowen, 1994)TQM is a

management philosophy or an approach characterized by principles, practices, and techniques. They pointed out three principles that most quality frameworks had in common – customer focus, continuous improvement, and teamwork. Each principle is implemented through set of practices, and these practices, in turn, are supported by a broad set of techniques.(Anderson et al., 1994, Hill and Wilkinson, 1995).

2.7.2.4 TQM factors

According to (Ahire et al., 1996, Saraph et al., 1989, Badri et al., 1995, Zhang et al., 2000) the factors of TQM were :Top Management commitment, Supplier quality management, Continuous improvement, Product Innovation, Benchmarking, Employee involvement, Reward and recognition, Education and training, Customer focus and Product quality.

2.7.2.5 The influence of Top Management commitment in implementing TQM

(Ahire et al., 1996) stated that the success of any effort targeted at changing the operational philosophy of the organization is strongly linked with the top management commitment. It is very arduous to change the behavior of the members of the organizations without the support of top management.

(Senge, 2006) stated that the change will be more successful if the top management is committed to the change. He also noted that top management plays a critical role in shaping the success of strategic changes in organizations

(Bourgeois III and Eisenhardt, 1988) demonstrated that the Top management plays a decisive role in paradigm shifts in critical areas such as quality management, product development and innovation.

2.7.2.6 TQM barriers

A large number of industries have implemented TQM initiatives. A majority of these industries encounter significant barriers in achieving their TQM goals. Various

reasons have been given for their failure, majority of the cited reasons were on management's inability to implement a total system approach(Shortell et al., 1995). Some TQM practitioners' also claim that if a company's culture is not conducive to total quality, the culture must be changed before total quality program can be implemented (Subrahmanya Bhat and Rajashekhar, 2009).

2.7.3 Six Sigma

Six Sigma is a business management strategy originally developed by Motorola, USA in 1981. As of 2010, it enjoys widespread application in many sectors of industry. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes Six sigma approach to create quality innovation and total customer satisfaction. The element of defects reached 3.4 per million of products(Rahman et al., 2009)

2.7.4 5S

5S; Representing Japanese words Seiri (Sorting), Seiton (Set in Order), Seiso (Shining), Seiketsu (Standardizing) and Shitsuke (Sustaining); is a method for organizing a workplace, especially a shared workplace (like a shop floor or an office space), and keeping it organized. Is a system to reduce waste and optimize productivity through maintaining an orderly workplace and using visual cues to achieve more consistent operational results. A sixth phase "Safety" is sometimes added. This method emerged as the 3S, and it spreads in the latest trends up to7S. According to some authors this is a separate method, while the others treat it as an integral part of the Lean approach (Rahman et al., 2009).

2.7.5 Kaizen system:

Kaizen system is the Japanese management practices and the most important tools of Kaizen is the 5S, that is, Sort, Set in order Straighten, Shine, Standardize/Systemize, and Sustain is a continuation of incremental improvements and improvements in quality, technology, processes, company culture, productivity, security and governance. This method involves all employees. The basic philosophy of Kaizen management is fast, simple and easy, but constant improving of operating efficiency. Kaizen requires small financial investments, but major changes in its views, the way

of work and thinking of all employees'. Kaizen method is often found in other methods and techniques (JIT, Kanban, 5S, 20 keys) (Colovic, 2011).

2.7.6 Just-In-Time (JIT)

It is a management idea that attempts to eliminate sources of manufacturing waste by producing the right part in the right place at the right time.is a concept which appeared in the twenties of the 20[th]century. In 1970 Toyota shown that it could be applied to all industries. For the development and progress of each PBS a necessary factor is synchronized and precise work that finally gives a quality product. JIT system is necessary to improve all aspects of control of both the input of raw materials and the intermediate control, and stimulate the workers to make more effort in performing the job, in order to avoid making mistakes and unnecessary repairs (Colovic, 2011).

2.7.7 Toyota production systems

After the Second World War Japan, faced with prejudices that their products are cheap and of poor quality, introduces the importance of quality and thus creates TQC (Total Quality Control). The basic principle of this concept is that all employees, from managers to workers in production, view a product from the standpoint of consumers. Therefore, quality controls are done with planning and designing with pre-secured quality without waste. Creating a strategy of quality Zero defect. Creator of the Toyota Production System (TPS) (Shing, 1989) defined it as a system that eliminates all the unnecessary things. TPS is a set of well-known techniques and methods for solving problems, the philosophy about responsible behavior and returning of values to customers, employees, properties and society (Colovic, 2011).

2.7.8 Kanban system

Kanban system is a part of the Japanese manufacturing philosophy that quick and easy methods manage the production, and introduced in the 50s of the previous century, in order to control the production and introduced JIT at Toyota Company. Basic principles of Kanban in a Toyota production system are as following:

- Continuous improvement of labor productivity, product quality, and efficiency of changing tools, etc.
- Efficient and simple methods for achieving high quality

- ▪ Efforts in production process to reduce or eliminate parts that do not contribute to increasing (Colovic, 2011)

2.7.9 Program 20 keys or PPORF

Program 20 keys or PPORF (The Practical Program of Revolution in Factories and Other Organizations), was developed by a Japanese professor(Kobayashi, 2018),and was first implemented in the Toyota Company. It includes 20 practical and integrated methods for improving competitiveness with improving the product, their faster delivery and lower prices. Today, the method is implemented in about 700 companies in 55 countries, which:

Basic principles of20 keys or PPORF in a Toyota production system are as following:

● achieve strategic business objectives,

● improve the speed of learning and innovation,

● increase the productivity and flexibility for better acceptance of market demands

● eliminate all types of waste,

● motivate employees

● improve competitiveness, profitability and long-term success (Colovic, 2011)

2.8 Problem statement

Sudanese garment manufacturing at the present time has obsolete equipment lagging technology that produces single variety of products in addition to ineffective management and poor ability of employees, as a result the economic benefit of the whole textile industry is very little. From year 2000 since now Sudan allowed its clothing market to importation of textile products to the outside world, unfortunately, Sudan now imports more than 90 % of its needs of fabric and garments from outside countries such as China, India, Pakistan and Egypt, Turkey, Thailand and …etc. almost all the local factories shown a state of incapability in competition. Numerous Sudanese factories that could not succeed in international competition or exports because their products are of unacceptable for customer or international quality

2.9 Hypotheses

The five elements those are very important in the process of improving productivity and profitability in the garment manufacturing as the following

1- Good Planning

The planning is the first important element for improving productivity and profitability in the garment quality because planning is the sequence of work by select the first task should be done regular in orderly in all processes organizing allocating and assessing and determine time of each process. The development of planning depends on the team effort by a number of people involved from a number of departments in an apparel organization. The initial step of this process is planning a line of products for a particular season or particular time period, depending on the company's selling seasons or selling practices. The product team is generally comprised of several people from designing, merchandising, research, raw material development, technical design, sales and marketing, finance, operations, planning, and quality assurance. The product team uses the information from research on trends, colors, materials, previous successes or failures, past sales records, experience from previous lines, and mark-down reports. The information from this effort will assist the designers and the product team to formulate a plan for the new line with a positive (brand) image to influence the consumer requirement and company targeting for its sales.

2- Good work environment

The second important element for improving productivity and profitability in the garment quality is the good work environment which include place of production, workshop, and store house. To improve the store house must be available the shelves to put on it all raw material to avoid it to touch the floor to prevent it from different factors environment such as moisture, dust, temperature , bacteria and rodent insect and available resources of air and adequate light. Place of production first corrective layout the place of production by provides it with all machines, tools and equipment and applying the 5s system in the place of production

Also available clear and adequate light and air resources in the place of production especially in the cutting room, available meal, available transportation to workers available work clothes, established clinic and provide it with all patient requirement , adopted recreational day and available child care for mother workers because in the section of garment manufacturing most of workers female.

3- Good quality of raw material (fabric, accessories and trimmings)

The testing and inspection of raw materials must be attained an important position in garment manufacturing lead to insure high quality and meet particular end use of fabric to achieve good reputation of the factory in the market and meeting customer satisfaction and requirement and the product leave long time, satisfaction and requirement and the product leaves a long time

4-Modern level technology of machine and equipment

Selected modern technology of machine and equipment of garment manufacturing such as fabric inspection machine, spreading machine, computerize and automation sewing machine, design equipment (CAD&CAM) Finishing machine, Package machine. All these machines and equipment are very important to achieve high quality of productivity and profitability because the modern technology machines, facilitate the process of manufacturing, reduce the number of workers, reduce the time cycle of production, reduce the manufacturing waste and the cost.

5-People

People have effective role to achieve high quality and profitability for garment manufacturing as the following

1.Leadership

Must be establishes unity of purpose and direction of organization, create and maintain the internal environment in which people can become fully involve in achieving the organization goal, facilitate all difficult in organization, guides without directing, bring change without disruption

2. Top manager

Must be understand the structure and strategy of organization which depend on type of technology, skill and experience of manpower, size of investment, type of production, help all employees to discover new approaches, breaks barrier between workers, preserves the group, improve and quick the customer service, building corrective and clearly layout before starting any activity

3. Designers

Designer must be understand all factors which will effect to the customers when selecting their garment such as (gender, age, income environment ,socio), analysis

the customer requirement   by visiting the social media and popular market and fashion centers   and also must be understanding   all the factors for customers evaluated or selecting   their garment and factors to   customers satisfaction and expectation such as (new fashion, fabric fit to environment, size fit and body shape, garment aesthetic and …etc.)

4. Suppliers

Must be available the raw material with good properties to customers satisfaction such as (durability of raw material, fabric structure, fabric comfortable, color fastness of washing , light ,sunlight, dry clean, perception and washing , perception , washing and also garment resistant to tearing and rubbing) and must be contact with organization continuously

5. Customers

This is the main element for development garment quality because complaint and orientation of the customer lead the organization to improve the product quality.

6. Workers

Workers include (production supervisor, maintenance worker, tailor, assistant tailor, controller, quality inspector, presser, package worker) they are plays an important role for improving productivity and profitability depending on their masterly achievement and their high experience and their continues training for continues improvement

7. Retailer

Plays an important role to the customer satisfaction by available good services and attractive aesthetic when the customer shopping to selected their garment.

8. Government

Plays an important role to improve quality of productivity and profitability by

1. Establish educational institutes for training human resources of new technology and facilitate all method inside the country and out the country

2. Facilitate all difficult interruption the human resources improvement

3-Reduce the cost of training

4-Reduce the customhouse and taxes of the section of textile and garment manufacturing

5- Available adequate power saving for operating

2.10 Objectives of the study

This research has been focused on the process, problems and their solutions of the exportation of garments and also helps to get a complete picture of exportation viability of garments from Sudan to other countries. In general, the study will aim to attain the following objectives:

- Identify the process of garments quality.
- Improving productivity and profitability
- Determination of the potential for competitive production of garment industry in Sudan.
- Recognize and assess the problems within the process of garment manufacturing.
- Enhance and maintaining harmony manufacturing environment to reduce manufacturing waste and the cost
- Customers satisfaction and meeting their expectation
- Improving ability of manpower

2.11 Thesis out lines

This thesis is divided into five chapters. Each chapter is briefly introduced as following:

- Chapter one is an introduction of thesis

- Chapter two literature review, problem statement, hypotheses and objectives of study

- Chapter three material and method by design several surveys, one of survey focus on attempted to implementation total quality management (TQM) in the garment manufacturing among garment factories in Sudan, other survey

designed for consumer to explore and attempted to identified how the consumers in the Sudan evaluate and selecting their clothing quality and determine all the factors influence perception of their garment quality and selection to assist the designers and manufactures of garment to understanding and available all specification and consumer requirement , reduce the waste time for process of garment manufacturing by study time and assess standard time for each step of garment manufacturing ,the role of type of system of garment production and it is effect to the time cycle of production and quality of production , the modern technology and human resources and their effect with high quality and productivity and reduce the cost .the major purposes of the use of lean production are to increase productivity, improve product quality and manufacturing cycle time, reduce inventory, reduce waste time, and eliminate manufacturing waste and scrape of product

- Chapter four results and discussion for surveys of local factories and survey of consumer and comparison between x_1 and x_2 factories one applying TQM and other don't applying TQM and this two factories selected as the case study in this research , finally the improvement achieving in x_1 garment factory during research study

  - Chapter five of this thesis covers conclusion (the main summary of the research) and recommendations and future work.

Chapter 3   Materials and methods

3.1 Introduction

As many studies mentioned in chapter two which we're conformed the suitability of the importance of application of TQM in garment manufacturing in propose of rise the quality of production and productivity and enhance the profitability. This study is attempting as a case study to investigate the application of TQM in garment manufacturing in Sudanese garment factories to know how a range of TQM concept and tools was applied. To answer this question, two full surveys have been designed to local Sudanese garment factories and Sudanese consumers, respectively.

From the results of the local Sudanese garment factories survey, two different local Sudanese factories were selected as the case study of this research to know how TQM was implemented in local Sudanese garment factories.

3.2 Materials

3.2.1 The survey for local factory

A full survey was designed and employed conducted among a sample of the local garment factories in Sudan. This study aims to focus on attempted to implementation (TQM) in the garment manufacturing among garment factories in Sudan to determine the impact on company strategy, management practices and performance. A survey is conducted of Sudanese factories to identify the weakness and strength and solving weakness

The important items chosen from the survey of local factories to analysis, it contained of 12items and 10 questions as the following

1-The time consumption for manufacturing one product

2- The fabric consumption (meter) for manufacturing one piece of product

3-Production system using in the factory

4- Number of lines available in the factory

5- Type of machine and equipment use in each phase

6- Level of technology used in the factory

7- Laboratory test viability in the factory

8- Method of management quality system applying in the factories

9- System of fabric inspection applying in the factory

10- Meeting and satisfaction, customer requirement by the factory

11- Time delivery to customer orders

12-Maintenancesystems applying in the factory

The questions as the following

1- Does your factory faced any competition in the global market?

2-If your factory has not faced any competition in the global market, has tried to achieve global competition in the future?

3-Does your factory has maintenance section?

4- What the percentage of maintenance during the month?

5-What the percentage of sales in the year?

6-What the percentage of treatment the defect in the day?

7-What the percentage of scrap in the day?

8-What the percentage of the cost of (defect, treatment, scrap, reworks?

9-Does your factory has gain any quality certificate international or locally?

10-What is the certificate that your factory tries to gain it in the future?

Also the survey of local factories contains of comparison between products of10 local factories for sewing quality, time for manufacturing one product and quality of raw material. Also determined and identified the problems of 10 local factories

3.2.2 The comparison between imported and local product

Chosen imported and local product for comparison, in sewing quality appearance and strength of stitch, number of stitches per inch, accessories quality and package durability and aesthetic

3.2.3 The survey for consumer

A full survey was designed and employed for Sudanese consumers. The purpose of this questionnaire is attempting to explore and identify how the Sudanese consumers evaluate garment quality and determine all the factors influence perception of garment quality and selection.

The Surveys are technique method for asking the customers to give their opinion on the products and services of one's business in the garment manufacturing.

The questions focus on the factors that assist the local manufacturer's and designers of garments in Sudan how current and emerging consumer requirements and expectations, and which factors have negative effects for consumers to understand the garment quality.

The important items Chosen from the survey designed for consumer contained 12 items and 10 questions as the following:

1. Our choice for garment quality subjective to household and income

2. The social media assist to rapidly spread the fashion in the whole world in one time

3. Consumer attractive to aesthetic and external package more than content product quality

4. The consumer related the garment quality with country origin

5. The complaints of the customers and their opinions lead to enhanced product quality

6. The consumer returns back the consignment orders if there any defect or fault in their specification need

7. The wide spreading of retailers in the huge number in the street it very effect to lack understand consumer to garment quality

8. The garment designer don't interested with customer satisfaction

9. Incorrect information in the product leads to lack understanding the consumer of garment quality, bad reputation to the organization and losses the customers

10. Consumer ignorance to the basic symbols in the garment leads to faultfinding until it is high quality

11. The garment manufacturers interested in time delivery more than quality

12. Consumer understanding of quality lead the manufacturers and designer trend to it

3.2.4 The case study

3.2.4.1 Introduction

Selected two factories from the factories have been covered by the survey of the local garment factories in Sudan. The two selected factories where most garment factories in Sudan have fully equipped and described as top. The comparison was made between the two selected factories to investigate the applicability of total quality management (TQM) in local garment factories in Sudan. The first one factory doesn't apply total quality management (TQM) and the second one factory applying TQM. known to both as $x_1$factory and $x_2$factory, respectively. The comparison cover and containing the following item:

3.2.4.2 Range of application of total quality management (TQM)

To know how the TQM system is applied in the two selected factories or not, the comparison was made between x_1 and x_2 factories. The comparison items contain the framework such as (work environments, planning, level of technology, method of management practice, work method, maintenance system, system of fabric inspection, training, level of productivity, type of place of production, Laboratory test of fabric and accessories, safety system, cycle time for manufacturing one product and Raw material quality.

3.2.4.3 The investigation of time study of garment manufacturing steps of x_1 and
       x_2 factories

Study each operation time to establish standard time for garment manufacturing time in Sudan, the attempt of comparison has been made to reduce the waste time for each

operation in garment manufacturing starting from design to packaging. In addition to identified the main reason of wasting time in the selected factories and solving all the reason causes the waste time. Moreover, to eliminate all the traditional and manual of equipment, machines and operations in the company. As well as, to improve human resources.

The comparison as the following:

1. The variation time of first steps of garment manufacturing of x_1 and x_2 factories, respectively.

2. The variation time of manufacturing one piece of shirt and trouser between x_1 and x_2 factories. Respectively

3. The variation of percentage of sewing product components defects between x_1 and x_2 factories. Respectively

3.2.4.4 The investigation of time study of garment manufacturing steps of x_1 factory

The attempt has been made to the selected x_1 factory as the case study to identify if it applies TQM tools for improving productivity and profitability and reduce the cost and manufacturing waste time, as the following

1. The lean manufacturing tools TQM ,(JIT,5S,Checklist,quality assurance) was employed and carried out in all the phase of garment manufacturing from design to package section to identify the reason of time waste in the x_1 factory by Time Study for one piece of men shirt and trouser which produced continues production system, in addition to 10 piece of shirt which produced by complete whole production system , between three workers to noticing the change of the time to calculate the average time by using stopwatch timer and identified the waste time reason loses in the x_1 factory and cycle time elongate, and determine the standard time.

2. Investigate the number of daily product in section quality (Product with defect and product require treated) in x_1 factory before and after implementation, quality assurance and basic of quality tools (check list)

3. Investigate the number of daily product in line production in x_1 factory before and after implementation, quality assurance and basic of quality tools (check list)

4. Comparison between percentage % of defect before and after applying quality assurance and check sheets in x_1 factory in section quality

5. The compression between two types system of production in x_1 factory

6. Investigate the improvement in $x_1$factory during the research study

3.3 Methods

The SPSS (Statistical Package for the Social Sciences) program has been used in this study for analysis of the results. The correlation, Paired Samples T Test, and One-way ANOVA analysis inside the SPSS were used.

The phrase "analysis of variance" was coined by arguably the most famous statistician of the twentieth century, Sir Ronald Aylmer Fisher, who defined it as "the separation of variance ascribable to one group of causes from the variance ascribable to the other groups". Stated another way, the analysis of variance (ANOVA) is a partitioning of the total variance in a set of data into a number of component parts, so that the relative contributions of identifiable sources of variation to the total variation in measured responses can be determined. From this partition, suitable F-tests can be derived that allow differences between sets of means to be assessed.To compare independent tow group we can use t-test, but what if we had more than two groups to compare? What if we had three or more? This is where ANOVA comes in.In ANOVA, we will evaluate null hypotheses of the sort H0: $\mu1 = \mu2 = \mu3$ against an alternative hypothesis that somewhere in the means there is a difference (e.g. H1: $\mu1 \neq \mu2 = \mu3$). Hence, in this regard, the ANOVA can be seen as extending the independent-samples t-test, or one can interpret the independent-samples t-test as a "special case" of the ANOVA.

Chapter 4   Results and Discussion

4.1 Introduction

As mentioned in chapter two, this study is attempt as cases study to investigate application of TQM in garment manufacturing in Sudanese garment factories to know how range of TQM concept and tools was applied. To answering this question, the results of two surveys of local Sudanese garment factories and Sudanese consumers were presented and discussed in this chapter respectively. In addition to the results of the selected two factories as case study to know the applicability of TQM in local garment manufacturing in Sudan.

4.2 Resulting of Survey for local factories

In the Sudan there are more than 100 garment manufacturing factories. 58% of these factories are registered as members of Sudanese chambers of industries association which we tried to collect information from them, we found around most of them are small household units having no less than 20 sewing machines and most of them between 70 to 500 sewing machines. Most of all these factories does not applied and implemented TQM practice except few factories has success complete application.

However, to implement this study, the questionnaire was distributed to a number of garment factories. The number of factories responding to the questionnaire was 17factories which were consider as collected samples of study. The 17th garment manufacturing factories were distributed from different industrial zone like Bahery, Omdurman and Khartoum. Percentage of the factories from the 17th factories were give us full response to our survey60% and consider as collected samples of study, because of 23% of factories closed and 17% of factories refused to fill the questionnaire and don't replied to the questions. The 10thfactories referred in the research as $(x_1,x_2,x_3,x_4,x_5,x_6,x_7,x_8,x_9,x_{10})$.A survey was conducted of Sudanese factories to identify differences in their quality practices depending on whether or not they have implemented TQM.

The level of technology of factories closed modern, medium and traditional and the number of machines about 100 to 20 machines and the main reason of factories closed unqualified the workers, high cost of customhouses and taxes and un abounds services. Also survey shown 17% factories refused to fill the questionnaire and don't replied to the questions .All the local factories have problems concentrated on (bad work environment, unqualified and trained the workers, traditional level of technology, bad store house situation, un established workshop in the all factories except two factories, but also in these two factories does not provide the workshop with all tools requirement to the maintenance, accessories and spare parts of all machines and equipment . The other problems safety problem in all the factories, doesn't provide place of production with the full safety and doesn't available the safety tools for the workers, also problems concentrated on system of maintenance all the local factories applying protective maintenance system except one factories applying treated maintenance system and other problems concentrated on bad planning, conflicts between internal customer, un motivate the worker moral, instabilities management and others problems.

4.2.1 The results of analysis of the chosen items and questions from the local factories survey

4.2.1.1 The time cycle for manufacturing shirt per minute

The time cycle for manufacturing shirt was shown in Table 4.1theresults found that, the time about 29 to 50 minutes for manufacturing shirt. Also The observed results found that the shorten cycle time related to the level of technology, factory strategy, management practices and type of production system for all 10 factories. The shorten time for manufacturing shirt was found in x_2 factories because of x_2 factory has a good work environment, modern level of technology, applying TQM system, using continuous production system and the workers has continuously trained. The longest time for manufacturing shirt was found in $x_4$factory because of x_4 factory has bad work environment, traditional technology and don't applying TQM system and using the complete whole production system.

Table 4.1 The time for manufacturing shirt men for local factories per minute

The factory	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
The time per minute for manufacturing shirt	37	29	30	50	36	31	36	38	40	24 lady item

4.2.1.2 Production systems available in the local factories

Table 4.2.shown production system applying in 10 factories , according to the observed result, there were 7 factories applying Complete whole production system and there were 3factories applying continuous production system. The cycle time of manufacturing was shorted when applying continuous production system while the cycle time of manufacturing was long when applying complete whole production system.

Table 4.2.Production system available in local factories

Direction	Number	Factories
Continuous production system	3	X_1, X_2, X_{10}
Complete whole or individual production system	7	$X_3, X_4, X_5, X_6, X_7, X_8, X_9$

4.2.1.3 Number of production phases available in the local factories:

As the survey, the production phases available in the 10 factories were shown in table 4.3 The observed results found that 6 production steps were available in the all ten factories, and there were 3 production steps such as Fabric inspection, Quality assurance, Inspection after package available in the $x_2$factory only which was applying TQM. The availability of production steps in $x_2$factory was lead to reduce the defect and scrap in the raw material and in sewing section and in the final product. Also results were found washing step does not available in all ten factories.

Table 4.3 Number of production phases available in the local factories

The production phases available	Number of factories	The Factory
Fabric inspection	1	X_2
Fabric spreading	10	All the ten factories
Fabric cutting	10	All the ten factories
Design	10	All the ten factories
Sewing	10	All the ten factories
Quality assurance	1	X_2
Washing	Non	Non
Quality control	3	X_1, X_2, x_4
Finishing operation	10	All the ten factories
Package	10	All the ten factories
Inspection after package	1	X_2

4.2.1.4 Types of machines and equipment available in the local factories:

The observed results shown in table 4.4 the type of machines and equipment which were available in all ten factories. According to the results, there were modern technology machinery and equipment available in X_2 factories while in X_1 factories there were modern and medium technology was available. Because of the non-perfect usage of availability modern technology in x1 factory lead to long time cycle for manufacturing the product and make occur of defect and scrap of product and this requires a long time for treated, the machines and equipment available in other 8 factories were medium and traditional technology which leaded for long cycle time

for manufacturing also and help to occur more defect and scrape, and more waste of fabric.

Table 4.4 Types of machines and equipment's available in the10 factories

Number	Machines available in production phases	Number of factories	The factories
Inspection and spreading machines			
1	Fabric inspection machine	2	X_1, X_2
2	Fabric spreading machine	3	X_1, X_2, X_{10}
3	Manual spreading (by hand)	8	$x_1, X_3, X_4, X_5, X_6, X_7, X_8, X_9$
Cutting machines and design tools			
1	Electric cutting machines straight knife for fabric	9	$x_1, x_2, x_3, X_5, X_6, X_7, X_8, X_9, X_{10}$
2	Electric cutting machines round knife for fabric	3	x_1, x_2, x_3
3	Electric cutting machine for interlining	2	X_1, X_2
4	CAD&CAM computer Equipment for design and cutting	2	X_1, X_2
5	Traditional tools for making pattern design(Ink- pencil- paper line- table	9	$x_1, X_3, x_4, x_5, X_6, X_7, X_8, X_9, X_{10}$
6	Ordinary clipper by hand	1	x_4
Sewing machines			
1	Ordinary single needle for lock stitch machine with computer(high technology)	2	X_1, x_2
2	Ordinary single needle for lock stitch machine without computer(traditional technology)	8	$X_3, ,x_4, x_5, X_6, X_7, X_8, X_9, X_{10}$
3	Double needle for lockstitch machine without computer	2	X_{10}, x_4
4	Double needle for lockstitch machine with computer(new technology)	2	X_1, X_2
5	Over lock machine five thread	5	$X_1, X_2, x_4, x_9, X_{10}$
6	Over lock machine three thread	10	All 10 factories
7	over lock special machine for trouser	2	X_1, X_2

8	Special sewing machine (new technology)	2	x_1, x_2
9	Attachment machine for attaching shirt pocket	2	x_1, x_2
10	Attachment machine for attaching back pocket for trouser	2	x_1, x_2
11	Attachment machine for attaching waist band	2	x_1, x_2
12	Attachment machine for attaching button automatic	1	x_2
13	Attaching machine for attaching button ordinary	9	except x_8
14	Machine for making cuff (placket)	2	x_1, x_2
15	Machine for making button hole	9	except x_8
16	Machine for making tape	1	x_2
17	column machine	2	x_1, x_2
18	Par tacking machine	4	$x_1, x_2. x_4, x_6$
19	Arrases machine	3	x_1, x_2, x_7
20	Washing machine	Nun	Nun
Finishing machines			
1	Steam press iron	6	$x_1, x_2, x_3, x_5, x_9, x_{10}$
2	Ordinary hand iron	4	x_4, x_6, x_7, x_8
3	Pressing machine for perfectly of garment	1	x_1
4	Fusing machine	2	x_1, x_2
Transportation machines			
1	Trolley for transport product from cutting section to place of production and also transport product for sore house	3	x_1, x_2, x_{10}
Package machines			
1	Package automatic machine for one set product	1	x_1
2	Package automatic machine for quantity of products	1	x_2
3	Traditional package for one set of	9	All except x_1

	product		
4	Traditional package for quantity of product	9	All except x_2

4.2.1.5 Level of technology used in the local factories

As a result which was shown in table 4.5 found that the level of technology used in the 10 factories. Modern technology used in 2 factories, medium and traditional technology used in the other factories.

Table 4.5 Level of technology used in the local factories

Level of technology	The factories
Modern	x_2
Medium	$x_1, x_3, x_5, x_6, x_9, x_{10}$
Traditional	x_4, x_7, x_8

4.2.1.6 Laboratory test available in the local factories:

Table 4.6 shown that the laboratory test available in the factories, according to the results found that the most of factories don't interested with laboratory testing, expect x_2 factories only, x_2 interested with all laboratory test ,x_7 interested with shrinkage of fabric only.

Table 4.6 Laboratory test available in the local factories

Test	The factory
1. color fastness of fabric	X_2
2. shrinkage of fabric	X_2, x_7
3. testing of accessories	x_2

4.2.1.7 Management practices applying in the local factories

Table 4.7 shown that the method of management quality system applying in the 10 factories, according to the results it has been found that only one factory applying total quality management, quality control and quality assurance system, also one factory applying quality control system only and all the 8th factories applying other method for control by control product during package and this leaded to long cycle time for manufacturing delay in time delivery for the customers.

Table 4.7 Management practices applying in the local factories

Direction	The factory
Quality assurance, TQM	x_2
Quality control	X_1
Others	X_3, ,x_4, x_5,x_6,x_7,x_8,x_9,x_{10}

4.2.1.8 System of fabric inspection applying in the local factories

Table 4.8 shown that the system of fabric inspection applying in the factories, according to the results found there was only one factory applying 4 point system for inspection, all other 9th factories don't a applying any method for inspection the fabric. The 4point system reduce the defect and scrape of product and reduce the long cycle time of manufacturing because in this system inspection the   maximum of number point of defects are acceptable in 100 meter are 22 points more than 22 point the roll had been rejected.

Table 4.8 System of fabric inspection applying by the factories

System of inspection	The factory
4point system	X_2
During fabric spreading	X_1,X_{10}
Others	X_3, x_4, x_5, x_6, x_7, x_8, x_9

4.2.1.9 Customer satisfaction and specification in the local factories

The investigating of the customer satisfaction and specification in the all factories was shown in table 4.9 according to the observed results there were 9 factories sometime meet customer expectation and one factory always meeting it. The investigated the customer specification is very important for factory reputation in the market and continues improving quality of productivity and profitability.

Table 4.9 The customer satisfaction and specification in the local factories

Direction	The factory
Always meet expectation	X_3
Sometime meet expectation	$x_1, x_2, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}$

4.2.1.10   Time delivery for customer orders by the 10 factories

The observed results of time delivery to customer orders were shown in table 4.10 according to the results there were 2 factories don't receive the consumer order in time, 5 factories sometime receive the consumer order in time, 3 factories receive the consumer order just in time. As The observed results, even the three factories which were receive the consumer order just in time; make it without their production planning for the order agreements. Just in time very important for profitability and good reputation in the factory, all the local factories interested with quantity more than quality.

Table 4.10 Time delivery for customer orders by the 10 factories

Direction	The factory
don't receive the consumer order in time	x_1, X_9
sometime receive the consumer order in time	$X_5, x_4, , x_6, x_7, x_8$
receive the consumer order Just in time	X_2, x_3, X_{10}

4.2.1.11   Maintenance system applying in the local factories

The maintenance system applying in all the 10 factories were shown in table 4.11. the result found that there was only one factory applying the protective maintenance system and the 9th factories applying treated maintenance system, and found treated maintenance system related with high productivity, shorted the cycle time of manufacturing and reduce the cost and available the safety for the workers.

Table 4.11 Maintenance system applying in the local factories

Direction	The factory
Protective maintenance system	X_2
treated maintenance system	x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}

4.2.1.12   The questions orientation to the local factories and their replying

Table 4.12 shown that the questions orientation to the local factories and their replying for the question (9) , according the survey finding, the results found that all the factories don't replied for most questions such as the percent of average of the sale in the year, all the factories don't faced any competition in global market except two factories , most of the factories don't having any international and locally quality certificate except one factory have local quality certificate , most of the factories don't replied for question percent of daily treatment excepts 3 factories, x_1 replied (30%), x_3 (25%), X_{10} (20%),most of the factories don't replied for question percent of scrape of product in the day except 2 factoriesx_1 (3%), x_2 (0%), most of the factories don't have section of maintenance except 2 factories only finally all the 10 local factories attempting to improving quality and quantity of productivity to attains ISO certificate to faced competition in global market to meeting global challenges.

Table 4.12 The questions orientation to the local factories and their replying

The questions orientation to the local factories	The reply of the factory
1-Does your factory faced any competition in global market?	X_1,x_2(yes),$x_3,x_4,x_5,x_6,x_7, x_8,x_9,x_{10}$ (no)
2-If your factory has not any competition in global market has tried gaining it in the future?	$x_3,x_4,x_5,x_6,x_7,x_8,x_9X_{10}$ (yes)
3-How many countries targeted in the future?	$X_2,x_4,x_5,x_6,x_7,x_8,x_9X_{10}$ (vicinity country), x_2(the Sudan country, vicinity country), x_1(Europe, vicinity country)
4-Does your factory have maintenance section? What the percentage of maintenance in the month?	X_1,x_2(yes), (no) $x_3,x_4,x_5,x_6,x_7,x_8,x_9X_{10}$
5-What the percent of average of sale in the year?	All the factories don't replied
6-What the percent of daily product treatment	x_1 (30%), x_3 (15%), X_{10} (17%), $x_2,x_4,x_5,x_6,x_7,x_8,x_9$ (don't replied)
7-What the percent of scrap in the day?	X_1(3%), x_2 (0%), $x_3,x_4,x_5,x_6,x_7,x_8,x_9X_{10}$ (don't replied),
8-doess your factory has any quality certificate international or locally.	All 9 factories replied (no) expect x_{10} have local quality certificate
9-What is the certificate that your factory try to gain it in the future?	$X_1,x_3, x_5,x_6, x_8,x_9,x_{10}$, replied the (ISO), $x_4x_{,7}$ (don't replied)

4.2.1.13   Comparison between Products of the local factories

As a result mention in table 4.13 found that the quality of the local garment most of its bad and not bad quality and this return to individual production system, traditional of technology poor quality of raw material , bad work environment un applying quality assurance in the line of production and untrained the workers and three factories it   garment with good quality because applying quality assurance and quality control, and others two factories their garment with good quality because the workers continues training and the level of technology was modern and good work environment and applying the quality assurance in the line of product and good quality of raw material.

Table 4.13 Comparison between products of local factories

The factory	The system of production	Work environment	The level skill of workers	Sewing quality	Fabric and accessories quality	Level of technology	Time of product shirt
X1	continues system and individualistic system	Not Bad	Un trained	Good	Poor quality	Modern, medium, tradition	37
X2	continues system and individualistic system	Excellent	Continuous training	good	Poor Quality	Modern	29
X3	individualistic system	Bad	Un trained	Not bad		Tradition and medium	39
X4	individualistic system	Not bad	Trained	Good	Good quality	Tradition	50
X5	individualistic system	Not bad	Un trained	Bad	Poor quality	Tradition	36

X6	individualistic system	Not bad	Un trained	Bad	Poor quality	Tradition	35
X7	individualistic system	Bad	Un trained	Bad	Poor quality	Tradition	36
X8	individualistic system	Bad	Un trained	Bad	Poor quality	Tradition	37
X9	individualistic system	Bad	Untrained	Not bad	Poor quality	Medium and tradition	38
X10	continues system	Bad	Untrained	Not bad	Poor quality	tradition	24 lady item

4.2.1.14   Problems of the local factories

As a result shown in table 4.14 the main problems of local factories concentrated on bad and opened work environment, bad store house environment, safety problems, most of the factories don't establish workshop, , un trained manpower, traditional level of technology and manual operation , un motivate the worker moral and financial, old fashioned product design, Poor quality of product, conflicts between internal customers, Bad planning, don't available health insurance card for the workers, continuous absence and resignation the workers, Instability the top managers, don't adopted recreational day in the year , don't available child care for mothers workers because in the section of garment manufacturing most of worker are females

Table 4.14 Problems of the local factories

The factories / The problems	X_1 Factory	X_2 factory	X_3 Factory	X_4 Factory	X_5 factory	X_6 Factory	X_7 factory	X_8 factory	X_9 factory	X_{10} factory
Work environment	Open and bad	Good and closed	Open and bad	Good and closed	Open and bad	Open and bad	Open and bad	Open and bad	Open and bad	Open and bad
Store house environment	Bad	Good	Bad	Good	Bad	Bad	Bad	Bad	Bad	Bad
Safety tools	Don't available	Available	Don't available	Available	Don't available	Don't available	Don't available	Don't available	Don't available	Don't available
Maintenance workshop	Established work shop but don't provided it with all spare parts	Established work shop and provided it with all spare parts	Don't establish	Don't establish	Don't establish	Don't establish	Don't establish	Don't establish	Don't establish	Established work shop but don't provided it with all spare parts
Trained for manpower	Poor Trained	Continuous training	Poor trained	Continuous training	Poor trained	Poor trained	Poor trained	Poor trained	Poor trained	Poor trained
Level of technology and methods of operations	Traditional, medium and modern	Modern technology and automation operation	Tradition technology and manual operation	Traditional technology and manual operation	Tradition technology and manual operation	Tradition technology and manual operation	Tradition technology and manual operation	Tradition technology and manual operation	Tradition technology and manual operation	Tradition technology and manual operation
Motivation	un motivate the worker	Motivate the worker	un motivate the worker	motivate the worker	un motivate the worker	un motivate the worker	un motivate the worker	un motivate the worker	un motivate the worker	un motivate the worker
Fashioned of product design	All the ten local factories manufactures the product with old fashioned design									

Quality of product	Not bad	Good	Bad	Good	Bad	Bad	Bad	Bad	Bad	Bad
Conflicts	All the ten local factories found conflicts between internal customer expect in x_4 factory									
Planning	Bad	Not bad	Bad	Not bad	Bad	Bad	Bad	Bad	Bad	Bad
Health insurance card	doesn't available	Available	doesn't available	Available	doesn't available	doesn't available	doesn't available	doesn't available	doesn't available	Available
Continuous absence and resignation the workers	Continues absence	Sometime	Continuous Absence	Sometime	continuous absence	Continuous absence	continuous absence	continuous absence	continuous absence	Sometime
Instability the top manager	Instability	stability	stability	stability	stability	stability	stability	Stability	stability	Stability
Recreational day	All the ten local factories don't adopted recreational day									
Child care	All the ten local factories don't available child care									

4.3 Comparison between Imported and local garment

The observed result in Table 4.15 shown that the quality of imported garment good was better than the quality local garment in appearance of stitch and strength of seam, number of stitches per inch, fabric and accessoriness quality and package durability and aesthetic and size system.

Table 4.15 Comparison between Imported and local garment

The product	Sewing quality	Fabric and accessories quality	stitch in inch and appearance of stitch and strength of stitch	Label Contain	Package quality
Imported shirt	Excellent	Good	stitch per inch (20) appearance of stitch excellent stitching very durability and regular	The label contains: 1-five basic symbols(washing or laundering -dry clean-drying-bleaching-ironing) 2.percent of contain fiber 3. country origin 4.brand 5. size	1.Item of package durability to 2.Iitem of package with good appearance
local shirt	Not bad	Bad	stitch per inch(12) appearance of stitch not bad, length of stitch variation in one product from one component to anthers and stitching not irregular	The label contain name of factory and size of product only	The item of package poor quality

4.4 Resulting of survey for consumer:

4.4.1 Introduction

Customer Surveys are techniques of asking the customers to give their opinion on the products and services of one's business in the garment, and Customer Surveys are highly effect identified in the garment to quality .Some researchers have attempted to understand consumers' perceptions of clothing quality by conducting focus group studies or individual interviews (Swinker and Hines, 2006).

In (O'Neal, 1988) qualitative study, consumers discussed quality based not only on concrete attributes, but also on abstract cues such as performance expectations, psychological expectations and aesthetic appeal. In addition, consumer's age, household income, education level, occupation and ethnicity also affect their choice. Consumers of recent times are becoming more selective, multidimensional and complex. Due to increased awareness and readily available information on the products and designs. Consumer's choice is shifting from traditional designs towards luxury high-fashion items. ,the purpose of this questionnaire explore how the consumers evaluate clothing quality and determine all the factors influence perception of garment quality and selection, The factors assist the manufacturers and designers of garments in Sudan how current and emerging consumer requirements and expectations , The factors have negative effective for the consumer to understand garment quality , the positives effective investigate for the garment manufacturing in the Sudan if the consumer understanding and interested with garment quality. And the general vision and opinions of consumer of the way of garment quality according difference of ages, sexuality and education level. The consumer survey covered male and female with different age start from (20-30),(30-40),(40-50),(50-60), most of them retailers, merchandisers student secondary school and university graduate student ,over university student , business men and women and other employee with different jobs.

4.4.2 The influences factors for the consumer when evaluating and selected of garment quality according difference of gender

4.4.2.1 Consumer income

The result which was shown in Figure 4.1 found that the sexuality related with the factor income. And shown the factor income was influence for the both female and male respondents confirm that income was very important and influence when consumer evaluating and selection garment quality, also survey shown the female was interested with factor income to evaluate the garment quality more than male. This result is similar to the findings of (Saricam et al., 2012)
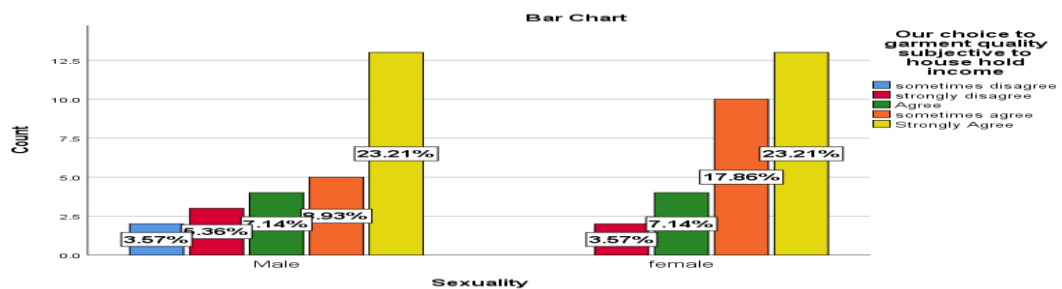
Figure 4.1Consumer choice the garment quality subjective to house hold income

4.4.2.2 The social media assist to spreading the fashion

The results which was shown in Figure 4.2 found that the sexuality related with the factor fashion and social media, shown the factor fashion was influence for the both female and male respondents confirm that fashion was very important and influence when the consumer evaluating and Perception garment quality**,** the survey result shown that the female respondents confirm that social media assist to spreading the fashion more than male respondents.
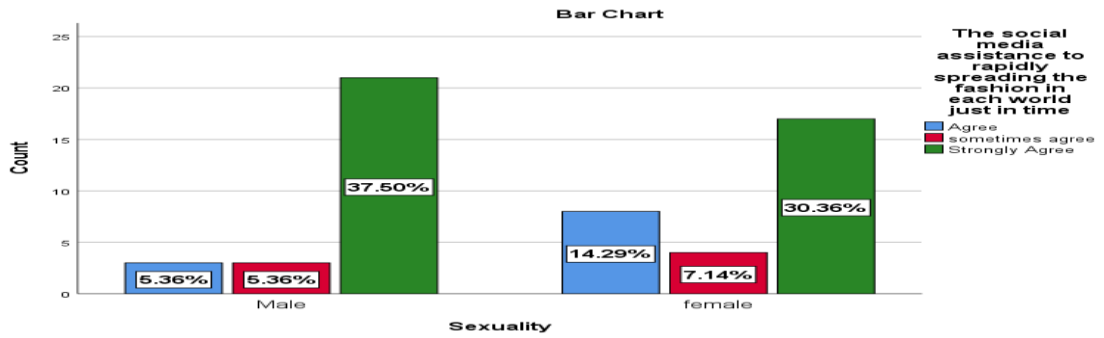
Figure 4.2 social media assist to spreading the fashion in all the world in one time

4.4.2.3 The consumer attractive with external appearance aesthetic more than internal content of product

The result which was shown in Figure 4.3 indicates that the sexuality related with the factor Aesthetic and supports findings of other studies that have included aesthetic cues. Even in the(Hines and Swinker, 2001) . And shown the factor Aesthetic was very important and influence for the both female and male respondents confirm that when evaluating and Perception garment quality, the survey result shown that the female was care with aesthetic more than male.
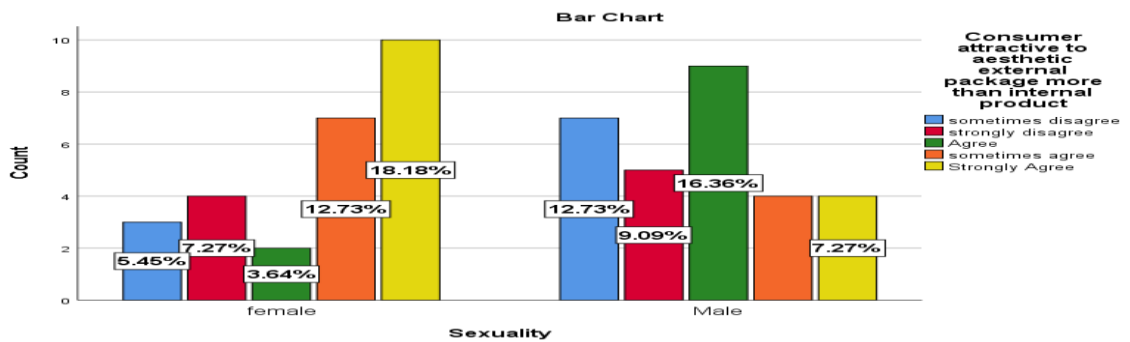
Figure 4.3 Consumers attractive with external appearance aesthetic more than internal content of product

4.4.2.4 The consumer determine garment quality by country origin

The result which was shown in Figure 4.4 found that the sexuality related with the country origin. And shown the country was influence for the both female and male respondents confirm that country origin was very important and influence when consumer evaluating and Perception garment quality, the survey result shown that

the male care with country origin more than female this supported with other studies by(Jang et al., 2005) and (Wall and Heslop, 1986), a strong relationship between country of origin and perceived clothing quality was reported, while (Sternquist and Davis, 1986) found no relationship.
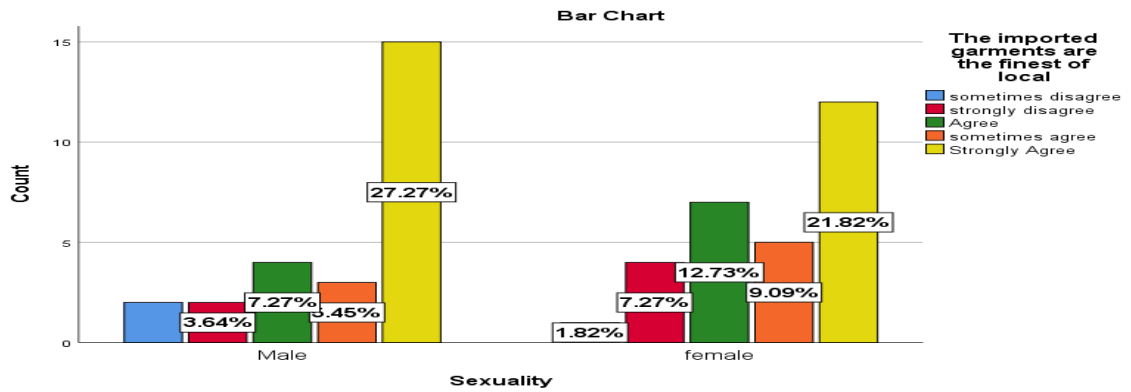
Figure 4.4 The consumer determine garment quality by country origin

4.4.3 The factors assist the manufacturers and designers to understanding consumer Requirements and expectations

4.4.3.1 Consumer complaint and opinions lead the manufacturers to improve garment quality

The result which was shown in Figure 4.5 found that the sexuality related with the important of consumer complaint for manufacturers and designers to improving garment quality. the survey shown that the both male and female respondents confirm that consumer complaint was very important and assist to improving garment quality, and female respondents confirm that the consumer complaint assist to improving garment quality more than male.
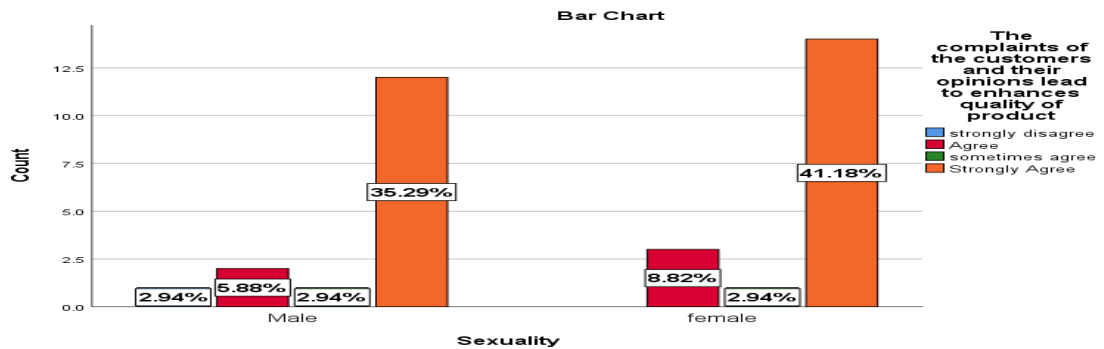
Figure 4.5 Consumer complaint and opinions lead the manufacturers to improve garment quality

4.4.3.2 The consumer returns back the order if there any defect in specification requirement

The result which was shown in Figure 4.6 found that the sexuality related with the important of consumers return back the order if there any defect in their specification and requirement to assist manufacturers and designers to improving garment quality. the survey shown that the both male and female respondents confirm that consumer return back the order if there any defect in specification requirement for the designers and manufacturers to improving garment quality, the respondents confirm the female strong agree more than male.
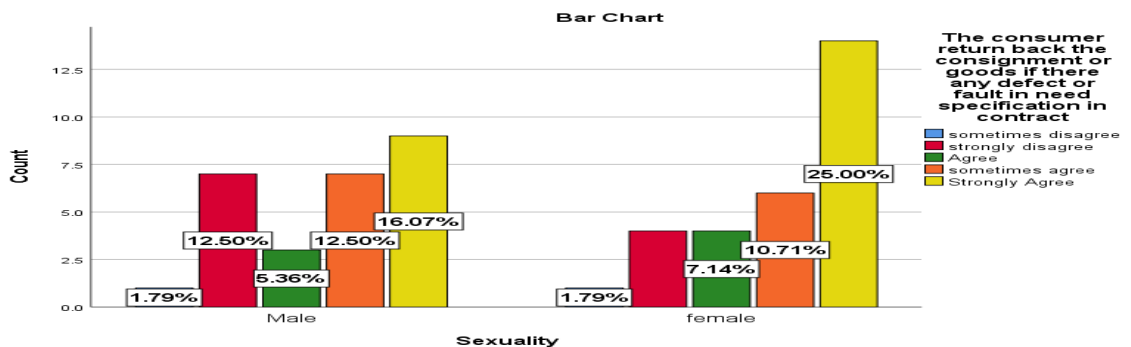
Figure 4.6 Consumer return back the order if there any defect in specification requirement

4.4.4 The negative factors effect for consumer to understand the garment quality

4.4.4.1 The wide spreading of retailers in the huge number in the streets randomly

As the result which was shown in Figure 4.7 found that the sexuality was related with the negative effect of wide spreading of retailers in the huge number in the street to lead of lack understanding consumer of garment quality. The survey shown that the both male and female respondents confirm that the female strong agree more than male.
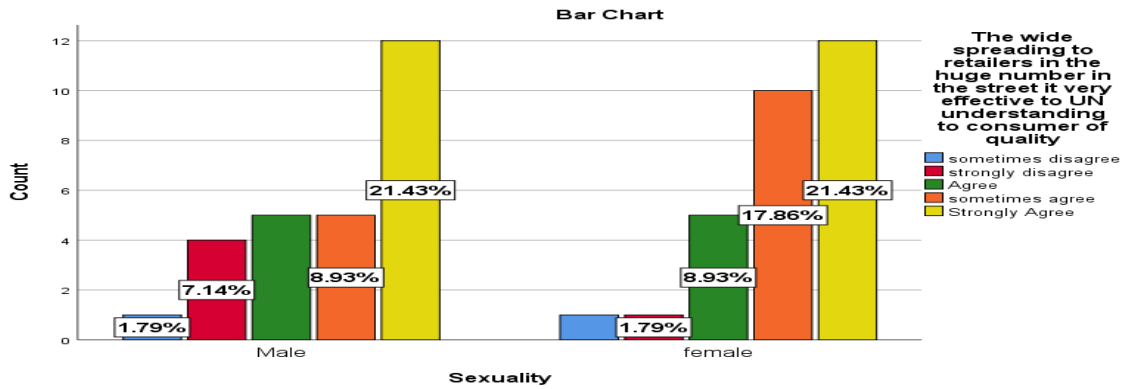
Figure 4.7 The relation of wide spreading of retailers in the huge number in the streets randomly to garment quality

4.4.4.2 Interested the garment designer to customer specification and satisfaction

The result which was shown in Figure 4.8 found that the sexuality related within interested the garment designers to consumer satisfaction and specification. The failure of garment designers to understand the needs of the consumer satisfaction and specification has a negative impact on the consumer's lack of understanding of quality. The result of the survey confirmed that agree males more than females.
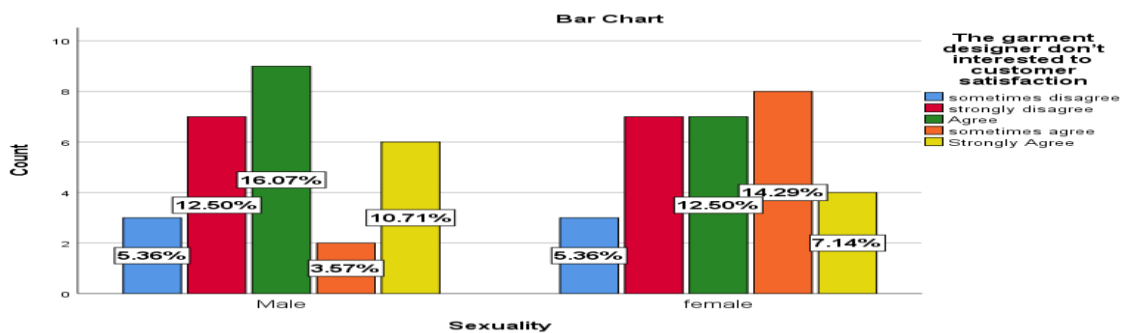
Figure 4.8 The garment designer don't interested to customer specification and satisfaction

4.4.4.3 Incorrect information in the product and it relation with consumer understanding for garment quality.

The result which was shown in Figure 4.9 illustrate that the sexuality relation with incorrect information in the product lead to lack of understanding of garment quality , And the survey shown the both male and female respondents confirm that incorrect information in the product lead to lack of understanding of garment quality, and the male strong agree than female.
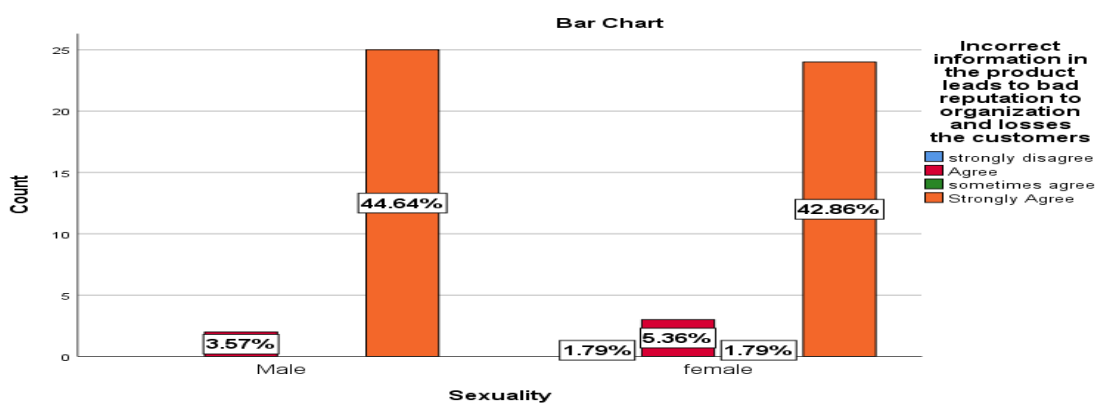
Figure 4.9 In correct information in the product and it relation with consumer understanding for garment quality.

4.4.4.4 Uninterested the manufacturers in the Sudan with the basic symbols of care labeling and it relation to Consumer understanding of garment quality

The results which were shown in Figure 4.10 illustrate that the sexuality related with un interested with the basic symbols of care labeling in product lead to lack of understanding of garment quality, And the survey shown the both male and female respondents confirm that un interested with the basic symbols of care labeling in product lead to lack of understanding of garment quality and the respondents confirm that female strong agree than male.
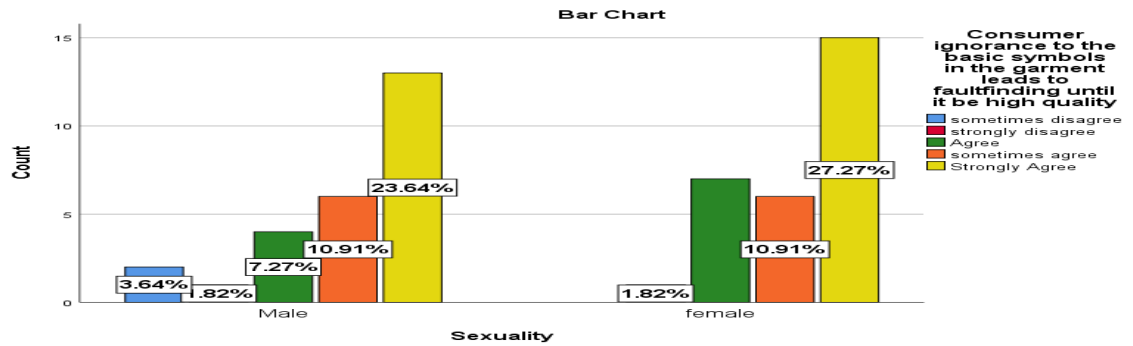
Figure 4.10 uninterested the manufacturers in the Sudan with the basic symbols of care labeling and when the Consumer ignorance to the basic symbols in the garment leads to fault finding the garment until it be with high quality

4.4.4.5 The local garment manufacturers interested with time delivery more than quality:

The result which was shown in Figure 4.11 demonstrate that the sexuality related with interested of the local garment manufacturers with time delivery more than quality and this lead to lack of understanding of garment quality, and the survey shown the both male and female respondents confirm that the interested of local garment manufacturers with the time delivery more than quality lead to lack of understanding of garment quality and the respondents confirm that female strong agree than male.
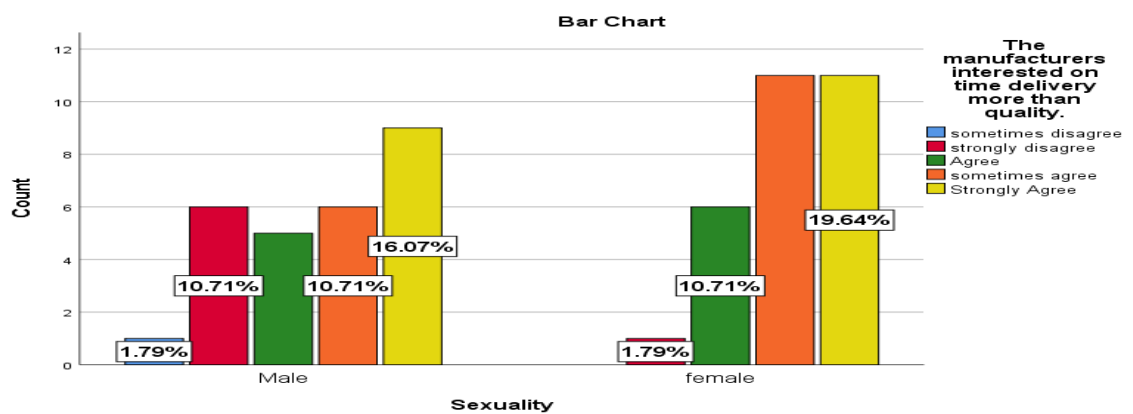
Figure 4.11The local garment manufacturers interested with time delivery more than quality

4.4.5 The positives effective investigate for the garment manufacturing in the Sudan if the consumer understanding and interested with garment quality.

4.4.5.1 Reduce of imported and lead the designers and manufacturers trend to garment quality

As a results which was shown in Figure 4. demonstrate the sexuality related with positives effective investigate for the garment manufacturing in the Sudan if the consumer understand the garment quality, And the survey shown the both male and female respondents confirm that the respondents confirm that female strong agree than male.
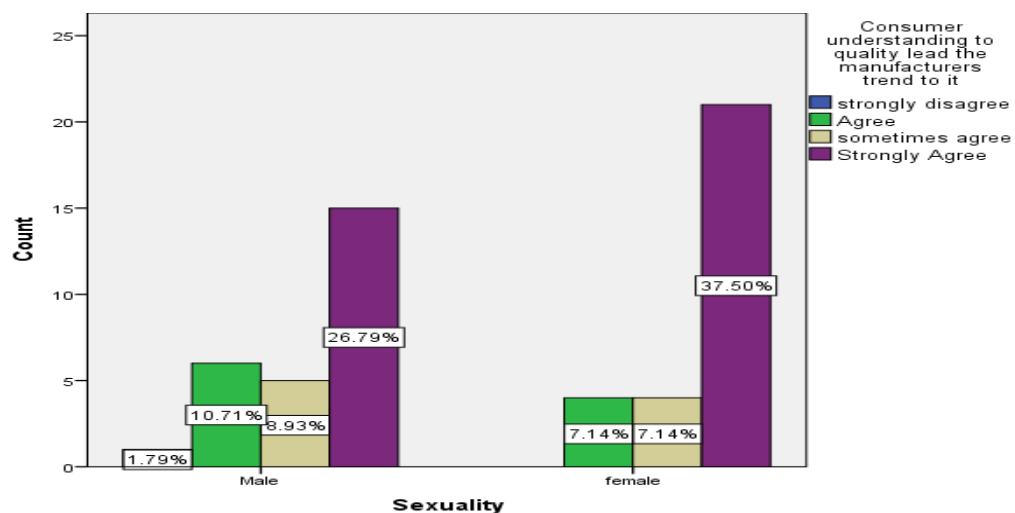
Figure 4.12 Positives effects investigate if consumer understanding and interested with garment quality reduce of imported and lead the designers and manufacturers trend to garment quality

4.5 The Case study

4.5.1 Introduction

Two factories were selected from the factories have been covered by the survey of the local garment factories in Sudan. The Selected two factories to comparison one of the factory don't applying total quality management (TQM) referred as x_1 factory

and other factory applying TQM referred as $x_2$factory. The item of comparison containing the frame work, work environment, planning, level of technology, variation of percentage of product components defects between x_1 and x_2 factories, variation of average for manufacturing one piece of shirt and trouser and variation time of first steps of garment manufacturing for x_1 and x_2 factories.

4.5.2 Comparison between x_1 and x_2 factories in frame work

As a result which was shown in Table 4.16 found that the x_1 factory doesn't applying TQM system, quality assurance and 5s tool only applying quality control (QC) and in x_2 factory applying TQM system, 5s and quality assurance. work environment in x_1 factory opened and don't available adequate resources of air environment and adequate light in place of production especially in the cutting room and section of inspection ,the meal unenhanced, the restaurant unenhanced, most of the worker sitting on the floor to having the meal, and in x_2 factory the work environment good available adequate resources of air environment but also inx_2 factory don't available adequate light in place of inspection ,the meal enhanced, the restaurant enhanced. In $x_1$factory the clinic doesn't provide with drug for patient requirement and in $x_2$factory the Clinic provide with all drug for patient requirement, don't established child care in x_1 and x_2 factories for mother worker because in the section of garment manufacturing most of worker female. In $x_1$factory the environment of store house was very bad the raw material put directly on the floor and must be expose to different factors environment (moisture- dust- temperature, bacteria and rodent insect. And in x_2 factory the environment of store house was good the raw material put directly on shelves. In $x_1$factory the workshop poorly organized maintenance service and repair of the machines and in x_2 factory the workshop was good and provide with all spare parts and tools require to maintenance. In $x_1$factory productivity was low and in x_2 factory the productivity was very high. In x_1 factory the level of technology and operations was modern and in x_1 factory the level of technology and operations was manual, traditional, medium and modern. In $x_1$factory the system of fabric inspection was visual and in $x_2$factory applying 4point system of fabric inspection. In $x_1$factory applying treated maintenance system and in x_2 factory applying protective maintenance system. In $x_1$factorythere was delay for received the orders of consumer in his time and in $x_2$factory received the orders of consumer in

time. In x_1 factory don't meeting expectation and satisfaction of the customer and in x_2 factory meeting satisfaction and expectation of the customer. In $x_1$factorythe cycle time consumption for manufacturing one item taken short time and in $x_2$factorythe time for manufacturing one item taken long time. In x_1 factory don't available adequate safety for the workers and in the place of production and in x_2 factory available adequate safety for place of production and for the workers. In x_1 don't establish laboratory for testing the fabric and accessories and in x_2 factory establish laboratory for testing the fabric and accessories. In x_1 factory the raw material was poor quality and in $x_2$factory the raw material was good quality. Also thetable3.16 shown that the planning and layout in $x_1$factorywas poor and in $x_2$factory the planning not bad and the layout were good. The management in x_1 factory Insufficient quailed and in x_2 factory was sufficient quailed. In $x_1$factory un motivate the workers moral and financial and in $x_2$motivate the worker moral and financial. In $x_1$factory found disputes between the internal customers and in $x_2$factory building team work. In $x_1$factory un available insurance healthy card for the workers and in $x_2$factory available insurance healthy card for the workers. In $x_1$factory the manpower continuous resignation and absence and in $x_2$factory the manpower continuously increasing. In x_1 factory don't established functional structure and established functional structure in x_2 factory. In $x_1$factoryun available Sufficient and continuous training for continuous improvement and x_2 factory available Sufficient and continuous training for continuous improvement. In x_1 factory the experiences and skills of the workers unqualified and in x_2 factory the experiences and skills of the workers good qualified. In $x_1$factory un established Planning administration, Marketing administration, Purchases administration and don't adopted recreational day and in x_2 factory established Planning administration, Marketing administration, Purchases administration and adopted recreational day.

Table 4.16 comparison between x_1 and x_2 factories in frame work

Number	Item	The Evaluation	
		X_1	X_2
1	Method of management quality system	QC	TQM
2	The tool of 5s	Don't applying	Applying
3	Quality assurance	Don't applying	Applying
4	Work environment	Bad	Good
5	Store house environment	Bad	Excellent
6	Place of production	Accumulation production and raw material in the place of production(making confusedly)	Organized
7	Type of Place of production	Opened	Closed
8	Maintenance workshop	Poorly organized maintenance service Don't provide it with all tools and spare part required to the maintenance	Good and provide with all tools and spare parts
9	Level of Productivity	Low	High
10	Level of technology	Traditional ,medium	Modern

		and modern	
11	System of fabric inspection	Other	4point system
12	Maintenance system	Treated maintenance system	Protective maintenance system
13	Time delivery to the customer orders	Delay of the time	Just in time
14	The time cycle consumption for manufacturing one shirt	37 minute	29 minute
15	The time cycle consumption for manufacturing one trouser	32 minute	23 minute
16	The fabric consumption (per meter) for manufacturing one shirt	2.25 meter	1.70 meter
17	The fabric consumption (per meter) for manufacturing one trouser	1.75 meter	1.30 meter
18	The safety system	Un Available adequate safety for the workers and place of production	Available adequate safety for the workers and place of production
19	Laboratory test of fabric and accessories	Un available	Available
20	Raw material	Poor quality	Good quality
Others			
1	Planning	Bad	Not bad

2	Management	Instability	stability
3	Motivation	Un Motivate the worker moral and financial	Motivate the worker moral and financial
4	Team work	Disputes between the internal customers	Building team work
5	Insurance healthy card for the worker	Un available	Available
6	The manpower	Continuously resignation and absence	Continuously increasing
7	Training	Un available	Sufficient and continuously for improvement
8	Experiences and skills of the workers	Unqualified	Qualified
9	Planning administration	Un available	Available
10	Marketing administration	Un available	Available

4.5.3 Variation time of first steps of processes of garment manufacturing between x_1 and x_2 factories

As the results which were shown in Table 4.17 and figure 4.13 found that the reasons of variation time of first steps of processes of garment manufacturing between x_1 and x_2 factories as the following:

- The Level of technology using in x_1 factory in design, making pattern, spreading, cutting phase (medium and traditional technology) and multi manual operations

- In the design phase the different time was (50) minute, the main reason in the$x_1$factory the design and making pattern way was traditional by the hand, and in $x_2$factory by CAD&CAM

- In the spreading phase the different time was (65) minute, the main reason in the$x_1$factory the spreading method was traditional by the hand, and it required number of five workers as minimum and in $x_2$factory the spreading method by new technology machine and it required one worker only.

- In the cutting phase the different time was (69) minute, the main reason in the $x_1$factory in the cutting phase used manual method by used electric equipment by hand and in $x_2$factory used electric equipment by CAD&CAM

- In the design   phase of interlining the different time was (40) minute, the main reason in the $x_1$factory making pattern design of interlining was traditional by hand in comparison to $x_2$factory the design interlining by CAD&CAM

- In the cutting phase of interlining the different time was (57) minute, the main reason in the $x_1$factory cutting interlining by electric equipment for fabric cutting   and in $x_2$factory used especially electric equipment for interlining by CAD&CAM.

From above mentioned the major noticed that the reasons of deference time of first steps of processes of garment manufacturing between x_1 and x_2 factories were the level of technology used inx_1 factory (medium and traditional) and multi manual operations .

Table 4.17 Variation time of first steps of garment manufacturing between x_1 and x_2 factories

NO	The process	The time of process in $x_1$factory (min)	The time of process in $x_2$factory (min)	The variation time (min)
1	Design (three dresses)	110	60	50
2	Spreading the 100 layers of fabric	95	30	65
3	Cutting 100 layers of fabric contained to 300 dresses	99	30	69
4	Design interlining (thick and thin)with length and width for collar- stand collar- cuff- belt loop and cover pocket	55	15	40
5	Cutting interlining(thick and thin) with length and width for collar- stand collar- cuff- belt loop and cover pocket	97	40	57
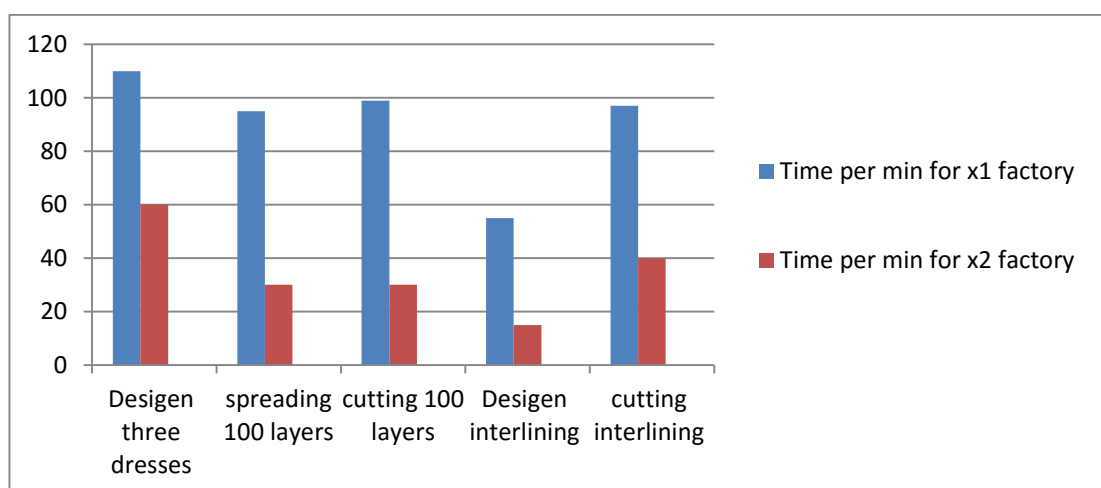
Figure 4.13 Variation time of first steps of garment manufacturing between x_1 and x_2 factories

4.5.4 Variation of average time of manufacturing one piece of shirt for x_1 and x_2 factories by continuous production system

As results which were shown in Table 4.18 found that the main reason of variation time between x_1 and x_2 factories for manufacturing shirt as following:

❖ Poor quality of raw material (fabric and accessories) in x_1 factory

❖ poor applying tool 5S in x_1 factory

❖ Poor layout and poor planning in x_1 factory

❖ Problems of machine maintenance and the system of maintenance applying in x_1 factory treated maintenance system and the maintenance worker un qualified

❖ The tailor un qualified and un corrective using the machine in x_1 factory (un trained)

❖ Poor qualified of production supervisors in x_1 factory (un trained)

❖ Most the knifes in sewing machine in x_1 factory don't sharp the tailor spent long time for cutting thread manual with hand cutter and in x_2 factory the machine knifes very sharp and the thread cutting directly

❖ The level of technology of the machine and equipment manual and medium in x_1 factory and in x_2 factory using modern technology

❖ Management practices applying in x_1 factory quality control only for final product but in x_2 factory applying both quality assurance and quality control

Table 4.18 the variation of average time of manufacturing one piece of shirt for x_1 and x_2 factories by continuous production system

The average time of manufacturing one shirt x_1 factory(min)	The average time of manufacturing one shirt in x_2 factory (min)	The different time (min)
37	29	8

4.5.5 The variation average time of manufacturing one piece of trouser for x_1 and x_2 factories by continuous production system

As results which were shown in Table 4.19 found that the main reason of variation time between x_1 and x_2 factories for manufacturing trouser were:

❖ Poor quality of raw material (fabric and accessories) in x_1 factory

- ❖ poor applying tool 5S in x_1 factory
- ❖ Poor layout and poor planning in x_1 factory
- ❖ Problem of machine maintenance and the system of maintenance applying in x_1 treated maintenance system and the maintenance worker un qualified
- ❖ The tailor un qualified and un corrective using the machine in x_1 factory (un trained)
- ❖ Poor qualified of production supervisors in x_1 factory (un trained)
- ❖ Most the knifes in sewing machine in $x_1$factory don't sharp the tailor spent long time for cutting thread manual with hand cutter and in $x_2$factory the machine knifes very sharp and the thread cutting directly
- ❖ The level of technology of the machine and equipment manual and medium in $x_1$factory and in $x_2$factory using modern technology
- ❖ Management practices applying in x_1 factory quality control only for final product but in x_2 factory applying both quality assurance and quality control

Table 4.19 the variation average time of manufacturing of one piece of trouser for x_1 and x_2 factories by continuous production system

The average time of manufacturing trouser in x_1 factory (min)	The average time of manufacturing trouser in $x_2$factory (min)	The variation time (min)
32	23	9

4.5.6 Sewing defects of trousers in $x_1$and x_2 factories for 500 products

As results which were shown in Table 4.20 and Figure 4.14, to Figure 4.16 found that the defect of sewing trouser in x1 factory more than x_2 factory because in x_2 factory using computerize sewing machine and automation machine for attaching accessories and some parts of garment and applying quality assurance system to prevent defect, the production supervisors and tailors have been trained. In x_1 factory using machine with computerize sewing machine but the scissor of the machines deactivated and attaching accessories and parts of garment traditional by hand and don't applying quality assurance to prevent defect only using quality control in the final product and the production supervisor and tailors un trained.

Table 4.20 Percentage of sewing defect of trousers in x_1 and x_2 factories for 500 products

Number	Name of defect	Percentage of defect in x_1 factory	Percentage of defect in x_2 factory
1	Irregular attaching two side pocket	38.0%	0.0%
2	Irregular attaching belt loop	15.0%	0.0%
3	Wrong attaching zipper	0.0%	0.0%
4	Irregular stitch	17.0%	0.3%
5	Missing size	02.0%	0.0%
6	Defect of Sewing 6ml in sides pocket	11.0%	1.0%
7	Open seam of over lock in the leg sides	07.0%	0.0%
8	irregular attachıng pack pocket	03.0%	1.0%
9	Faulting Bara tacking back pocket	02.0%	0.0%
10	Irregular Sewing cross point	12.0%	5.0%
11	Defect attachıng waıstband	08.0%	0.0%
12	Missing barracking under zipper	0.6%	0.3%
13	irregular leg hemming	10.0%	0.0%
14	Wrong attaching buttons	0.1%	0.0%
15	Hole in fabric during eliminated sewing thread	0.1%	0.0%
16	Breakage the button	02.0%	1.0%

17	Defect in Close waistband and attaching label and size	0.1%	2.0%
18	Missing button	0.2%	0.0%
19	Missing Bara tacking sides pocket	02.0%	0.0%
20	Wrong mark button hole	01.0%	0.2%
21	Stitch pucker	03.0%	3.0%
22	un seamed	07.0%	0.0%
23	Damage teeth of zipper	0.1%	0.0%
24	Folding stitch	4.0%	0.0%
25	Double stitch	0.2%	0.0%
26	Wrong button mark	12.0%	0.0%
27	Brocken stitch	07.0%	0.3%
28	Loose stitch	4.0%	0.2%
29	Wrong size attaching	0.5%	0.0%
30	Wrong folded in parts require to iron	10.0%	0.0%
31	Dirt spot	2.0%	0.0%
32	Hole in fabric result needle breakage	0.5%	0.0%
33	Hole in fabric result misuse the tailor to the cutter	0.3%	0.0%
34	Skip stitch	2.0%	0.5%
35	Joint stitch	4.0%	0.3%

4.5.6.1 Sewing defect of shirt in $x_1$and x_2 factories for 500 products

As results which were shown in Table 4.21and Figure 4.14 to Figure 4.16 found that the defect of sewing shirt in x_1 factory more than x_2 factory more than x_2 factory because in x_2 factory using computerize sewing machine and automation machine for attaching accessories and some parts of garment and applying quality assurance system to prevent defect and the production supervisors and tailors have been trained and in x_1 factory using machine with computerize sewing machine but the scissor of machines deactivated and attaching accessories and parts of garment traditional by hand   and don't   applying quality assurance to prevent defect only using quality control in the final product and the production supervisor and tailors un trained

A   B   C

D   E   F
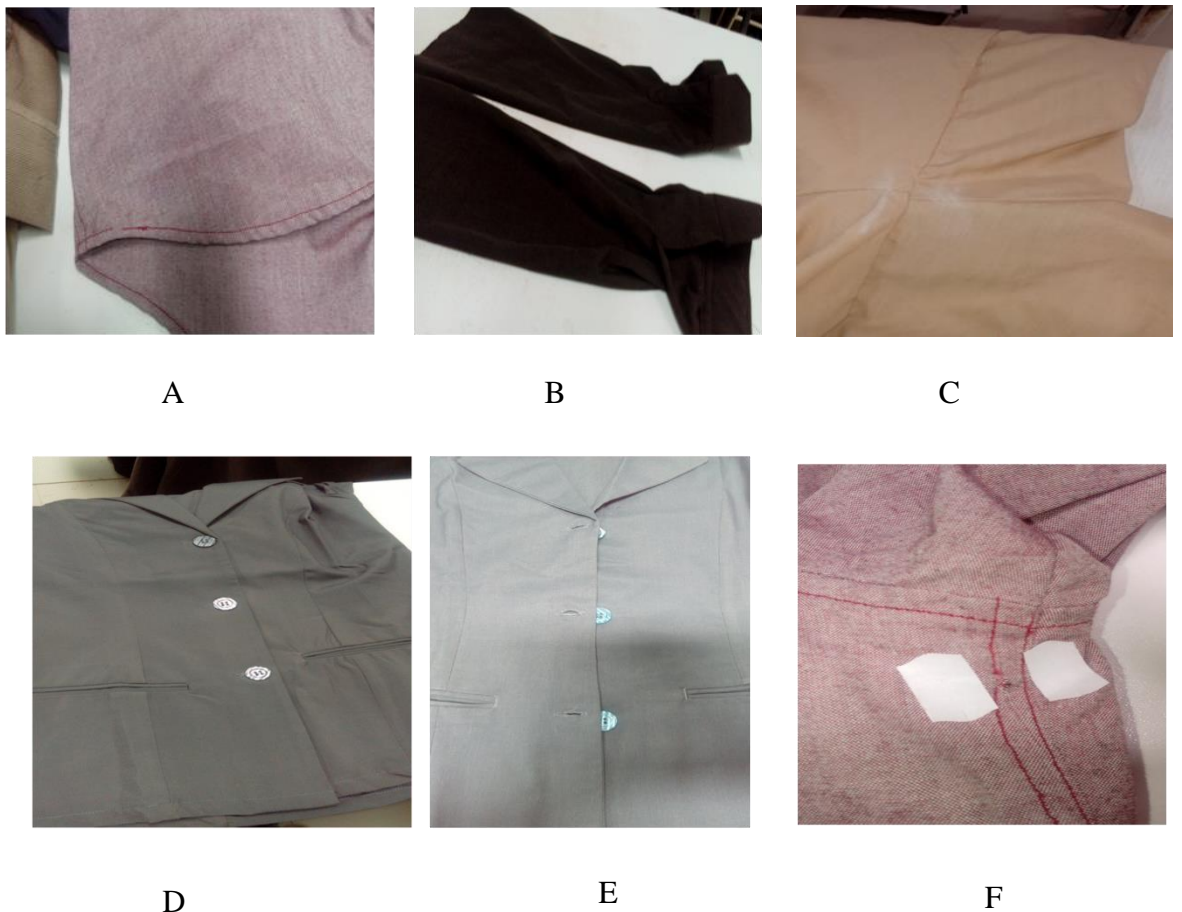
Figure 4.14 Sewing defect in x_1 factory; A joint and missing stitch ,B turnover the sleeves in one product, C unbalance attaching sleeve , D unbalance pockets and hemming ,E unbalance buttons markers , F joint stitch and hole in fabric

A	B	C
D	E	F
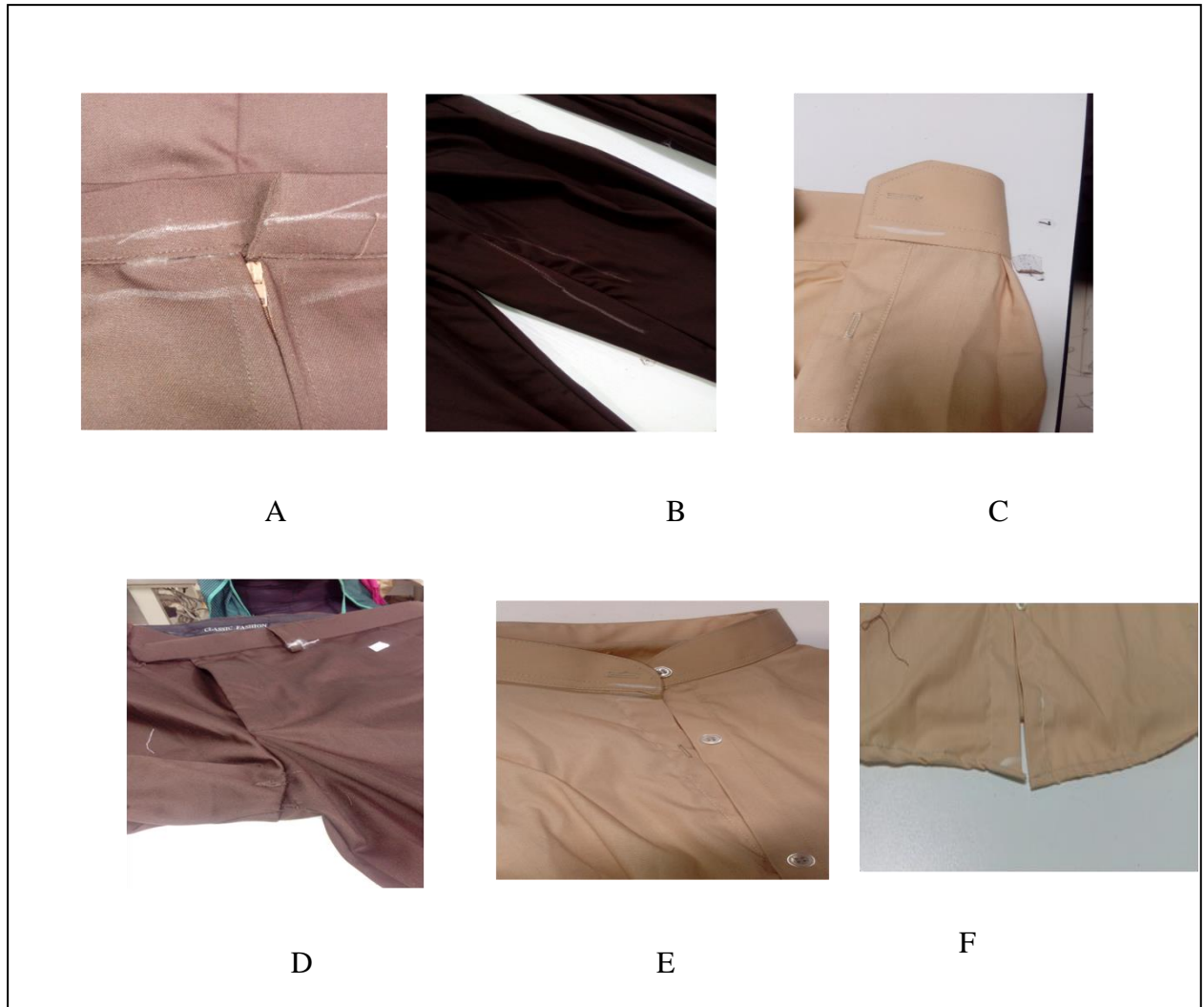
Figure 4.15 sewing defect in x_1 factory; A wrong attaching waist band , B seam pucker ,C opened seam, D unbalance join point on trouser , E wrong attaching stand collar, F folding stitch and un balance hemming

A	B
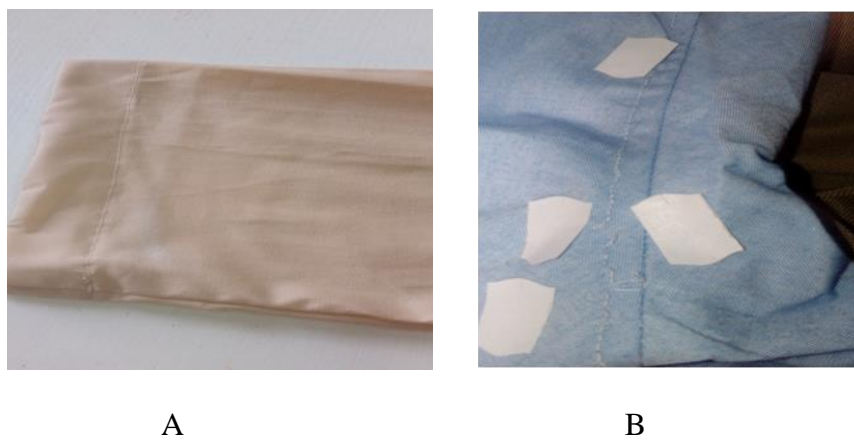
Figure 4.16 Sewing defect in x_1 factory; A and B skip and slip stitch

Table 4.21 Percentage of sewing defects of shirt in x_1 and x_2 factories for 500 products

Number	Name of defects	Percentage of defect in x_1 factory	percentage of defect x_2 factory
1	Irregular attaching tow front pocket	40.0%	0.5%
2	Wrong Attaching collar	5.0%	0.0%
3	fault in sewing front facing	3.0%	0.0%
4	defect in attaching stand collar to collar	5.0%	0.3%
5	Defect Close collar and attaching size and label	20.0%	2.0%
6	fault in attaching sleeve	11.0%	1.0%
7	defect attaching pen pocket	03.0%	0.0%
8	Wrong in size in components of one shirt	09.0%	0.1%
9	Mismatch size of cover pocket to the pocket	22.0%	0.0%
10	Irregular Attaching belt loop	11.0%	0.0%
11	Wrong Attaching bird	08.0%	0.0%
12	irregular attaching buttons	0.6%	0.0%
13	Open seam during eliminate sewing thread	7.0%	0.0%
14	Wrong sewing cuff	18.0%	0.3%
15	Wrong mark in button hole	9. %	0.0%

16	Wrong mark in button	2.0%	0.0%
17	Opened over lock	20.0%	0.1%
18	irregular stitch in Joint (ml)shoulder	00.1%	0.0%
19	Missing bar tacking in pocket	03.0%	0.2%
20	Missing bar tacking g in pen pocket	07.0%	0.0%
21	Stitch pucker	12.0 %	2.0%
22	wrong attaching size	0.2%	0.0%
23	Folding stitch	12.0%	0.0%
24	Insecure shoulder stitch	07.0%	0.0%
25	Missing size	4.0%	0.2%
26	Brocken stitch	10.0%	1.%
27	Loose stitch	11.0%	1.0%
28	Wrong size	2.0%	0.0%
29	Missing stitch	6.0 %	0.5%
30	Wrong folded fabric	0.9%	0.0%
31	Lost button	2.0%	0.5%
32	color variation within the garment components in one shirt	38.0%	5.0%
33	Button breakage	5.0%	0.2%
34	Dirt spot	0.0%	0.0%
35	Hole in fabric result needle breakage	02.0%	0.0%
36	Hole in fabric result misuse the tailor to the cutter	02.0%	0.0%
37	Skip stitch	13.0%	3.0%
38	join stitch	08.0%	2.0%

| A | B | C |
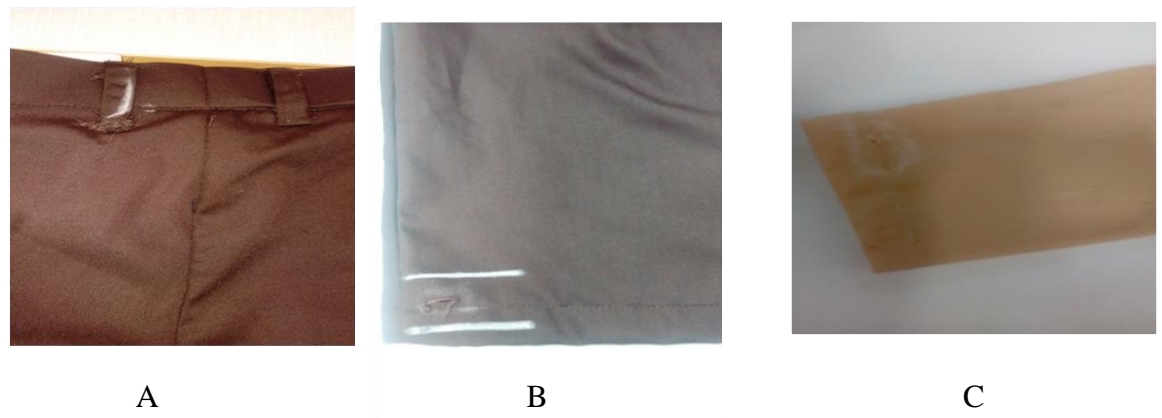
Figure 4.17 ; Hole in product in x_1 factory, A hole resulted try to treated the defect in the belt loop ,B hole result to the worker eliminated the sewing thread by hand cutter and C the hole result to the tailor using scissor for cutting thread

Figure 4.18 More numbers of sewing thread in the product in x_1 factory because the scissors of the sewing machine deactivated

4.6 The case study for x_1 factory

Selected x $_1$ factory as the case study to identified if it applying TQM or not applying TQM and advices had been given to x_1 factory for improving productivity and profitability and reduce the cost

4.6.1 Variation time between three workers for manufacturing one piece of shirt in x_1 factory

As the result s which were shown in Table 4.22 and Figure 4.19 to Figure 4.25 the found that the reason of variation time for manufacturing one piece of shirt by continues production system in x_1 factory between three workers as the following:

1- In the item 3.2 from Table 4.22 the different time was (12.5) sec, and in item 3.3 the different time was (18) sec, the main reason occur due to the empty bobbin from thread and the process was stopped and the tailor filled the bobbin with sewing thread from another machine

2- In the item 3.6 from Table 4.22 sewing cuff (sewing –turn over cuff- 6ml in cuff) the different time was (31) sec the main reason un qualified tailor.

3- In item 3.9 sewing from Table 4.22 cover pocket (sewing – turn over – ml) the different time was (12) sec the main reason occur due to Knot in sewing thread the tailor was spent long time to treated the knot

4- In item 4.3 from Table 4.22 Sewing the ml on the back, the different time was (14.5) the main reason occur due to the   Knife in sewing machine was not sharp the tailor used cutter to cutting sewing thread

5- In item 4.9 from Table 4.22 attaching cover for front pocket, the different time was (6) sec the main reason the sewing Thread prepackage and the tailor entered thread into needle again.

6- In item 4.10 from Table 4.22 the different time was (29) sec ,Join the front facing for button and front facing for button hole on back the main reason needle breakage replaced the needle with new one

7- In item 4.11 from Table 4.22 Top stitch the shoulder (sewing ml) the different time was (16) sec the main reason empty Bobbin filled bobbin with sewing thread from other machine

8- In item 4.12 from Table 4.22sewing tape on sleeve (placket)the different time was (40.5) sec the main reason sewing Thread break aged   the tailor entered sewing thread into the needle again

9- In item 4.14 from Table 4.22 attaching belt loop in two sides of shoulders the different time was (20.5) sec the main reason occur due to Knot in sewing thread un qualified tailor.

10- In item 4.17 from Table 4.22 sewing 6ml on sleeve, the different time was (24) sec the main reason of different time Unqualified tailor.

11- In item 4.18from Table 4.22 Attaching the cuffs in right and left sleeve, the different time was (69.5) sec the main reason empty Bobbin filled bobbin with thread from other machine.

12-   In the item 4.19 from Table 4.22 Attaching collar first step ,different time was (14.5)sec the main reason un qualified Tailor

13-   In item 4.20 from Table 4.22 Close the collar and attaching size and label, the different time was (22.5) sec the main reason of different time un qualified tailor.

14-   In item 4.21from Table 4.22 hemming, the different time was(56.5) sec un qualify tailor to using automation machine

15-   In item 5.2 from Table 4.22sewing button hole ,the different time was (26.5) sec the main reason un qualified tailor

16-   In item 5.4 from Table 4.22 attaching button, the different time was(31.5) sec the main reason of different time was empty bobbin with thread and stopped the process to filled bobbin with sewing thread from another machine

17-   In item 6.1from Table 4.22 remove the sewing thread from final product the different time was (130) sec the main reason of waste time the final product fill with sewing thread because the knife of the machine not sharp and the cutter not sharp also in additional to un qualified the worker.

18-   In item 6.2 from Table 4.22 quality control to detected the defect, the different time was (64) sec, the main reason unqualified the worker.

19-   In item 7.3from Table 4.22 ironing complete one piece the different time was (17.5)sec the main reason un qualified the presser

20-   In item 7.4from Table 4.22 package many of sets of products in carton the different time was (17.5) the main reason unqualified the worker

Table 4.22 Variation of time for manufacturing shirt by continues system inx_1 factory between three workers

NO	Manufacturing steps For shirt in X_1 factory	Time consumption (sec) from Worker			Average time Per sec	Time wasted per sec
		A	B	C		
1	**Preparing by Fusing machine**					
1.1	Fusing interlining to collar	7	8	9	8.5	1.5

1.2	Fusing interlining to stand collar	6	7	8	7.5	1.5
1.3	Fusing interlining to the cuff	1	2	3	2.5	1.5
1.4	Fusing interlining to the belt loop	3	3	3	3	-
1.5	Fusing interlining to the cover pocket	2	4	4	4	2
	Total	19	24	27	25.5	6.5
2	**Preparing by steam ironing**					
2.1	front pocket for write side (by pattern)	13	14	16	15	2
2.2	pen pocket (by pattern)	9	11	13	12	3
2.3	Back	9	11	14	12.5	3.5
2.4	front facing for button	13	15	17	16	3

Continues table 4.22

NO	Manufacturing steps For shirt in X_1 factory	Time consumption (sec) from Worker			Average time	Time wasted per sec
		A	**B**	**C**		
2.5	front facing for button hole	14	14	16	15	1
2.6	Cover pocket	9	10	12	11	2
2.7	front pocket for left side (by pattern)	13	15	16	15.5	2.5
2.8	Sleeve	12	12	12	12	-
2.9	tape for placket	15	16	18	17	2
Total		107	118	162	141	19
3	**Preparing by sewing**					
3.1	sewing collar (turn over collar- 6ml on collar)	43	46	50	48	5
3.2	sewing stand collar	30	42	43	42.5	12.5

3.3	sewing stand collar on collar	30	34	62	48	18
3.4	sewing belt of bird the belt make ten bird(cutting balance- sewing)	105	111	117	114	9
3.5	sewing tape of placket	7	8	9	8.5	1.5
3.6	sewing cuff(sewing –turn over cuff- 6ml in cuff)	54	62	108	85	31
3.7	sewing pen pocket in left side sleeve (hemming)	14	16	17	16.5	2.5
3.8	sewing belt loop(sewing – turn over-6 ml)	49	56	63	59.5	10.5
3.9	sewing cover pocket (sewing – turn over – ml)	74	82	90	86	12
3.10	sewing cover pocket for front pen pocket (sewing – turn over – ml and Para tacking)	35	37	44	40.5	5.5
Total		441	494	603	548.5	107.5
4	**Steps of assembling shirt by sewing**					
4.1	Marker for attaching pocket	21	30	42	36	15
4.2	Join the yoke on back	30	38	39	38.5	8.5
4.3	Sewing the ml on the back	37	43	60	51.5	14.5
4.4	Sewing front facing for button	45	51	59	55	10
4.5	Sewing front facing for button hole	9	14	30	22	13
4.6	attaching front pen pocket	27	31	38	34.5	7.5
4.7	attaching front pocket	60	67	71	69	9
4.8	attaching cover for pen pocket	24	27	30	28.5	4.5
4.9	attaching cover for front pocket	15	20	52	21	6
4.10	Join the front facing for	56	73	97	85	29

	button and front facing for button hole on back					
4.11	Top stitch the shoulder (sewing) ml	31	32	62	47	16
4.12	sewing tape on sleeve(placket)	26	53	80	66.5	40.5
4.13	attaching pen pocket in sleeve	33	37	45	41	8
4.14	attaching belt loop in two sides of shoulders	25	32	59	45.5	20.5
4.15	attaching bird	12	14	16	15	5
4.16	attaching sleeve in arm hole	19	20	35	27.5	8.5
4.17	sewing 6ml on sleeve	63	69	105	87	24
4.18	Attaching the cuffs in right and left sleeve	55	97	152	124.5	69.5

Continues table 4.22

NO	Manufacturing steps For shirt in X_1 factory	Time consumption (sec) from Worker			Average time	Time wasted per sec
		A	B	C		
4.19	Attaching collar first step	21	31	40	35.5	14.5
4.20	Close the collar and attaching size and label	26	30	67	48.5	22.5
4.21	Hemming	15.5	103	41	72	56.5
Total		647	842	1220	1051	402.5
5	Steps of finishing					
5.1	button hole marker	13	17	20	18.5	5.5
5.2	making button hole	37	44	73	63.5	26.5
5.3	button marker	32	37	39	38	6
5.4	attaching button	33	54	75	64.5	31.5
5.5	Partaking	56	63	65	64	8
Total		171	215	272	248.5	77.5

6	Quality control					
6.1	Eliminate flying threads from final product	90	180	260	220	130
6.2	Quality control(detected defect)	61	75	139	107	64
6.3	open button hole	26	30	39	34.5	8.5
6.4	close button	19	22	30	26	7
Total		196	307	468	387.5	209.5
7	Pressing and package					
7.1	iron side of piece	18	22	25	23.5	5.5
7.2	Irion whole piece	30	42	53	47.5	17.5
7.3	package one set	14	15	15	15	1
7.4	Package many of sets in one item of package carton	30	35	60	47.5	17.5
Total time per second		92	114	153	133.5	41.5
Total time per minute		28 (min)	35.5 (min)	48 (min)	42 (min)	14 (min)

From the data mentioned in table 4.22 the major noticed that the reason of variation time for manufacturing one piece of shirt by continues system production in x_1 factory between three workers were:

1. Poor quality of raw material (fabric and accessories)
2. Poor applying 5S tool and poor layout to spent long time when transportation material from first step to last step because the machine sequencing irregularly and this require the tailors assistant also defects being disappearance to eliminated.
3. Poor planning (waiting long time to waiting raw material to reach the place of production this lead to daily in time delivery for the customer
4. Continuously Deactivate in machine and un corrective system of maintenance applying in x_1 factory (treated maintenance) and the maintenance operator un qualified
5. Unqualified and un trained tailor for using the modern machine.

90

6. Poor qualified of production supervisors

7. Medium and traditional technology and manual operations using in x_1 factory

8. Poor work environment lead to continually absence the workers and low productivity .this finding agreed with (Hassall and Xiao, 2015, Colovic, 2014)

9. Disputes between the internal customers

10. Unconformity every worker to performance his main function

11. Management practices applying in x_1 factory quality control only for final product but don't applying quality assurance in line product throw manufacturing to prevent defect.

Figure 4.19 Variation time between three workers in preparing by fusing for shirt in x_1 factory
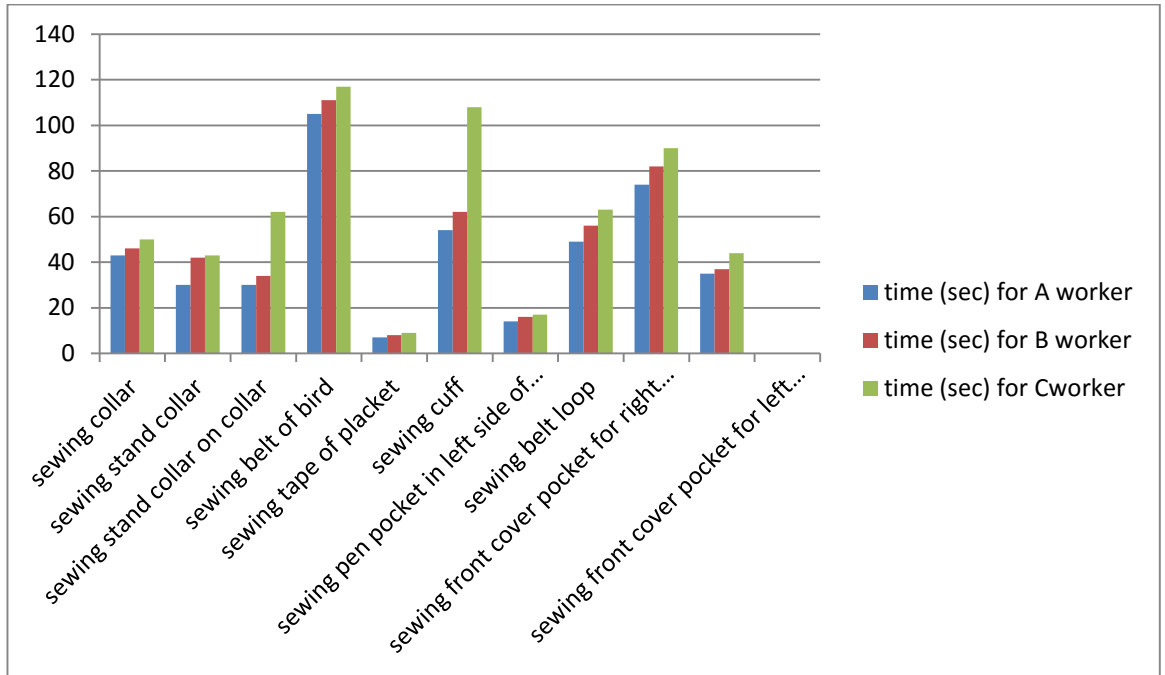
Figure 4.20 Variation time between three workers in preparing by sewing for shirt in x_1 factory
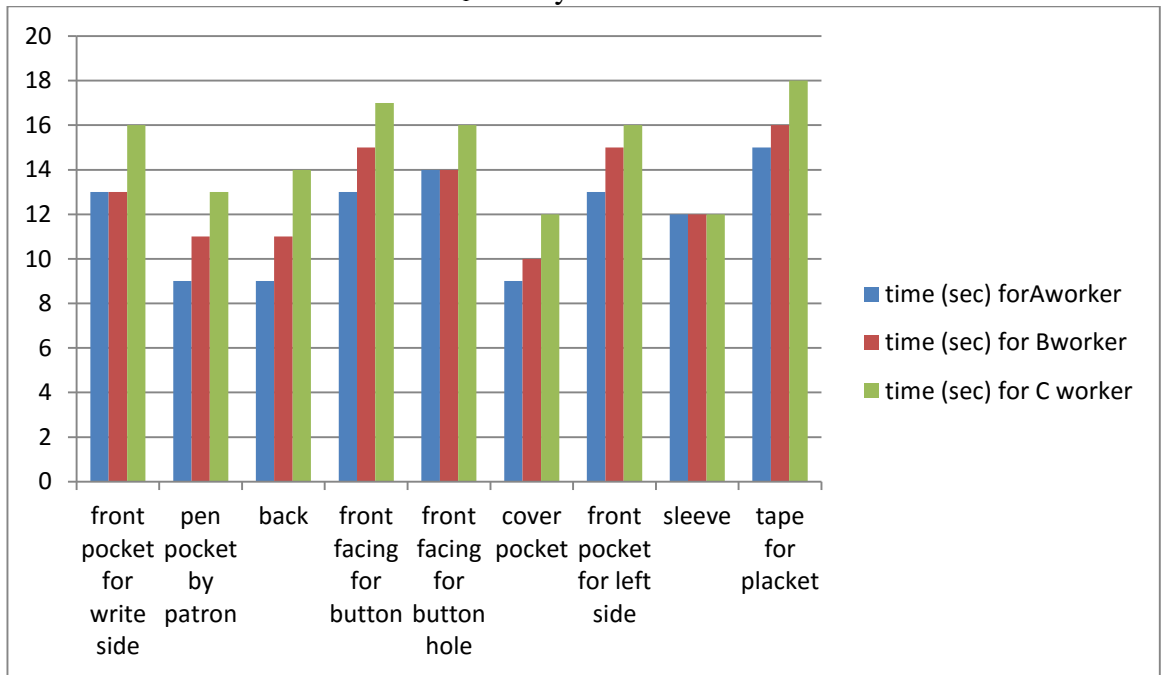
Figure 4.21 Variation time between three workers in preparing by steam iron for shirt in x_1 factory

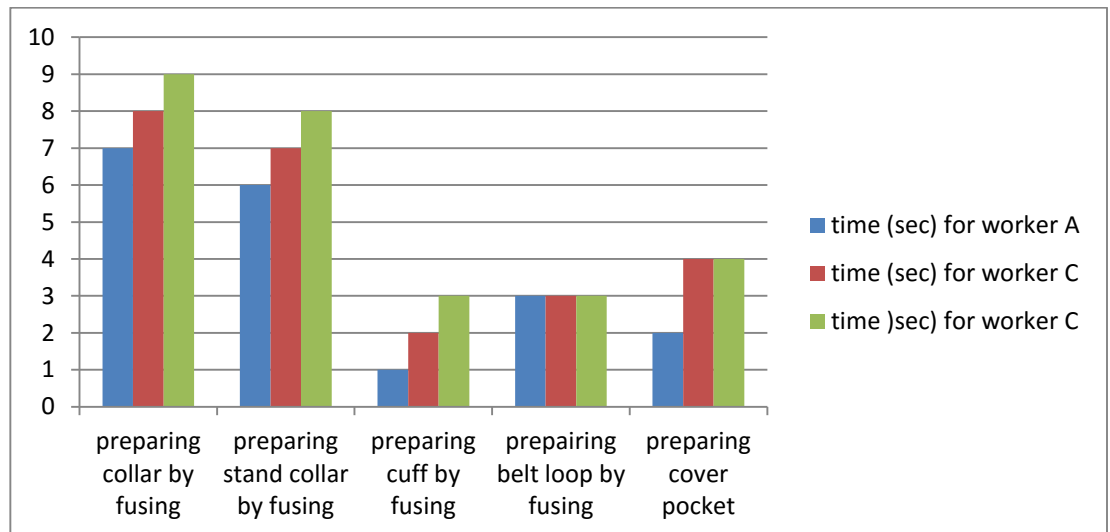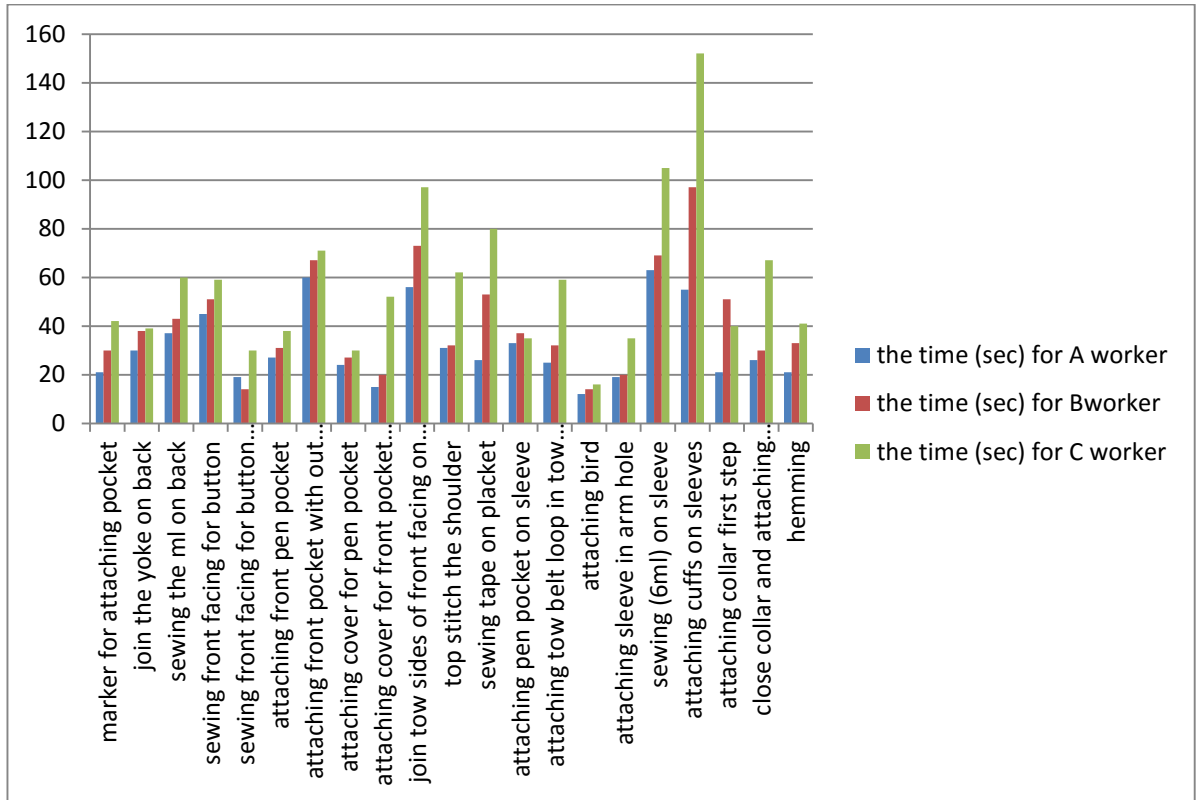Figure 4.22 Variation time between three workers in assembling by sewing for shirt in x₁ factory
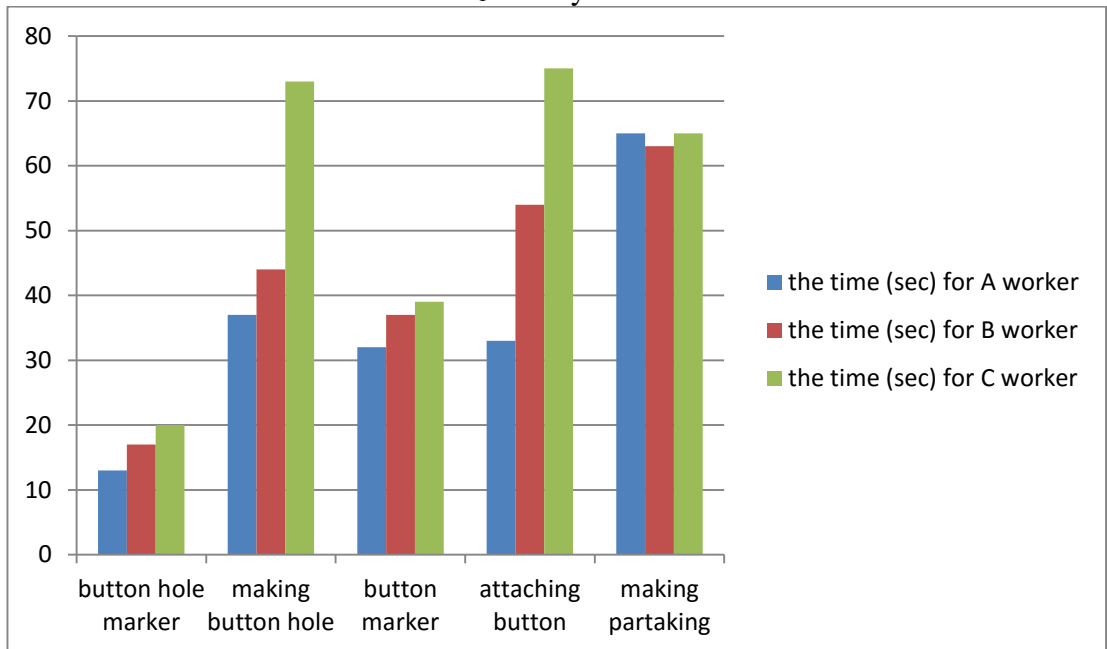
Figure 4.23 Variation time between three workers in finishing operation for shirt in x₁ factory
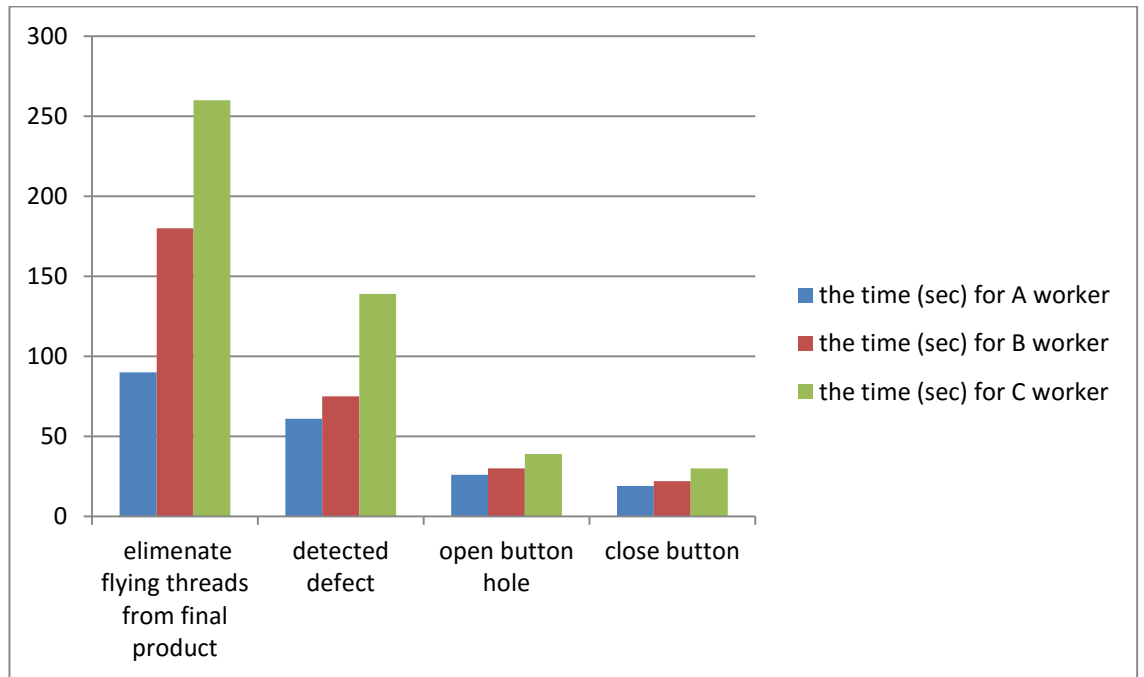
Figure 4.24 Variation time between three workers in quality control section   for shirt in x_1 factory
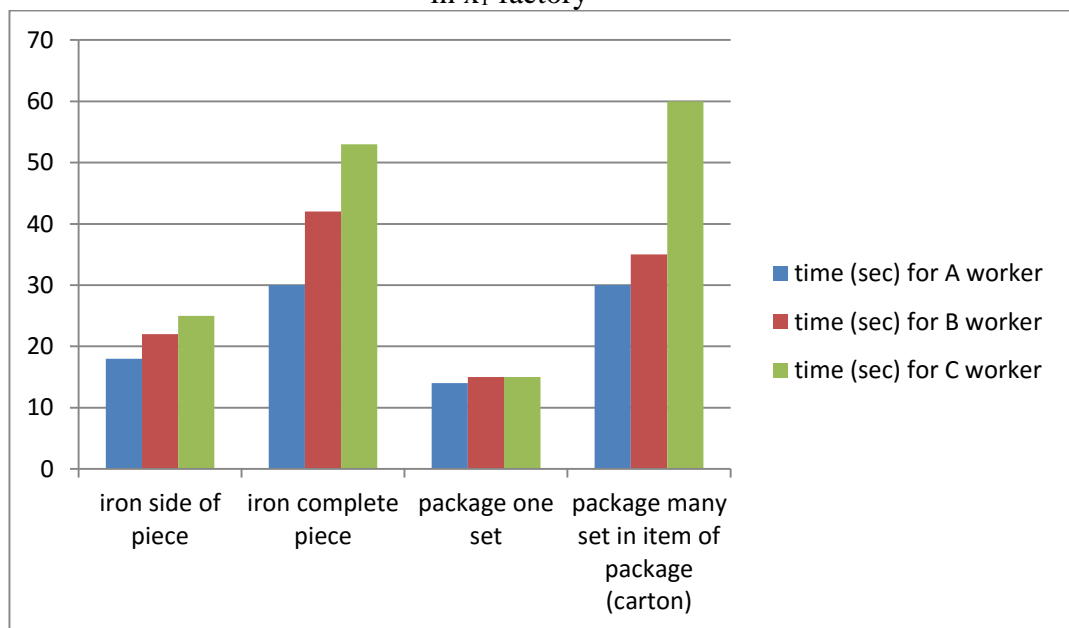
Figure 4.25 Variation time between three workers in iron and package section for shirt in x_1 factory

4.6.2 Variation time for manufacturing one pieces of trouser between three workers by continuous system in x₁ factory

As the results which were shown in Table 4.23 and Figure 4.26 to Figure 4.33 found that the reason of different of time for manufacturing one piece of trouser by continues system production in x_1 factory between three workers were

1- In the item 2.1 from Table 4.23 the different time was (21) sec, the main reason unqualified the worker.

2- In the item 3.1from Table 4.23 sewing belt loop (sewing, turn over, sewing 6mlthe different time was (14) sec the main reason un qualified tailor.

3- In item 4.2from Table 4.23sewing side pocket the different to time was (24.5) sec the main reason occur due to Knot in sewing thread the tailor was spent long time to treated the knot

4- In item 4.3from Table 4.23 sewing ml in side pocket the different time was (14) sec the main reason occur due to the Knife in sewing machine was not sharp the tailor used cutter to cutting sewing thread

5- In item 4.7from Table 4.23sewing front fly the different time was (14.5) sec the main reason the sewing Thread prepackage and the tailor entered thread into needle again.

6- In item 4.11from Table 4.23Sewing 6ml in side pocket the different time was (29.5) sec, occur due to the   Knife in sewing machine was not sharp the tailor used cutter to cutting sewing thread.

7- In item 4.12from Table 4.23par attacking (2) in side pocket the different time was (24.5) sec the main reason empty Bobbin filled bobbin with sewing thread from other machine.

8- In item 4.15 from Table 4.23 Attaching front fly and making (2) partaking under and over zipper different time was (29) sec the main reason sewing Thread break aged   the tailor entered sewing thread into the needle again.

9- In item 4.2.7 from Table 4.23Stitching the back pocket the different time was (17.5) sec the main reason un qualified tailor.

10- In item 4.2.12 from Table 4.23 attaching the waist band first step the different time was (22.5) sec the main reason of different time Unqualified tailor.

11- In item 4.2.15 from Table 4.23 Attaching the cuffs in right and left sleeve the different time was (16.5) sec the main reason empty Bobbin filled bobbin with thread from other machine.

12- In the item 5.3 from Table 4.23 attaching button, the different time was (30) sec the main reason the needle breakage replace the needle with new one.

13- In item 5.4 from Table 4.23 partaking sides pocket, the different time was (16) sec the main reason of different time un qualified tailor.

14- In item 6.1 from Table 4.23 Eliminate flying threads from final product, the different time was (109.5) sec the main reason of waste time the final product fill with sewing thread because the knife of the machine not sharp and the cutter not sharp also in additional to un qualified the worker.

15- In item 6.2 from Table 4.23 quality control to detected the defect, the different time was (21) sec, the main reason unqualified the worker.

16- In item 7.2 from Table 4.23 ironing complete one piece the different time was(27.5) sec the main reason un qualified the presser

17- In item 7.4 from Table 4.23 package many of sets of product in carton the different time was (17.5) the main reason unqualified the worker

Table 4.23 Variation time for manufacturing one pieces of trouser between three workers by continuous system in x_1 factory

NO	Manufacturing steps For n Trouser in X_1 factory	Time consumption per sec from worker			Average Time per sec	Time wasted per sec
		A	B	C		
1	**Preparing by fusing**					
1.1	Fusing waistband	13	15	15	15	2
1.2	fusing interlining for back pocket	15	16	18	17	2
1.3	fusing interlining for front fly	14	14	14	14	-
1.4	fusing interlining for belt loop	20	20	23	21.5	1.5
2	**Preparing by steam hand iron**					
2.1	Waistband	30	42	60	51	21

2.2	thin interlining for two sides of trouser to sewing sides front pocket	30	32	35	33.5	3.5
3	**Preparing by sewing**					
3.1	sewing belt loop (sewing –turn over- sewing 6ml)	67	73	89	81	14
4	**Process assembling by sewing**					
1	**front side for trouser**					
4.1	Over lock front right side	30	32	37	34.5	4.5
4.2	sewing side pocket	32	53	60	56.5	24.5
4.3	sewing ml in side pocket	22	27	45	36	14
4.4	sewing 6ml in side pocket	43	44	44	44	1
4.5	partaking (2) in side pocket	35	38	43	40.5	5.5
4.6	attaching zipper	30	36	57	46.5	16.5
4.7	Sewing front fly	21	32	45	38.5	17.5
4.8	Over lock front left side	24	24	24	24	-
4.9	Sewing side pocket	31	36	38	37	6
4.10	sewing ml in side pocket	29	35	53	44	15
4.11	Sewing 6ml in side pocket	30	54	65	59.5	29.5
4.12	par attacking (2) in side pocket	18	32	53	42.5	24.5
4.13	attaching front fly in left side	42	45	56	50.5	8.5

4.14	join front sides	42	56	60	58	16
4.15	Attaching front fly and making (2) partaking under and over zipper	38	65	69	67	29
4.16	Over lock left side pocket	30	30	43	36.5	6.5
4.17	Over lock right side pocket	24	25	27	26	2
2	**Back side for trouser**					
4.2.1	close dart to right side	14	15	17	16	2
4.2.2	Over right side	30	30	30	30	-
4.2.3	close dart to left side	15	16	16	16	1
4.2.4	Attaching back pocket	43	43	43	43	-
4.2.5	partaking (2) in back pocket	49	53	59	56	7
4.2.6	Making button hole	12	16	21	18.5	6.5
4.2.7	Stitching the back pocket	33	42	55	48.5	17.5
4.2.8	Over lock the back pocket	24	25	27	26	2
4.2.9	join front sides to the left part of back	66	69	85	77	11
4.2.10	join front sides and left part of back to right part of back	55	60	72	66	11
4.2.11	sewing cross point	49	52	69	60.5	11.5
4.2.12	attaching the waist band first step	57	73	86	79.5	22.5
4.2.13	close the waistband and attaching size	78	79	88	83.5	5.5
4.2.14	attaching belt loop	71	73	85	69	2

4.2.15	Hemming legs	54	68	73	70.5	16.5
5	**Finishing process**					
5.1	marker button hole	13	15	17	16	3
5.2	Marker button	20	23	24	23.5	3.5
5.3	attaching button	30	43	77	60	30
5.4	partaking sides pocket (2)	60	65	87	76	16
5.5	partaking Zipper	21	32	32	32	11
5.6	Partaking cross point	36	36	36	36	-
5.7	Making button hole	38	42	58	50	12
6	**Process quality**					
6.1	Eliminate flying threads from final product	102	180	243	211.5	109.5
6.2	Quality control to detect defect	90	97	125	111	21
7	**Pressing and package**					
7.1	iron side piece	36	39	60	49.5	13.5
7.2	Iron complete product	25	45	60	52.5	27.5
7.3	package one set	14	17	21	19	5
7.4	Package many of sets in one item of package carton	30	35	60	47.5	17.5

From the data mentioned in table 4.23 noticed that the reason of variation time for manufacturing one piece of trouser by continues system production in x_1 factory between three workers were:

1- Poor quality of raw material (fabric and accessories)

2- Poor applying 5S tool and poor layout to spent long time when transportation material from first step to last step because the machine sequencing irregularly and this require the tailors assistant also defects being disappearance to eliminated.

3- Poor planning (waiting long time to waiting raw material to reach the place of production this lead to daily in time delivery for the customer

4- Continuously Deactivate in machine and un corrective system of maintenance applying in x_1 factory (treated maintenance)and the maintenance operator un qualified

5- Un qualified and un trained tailor for using the modern machine.

6- Poor qualified of production supervisors

7- Medium and traditional technology and manual operations using in x_1 factory

8- Poor work environment lead to continually absence the workers and low productivity .this finding agreed with (Hassall and Xiao, 2015, Colovic, 2014)

9- Disputes between the internal customers

10- Unconformity every workers to performance his main function

11- Management practices applying in x_1 factory quality control only for final product but doesn't applying quality assurance in line product throw manufacturing to prevent defect
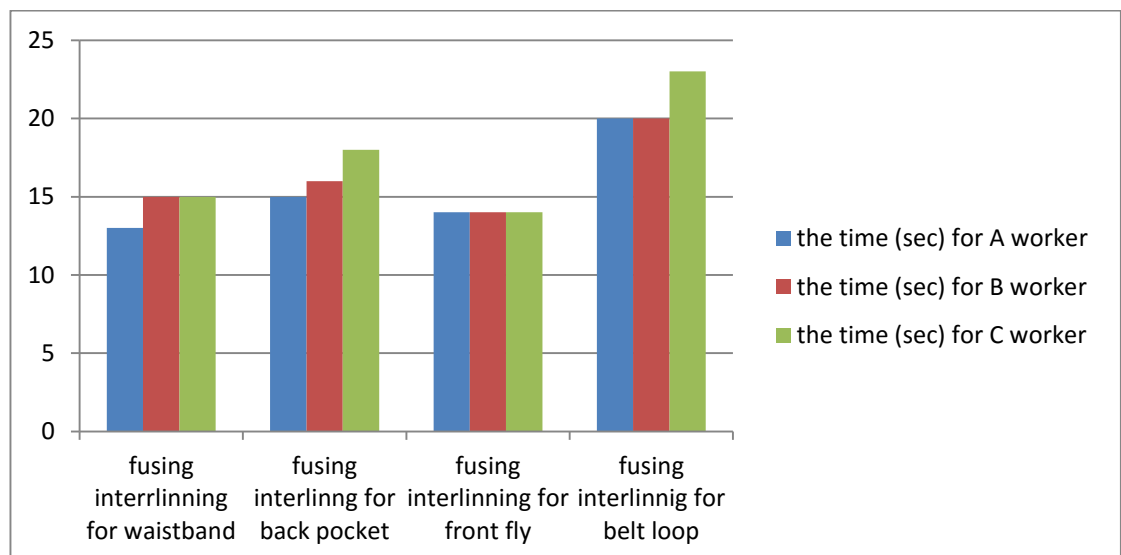
Figure 4.26 Variation time between three workers in preparing by fusing for trouser in x_1 factory
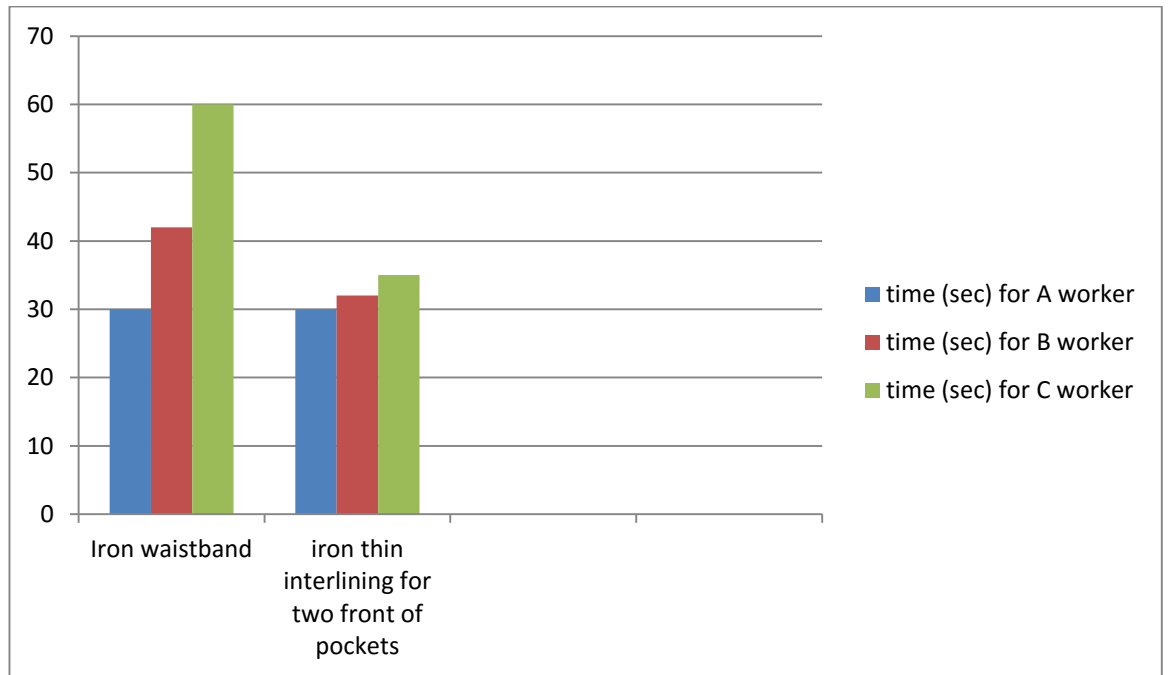
Figure 4.27 Variation time between three workers in preparing   by iron for trouser in x_1 factory
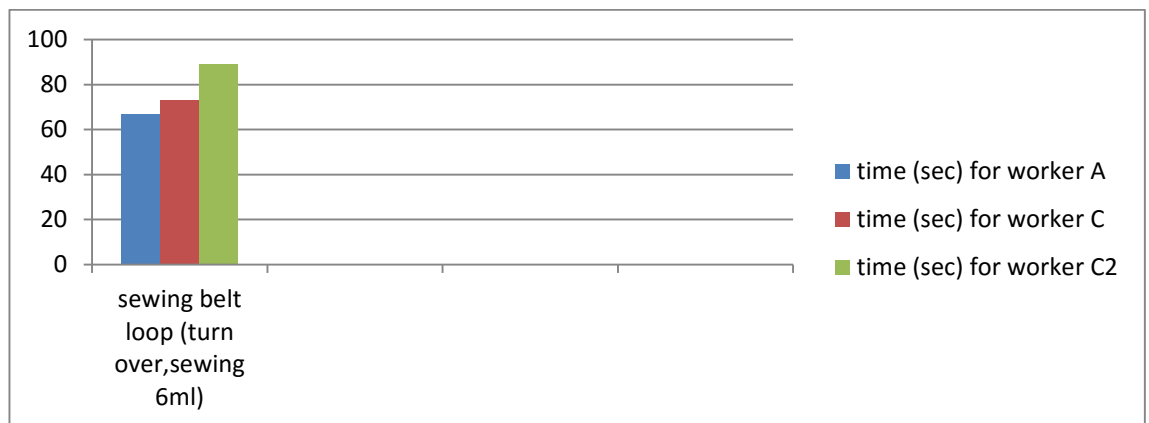
Figure 4.28 Variation time between three workers in preparing   by sewing for trouser in x_1 factory
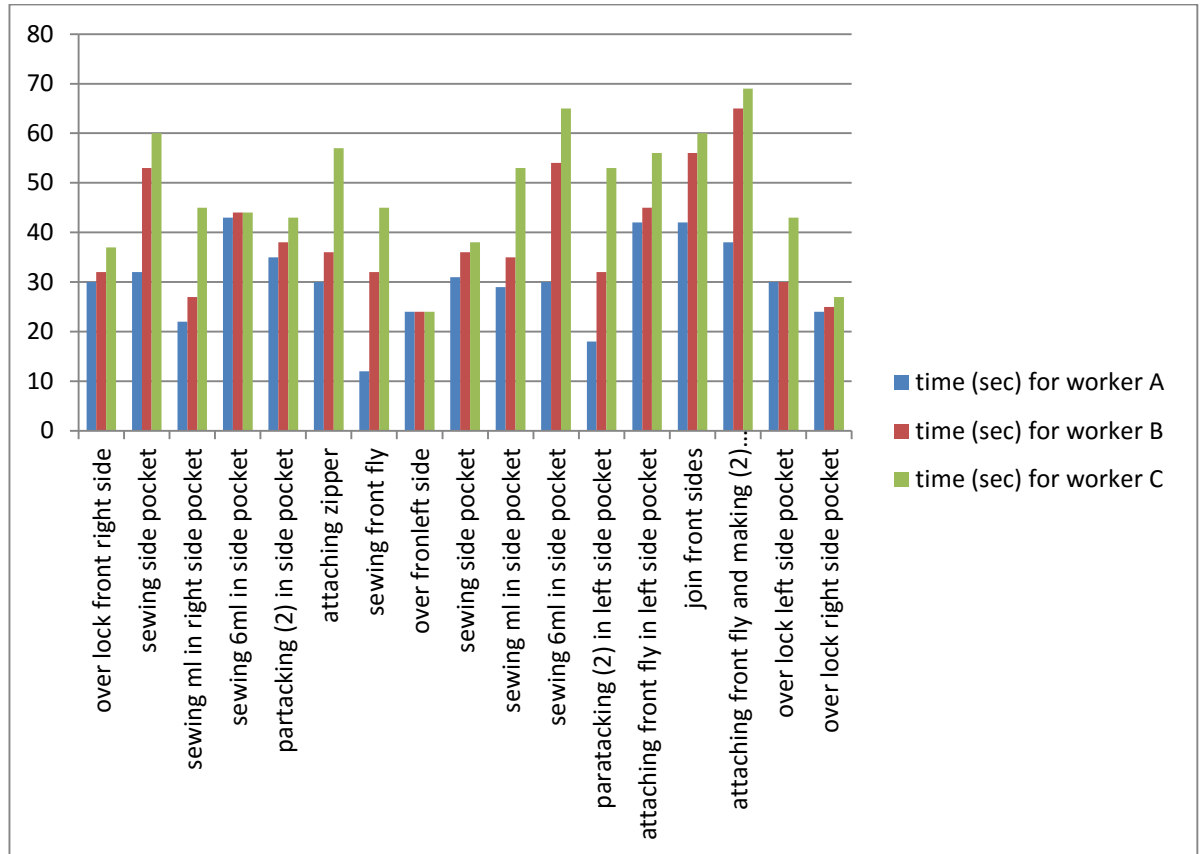
Figure 4.29 Variation time between three workers in assembling   by sewing for front side of trouser in x_1 factory
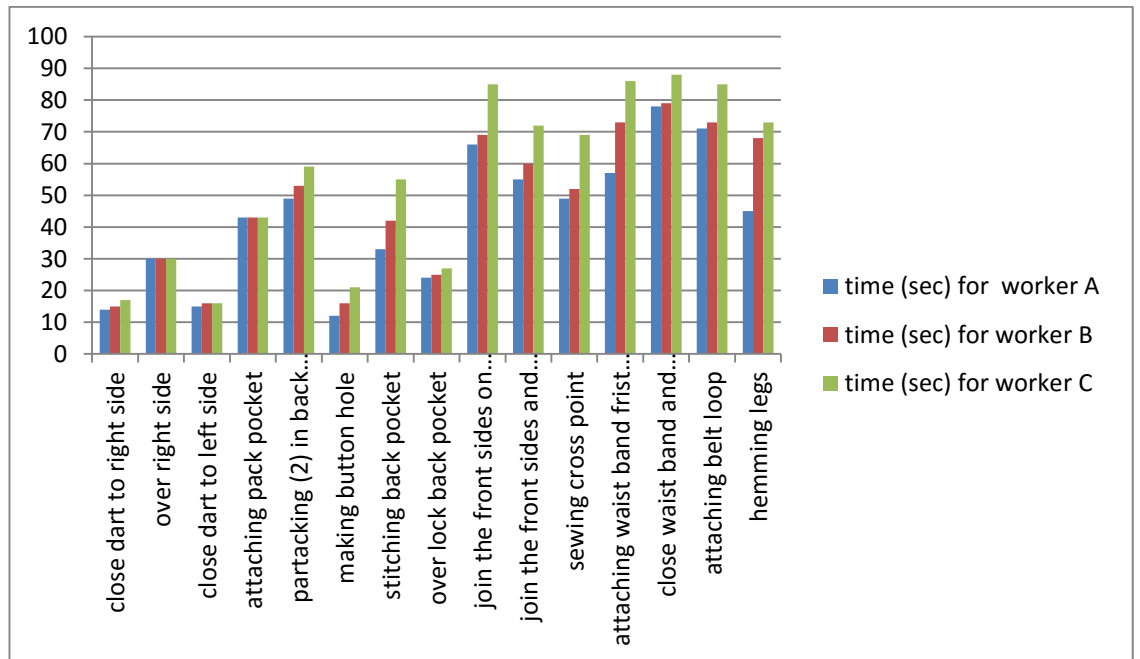
Figure 4.30 Variation time between three workers in assembling   by sewing for back side of trouser in x_1 factory
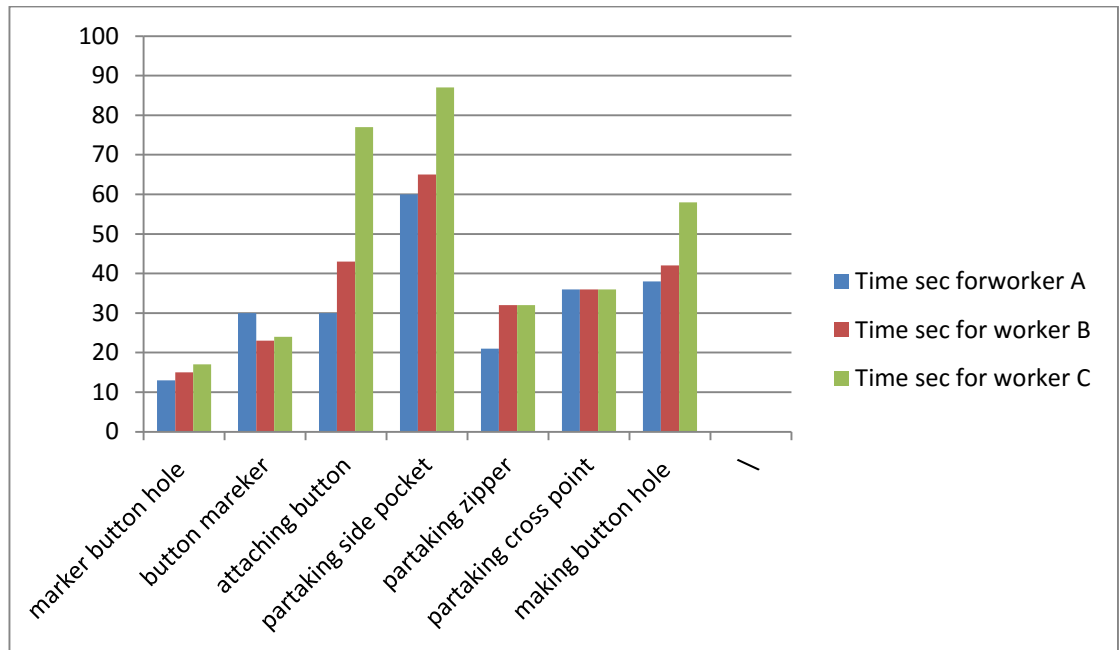
Figure 4.31 Variation time between three workers in finishing for trouser in x_1 factory
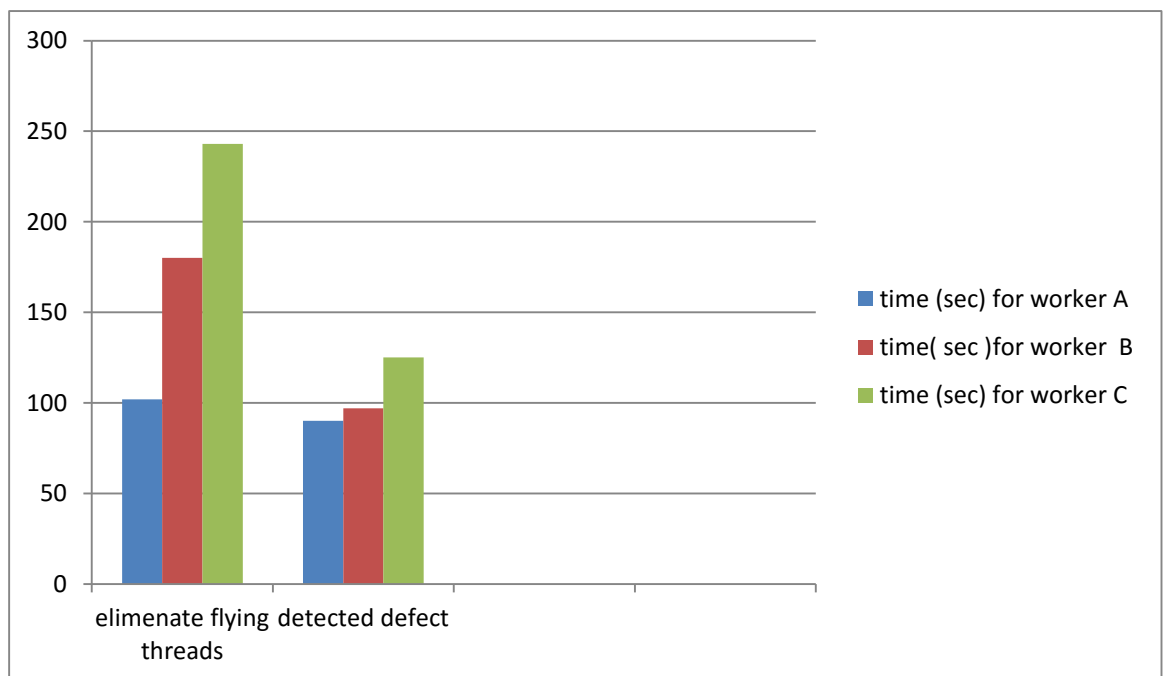
Figure 4.32 Variation time between three workers in section quality for trouser in x_1 factory
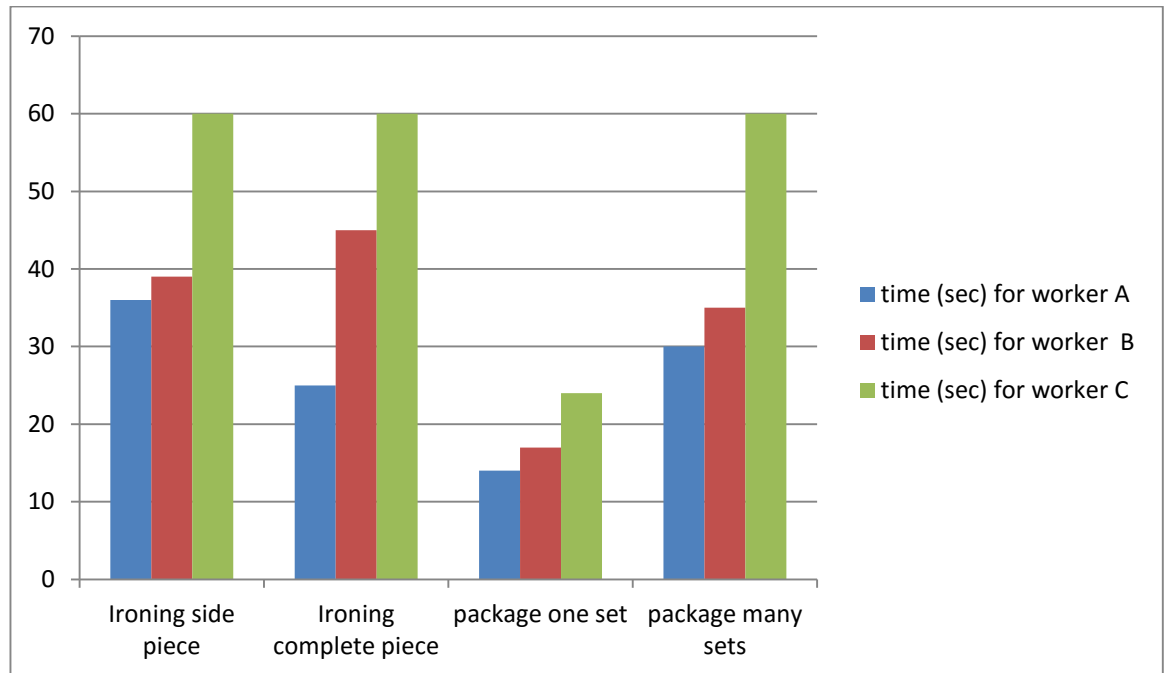
Figure 4.33 Variation time between three workers in section pressing and package for making trouser in x_1 factory

4.6.3 Variation time between three workers for manufacturing 10 pieces of shirts in x_1 factory by individual production system

As a results which was shown Table 4.24 and Figure 4.34 shown that the main reason of different time between three tailors for manufacturing 10 shirts by complete whole production system or individual system in x_1 factory for number of hours work day (7 hr. or 420 min). The result of Analysis of time of the entire three tailors for manufacturing (10) shirt found there were big difference of time. The main reason of different time between three tailors were unqualified tailors and different of their speed and their age, because the results found different time when the tailors inter the sewing thread into needle when thread breakage and treated the knot of thread and the time spent for moving to drink water and going to the bathroom because all the three sewing machine are the same (modern technology with sharp knife cutting the sewing thread automation and the bobbin fill with thread automation with machine.

Table 4.24 The variation time for manufacturing 10 shirts by whole complete system in x_1 factory between three workers for number of hour work day 7 hr.

Time consumption (min) from three Tailors to manufacturing 10 shirts			Average time	Different time
X	**Y**	**Z**		
420	518	703	610.5	190.5
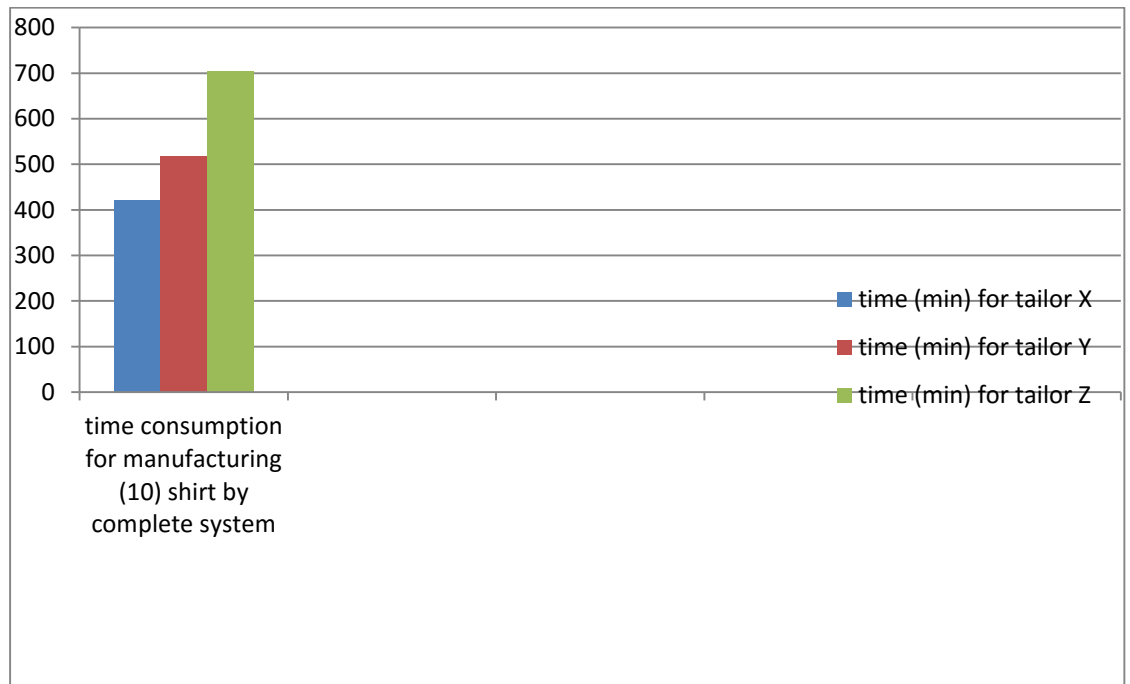
Figure 4.34 variation time for manufacturing 10 men shirt by whole complete system in x_1 factory between three workers

4.6.4 Number of daily product in section quality (Product with defect and product require treated) in x_1 factory before implementation quality assurance and basic of quality tools (check sheets)

As results which were shown in Table **4.25** and Figure 4.35 to Figure 4. found that there was big number of product in section quality doesn't disproportional with number of daily production in line manufacturing and found the reasons of variation were: The product return back to the line of production to treated the faults periodically because in one product found different defects in different components and the tailors don't care to corrective all defects in all the components of product in one time, the tailor corrective only one defect of component and when the controller inspection the product in section quality found other defect in product which had been inspected and also return back to the line of production to treated

the defect again and this spent long time, and this is the main reason of accumulate the production and referred to un applying quality assurance in x_1 factory

From mentioned above notice**:** The daily number of production in section quality un conformable to daily product in the line production. Because there are big accumulated number of production. Also result found the main reason of accumulated the productions in the place of production were:

- Un available the accessories such as button, zipper, sewing thread, item of package production, lining and interlining
- Big number of products (trouser) require waistband because the machine of fusing interlining deactivated require maintenance
- The abounding the sewing thread in final product because the knife in the machine not sharp and deactivate require maintenance and new spare
- The machine of attaching button, making buttonhole and partaking machine un conform to number of day production
- Gather the tow lines of production (shirt and trouser) together to product all days of week trouser and other week product shirt
- Also most of products scarp in the place of production and store house. The main reason of scrap unqualified the production supervisors and tailors
- Most products with grate defects which it difficult to treated. sailed by few price and this lead to high cost and delay of time delivery to the customer and missing the customer. The main reason of defect un qualifies the production supervisors and the tailors,

Table 4.25 Total number of product in section quality (product with defect and product require treated) in x_1 factory before implementation quality assurance and basic of quality tools (check sheets)

Date	Total number of daily product	The product without defect	The product with defect require treatment	Percentage % of defect
1.11.2017	1041	329	912	88%
2.11.2o17	719	464	255	36%
4.11.2017	515	173	342	66%
8.11.2017	176	57	119	68%

14.11.2017	422	190	365	86%
15.11.2017	560	221	339	61%
16.11.2017	305	172	133	44%
19.11.2017	820	402	418	51%
20.11.2017	1102	484	618	56%
21.11.2017	1030	618	412	40%
22.11.2017	980	449	531	54%
23.11.2o17	1260	645	615	49%
25.11.2017	900	390	510	57%
26.11.2017	1250	520	730	58%
27.11.2017	1300	560	740	57%
28.11.2017	765	522	243	32%
Total	**13145**	**6196**	**7282**	**55%**

Figure 4.35 Total number of product in section quality (product with defect and product require treated) in x_1 factory before implementation quality assurance and basic of quality tools (check sheets)

A   B   C
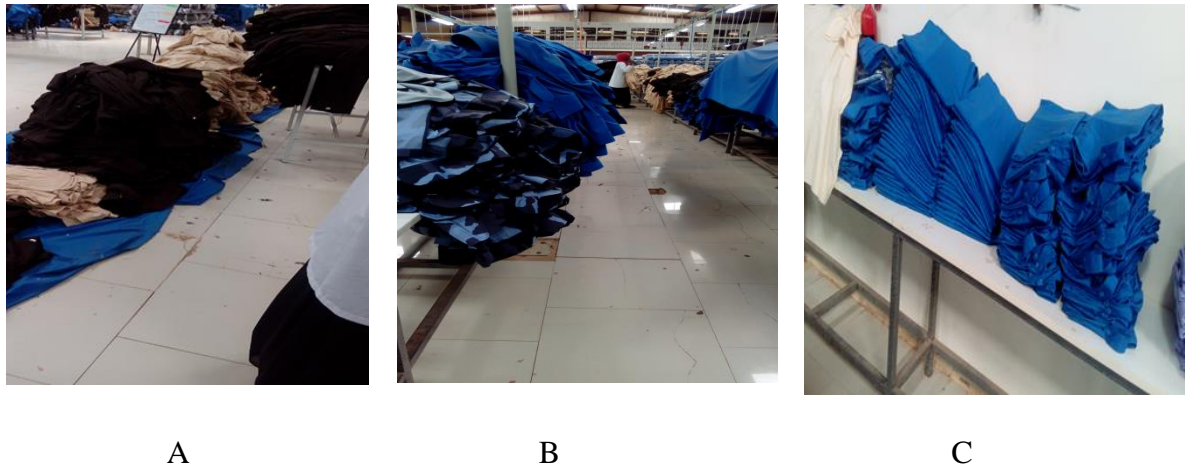
Figure 4.36 accumulated products in section quality in the x_1 factory; A products require inspection and eliminate of sewing thread ,B products require inspection and others faulted require treated some of products with wrong size for example size (M) attaching on it size(S),C products with variation degree of color in one piece of product

A   B

C   D
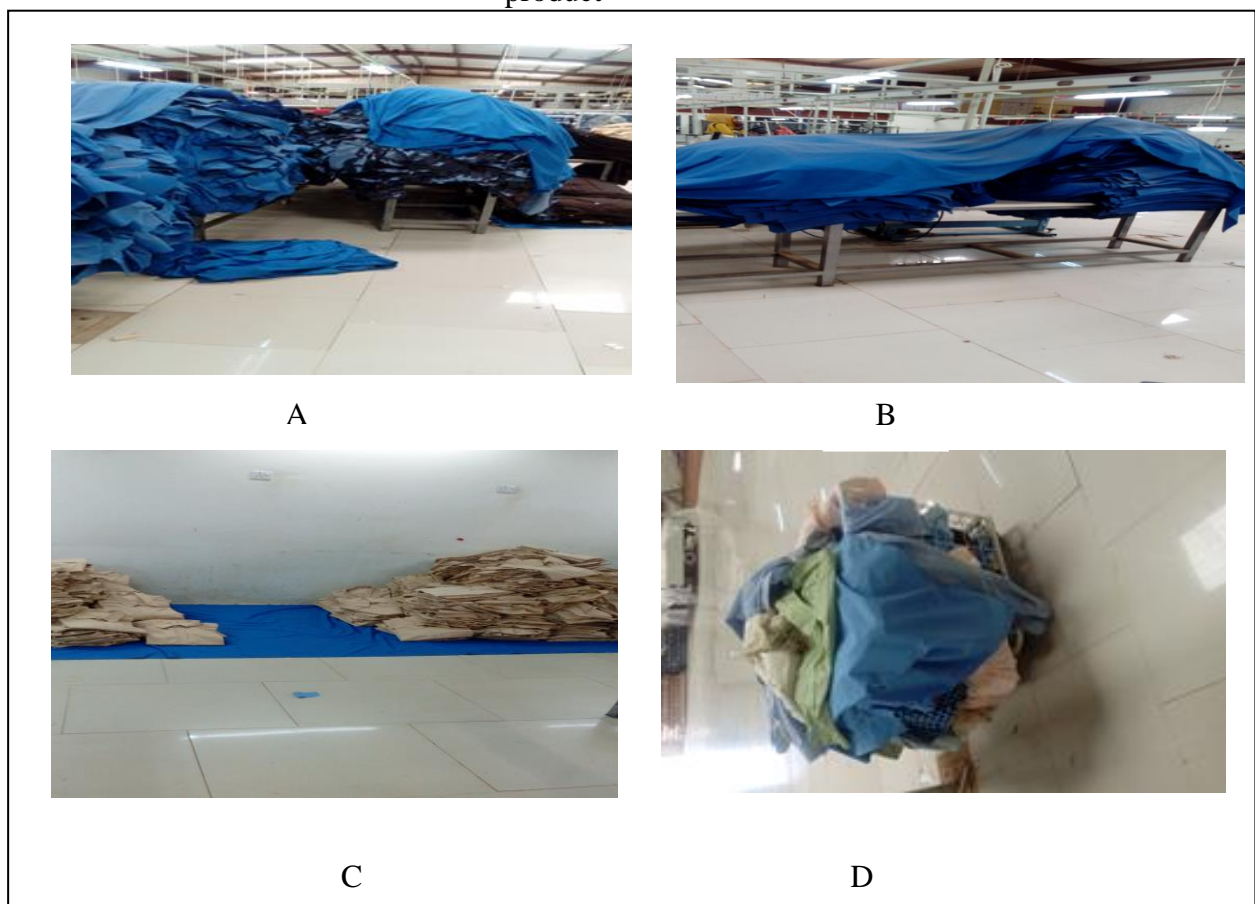
Figure 4.37 accumulate of production in place of production in $x_1$factory; A and B accumulate of product require button, C shirt require trouser result of poor planning because in all the lines manufacturing shirt for many days and then manufacturing trouser for many days, D scrape products

4.6.5 Number of daily product in section quality (Products with defect and products require treated) in x_1 factory after implementation quality assurance and basic of quality tools (check sheets)

As results which were shown in Table 4.26 and Figure 4.38 found that the defects in production decreasing considerably after applying quality assurance and the basic of quality tools (check sheets), improving of quality. But the production lower because the manpower decrease from 320 to 170becausecontinuously resignation and absent of the workers resulted of the bad work environment

Table 4.26 Total number of products in section quality (products with defect and products require treated) in x_1 factory after implementation quality assurance and basic of quality tools (check sheets)

Date	Total number of products	The products without defect	The products with defect require treatment	Percentage of defect %
1.3.2018	700	631	69	10%
3.3.2018	600	522	78	13%
4.3.2018	400	295	105	26%
5.3.2018	350	293	57	16%
6.3.2018	220	175	45	20%
7.3.2018	150	133	17	11%
9.3.2018	230	204	26	11%
10.3.2018	500	440	60	12%
11.3.2018	405	357	48	12%
12.3.2018	291	249	42	14%
13.3.2018	102	90	12	11%
14.3.2018	540	480	60	11%
15.3.2018	199	170	29	15%
20.3.2018	233	189	44	19%
21.3.2018	465	403	62	13%
22.3.2018	187	154	33	18%
24.3.2018	248	210	38	15%
25.3.2018	360	300	60	17%
26.3.2018	145	117	28	19%
27.3.2018	225	193	62	28%
28.3.2018	310	275	35	11%

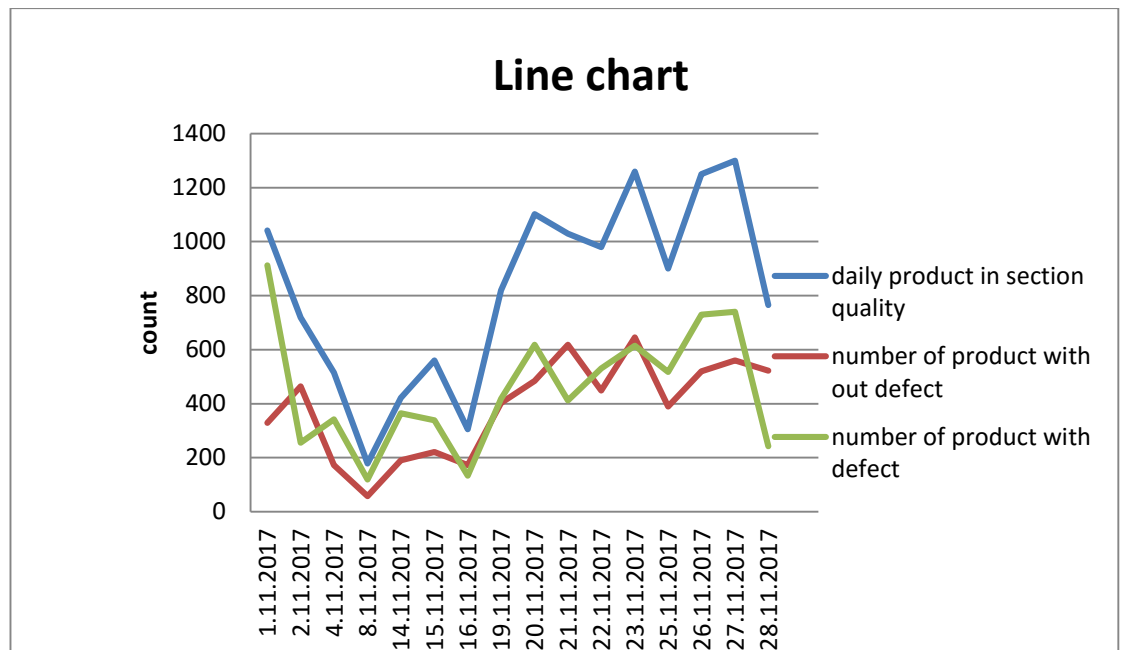| 29.3.2018	430	346	54	13%
31.3.2018	280	230	50	18%
Total	**7570**	**6456**	**1114**	**15%**
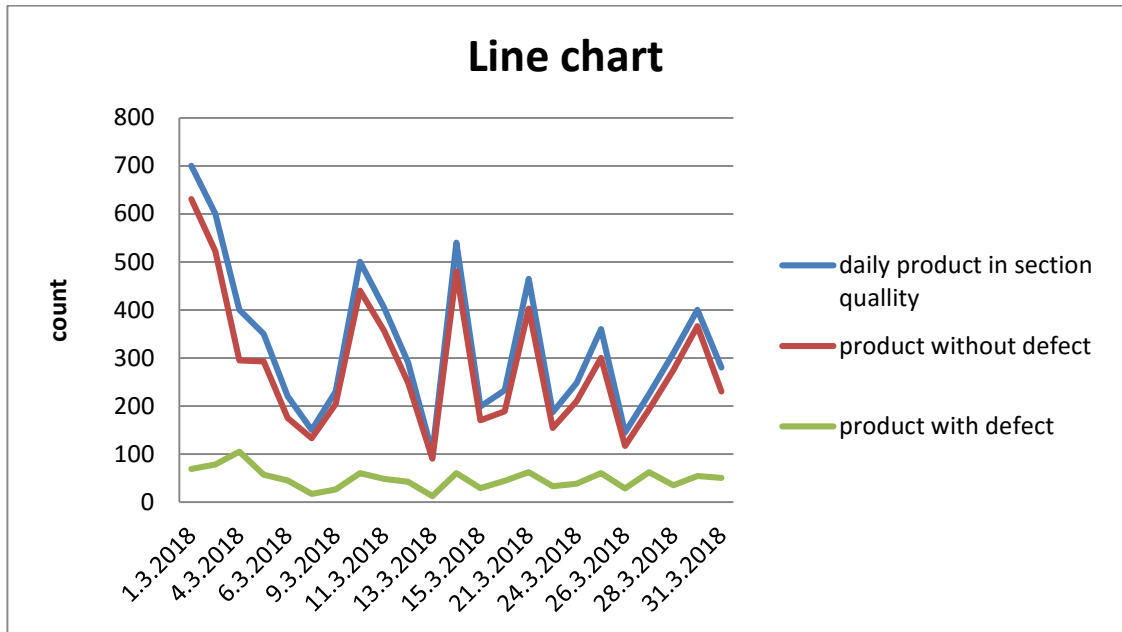
Figure 4.38 Total number of product in section quality (product with defect and product require treated) in x_1 factory after implementation quality assurance and basic of quality tools (check sheets)

4.6.6 Comparison between percentage % of defect before and after applying quality assurance and check sheets in x_1 factory in section quality

As results which were shown in Table 4.27 and Figure 4.39 found that before applying quality assurance and check sheets defects more than fifty percentage of products faulted and after applying quality assurance and check sheets found that the defect of products was very lower.

Table 4.27 Comparison between percentage % of defect before and after applying quality assurance and check sheets in x_1 factory in section quality

The period	The number of products	The number of products with defect	Defect Percentage %
November 2017 before implementation quality tools	13145	7282	55%
March 2018 after implementation quality tools	7570	1114	15%
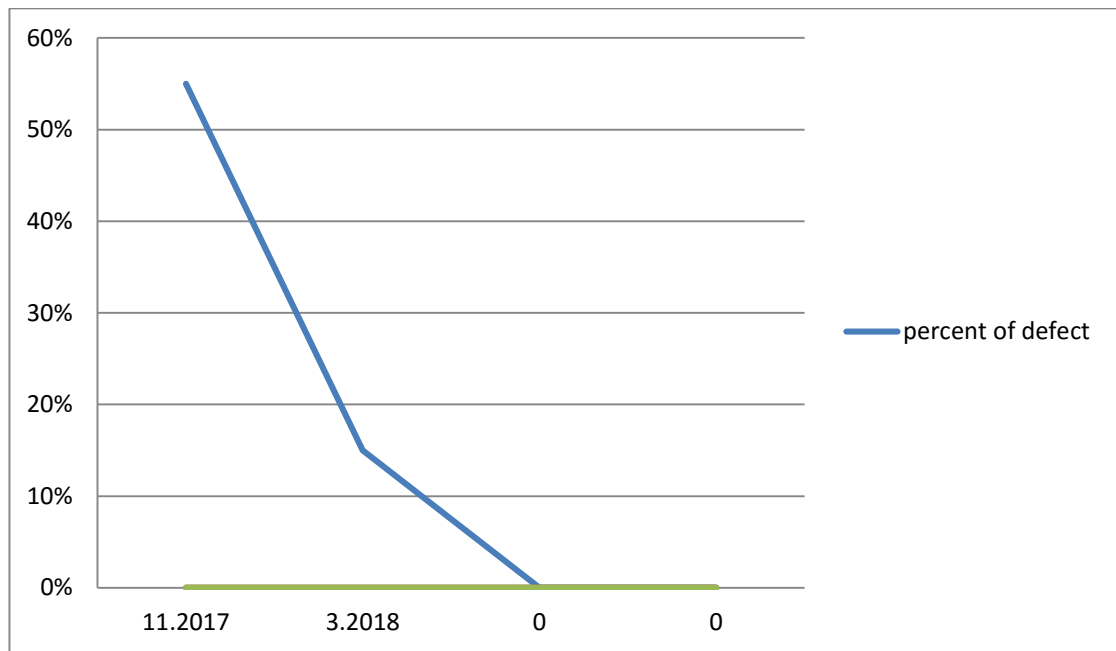
Figure 4.39 Comparison between percentage% of defect before and after applying quality assurance and check sheets in x_1 factory in section quality

4.6.7 Number of daily products and number of defect of shirt before applying quality assurance and basic quality tools in line production (sewing section) in x_1 factory

As results which were shown in Table 4.28 and Figure 4.40 found that the defect very big in November2017 or nearly fifty of products faulted because un applying any quality tools in the factory and unstable the average of production in the day

Table 4.28 Number of daily product and number of defect of shirt in November.2017 (before applying quality tools) in line production in x_1 factory

The date	The number of products	Number of defect	Defect Percentage %
1.11.2017	220	104	47%
2.11.2017	176	83	47%
5.11.2017	400	198	49%
6.11.2017	400	153	38%
7.11.2017	360	180	50%
8.11.2017	460	200	43%
9.11.2017	340	170	50%
10.11.2017	553	133	24%

11.11.2017	460	180	39%
12.11.2017	623	250	40%
13.11.2017	500	200	40%
14.11.2017	356	197	55%
15.11.2017	629	260	41%
16.11.2017	595	258	43%
17.11.2017	600	320	53%
19.11.2017	400	138	35%
20.11.2017	550	150	27%
21.11.2017	620	213	34%
22.11.2017	470	230	48%
23.11.2017	450	278	61%
25.11.2017	420	160	38%
26.11.2017	520	211	40%
27.11.2017	570	154	27%
28.11.2017	510	178	34%
Total	**11142**	**4598**	41%
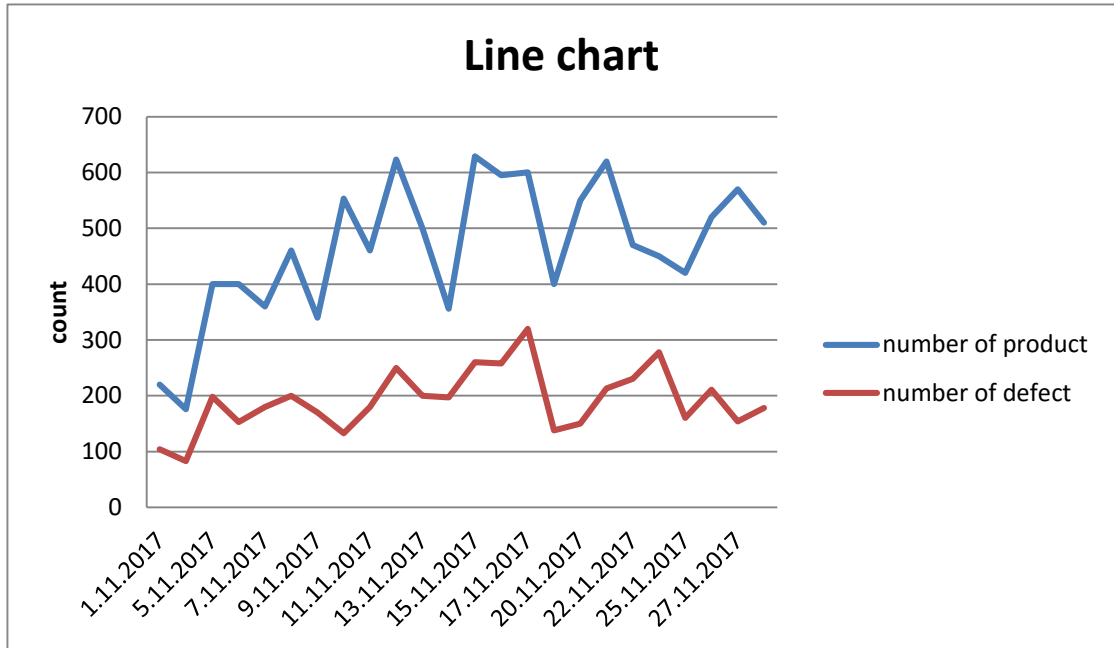
Figure 4.40 Number of daily product and number of defect of shirt in November.2017 (before applying quality tools) in line production in x_1 factory

4.6.8 Most types of defect and number of defects of shirt in November 2017in x_1 factory

As results which were shown in Table 4.29 found that the number of shirt defects in November 2017 very high because found defects in all the shirt components for example in the collar types of defects were wrong attaching collar in stand collar, joint stitch, defect in closed collar and attaching size. In the pocket types of defects were Irregular attaching front pocket defect attaching cover of front pocket, Mismatch size of cover pocket to the pocket and s Mismatch size of cover pocket to the pocket skip stich and the high number of defects because un applying quality tools and quality assurance only applying quality control in final product.

Table 4.29 Most types of defects and number of Defects of shirt (before applying quality tools) in x_1 factory

Type of defect	Number of defect
Irregular attaching front pocket	343
Wrong Attaching collar	296
fault in sewing front facing	Not found

113

defect in attaching stand collar to collar	0.2
Defect Close collar and attaching size and label	11
fault in attaching sleeve	111
defect attaching cover of front pocket	275
Wrong in size in parts of shirt	136
Mismatch size of cover pocket to the pocket	315
Irregular Attaching belt loop	340
Wrong Attaching bird	180
irregular attaching buttons	Not found
Brocken stitch during eliminate sewing s thread	126
Wrong in attaching cuff	734
Wrong marker button hole	Not found
Wrong marker button	66
Wrong sewing cuff	34
Open over lock in the sides	47
Fabric defect	140
Missing bar tacking in pocket	75
Missing bar tacking g in pen pocket	Not found
Stitch pucker	84
Insecure shoulder stitch	50
Missing size	26
Missing button	35
Shade variation within the garment parts in one piece	667
Button breakage	Not found
Dirt spot	12
Hole in fabric result needle breakage	8
Hole in fabric result misused the tailor to the cutter	20
Skip stitch	40
join stitch	307
Irregular hemming	108
Total of defect	**4598**

4.6.9 Number of defect of shirt in March 2018 in $x_1$factory (after applying quality tools) in line production

As results shown in Table 4.30 and Figure 4.41 found that low of productivity and improving of quality and the reason were:

1. The production decreasing considerably in March 2018 because the manpower decrease from 320 to 170 because continuously resignation and absence of the workers

2. The defect improving of quality because applying quality assurance in the line of production and check sheets

Table 4.30 Number of daily product and number of defect of shirt in March .2018 in line production in x_1 factory

The date	The number of products	Number of defect	Defect Percentage %
1.3.2018	485	66	14%
2.3.2018	166	27	16%
3.3.2018	60	5	8%
5.3.2018	310	53	17%
6.3.2018	300	26	8%
7.3.2018	320	45	14%
10.3.2018	320	67	21%
11.3.2108	300	28	9%
12.3.2018	400	52	13%
13.11.2018	400	43	11%
14.3.2018	380	51	13%
15.3.2018	430	62	14%
18.3.2018	340	46	14%
19.3.2018	310	55	18%
20.3.2018	370	72	19%
21.3.2018	340	36	11%
22.3.2018	400	86	22%
24.3.2018	430	60	18%
25.3.2018	390	49	13%
26.3.2018	320	44	14%

27.3.2018	350	47	13%
28.3.2018	400	70	18%
29.3.2018	360	59	16%
31.3.2018	380	34	9%
Total	**8261**	**1183**	**14%**
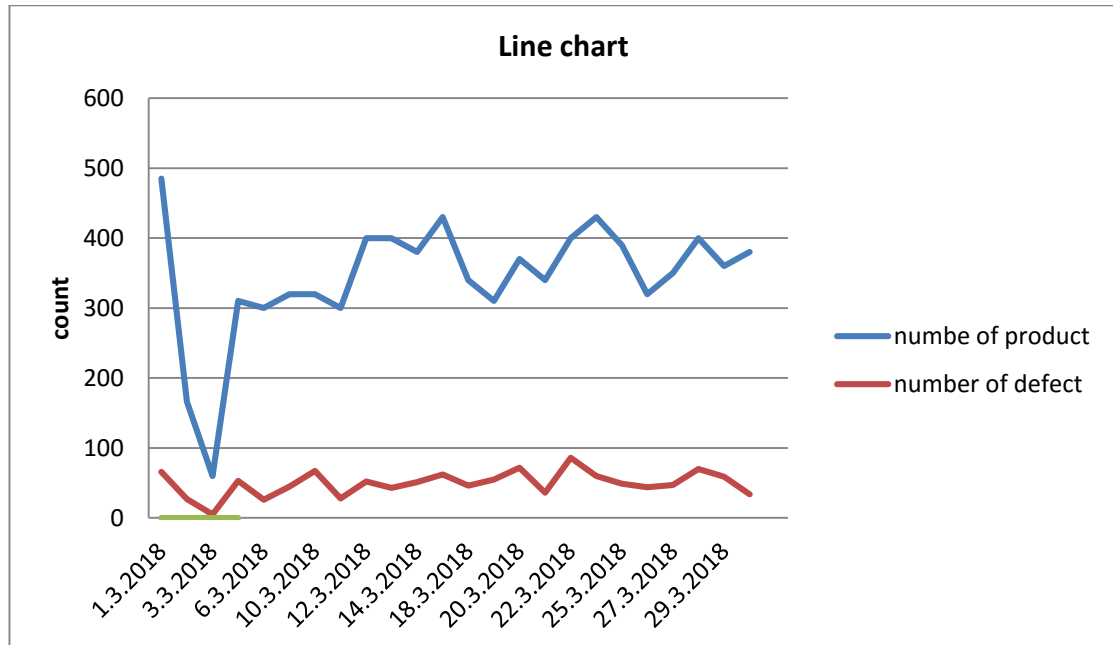
Figure 4.41 Number of daily product and number of defect of shirt In March 2018 in line production in x_1 factory

4.6.10 Most types of defect of shirt in March 2018 in x_1 factory in line product

As results which were shown in Table 4.31 found that the number of shirt defects after applying quality tools and quality assurance low before applying quality tools and quality assurance for example in the collar don't found defects in attaching collar and stand collar because the tailors trained and also applying quality assurance in the line of production.

Table 4.31 Most types of defects of shirt in March 2018 (after applying quality tools) in x_1 factory

Types of defects	Number of defect
Irregular attaching front pocket	120
Wrong Attaching collar	Not found
fault in sewing front facing	Not found
defect in attaching stand collar to collar	Not found
Defect Close collar and attaching size and label	Not found
fault in attaching sleeve	6
defect attaching cover of front pocket	79
Wrong in size in parts of shirt	Not found
Mismatch size of cover pocket to the pocket	156
Irregular stitching (6ml) in arm hole	47
Irregular Attaching belt loop	78
Wrong Attaching bird	35
irregular attaching buttons	Not found
Brocken stitch during eliminate sewing s thread	40
Wrong in sewing cuff	18
Wrong marker button hole	45
defect marker button	18
Missing paratacking In cuff (placket)	14
Wrong attaching cuff	172
Open over lock in the sides	47
Fabric defect	29
Missing bar tacking in pocket	17

Missing bar tacking g in pen pocket	5
Stitch pucker	30
Insecure shoulder stitching	45
Missing size	11
Lost button	25
Shade variation within the garment parts in one piece	Not found
Button breakage	Not found
Dirt spot	3
Hole in fabric result needle breakage	Not found
Hole in fabric result misused the tailor to the cutter	Not found
Missing stitch	33
Skip stitch	18
join stitch	80
Irregular hemming	20
Total of defect	**1183**

4.6.11 Comparison between product and defect and percentage of defect in November .2017 and March.2018 in x_1 factor in line production

As results which were shown in Table 4.32 and Figure 4.42 and also Figure 4.43 found that the percentage of defects in March 2018 less than November 2017 because applying quality assurance system in line of production and one of the basic quality tools (check sheets) and good and continuously monitoring of production supervisors for the process. In November nearly fifty of product faulted because don't applying quality assurance in the line of production and supervisor don't monitoring the process continuously.

Table 4.32 Comparison between product and defect and percentage
Of defect in November .2017 and March.2018 in x₁ factory in line production

The period	The number of products	The number of defect	Defect Percentage %
November 2017 before applying quality tools	11142	4598	41%
March 2018 after applying quality tools	8261	1183	14%
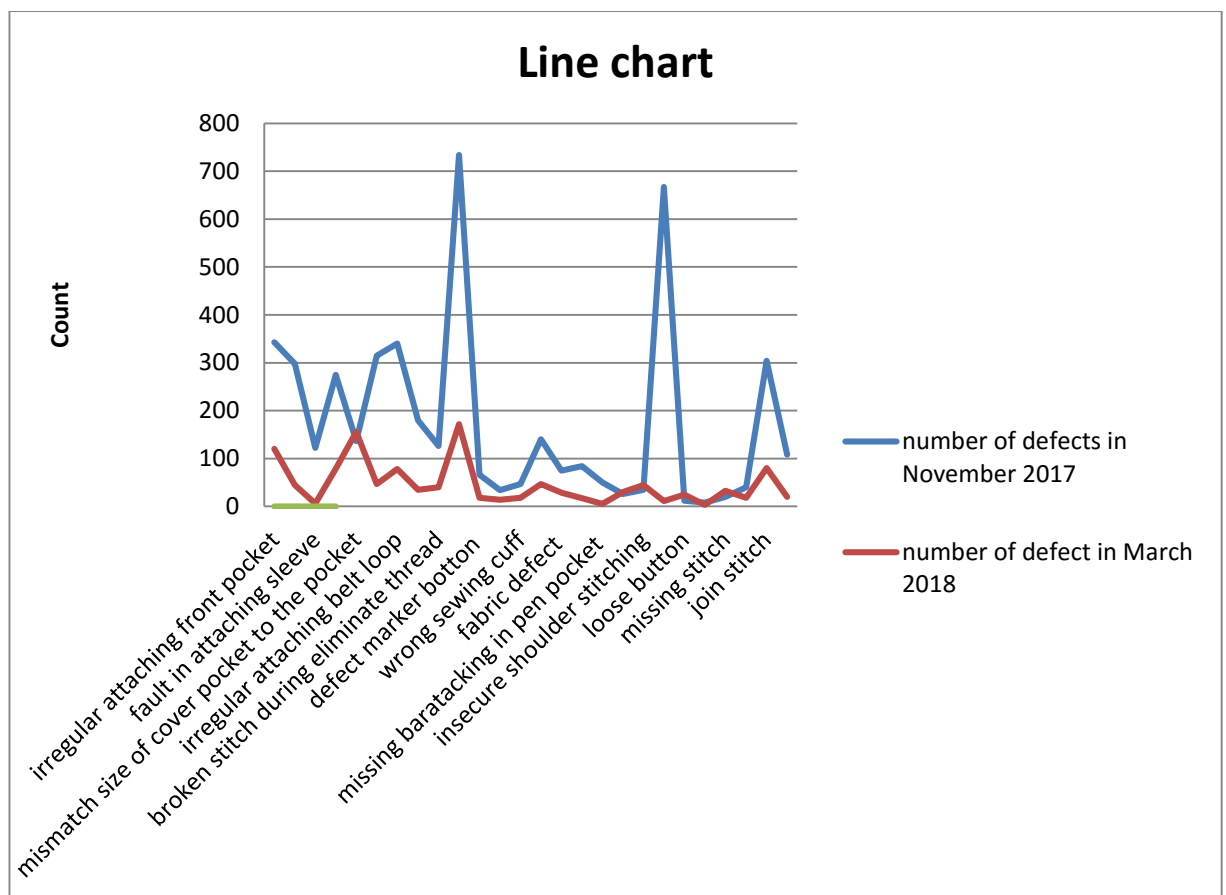
Figure 4.42 Number of the most defect of shirt in x₁ factory
Before and after applying quality tools and quality assurance

119
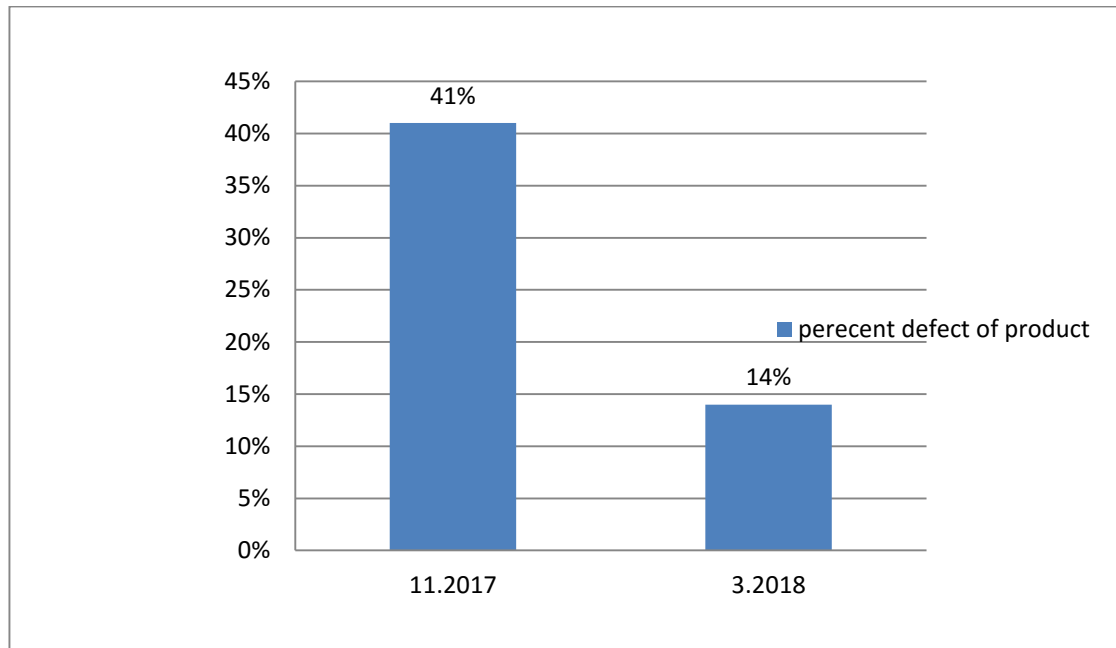
Figure 4.43 percentage of defect of product in November 2017 (before applying quality tools) and in March 2018 (after applying quality tools) in x_1 factory

4.6.12 Comparison between the two types of production system in x_1 factory

As results which were shown in Table 4.33 found that assembling line production system better than whole or individual production system because in assembling line production system found that:

1- The process of manufacturing spent few time
2- The final product with good quality
3- This production system may allow better utilization of specialized garment production machines, as output from one special purpose automated garment machine may be able to supply several garment machine operators for the next operation.
4- Increase productivity
5- Labor cost lower

In individual production system found:

1- The process spent long time
2- The tailor interested with quantity more than quality
3- Low productivity because require addition time to corrected the defect

4- Labor cost is higher due to the utilization of highly skilled laborers for the particular job.

Table 4.33 Comparison between the types of production system in x_1 factory

Type of production system	Type of product	Average time for manufacturing one piece(min)	Advantage of production system	disadvantage of production system
Assembling line production system	Shirt	37	1.The process of manufacturing spent few time 2.The final product with good quality	1- The tailor require tailor assistant because the machine in the line don't collator sequentially 2- This system depend on all internal customer to be care in all stage of manufacturing
	Trouser	32	3. This production system may allow better utilization of specialized garment production machines, as output from one special purpose automated garment machine may be able to supply several garment machine operators for the next operation. 4. Increase productivity 5. Low cost of labor	3- Variety of styles of lesser quantity are not effective in this system. 4-Absenteeism, machine failure, and slow processing are also some major bottlenecks in this system
Complete whole production system or individual production system	Shirt	42	1. Tailor will be specialized in his own working area depend on himself in all process	1.The process spent long time 2. the tailor interested with quantity more than quality
	Trouser	36	2-This system is more effective when a very large variety of garments have to be produced in extremely small quantities.	3. low productivity because require addition time to corrected the defect 4. Labor cost was higher due

121

4.6.13 Improving inx1 factory during research study

From above mentioned and discussed, the following points where figured out as results of improving in x_1 factory which leads to enhance quality of productivity and profitability:

1. Sufficient management commitment and effective and contact with the production directly by making production observation committee to advent all problems and plighted

2. The top manger Visiting the other organization which applying TQM continuously

3. Good layout, the line of production (machines regularly sequencing in sewing room from first step to last step)and this lead to reduce the tailor assistance and cycle production time

4. Enhance the work environment, maintenance the air environment and available adequate light

5. Enhanced meal

6. Maintenance restaurant

7. Adopted recreational day

8. Motivated the worker moral and financial

9. Maintenance most of machines

10. Continuous Training to the manpower

11. Available insurance healthy card for the workers

12. Interested every workers to performance his main function

13. Decrease absence of the workers

14. Genesis functional structure in the factory

15. Genesis planning section in the factory

16. Solving disputes between the internal customers and supervisors in one section by building team work

17. .Available the clinic with some drug to patient requirement.

18. Available the protection and safety tools in the workplace

19. Design new pattern to treated any fault in the size and garment measurement

20. Using new basic tools of quality as flowchart, check sheets

21. Applying quality assurance in the line of production

22. Using fabric inspection machine

23. Genesis   committee   for   inspection   of   fabric   and   accessories

Chapter 5   Conclusion and Recommendation

5.1 Conclusion

This study investigates to attempted TQM in garment manufacturing in Sudan focus on all phases of garment manufacturing starting from design to storage, by applied lean manufacturing tools such as TQM,(JIT, 5S, Quality assurance, six sigma and basic quality tools) as ways of improving garment manufacturing systems that lead to shortening the cycle time of production, Improving quality of productivity and profitability, reduce the cost, meeting the customer expectation in the time delivery, reduces all forms of non-value added activities in organizations and improves its performance. From the analysis of the data collected, it appears that the factories which was adopt total quality management as a working philosophy within their organizations can make significant improvement in terms of their operational performance. It is obvious that there are strong benefits to be gained from implementing total quality management system, as demonstrated by the factories in this study. In present world where competition is at the highest level, the factories that can produce accumulated technological knowledge and can make their production flexible while considering the market variability, gain very high competitive by providing their customers with products of higher quality, which are appropriate to standards, and are available at lower prices. This study designed and employed two surveys one survey conducted among a sample of the local garment factories in Sudan to determine the impact on company strategy, management practices and performance to identify the weakness and strength and solving weakness. Other survey was conducted and employed for Sudanese consumers, the purpose of this survey is attempted to explore and identify how the Sudanese consumers evaluate garment quality and determine all the factors influence perception of garment quality and selection. Thus, factories should do the following to increase their competitive power: establish closer relations with their customers, meet their expectations of production quantity and time delivery, assess complaints, observations and satisfactions separately, ensure continuity in their development of their products, the study observed non-value activities such as unnecessary transportation and manual operations, waiting for raw material   due to poor layout and there were also product defects due to poor applying 5S system and unqualified

the workers. After considering lean tools, using process flow chart and check sheets, quality assurance, the cycle time analysis, the standard time operation was determined, the skill of manpower was enhanced. Likewise, the non-value added activities were reduced, thus quality of productivity was improved, the cost was reduce , the scrape, rejection and defect of production are reduced and the factory meeting the customer satisfaction and expectation and the factory has a good name and reputation in the market.

5.2 Recommendations

For investigated the target of this study must be:

- Enhance and maintaining harmony of the work environment which include place of production ,store house and work shop
- Adopt continues training for every one of the organization starting from top manger to tailors to understand TQM system and enhance commitment throughout the organization.
- using modern technology and new quality tools to improving quality and profitability
- organization must be committed to quality and each step of the TQM is identified and carefully planned before its implementation
- Every testing and inspection should be done as per international standard as well as consumers requirement.
- The 4point system for fabric inspection has some limitations so that this system should be used with proper care
- Every garment factories in Sudan must be implement different tools of lean manufacturing such as TQM, 5S, 6 Sigma , kanaban system ,kaizen system , PPORF 20 key, quality assurance for perfect quality management method to improving productivity and profitability because In today's competitive manufacturing environment is constantly looking for ways on how to improve the product to meet customers satisfaction
- For successful of TQM implementation the top management must be commitment
- The designer must be understanding all factors which effect to customer when selecting their garment and analysis the customer perception by visiting

the social media ,fashion centers and popular markets and identified all the factors effect for the customer to select their garment such as(gender, age, income ,environment ,socio) and also must be understanding all the factors for customers evaluated garment quality to satisfaction their expectation and specification such as (new fashion, fabric fit to environment, size fit and body shape, garment aesthetic …etc.**)**

- Recourse by advisers in the garment manufacture field in and out the country
- Government must be Establish educational institutes for training manpower of new technology and facilitate all method in inter the country and out the country, Facilitate all difficult interruption the human resources, reduce the cost of training, reduce the customhouse and taxes of the section of textile and garment manufacturing and available adequate operation power
- Improve production planning and control systems to plan and schedule the work process more effectively to reduce the cost
- Building efficient supply chain Management with collaborations of supplier and other market intermediaries.
- Establish efficient communication chain for flow of information with the help of information technology
- Software is a high technique equipment and intelligent services, it has become the most advanced department in garment manufacturing

5.3 Future Work

Many different adaptations, tests, and experiments have been left for the future due to lack of time.

This thesis has been mainly focused on implementation lean manufacture system in garment manufacturing in the Sudan. The following ideas could be achieving:

- It could be interested to addresses all complex problems in garment manufacturing in Sudan and find suiting solution of its
- The control team work must be detected and noticed all faults and defects early in whole phases graduate, to prevent occurring of the problems in the final product.

- According to the wide range of designs and variation styles of garment and continues change of the fashion   in the world , must be using (CAD &CAM) in pattern making and design

- The modern technology and soft word using in garment manufacturing reduces the cost consequently by reduces the waste of manufacturing and reduces the number of workers and also simplify operation of automated systems and improve work process monitoring and control systems to operate machinery without special knowledge, experience or additional training.

- Modern machines with automation sensing and control capabilities would certainly ease the work of operators and technicians and assure higher levels of quality and control over the produced seams

- Also the development of cutting room technologies is important target for increase cutting speed, to improve cutting tool technology and to reduce cutting time

- Improve production planning and control systems to plan and schedule the work process more effectively for reduces manufacturing waste

- To improve fabric defect elimination must be use standard inspection system

- To meeting customers satisfaction and expectation the designers must be understanding all the customer's needs by marketing research.

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Appendix A

A.1 Survey for local factories

Please indicate √ marker to which each of the following apply

1- Level of productivity

1. Very high

2. Continues decreasing

3. Consistent

4. Unstable

5. Meet expectation

2- Type of products

1. ……………………………..

2. ………………………………

3. ……………………………….

4. ………………………………

5. ………………………………..

3 - Number of workers in the factory

Number of the workers	The number available
Less than 100	
110- 200	
210- 300	
310- 400	
410 -500	
510 – 600	

610 -700	
710- 800	
More than 800	

4- Number of phases of production available in the factory

Type of phases	Available phase
Fabric inspection	
Fabric spreading	
Fabric cutting	
Sewing	
Washing	
Finishing operation	
Package	
Inspection after package	

5- Type of machine and equipment use in each phase and place of original and number of it

Type of machines	Name of machines	Original made	Number of machines available
Fabric inspection machine			
Fabric spreading machine			
Cutting machine			
Sewing machine			
Machine to attaching accessories			
Washing machine			
Finishing machine			

Package machine			
Other			

6- Level of technology using in the factory

1. Modern

2. Medium

3. Traditional

7- The methods for bring the raw material for the factory

1. By the air

2. By ships

3. By trucks

4. The factory has line of manufacturing raw material

8- **Laboratory test**

1. …………………………..

2. ……………………………

3. ……………………………

9- System of quality applying in the factory

1. Quality control (QC)

2. Total quality management (TQM)

3. Quality assurance (QA)

4. ISO 9002 – ISO 9000 – ISO 9001

5. Basic quality tools

6. Others

10 - System of fabric inspection applying in the factory

1. 4point system
2. 10 point system
3. Granitevile78 system
4. Dallas system
5. Others

11- Expectation and satisfaction the customer

1. Sometime meet expectation
2. Always meet expectation
3. Expectation exceeded delighted customers

12- Time delivery to customer order

1. Just in time
2. Sometime in time
3. Delay in time

The questions orientations to all the 10 local factories

1- Does your factory faced any competition in global market?

2- If your factory has not any competition in global market, has try gaining it in the future?

3- How many countries targeted in the future?

4- Does your factory have maintenance section? What the percentage of maintenance in the day?

5- What the percentage of sale in the year?

6- What the percentage of treatment the defect in the day?

7- What the percentage to rework the product in the day?

8- What the percentage of scrap product in the day?

9- What the percentage of the cost of (defect, treatment, scrap, rework?

10- Does your factory have any quality certificate international or locally.

11- What is the certificate which your factory try to gain it in the future?

A.2 Appendix 2 Survey for Consumer

Please put √ marker entered empty rectangle to your reply

The number: ……………………………

1- Sexuality:

Male   Female

☐   ☐

2- Education level:

Over university   Graduate student University student Secondary school Others

☐   ☐   ☐   ☐   ☐

3- Age:

20-31 ……………..31-40   41-50   51-60   61-70

☐   ☐   ☐   ☐   ☐

4- The human clothing (male- female) identified the manner, behaviors and his characteristic whether positive or negative

Strongly Agree	sometimes agreed	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

5- Our choice to garment quality subjective to house hold income

Strongly Agree	sometimes agree	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

6- The big challenges and continuous improvement in industry and new culture effect and change in our behaviors and our life and effect to our choice and selective to our apparel

Strongly Agree	sometimes agree	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

7- Our selective to high quality of garment available to us more positive directly and indirectly

Strongly Agree	sometimes agree	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

8- The garment designers don't interested to customer satisfaction

Strongly Agree	sometimes agree	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

9- Understanding consumer satisfaction and obey its lead to limited import

Strongly Agree	sometimes agree	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

10- Consumer understanding to the quality leads the manufacturer's trend to it

Strongly Agree	sometimes agree	agree	strongly disagree	sometimes disagree
☐	☐	☐	☐	☐

11- The wide spreading to retailers in the huge number in the street it very effective to lack understanding to consumer of quality

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

12- The consumers return back the consignment or orders if there any defect or fault in their specification requirement

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

13- The garment manufacturers interested on time delivery more than quality.

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

14- The social media assist to rapidly spreading the fashion in whole the world just in time

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

15- Incorrect information in the product leads to bad reputation to Organization and losses the customers

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

16- Consumer ignorance to the basic symbols in the garment leads to faultfinding until it be with high quality

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

17- When to progress to our age our interested with the fashion are lessen

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

18- Consumer attractive to aesthetic external package more than internal product

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

19- The management is the first responsible to change and development of organization planning

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

20- The quality involve and responsibility of any one in the organization

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

21- Continuous training to the manpower leads to safety through operation and product quality

Strongly	sometimes	agree	strongly	sometimes
Agree	agree		disagree	disagree
☐	☐	☐	☐	☐

21- The complaints of the customers and their opinions lead to enhances product quality

Strongly   sometimes   agree   strongly   sometimes

Agree   agree   disagree   disagree

☐   ☐   ☐   ☐   ☐

Your view to understanding garment quality

……………………………………………………………………
……………………………………………………………………
……………………………………………………………………
……………………………………………………………………