REDUCTION OF CHANGE OVER TIME APPLYING SMED UNDER LEAN MANUFACTURING: A CASE STUDY

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By

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This thesis submitted to the Department of Industrial and Production engineering, Bangladesh University of Engineering Technology, in partial fulfillment of the requirement for the degree of Masters of Engineering in Advance Engineering Management.

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CERTIFICATE OF APPROVAL

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The thesis titled **"REDUCTION OF CHANGE OVER TIME APPLYING SMED UNDER LEAN MANUFACTURING: A CASE STUDY"** Submitted by Azim Mohammad, Roll. No. 0412082106(F), Session: April 2012 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Masters of Engineering in Advance Engineering Management** on December 17, 2013.

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

AZIM MOHAMMAD

DEDICATION

This thesis is dedicated to my elder brother **Arif MD Babu** whose tireless encouragement helps me to advance in future.

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At the very beginning I would like to express my sincere gratitude to the Almighty whose blessings made me capable of accomplishing this thesis work.

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ABSTRACT

The basic idea behind lean manufacturing is to eliminate waste, which does not add value to the end product. Any garments industry can maximize their profit margin by reducing all types of wastes. Lean manufacturing is one of those activities that focus on cost reduction by eliminating non-value added activities. This thesis work addresses the application of lean manufacturing philosophy to the mass production sector with a focus on sewing section of the garments industry. The core idea behind the thesis work was to introduce lean manufacturing concept in RMG sector of Bangladesh. In this concern, Single Minute Exchange of Die tools and techniques have been applied. The Single Minute Exchange of Die (SMED) is one of the important lean tools to reduce waste and improve flexibility in manufacturing processes allowing lot size reduction and manufacturing flow improvements. SMED reduces the non-productive time by streamlining and standardizing the operations for exchange tools, using simple techniques and easy applications. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. This rapid changeover is the key to reduce production lot sizes and thereby improving flow. There has a great applicability of SMED method in RMG sector. Several implementations have proven that the SMED method really works in practice and reductions of changeover time. As RMG sector is a large industrial sector in Bangladesh; change over time reduction can play a vital role for improving productivity as well as economic development for the country. It is found that a significant amount of time per style, per month can be minimized by applying this method. The implementation lean manufacturing has enabled reduction in setup time, unnecessary task elimination, quality rework reduction, material and information flow time reduction through company's internal resources reorganizations without the need for significant investment.

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ABBREVIATION	ELABORATION
SMED	Single Minute Exchange of Die
OEE	Overall Equipment Effectiveness
TPM	Total Productive Maintenance
SMV	Standard Minute Value
S/L	Single Needle Machine
O/L	Over Lock Machine
F/L	Flat Lock Machine
WIP	Work In Progress
RMG	Ready Made Garments

CHAPTER ONE
INTRODUCTION

1.1. INTRODUCTION

The tremendous success of readymade garment exports from Bangladesh over the last two decades has surpassed the most optimistic expectations. Today the apparel export sector is a multi-billion-dollar manufacturing and export industry in the country. The overall impact of the readymade garment exports is certainly one of the most significant social and economic developments in contemporary Bangladesh. With over one and a half million women workers employed in semi-skilled and skilled jobs producing clothing for exports, the development of the apparel export industry has had far-reaching implications for the society and economy of Bangladesh [1].

One of the major successes of RMG sector in Bangladesh is that they produce goods with low labor cost. But to maintain this growth in positive direction it is necessary to ensure proper utilization of every resource. In Today's competitive world, the most important driver for success is time; the company that delivers goods with a shorter lead time is the market winner. Financial growth of any company also depends upon productivity improvement and waste minimization. So, to gain profit from scarce time and to increase productivity as well as to minimize waste it is necessary to adopt new manufacturing concepts and technology in every sector of the garments industry and new business initiatives should be taken in this sector in order to stay alive in the new competitive market place. Lean manufacturing concepts are widely used among various countries; lean principle is also implemented among various apparel industries all over the world. But in Bangladesh, every industry runs in a traditional way, RMG sector also does not follow any innovative method of production. So the goal of this thesis work is to introduce lean manufacturing concept in RMG sector of Bangladesh and also to identify various types of problem related to waste and to picture the existing scenario of the sewing section by using various types of lean tools. Waste and productivity are the two major issues in RMG sector of Bangladesh. In this connection, this case study research has been conducted [2].

In fact, time demands will be the strategic focus for buyers and suppliers alike for at least the next decade. Time is the yardstick by which we increasingly judge those we work with, particularly organizations providing manufacturing services. For apparel manufacturers focusing on the three key areas of Timeliness, Quality and Cost Effectiveness, it is only through Continuous Improvement programs – of which Lean is the ultimate system which can survive and thrive [3].

This thesis aims to reduce changeover time in garments industry by the application of SMED under lean manufacturing philosophy.

1.2. BACKGROUND OF THE THESIS

Lean manufacturing process is an extensive way to reduce waste from any manufacturing industry with the help of various types of tools. Single Minute Exchange of Die (SMED) is one of them to improve flexibility in manufacturing processes as well as to reduce waste. SMED's main focus is to classify the works and convert internal works to external works. The ultimate goal of SMED is to complete any change over activity within single digit minute (up to 9 min) allowing lot size reduction and manufacturing flow improvements [4].

Today the world has become a global village; business competition crosses the national border. Every business arena is facing global competition. Survival becomes increasingly difficult and it becomes more and more critical to find new ways to grow or sustain business. Now producer's paramount importance is meeting the ever-shorter lead-time demands of customers and the garment industry of Bangladesh is not any exception [5].

Readymade garments sector plays a pivotal role in the economy of Bangladesh. About 74% of the country's foreign currencies are earned by the means of readymade garment exports [6].
Garment manufacturing involves a large amount of processes and lot of change over in various steps [7]. In order to meet this shorter lead-time and global competition, manufacturing systems have to adopt new production methods [8].

SMED can be quite valuable in optimizing product and process transition in garment manufacturing industry [9].Its standard implementation procedure under lean manufacturing techniques can bring a great improvement in productivity and efficiency in garment industry.

1.3. OBJECTIVES WITH SPECIFIC AIMS AND POSSIBLE OUTCOME

The objectives of the study are as follows:

i. To develop a guideline to reduce change over time as well as to reduce lead time, material flow, worker movement and thus to improve overall productivity applying lean manufacturing technique specifically SMED.
ii. To implement the proposed guideline of reducing change over time to the company studied.
iii. To compare the proposed guideline with the existing situation.

1.4.OUTLINE OF METHODOLOGY

The methodology of the study will be as follows

i. A study will be conducted to find the material movement frequency and subsequent flow of information of the knitwear garment industry.
ii. Information will be collected from a particular study area on production and changeover activity.
iii. A standard SMED implementation guideline will be developed with the help of the collected data.
iv. Proposed SMED guideline will be implemented in the company studied.
v. A comparison between the existing change over time and overall productivity with the proposed guideline will be carried out.

In this chapter the background, significance, research objectives and the methodology of this research has been described. Next chapter will discuss on the literature review portion of this research work.

CHAPTER-2

LITERATURE REVIEW

2.1. INTRODUCTION

Lean manufacturing represents a journey that should never end since it involves the identification and elimination of waste and inefficiencies. It is the continuous improvement of all operations and processes involved in manufacturing. It seems to imply that there will always be some waste and inefficiencies, and that better operations or processes will continue to emerge due to better equipment, newer technological developments and more informed management. The implementation of Lean production systems has saved many companies millions of dollars over the last 20 years or so. [10]

Market globalization era enhances the competitive economic situations and demands quicker supply of new products within short lead-time. Product innovation and production flexibility become the prime driver in manufacturing industry. In striving to remain competitive, the concepts of Single minute of exchange die (SMED) have been extremely employed to the manufacturing system. [11]

Single Minute Exchange of Die (SMED) is one of the many lean production methods for reducing changeover time in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. This rapid changeover is the key to reducing production lot sizes and thereby improving flow. The phrase "single minute" does not mean that all changeovers and startups should take only one minute, but that they should take less than 10 minutes (in other words, "single digit minute"). SMED is the term used to represent the Single Minute Exchange of Die or setup time that can be counted in a single digit of minutes. SMED is often used interchangeably with "quick changeover". SMED and quick changeover are the practice of reducing the time it takes to change a line or machine from running one product to the next. The need for SMED and quick changeover programs is more popular now than ever due to increased demand for product variability, reduced product life cycles and the need to significantly reduce inventories [12].

2.2. HISTORICAL BACKGROUND OF SINGLE MINUTE EXCHANGE OF DIE (SMED).

Taiichi Ohno at Toyota developed SMED in 1950. Ohno's idea was to develop a system that could exchange dies in a more speedy way. By the late 1950`s Ohno was able to reduce the time that was required to change dies from a day to three minutes. The basic idea of SMED is to reduce the setup time on a machine. There are two types of setups: internal and external. Internal setup activities are those that can be carried out only while the machine is stopped, while external setup activities are those that can be done while the machine is running. The basic idea is to make as many activities as possible from internal to external and also concluded that setup reduction is a tool, which is universally applicable. There has been lot of work done in detail for the SMED methodology in a textile processing industry and also suggest that the effective implementation of SMED necessitates a number of fundamental requirements, these are: team work, visual factory control, performance measurement, Kaizen and discussed about the role of manufacturing environment in implementation of SMED. The relationship between changeover and production leveling has also been studied and concluded that as the batch size decreases, the cost of each part will increase, since the changeover time will be spread over fewer parts. This leads to high manufacturing costs when changeover times are high and it also discussed the detail changeover analysis and concluded that in making a part, every degree of freedom of the machine must be specified and fixed. SMED is also used, as a tool to improve flexibility and the greatest benefit from reduction in changeover time is the ability to produce parts in smaller batches. The relation between SMED and equipment design is also correlated and it indicated that SMED is suitable not only for manufacturing improvement but also for equipment development. SMED tool has been successfully used in the pine factory and empirically the result was reduction in setup time from 45 min to 15 min and underlines the importance of lean in the application of Information Technology to manufacturing. New modified improvement framework for lean implementation has also been proposed and lean implementation has been divided it in to "waves" and put the SMED tool in second wave amongst overall four waves. Shingo states "SMED can be applied in any factory to any machine". Work regarding the application of design changes to the changeover process and balancing of production lines using the set up minimization [13].

2.3. INTRODUCTION TO LEAN MANUFACTURING

U.S manufacturing has always searched for efficiency strategies that help to reduce costs, improve output, establish competitive position, and increase market share. Early process oriented mass production manufacturing methods common before second world war shifted afterword result-oriented, output-focused, production system that control most of today's manufacturing business [14].

During II world war, the economic condition of Japan was heavily destroyed. Due to this there was scarcity of fund resulting in limiting access to corporate finance. In this situation, neither Toyota was able to set up a mass production system like their American counterparts, nor it was possible to layoff the employees to reduce their cost due to legislation. Anyhow Toyota had to devise a new system for reducing costs to sustain in the market. So they decided to produce a small batch of products, which would reduce inventories; it means they would need less capital to produce the same product. But this is obstructed by the practical difficulty of changing tools and production lines frequently. To cope with this problem they started making multipurpose tooling systems in their machines and trained their employees in changeover time reduction methods. At the same time, Toyota realized that investing in people is more important than investing in bigger size machinery and continues employee training throughout the organization. This motivates all employees and they are more open to the improvement process and everyone started giving their input to the company.

In this way, short production runs started by Toyota became a benefit rather than a burden, as it was able to respond much more rapidly to changes in demand by quickly switching production from one model to another. Toyota didn't depend on the economies of scale production like American companies. It rather developed a culture, organization and operating system that relentlessly pursued the elimination of waste, variability and inflexibility. To achieve this, it focused its operating system on responding to demand and nothing else. This in turn means it has to be flexible; when there are changes in demand, the operating system is a stable workforce that is required to be much more skilled and much more flexible than those in most mass production systems. Over time, all these elements were consolidated into a new approach to operations that formed the basis of lean or Toyota Production System or Lean Production [15].

The lean manufacturing concept was popularized in American factories. One of the foremost study by Massachusetts Institute of Technology on the movement from mass production toward production as described in The machine That changed the world, (Womack, Jones & Roos, 1990), which discussed the significant performance gap between Western and Japanese automotive industries. This book described the important elements accounting for superior performance as lean production. The term “lean” was used because Japanese business methods used less human effort, capital investment floor space materials, and time in all aspects of operations. The resulting competition between U.S. and Japanese automakers over the last 25 years has led to the adoption of these principles within all U.S. manufacturing businesses [16].

This chapter gives an overall idea about historical background of single minute of exchange of die and lean manufacturing. It also provides a clear overview about development of lean manufacturing and integration to wide range or industry. Next chapter will discuss the theoretical background that will help to understand lean tools and techniques.

CHAPTER THREE

THEORITICAL BACKGROUND

3.1. INTRODUCTION

Theoretical background chapter introduces the concrete weapons for this thesis. The term lean manufacturing is easy to define but implementation is not so easy in real practice. As different organization has different environment and implementation is not similar at different situation, it takes some time to understand lean manufacturing. This chapter will clarify all the lean manufacturing tools & their implementation strategy to provide a brief idea about lean manufacturing. Most of the texts are obtained from different books and journals; some relevant thesis works also help in this regard.

This chapter includes different types of lean tools and techniques such as value stream mapping, 5S, Kaizen, quick change over, as well as other relevant tools like mistake proofing (Poka yoke), total productive maintenance, quality at source, 5-why method which can be applied in any industry to eliminate excess, unnecessary things to improve the production flow, to reduce change over time and to achieve better productivity.

3.2. LEAN MANUFACTURING DEFINITION

Lean manufacturing is a systematic approach to identifying and eliminating waste (non-value – added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection [18]. Lean manufacturing process is a comprehensive way to reduce waste of all types. It could be a waste of time or material; it is still waste [18].

It’s an improvement approach to improve flow and eliminate waste that was developed by Toyota. Lean is basically about getting the right things to the right place, at the right time, in the right quantities, while minimizing waste and being flexible and open to change. Its focus is on improving lead times, quality and operating costs and requires employee involvement to be successful. The lean principles are ways of thinking and acting for an entire organization, not a tactic or a cost reduction program. Lean is a manufacturing philosophy that shortens the time between the customer order and the product build shipment by eliminating source of waste.

3.2.1. Five Basic Rules of Lean

i. Specify value from the standpoint of the end customer by product family.
ii. Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value.
iii. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
iv. As flow is introduced, let customers pull value from the next upstream activity.
v. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste.

3.2.2. Toyota Way Fourteen Principles

The 14 principles of Toyota Way are organized in four broad categories [19]

Section I: Long-Term Philosophy

Principle 1: Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.

Section II: The Right Process Will Produce the Right Results

Principle 2: Create a continuous process flow to bring problems to the surface.

Principle 3: Uses “pull” systems to avoid overproduction.

Principle 4: Level out the workload (Heijunka). (Work like the tortoise, not the hare.)

Principle 5: Build a culture of stopping to fix problems, to get quality right the first time.

Principle 6: Standardized tasks and processes are the foundation for continuous improvement and employee empowerment.

Principle 7: Use visual control so no problems are hidden.

Principle 8: Use only reliable, thoroughly tested technology that serves your people and processes.

Section III: Add Value to the Organization by Developing Your People

Principle 9: Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.

Principle 10: Develop exceptional people and teams who follow your company's philosophy.

Principle 11: Respect your extended network of partners and suppliers by challenging them and helping them improve.

Section IV: Continuously Solving Root Problems Drives Organizational Learning

Principle 12: Go and see for you to thoroughly understand the situation (Genchi genbutsu).

Principle 13: Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly (Nemawashi).

Principle 14: Become a learning organization through relentless reflection (Hansei) and continuous improvement (kaizen).

It is quite possible to use a variety of TPS tools and still be following only a select few of the Toyota Way principles. The result will be short-term jumps on performance measures that are not sustainable. On the other hand, an organization that truly practices the full set of Toyota Way principles will be following TPS and on its way to a sustainable competitive advantage.

3.2.3. Principles of Lean Manufacturing

Key principles behind lean manufacturing can be summarized as follows [20]

1. **Identification of Value-** In lean production, the value of a product is defined solely by the customer. The product must meet the customer's needs at both a specific time and price. The thousands of mundane and sophisticated things that manufacturers do to deliver a product are generally of little interest to customers. To view value from the eyes of the customer requires most companies to undergo comprehensive analysis of all their business processes. Identifying the value in lean production means to understand all the activities required to produce a specific product, and then to optimize the whole process from the view of the customer.

2. **Recognition of waste-** In this step is to recognize what does and does not create value from the customer's perspective. Any material, process of failure which is not required for creating value from the customer's perspective is waste and should be eliminated. This viewpoint is critically important because it helps to distinguish between value and waste.

3. **Standard process-** Lean requires an the implementation of very detailed production guidelines, called standard work, which clearly state the content, sequence, timing and outcome of all actions by workers .This eliminates variations in the way that workers performs their tasks.

4. **Continuous flow-** Lean usually aims for the implementation of continuous production flow free of bottleneck, interruption, detours, and backflows or waiting. When this is successfully implemented, the production cycle time can be reduced by as much as 75%.

5. **Continuous improvements-** The transition to a lean environment is never ending journey. A continuous improvement mentality is necessary to reach your company's goals. The term "continuous improvement" means incremental improvement of products, processes, or services over time, with the goal of reducing waste to improve workplace functionality customer service, or product performance. Lean is striving for perfection and eliminating every day waste which is uncovered in process.

6. **Perfection**- The concept of perfection in lean production means that there are endless opportunities for improving the utilization of all types of assets. The systematic elimination of waste will reduce the costs of operating the extended enterprise and fulfills customer's desire for maximum value at the lowest price. While perfection may never be achieved, its pursuit is a goal worth striving for because it helps maintain constant vigilance against wasteful practice.

7. **Customer focus**- Customer is the key focus in any business organization. Lean manufacturing develop a culture for ensuring customer demand with minimum resource requirements and waste free environment.

3.3. FOCUS ON WASTE IDENTIFICATION

The aim of lean manufacturing is to elimination of waste in every area of production including customer relations, product design, supplier networks and factory managements. Its goal is to incorporate less human effort, less inventory, less time to product development and less changeover time to bring new product from new product family.

Shigeo Shingo identified "Seven" forms of waste (Plus one – The eighth waste, underutilization of people). "A waste is anything that the customer is not willing to pay for it. Basically eight types waste is being considered in lean manufacturing" [21]. Typically the types of waste considered in a lean manufacturing system, their cause and impacts on organization are included:

Fig 3.1: Types of Lean Waste

Overproduction: To produce sooner, faster or in greater quantities than the absolute customer demand. Overproduction can occur with individual processes or across the entire value stream.

Table 3.1: Overproduction cause and impact on Organization

Caused by	Impact on Organization
1. MRP push rather than kanban pull 2. Large batch sizes 3. Looks better to be busy! 4. Poor people utilizations 5. Lack of customer focus.	1. Costs of money. 2. Consumes resource ahead of plan 3. Creates inventory 4. Hides inventory/defect problems 5. Space utilization

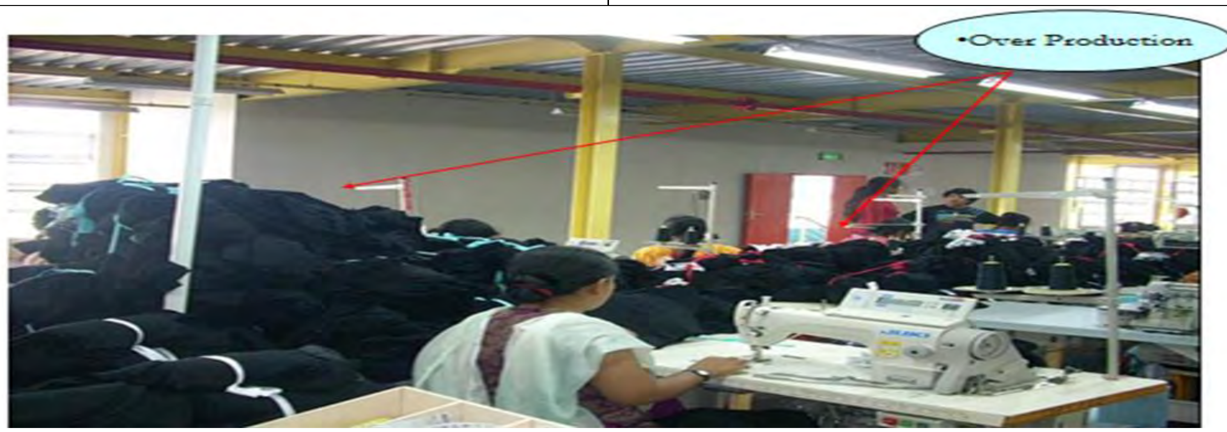

Fig.3.2: Overproduction

Inventory: This refers to inventory that is not directly required to fulfill current customer orders. Inventory includes raw materials, work-in-process and finished goods. All types of Inventory require additional space and handling equipment.

Table 3.2: Inventory cause and impact on organization

Caused by:	Impact on Organization:
1.Production schedule not level 2.Inaccurate forecasting 3.Excessive downtime/set up 4.Push instead of pull	1. Add maintenance cost. 2.Extra storage space required 3.Extra resource to manage 4.Hides shortages & defects

Fig 3.3: Inventory

Excess Motion: **M**otion is the movement of "Human or human body parts. This term refers to the extra steps taken by employees and equipment to accommodate inefficient process layout, defects, reprocessing, overproduction or excess inventory.

Table 3.3: Excess motion cause and impact on organization

Caused by:	Impact on Organization:
1. No standard operating procedure 2. Poor housekeeping 3. Badly designed cell 4. Inadequate training	1. It interrupts production flow. 2. Increases production time 3. Can cause injury

Fig.3.4: Excess Motion

Waiting: Also known as queuing, waiting refers to the periods of inactivity in a downstream process that occur because an upstream activity does not deliver on time. Idle downstream resources are then often used in activities that either don't add value or result in overproduction.

Table 3.4: Waiting cause and impact on organization

Caused by:	Impact on Organization:
1.Shortages & unreliable supply chain 2.Lack of multi-skilling/flexibility 3.Downtime/Breakdown 4. Ineffective production planning.	1.Stop/start production 2.Poor workflow continuity 3.Causes bottlenecks 4.Long lead times

Fig.3.5: Waiting

Transportation: This is unnecessary motion or movement of materials; such as work-in-process (WIP) is being transported from one operation to another.

Fig.3.6: Transportation

Table 3.5: Transportation cause and impact on organization.

Caused by:	Impact on Organization:
1.Badly designed process/cell 2.Complex material flows 3.Complex material flow paths 4.Poor close coupling 5.Wasted floor space	1.Increases production time 2.It consumes resource & floor space 3.Poor communication 4.Increases work in progress 5.Potential damage to products

Over Processing: This term refers to extra operations, such as rework, re-processing, handling or storage that occurs because of defects, overproduction or excess inventory.

Table 3.6: Over processing cause and impact on organization

Caused by:	Impact on Organization:
1.Out of date standards 2.Attitude - 'Always done it like this' 3.Not understanding the process 4.Lack of innovation & improvement 5.Lack of standard operation procedures	1.It consumes resource 2.It increases production time 3.It's work above and beyond specification 4.Can reduce life of component

Fig.3.7: Over processing

Non-Right First Time (Scrap, Rework and Defects): A defect is a component, which the customer would deem unacceptable to pass the quality standard and will not pay for it.

Table 3.7: Non-right first time cause and impact on organization

Caused	Impact on Organization:
1.Out of control/Incapable processes 2.Lack of skill, training & on the job support 3.Inaccurate design & engineering 4.Machine inaccuracy 5.Black art processes	1.Adds costs 2.It interrupts the scheduled 3.Reduces customer confidence 4.Defects reduce or discourage customer satisfaction 5.Defects have to be rectified

Fig .3.8: Non-right first time.

Nearly every waste in the production process can fit into at least one of these categories. Those that understand the concept deeply view waste as the singular enemy that greatly limits business performance and threatens prosperity unless it is relentlessly eliminated over time. Lean manufacturing is an approach that eliminates waste by reducing costs in the overall production process, in operations within that process, and in the utilization of production labor. The focus is on making the entire process flow, not the improvement of one or more individual operations.

3.4. LEAN TOOLS

Lean tools work to precisely define value in terms of specific products with identified capabilities offered at set prices through a dialogue with their customers. The process involves learning to adopt and employ a series of tools and techniques to achieve incremental improvements in an organization.

Lean manufacturing systems are inclusive of all employees and involve a major change in the embedded attitudes of the individuals that make up the organizations. It is a system, focused on and drives by the customers, both internal and external [23].

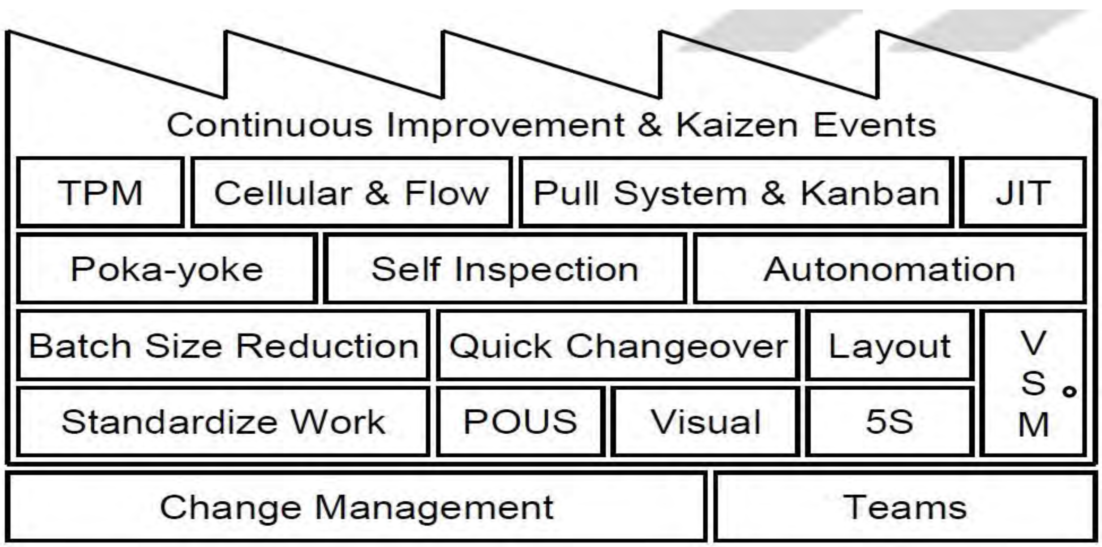

Fig. 3.9: Lean Building Block

3.4.1. Value Stream Mapping

“Material and Information Flow Diagrams” were originally developed by Taiichi Ohno and the Operations Management Consulting Division of Toyota to help suppliers learn total productive system (TPS) – visual communication tool able to identify & eliminate waste.

Mike Rother and John Shook adapted Toyota’s techniques and refined this technique into what we now call “Value Stream Mapping” [24].

Definition of VSM: Value Stream Mapping (VSM) is a lean technique used to analyze the flow of materials and information currently required to bring a product or service to a consumer. Value Stream Mapping works on the principle that "Value is added only when our action or operation contributes to transform the materials into the product that the customer is willing to pay for [25]."

The critical phrase in this definition is, "the customer is willing to pay for." If a company's customer walked through its process, how would that customer react? Every process the customers sees involves work that adds value in their eyes. Unfortunately, every process the customers sees also involves work for which they are not willing to pay - waste. While no one can eliminate all waste, using value stream mapping to identify waste helps determine a plan for eliminating it.

Objective of value stream mapping:

- Create a current state map analyses an overall process flow and present it in a visual form.
- Create a future-state map allowing the process to be re-designed to eliminate barriers (waste and unnecessary process) to flow.
- Develop and implement a plan to reach the future state by focusing all of process, functions and department also incorporate all of lean concepts and tools, such as takt time (cycle time based on customer demand), theory of constraints and pull-based scheduling systems.

Major benefits of VSM:

- Creates a common vision for everyone connected to the targeted value stream, of both current and future states
- Provides a visual map for ease of communications
- Allows waste to be seen by everyone so improvements can be focused
- Provides the foundation on which to base lean initiatives from the customer perspective

Steps of Value Stream mapping:

- Current stage map
- Future stage map
- Implementation plan

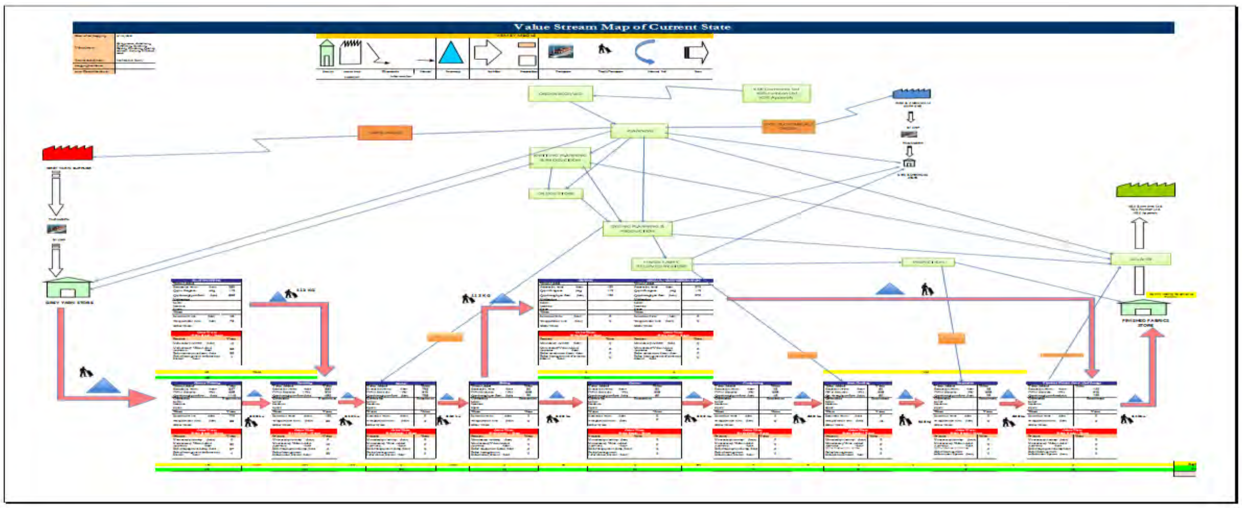

Fig.3.10: Typical Value Stream Map

3.4.2. Work Placeorganization-5S

5S methodology is a structured lean program that is implemented in a shared workplace deciding what should be kept, where it should be kept, and how it should be stored. 5S is a reference to five Japanese words beginning with "S" that describe 5 primary undertakings for a standardized cleanup program, to create a workplace suited for visual control and lean production. 5S is a set of techniques providing a standard approach to housekeeping within Lean.

5S Implementation Methodology:

First pillar: sort

Sort means that we remove all items from the workplace that are not needed for current production operations. Implementing this pillar creates a work environment in which space, time, money energy, and other resources can be managed and used most effectively.

Example:

- Unneeded of equipment, trims and others tools for current production to avoid obstacle to production activities.
- Quality defects result from unneeded in-process inventory and machines breakdown.
- Large quantity of inventory requires more space and management

Second pillar: Set in Order

Set in order can be defined as arranging needed items so that they are easy to use and labeling them so that they are easy to find and put away.

Example:

- All trims must be uniquely placed away organized in an identified and organized place. Rack, Drawers, etc.
- Documents, Métal parts as trimes, etc.

Arrange needed items so that they are easy to use and label them so that anyone can find them and put them away. The second pillar, Set in order can be implemented only when the first pillar is in place. Similarly, if sorting is implemented without Setting in order, it is much less effective. Sort and Set in order work best when they are implemented together. Standardization means creating a consistent way that tasks and procedures are carried out. Set in order is the core of the standardization. This is because the work place must be orderly before any type of standardization can be implemented effectively.

Third pillar: Shine

Shine means sweeping floors, wiping off machinery and generally make sure everything on the floor stays clean.

Example:

a. Machineries dust off and maintained.

b. Floor are free of any object could create obstacles and danger to employees and the product

It is the component that emphasizes the removal of dirt, grime and dust from the workplace. As such shine means that we keep everything swept and clean. Having clean and bright environment everyone can enjoy the working. When everything is kept in top condition, so that when someone needs to use something, it is ready to be used.

Fourth pillar: Standardize.

The first three pillars are activities to organize the workplace. But standardize is the method to maintain the first three pillars Sort, Set in order and Shine. Standardize pillar is to prevent setbacks in the first three pillars, to make implementing them a daily habit, and to make sure that all three pillars are maintained their fully implemented state.

Implementing 4th Pillar: Standardize

- Assign 3S responsibilities: If people are not given clear 3S job assignments based on their own workplaces, the Sort, Set in order and Shine activities will not have much meaning. 5S team has to make the 5S checklist showing clearly who is responsible for each job, which area, what to do, and when to do it.
- Integrate 3S Duties into regular work duties: Maintenance of 3S must become a natural part of everyone's regular work duties. As we discussed earlier we can launch "5 minutes 5S" program for every day. It will cover all three pillars (Sort, Set in order and Shine) rather than just the third. After we have assigned three pillar jobs and have incorporated three pillar maintenance into the everyday work routine, we need to evaluate how well the three pillars are being maintained.5S Team has to make the Standardization-level check list to evaluate the maintenance level.

Fifth pillar: Sustain

Sustain making a habit of properly maintaining correct procedures. The first four pillars can be implemented without any difficulty if the workplace is where employees commit to sustain the

5S conditions. Without sustain the others four pillars will not last longer. Sustain is not a technique and different than the other four pillar, result cannot be seen.

There are many tools and techniques a factory can use to help sustain commitment to 5S implementation. Some of them are offered below and 5S team can also develop some tools for the same purpose.

- 5S Slogans: Communicate the themes of the five pillar campaign in your factory. They can be displayed on machines, stickers, flags, or posters.
- 5S Posters: 5S slogans descriptions of 5S activities can be posted throughout the workplace.
- 5S Photo: Story board "Picture is worth a thousand words." Photo exhibits and Story board showing the before and after of 5S implementation activities.
- 5S Maps: Can also be used to get employee involved in five-pillar improvement on an ongoing basis. Those should be hung in a central location with suggestion cards attached so anyone can suggest improvements.
- 5S Pocket manuals: Can be created that contains five pillar definitions and descriptions, and is small enough to fit into the pocket of work clothes

.

Fig.3.11: 5S Implemented Picture

3.4.3. Kaizen

Kaizen is a Japanese word means, simply, continuous Improvement

1. Kai = To take part
2. Zen = To make good

Together these words mean to take something apart in order to make it better.

Kaizen is a basic scientific analysis in which you analyze (or take part) the elements of a process or system to understand how it works. Lean production is founded on the idea of kaizen-the small improvement has great impact on business result. It focuses on continuous improvement throughout all aspects of life. When applied to the workplace, Kaizen activities continually improve all functions of a business, from manufacturing to management and from the CEO to the kaizen workers. By improving standardized activities and processes, kaizen aims to eliminate waste [26].

The Basic Principle for Improvement

- Throw out all of your fixed ideas about how to do thinks
- Think of How the new method will work not how it won't
- Don't accept excuses. Totally deny the status quo.
- Don't seek perfection. A 50 percent implementation rate is fine as long as it's done on the spot.
- Correct mistakes the moment they're found
- Don't spend a lot of money on improvement.
- Problems give you a chance to use your brain.
- Ask "why" at least five times until you find the ultimate cause.
- Improvement knows no limit

Kaizen Event: Kaizen events are artificial groups set up to address single subject / area. They are usually one time only affaires. Kaizen events or blitzes can be held periodically to make focused changes in the workplace that affect the affect the whole team simultaneously and which require production at that area possibly shut down while changes is made. A kaizen event must be carefully prepared, well-coordinated, and thoroughly followed-up in order to be successful. Kaizen Event typically is measurable and last one week. Sometimes events are planned for shorter periods – a half day. One day up to 3 days. There events focus more narrowly and less planning required.

Kaizen blitz is a tool of which lean manufacturers can use over and over again, but it should never be used as the only vehicle for continuous improvement. The transition to a lean environment does not occur overnight. A continuous improvement mentality is necessary to reach your company's goal. The term Continuous improvement means incremental improvement of product process or services over time with the goal of reducing waste to improve workplace functionally, customer service or product performance. Continuous improvement principle as practiced by the most devoted manufacturers; result in astonishing improvements in performance that competitors find nearly impossible to achieve.

3.4.4. Total Productive Maintenance (TPM):

Total productive maintenance (TPM) originated in Japan in 1971 as a method for improved machine availability through better utilization of maintenance and production resources. TPM is a maintenance process developed for improving productivity by making processes more reliable and less wasteful. TPM is an extension of TQM (Total Quality Management). The objective of TPM is to maintain the plant or equipment in good condition without interfering the daily process. To achieve this objective, preventive and predictive maintenance is required. By following the philosophy of TPM we can minimize the unexpected failure of the equipment [27].

The goal is the total elimination of all losses, including breakdowns, equipment setup and adjustment losses, idling and minor stoppages, reduced speed, defects and rework, spills and process upset conditions, and startup and yield losses. The ultimate goals of TPM are zero equipment breakdowns and zero product defects, which lead to improved utilization of production assets and plant capacity.

Organizations typically pursue the four techniques below to implement TPM. Kaizen events can be used to focus organizational attention on implementing these techniques.

Efficient Equipment: The best way to increase equipment efficiency is to identify the losses, among the six described above, that are hindering performance. To measure overall equipment effectiveness, a TPM index, Overall Equipment Effectiveness (OEE) is used. OEE is calculated by multiplying (each as a percentage), overall equipment availability, performance and product quality rate. With these figures, the amount of time spent on each of the six big losses, and where most attention needs to be focused, can be determined. It is estimated that most companies can realize a 15-25 percent increase in equipment efficiency rates within three years of adopting TPM.

Effective Maintenance: Thorough and routine maintenance is a critical aspect of TPM. First and foremost, TPM trains equipment operators to play a key role in preventive maintenance by carrying out "autonomous maintenance" on a daily basis. Typical daily activities include precision checks, lubrication, parts replacement, simple repairs, and abnormality detection. Workers are also encouraged to conduct corrective maintenance, designed to further keep equipment from breaking down, and to facilitate inspection, repair and use. Corrective maintenance includes recording the results of daily inspections, and regularly considering and submitting maintenance improvement ideas.

Mistake-Proofing: Known as poka-yoke1 in lean manufacturing contexts, mistake-proofing is the application of simple "fail-safing" mechanisms designed to make mistakes impossible or at least easy to detect and correct. Poka-yoke devices fall into two major categories: prevention and detection. A prevention device is one that makes it impossible for a machine or machine operator to make a mistake. For example, many automobiles have "shift locks" that prevent a driver from shifting into reverse unless their foot is on the brake. A detection device signals the user when a mistake has been made, so that the user can quickly correct the problem. In automobiles, a detection device might be a warning buzzer indicating that keys have been inadvertently left in the ignition.

Safety Management: The fundamental principle behind TMP safety and environmental management activities is addressing potentially dangerous conditions and activities before they cause accidents, damage, and unanticipated costs. Like maintenance, safety activities under TPM are to be carried out continuously and systematically. Focus areas include the development of safety checklists (e.g., to detect leaks, unusual equipment vibration, or static electricity) the standardization of operations (e.g., materials handling and transport, use of protective clothing, etc.) and coordinating no repetitive maintenance tasks (e.g., especially those involving electrical hazards, toxic substances, open flames, etc.). In many cases, equipment can be modified (see mistake-proofing) to minimize the likelihood of equipment malfunction and upset conditions.

3.4.5. Why Method

The 5 whys is a simple problem-solving technique that helps to get to the root of a problem quickly. It is made popular in the 1970s by the Toyota Production System, the 5 Whys strategy involves looking at any problem and asking: "why?" and "what caused this problem?" [28]

Benefits of the 5 Whys include-

- It helps you to quickly determine the root cause of a problem.
- It's simple, and easy to learn and apply

Table 3.8: Sample 5 Why Method

Problem	**1st Why**	**2nd Why**	**3rd Why**	**4th Why**
Stain marks at the garment	Why stains mark at the garment? Marking ink cannot remove. Machine makes dirt marks. Operator makes dirt marks.	Why marking ink used for the garment? Cannot identify the place to attach the pocket?	Why cannot identify? Because proper method is defined.	Why no proper method defined? Because Nobody improves the methods.

3.4.6. Overall Equipment Effectiveness (OEE)

OEE is simple, practical and powerful. It takes the most common sources of manufacturing productivity losses and places them into three categories: availability, performance and quality. In doing so, it distills complex production data into simple understandable metrics that provide a gauge for measuring true manufacturing efficiency. It also forms the foundation for tools that help to improve productivity.

Overall Equipment Effectiveness (OEE) is a metric that identifies the percentage of planned production time that is truly productive. An OEE score of 100% represents perfect production: manufacturing only good parts, as fast as possible, with no down time. OEE measures how close you are to perfect production (manufacturing only good parts, as fast as possible, with no down time).

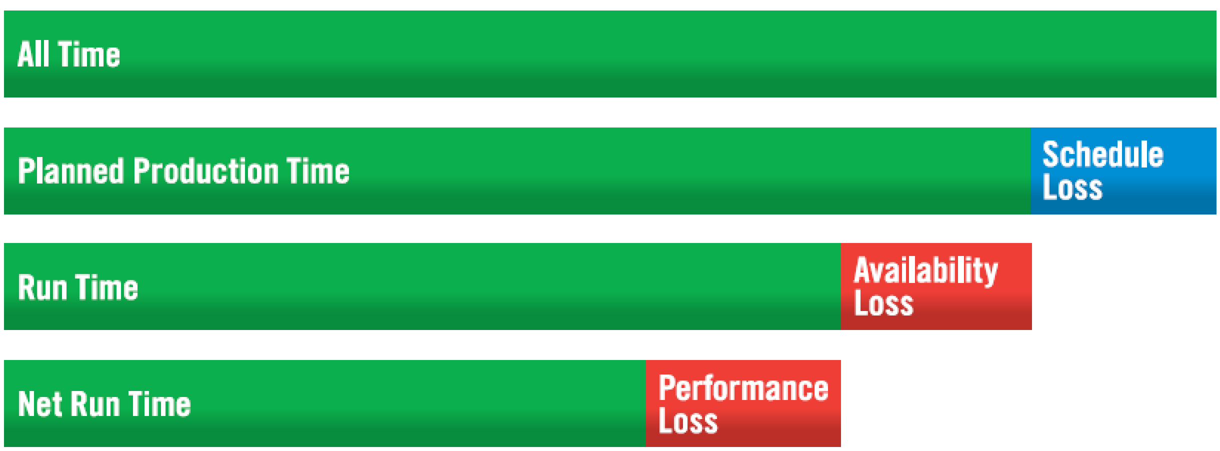

Fig .3.12: OEE Time Frame

Goal of OEE:

One of the major goals of OEE and TPM programs is to reduce and/or eliminate what are called the Six Big Losses—the most common causes of efficiency loss in manufacturing. The following table lists the Six Big Losses, and shows how they relate to OEE Loss categories.

Table 3.9: Losses in OEE

SIX BIG LOSS CATEGORIES	OEE LOSE	EVENT EXAMPLE	NOTE
Breakdowns	Down time Loss	-Tooling Failure. -Unplanned Maintenance. -Equipment Failure	There is flexibility on where to set the threshold between a breakdown and small stop.
Setup and Adjustment	Down time Loss	-Setup/Changeover. -Mental shortages -Operator shortages. -Warm-up time	One way to address this lose is through setup time reduction programs (SMED)
Small Stop	Speed Lose	-Obstructed Flow - Component jams. -Miss feeds -Sensor blocked - Cleaning/Checking	Typically only includes setups that are under five minutes and that do not require maintenances personal.
Reduce speed	Speed Lose	-Rough running. -Under nameplate capacity -Equipment Wear -Operator inefficiency	Anything only keeps the process from running at its theoretical maximum speed for a given product.
Startup Rejects	Quality Lose	-Scrap -Rework -In Process damage - Incorrect assembly	Rejects during warm-up startup or other early production. May be due to improper setup, warm-up period.
Production Rejects	Quality Lose	Scrap -Rework -In Process damage - Incorrect assembly	Rejects during steady state production.

Benefits:

In the short term, OEE identifies the total opportunity for improvement sometimes referred to as "uncovering the hidden factory" for a given piece of equipment Core process.

In the long term, OEE helps you drive improvement through a better understanding of losses. It also provides an objective way to set improvement targets and track progress towards reaching those targets.

3.5. SUPPORTING LEAN TOOLS

3.5.1. Quality at the Source

Quality at the source is a lean manufacturing principle which defines that quality output is not only measured at the end of the production line but at every step of the productive process and being the responsibility of each individual who contributes to the production or on time delivery of a product or service. In a practical sense it would involve each operator checking his or her own work before the part/component or product is sent to the next step in the process. This practice when first implemented within the workforce will be a challenging change to company culture but will highlight the relevance of the product's or service's conformance to customer requirements and standards, thus also imparting the importance of quality standards and customer satisfaction within the workforce [29].

Implementing quality at the source

In order to make the cultural shift within an operation's workforce to embrace quality at the source the following items should be considered:

- Employee understanding of who the customer is and their requirements
- Internal quality audits -Employee and team awareness of quality standards and benchmarks
- Employee understanding of the customer's intended use of the product or service
- Multi-skilled workforce which can provide support and help in different process steps

- Required tools and technology to identify quality flaws and rectify them in an efficient manner
- Proper data collection and tracking of quality faults
- Open communication of standards, performance and processes

The advantages of quality at the source are many, including: better informed employees, cultural awareness of the importance of quality to the customer, reduction in rework expenses, reduction in production waste, improvement in plant and process OEE , and most importantly he empowerment of employees in achieving the desired quality standard required by customers.

3.5.2. Benchmarking

Benchmarking is the comparative evaluation of technologies, production processes and products of an organization, compared to the leading European organizations in the same market. The results of benchmarking include an understanding of the weaknesses of any corporation or organization as well as the ability to measure accurately the limits of its improvement. Benchmarking also paves the way for other methods of innovation development to be applied, such as creativity, technology clinics, Business Process Reengineering (BPR), chain-of-production management, e-commerce, etc.

Procedure of Benchmarking:

The overall procedure involves five steps:

- Data Collection from the corporation / organization.
- Entering the data into the Best Practice database and compiling the evaluation diagrams.
- Composing the evaluation report based on results and diagrams from the database.
- Discussing the evaluation's results with the corporation / organization and with experts, in order to explore new solutions.
- Stating proposals for improvement and applying innovation methods.

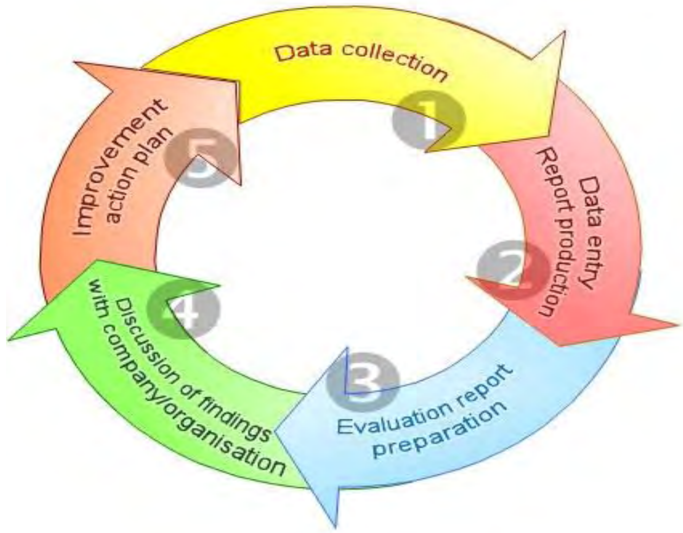

Fig. 3.13: Benchmarking Process.

3.5.3. Takt Time

Takt Time can be defined as the maximum time allowed producing a product in order to meet demand. It is derived from the German word taktzeit that translates to clock cycle, beat or tempo. There is a logic therefore to setting the pace of production flow to this Takt Time. Product flow is expected to fall within a pace that is less than or equal to the Takt Time. In a lean manufacturing environment, the pace time is set equal to the Takt Time. If you have a Takt Time of two minutes that means every two minutes a complete product, assembly or machine is produced off the line. Every two hours, two days or two weeks, whatever your sell rate is your Takt Time. It is used to synchronize the pace of production to match the pace of sales by determining the rate for producing a product and its components, based on sales rate.

Takt Time is calculated by taking available production time and dividing it by the customer demand as shown below:

$$T = \frac{T_a}{T_d}$$

Where

T = Takt time, e.g. [work time between two consecutive units]

Ta = Net time available to work, e.g. [work time per period]

Td = Time demand (customer demand), e.g. [units required per period]

Net available time is the amount of time available for work to be done. This excludes break times and any expected stoppage time (for example scheduled maintenance, team briefings).

When the order volume increases or decreases, Takt Time must be adjusted so that production and demand are synchronized. To avoid muda, the entire production sequence should run precisely to Takt Time.

This chapter defines lean manufacturing; differentiate value & waste, lean tools and techniques and supporting tools of lean manufacturing. The detail SMED implementation procedure is described in next chapter.

CHAPTER FOUR
PROBLEM IDENTIFICATION & METHODOLOGY

4.1. INTRODUCTION

Single-Minute Exchange of Die (SMED) is one of the many lean production methods for reducing waste in a manufacturing process that has a great impact of any manufacturing industries such as garment manufacturing industry. In Bangladesh garment industry carries maximum growth of whole economic development but most of them are lacking behind to a great extent in concern of productivity, efficiency, customer satisfaction level etc. To cover up some of these lacking, a standardized process of minimizing change over time to increase productivity, efficiency, customer service level and profit via waste elimination must be developed. Today's garment sector is continuously reaching in highly competitive environment of fashion and technology to fill the customer satisfaction where lean manufacturing tools have a great excellence [29].

SMED has a lot of other effects, which come from systematically looking at operations; these include stockless production, inventory freeing floor space, reduction of production time, elimination of setup error and setup time and elimination of unusable stock.

4.2. PROBLEM FORMULATION

Garments manufacturing system is a technological process of making a complete part by arranging several man and machine according to some sequential operations where are obliged by some terms and conditions to maintain the customer satisfactory level and quality. When manufacturing large-scale products, some of the internal and external elements and tool exchanges take place where changeover time always plays a vital role for slow production. A rapid changeover is widely acknowledged as an essential prerequisite to flexible and responsive production. The SMED system is a method that make possible to perform equipment setup and changeover operations within 10 minutes.

4.3. WORK STEPS IN IMPLEMENTING SMED

Working steps in implementing SMED will be as follows:

- Changeover Elements Classification.
- Step One – Identify Pilot Area
- Step Two – Identify Elements
- Step Three – Separate External Elements
- Step Four – Convert Internal Elements To External
- Step Five – Streamline Remaining Elements

4.3.1. Changeover Elements Classification

In SMED, changeover elements are divided in to two categories.

- An external activity involves operations that can be done while the machine is running and before the changeover process begins.
- Internal Elements are those that must take place when the equipment is stopped. Aside from that, there may also be non-essential operations.

Table 4.1: Elements Classification of SMED

External Elements	Internal Element
➢ Pre-Production Meeting. ➢ Provision of trim card. ➢ Getting cut panel from cutting section. ➢ Getting threads & accessories from store. ➢ Getting instruction about new style from supervisors. ➢ Provision of Layout and line balancing sheet. ➢ Provision of production sheet. ➢ Getting instruction for next job. ➢ Getting material for the next job from stores. ➢ Getting tools for the next job from tool stores. ➢ Returning tools for the last job to tool stores.	➢ Layout preparation ➢ Trial production ➢ Cleaning Machine surface ➢ Cleaning work surface ➢ Needle change ➢ Stitch adjustment ➢ Stitch measurement ➢ Guide adjustment ➢ Nose change ➢ Looper adjustment ➢ Tension adjustment ➢ Thread change ➢ Needle positioning

4.3.2. SMED Implementation

This section provides a step-by-step roadmap for a simple and practical SMED implementation. SMED projects have three conceptual stages:

- **Separate**- Internal & External elements
- **Convert**- Modify elements so they can be external, or remove them completely and
- **Streamline**- Complete elements within standard time.

This process is typically repeated in multiple passes, where a goal for each pass is to cut the changeover time in half.

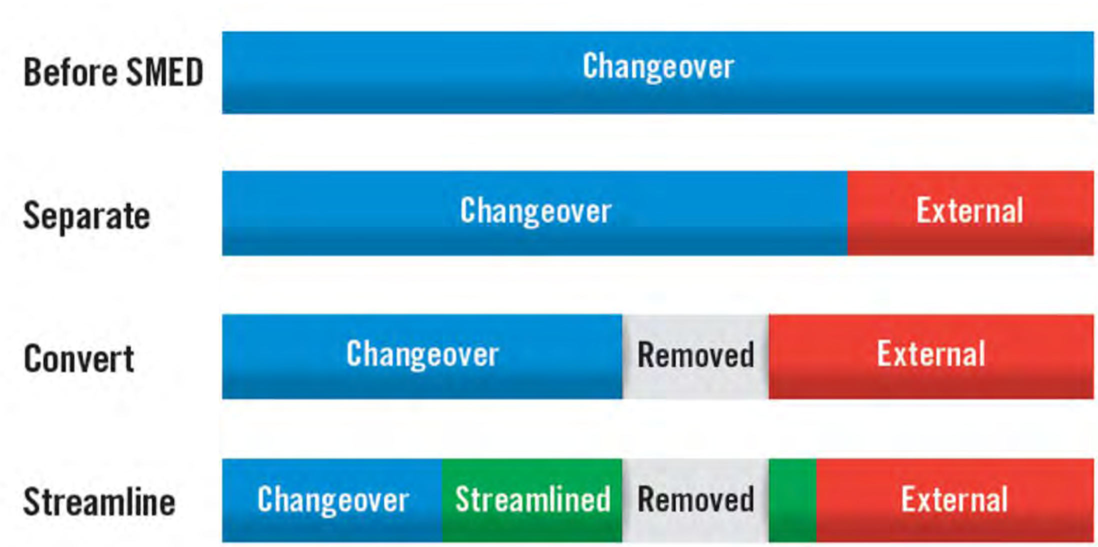

Fig .4.1: Changeover outline.

Before Starting

Virtually every manufacturing company that performs changeovers can be benefitted from SMED. That does not mean, however, that SMED should be the first priority. In the real world, companies have finite resources, and those resources should be directed to where they will generate the best return. Most companies, the first priority should be ensuring that there is a clear understanding of where productive time is being lost, and that decisions on improvement initiatives are made based on hard data. That means putting a system in place to collect and analyze manufacturing performance data. Once a system for measuring manufacturing performance is in place collect data for at least two weeks to gain a clear picture of where productive time is being lost.

If Changeovers represent a significant percentage of lost productive time (e.g. at least 20%) consider proceeding with a SMED program. Otherwise, consider first focusing on a Total Productive Maintenance program.

4.3.2.1. Step One – Identify Pilot Area

In this step, the target area for the pilot SMED program is selected. The ideal equipment will have the following characteristics:

- The changeover is long enough to have significant room for improvement, but not too long as to be overwhelming in scope (e.g. a one hour changeover presents a good balance).
- There is large variation in changeover times (e.g. changeover times range from one to three hours).
- There are multiple opportunities to perform the changeover each week (so proposed improvements can be quickly tested).
- Employees familiar with the equipment (operators, maintenance personnel, quality assurance, and supervisors) are engaged and motivated.
- The equipment is a constraint/bottleneck – thus improvements will bring immediate benefits. If constraint equipment is selected, minimize the potential risk by building temporary stock and otherwise ensuring that unanticipated down time can be tolerated.

In order to create a wide base of support for the SMED project, include the full spectrum of associated employees in the selection process, and work hard to create a consensus within the team as to the target equipment choice. Once the target equipment has been selected, a baseline time for the changeover should be recorded. Changeover time is measured as the time between production of the last good part (at full speed) and production of the first good part (at full speed). Be cognizant of the “Hawthorne Effect”; changeover times may temporarily improve as a simple result of observing the process. When possible, use prior data to baseline the changeover time.

4.3.2.2 Step Two – Identify Elements

In this step, the team works together to identify all of the elements of the changeover. The most effective way of doing this is to videotape the entire changeover and then work from the videotape to create an ordered list of elements, each of which includes:

- Description- What work is performed in entire process.
- Cost in Time - How long the element takes to complete.

Some useful tips for this step:

- A typical changeover will result in 30 to 50 elements being documented.
- A fast method of capturing elements is to create a series of post-it notes that are stuck to a wall in the order in which they are performed during the changeover.
- Be sure to capture both "human" elements (elements where the operator is doing something) and "equipment" elements (elements where the equipment is doing something). As discussed later, the human elements are usually easiest to optimize.
- While videotaping the changeover have several observers taking notes. Sometimes the observers will notice things that are missed on the videotape.
- Only observe – let the changeover take its normal course.

The deliverable from this step should be a complete list of changeover elements, each with a description and time "cost".

4.3.2.3. Step Three – Separate External Elements

In this step, elements of the changeover process that can be performed with little or no change while the equipment is running are identified and moved "external" to the changeover (i.e. performed before or after the changeover). It is not unusual for changeover times to be cut nearly in half with this step alone.

Examples of candidate elements for such treatment include:

1. Retrieval of parts, tools, materials, and/or instructions.
2. Inspection of parts, tools, and/or materials.

3. Cleaning tasks that can be performed while the process is running.
4. Quality checks for the last production run.

The deliverable from this step should be an updated list of changeover elements, split into three parts: External Elements (Before Changeover), Internal Elements (During Changeover), and External Elements (After Changeover).

4.3.2.4. Step Four – Convert Internal Elements to External

In this step, the current changeover process is carefully examined, with the goal of converting as many internal elements to external as possible.

This list should be prioritized so the most promising candidates are acted on first. Fundamentally, this comes down to performing a cost/benefit analysis for each candidate element:

- Cost as measured by the materials and labor needed to make the necessary changes.
- Benefit as measured by the time that will be eliminated from the changeover.

Once the list has been prioritized work can begin on making the necessary changes.
Examples of techniques that can be used to convert internal elements to external are:

- Prepare parts in advance (e.g. preheat dies in advance of the changeover)
- Use duplicate jigs (e.g. perform alignment and other adjustments in advance of the changeover)
- Modularize equipment (e.g. replace a printer instead of adjusting the print head so the printer can be configured for a new part number in advance of the changeover)
- Modify equipment (e.g. add guarding to enable safe cleaning while the process is running)

The deliverable from this step should be an updated list of changeover elements, with fewer internal elements, and additional external elements (performed before or after the changeover).

4.3.2.5. Step Five – Streamline Remaining Elements

In this step, the remaining elements are reviewed with an eye towards streamlining and simplifying so they can be completed in less time. First priority should be given to internal elements to support the primary goal of shortening the changeover time. As in the previous step a simple cost/benefit analysis should be used to prioritize action on elements.

Examples of techniques that can be used to streamline elements are:

1. Eliminate bolts (e.g. use quick release mechanisms or other types of functional clamps)
2. Eliminate adjustments (e.g. use standardized numerical settings; convert adjustments to multiple fixed settings; use visible centerlines; use shims to standardize die size)
3. Eliminate motion (e.g. reorganize the work space)
4. Eliminate waiting (e.g. make first article inspection a high priority for QA)
5. Standardize hardware (e.g. so fewer tools are needed)
6. Create parallel operations (e.g. note that with multiple operators working on the same equipment close attention must be paid to potential safety issues)
7. Mechanize (normally this is considered a last resort)

The deliverable from this step should be a set of updated work instructions for the changeover (i.e. creating standardized work) and a significantly faster changeover time!

4.3.3. Accelerate Progress – Focus On People First

When implementing SMED it is helpful to recognize that there are two broad categories of improvement:

1. Human (achieved through preparation and organization)
2. Technical (achieved through engineering)

Experience has taught that the human elements are typically much faster and less expensive to improve then the technical elements. In other words, the quick wins are usually with the human elements. Avoid the temptation, especially with technically proficient teams, to over-focus on technical elements. Instead, focus first on the human elements [30]

The following chart illustrates this principle, showing example areas of opportunity for SMED projects.

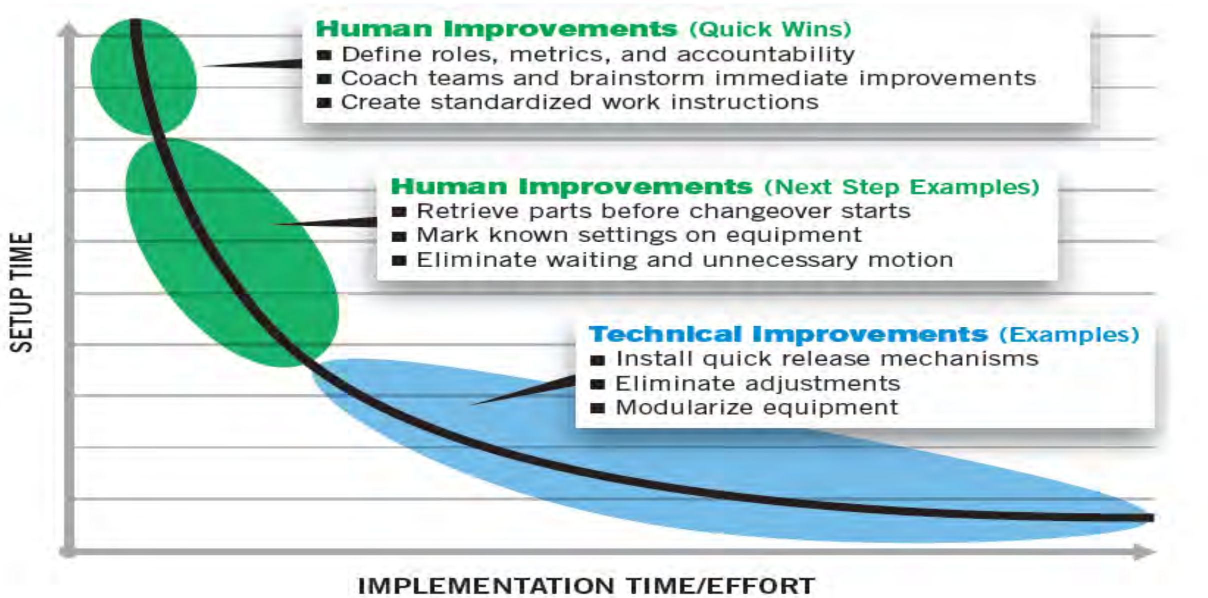

Fig 4.2: SMED Improvement Area.

This chapter described problem identification and methodology of SMED implementation steps in garments industry. If one organization wants to practice quick changeover methodology then it will guide them on how to implement SMED. In the next chapter case study on a particular garment factory will be described.

CHAPTER FIVE
CASE STUDY (CURRENT STATE ANALYSIS)

5.1. INTRODUCTION

Lean assessment process is used as a getting started to identify the wastes that block corporate performance and financial growth. The assessment should be both qualitative and quantitative and should cover all eight types of wastes in lean transformation. This will make a clear idea about information and material flow along the various processes of an organization and also will provide a qualitative feedback which is essential to transform a traditional organization into lean culture based one.

The study was carried in MASCO group a leading garment factory of Bangladesh to design a proper SMED guideline for the sewing section of the respective company. However the study includes data from the others sections like cutting, packing and cartooning and finishing sections of the factory

5.2. ORGANIZATION PROFILE

Bangladesh is one of the largest ready-made garments exporters in the world where MASCO group is playing a vital role .It started its journey as a ready-made garments exporter from June 2001. Now it’s a vertically set up knit composite factory with all in-house facilities of knitting, sewing, placement printing, embroidery and laundry.

MASCO group is now a well-equipped company having modern machineries in all the departments to ensure the best support to suite the taste of all customers.

Mission – Improvement in all time that brings sustainable development, where we prefer good thinking, better practice and best output.

Vision – Cope up us with 21st century’s change along with neo-invention make a timetable social business environment as well as help to remove the unemployment problem.

Strategies – MASCO believes that development is a never ending process. Therefore it takes special care to improve all every steps and appreciates all innovation ideas for customers and employees welfare.

Policies – MASCO fosters a belief in long term relationship ethics with the customers and considers them as business partners. MASCO is a compliant company and strives hard to uphold its commitments to consumers.

Decisions – We believe that “commitment is our first choice “and according this, improvement is happening every day in everywhere at MASCO.

Actions –MASCO takes all its actions in SMART (specific, measurable, achievable, realistic and time scale) way.

MASCO group total workforce consists of 10000 employees of whom 8500 are directly involved in the manufacturing process over 75 production lines in eight production unit.

Masco group produce range of knitwear as styling depends on market requirements and orders availability. Their core competency relies on knitted garments. They represent world renowned buyer.

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Fig 5.1: Buyer Names

ACCREDITATION

- BSCI Certificate
- CITIPAT Certificate
- SEDEX Certificate
- ETI Certificate
- OEKO-TEX Class-1 for whole supply chain
- Organic Certification (OE-100 & Blended)
- EU Flower Certificate
- ECO Certificate
- The Walt Disney Certificate

Fig 5.2: Certification

5.3. VALUE STREAM MAPPING - CURRENT STAGE

5.3.1. Product Family

Masco Group offer varied products and services like T-shirt, polo, cargo etc. It is relatively easy to make product family by constructing a simple table, like below one. The goal is not only to identify all product families, but also to identify what process steps each product utilizes. This will be a living, breathing table, so a project team should be prepared to make further revisions as it dives deeper into its analyses.

Table 5.1: Product family Analysis

Categorizing Product Family			
Factory	Masco Knitwear Ltd.	Enter a cycle time per unit inside the cells under each manufacturing stage	Product family is group of different type of product sharing same route (Manufacturing stages) or machineries
Champion	Mr Hamid		

Route	Product Type	Average of Monthly Quantity (average of	Workers Required	Cycle Time	Minutes Required	Ratio	Spreading	Manual Cutting	Fusing	Sewing	Finishing	Packing
01	Long-P	19604			0	4%	X	X		x	X	X
02	Hoody	20598	0	0	0	5%	X	X	X	x	X	X
03	Tank-T	72871	0	0	0	16%	X	X		x	X	X
04	Thicbo o	133636	206	19.2	2576235	30%	X	X		x	X	X
05	LSTS	39531	0	0	0	9%	X	X		x	X	X
06	Shorts	141031	0	0	0	31%	X	X		x	X	X
07	Polo	24137	0	0	0	5%	X	X	X	x	X	X
Total		451408			2576235	100%						

According to product family analysis it has been found that Tchiboo style has 30% production share and the maximum number in quantity produced per month. It would be wise to select this style for the further analysis table 5.1 shows the result in details.

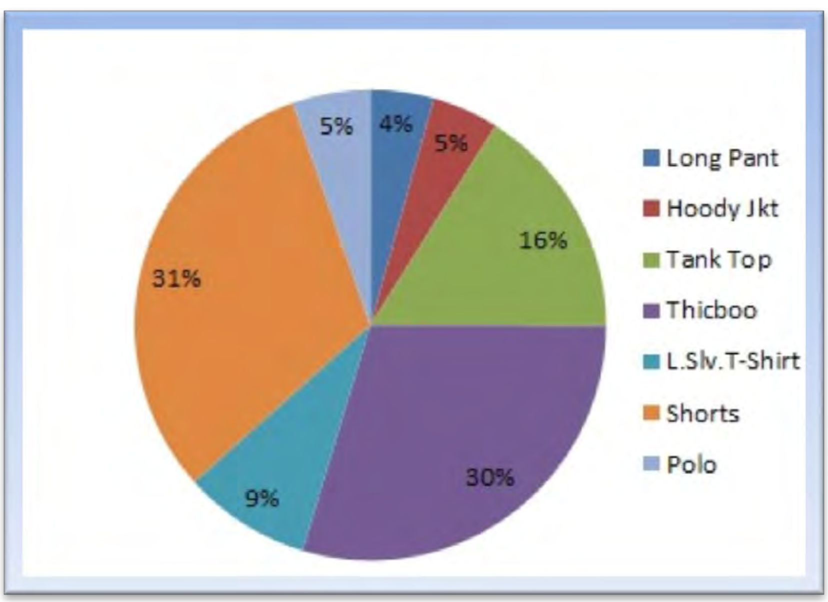


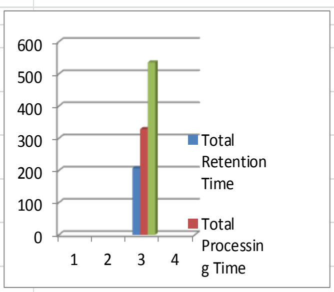
Fig 5.3: Product Family.

5.3.2. Data Collection with the Help of VSM Log Sheet

After selecting target product for Value stream mapping SIPOC diagram (suppliers, inputs, process, and output, customers) to document the process steps has been used this begins with the customers and work forward. Once the walk-through is completed, there should be enough initial data to understand the value stream, and to start creating a current-state value stream map with a more detailed depiction of the value stream. Date have been collected from three sections; cutting, sewing and finishing. Initially data of all the sections were analyzed and based on these a current stage map was drawn. Data log sheet from all the three sections are provided in appendix.

5.3.3. Data Analysis for Current State:

Simple analytical technique is used for data sorting and analysis. Microsoft Excel program is used for some calculations and pre-designed value stream map is used to build the scenario of the value-added and non-value-added time at different sections.



Total Retention Time	207.000
Total Processing Time	328.000
Total LeadTime	535.000
Total Value added Time	61%
Total non-value added Time	39%

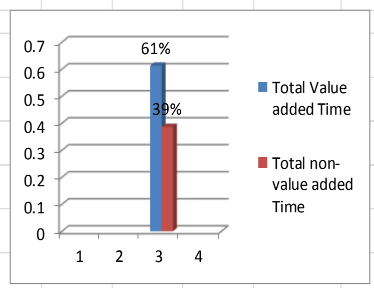
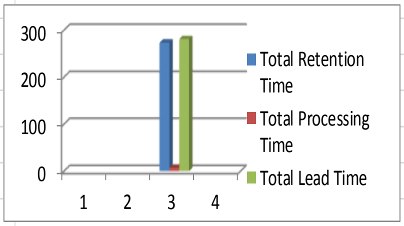


Fig 5.4: Current stage map for cutting

In fig-5.4 shows the current stage of the cutting section where the total working time is 535 minute, total retention or waiting time is 207 minute , Total value added activities is 61% and Non value added activities is 39%.



Total Retention Time	273.600
Total Processing Time	7.505
Total Lead Time	281.105
Total Value Added Time	3%
Total Non Value Added Time	97%

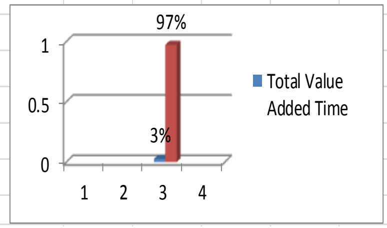
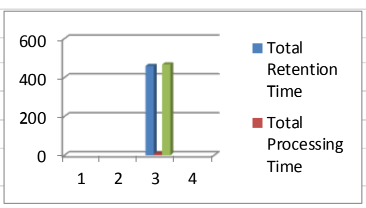


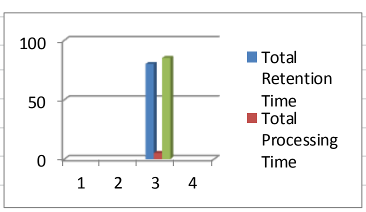
Fig 5.5: Current stage map for Sewing

Fig-5.5 shows sewing section has total working time 281.105 minutes, total retention or waiting time 273.60 minutes, total processing time 7.505 minutes, total value added activities 3% and Non value added activities 97% currently.

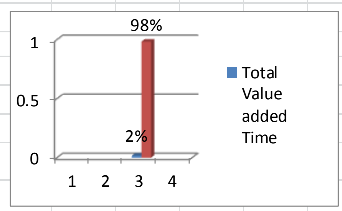
Fig-5.6 depicts finishing section having total working time 467.225 minutes, total retention or waiting time 459 minutes and total processing time 8.225 minutes, total value added activities 2% and Non value added activities 98%.

In Cartooning section total working time is 85.130 minute, total retention or waiting time is 80 minute and total processing time is 5.13 minute. Total value added activities is 6% and Non value added activities is 94%.





Finishing	
Total Retention Time	459.000
Total Processing Time	8.225
Total Lead time Time	467.225
Total Value added Time	2%
Total non value addedTime	98%
Cartoning	
Total Retention Time	80.000
Total Processing Time	5.130
Total Lead time Time	85.130
Total Value added Time	6%
Total non value addedTime	94%



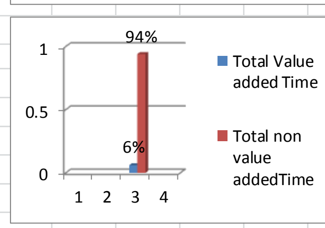
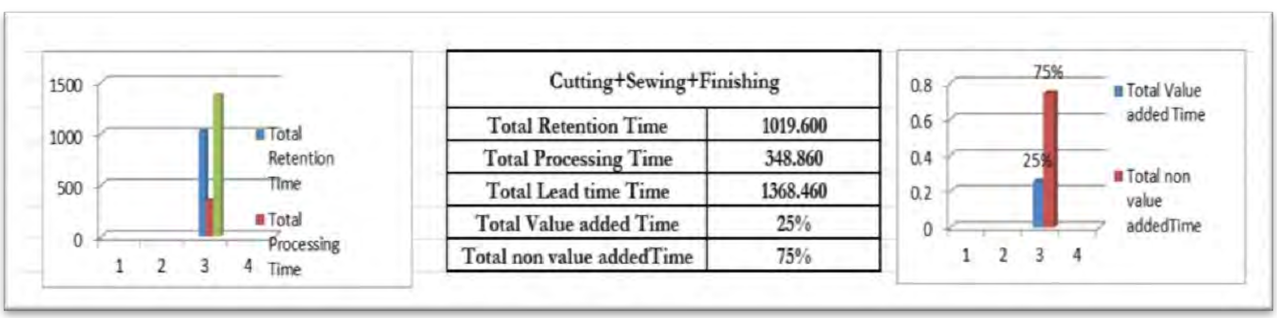


Fig 5.6: Current State Finishing & Car.

As any product needs to move through all these three sections, the total value-added and no-value-added time in theses sections are calculated to identify their respective contribution to the total process.

Table 5.2: VSM Current State Data

Masco Group G2					
Product Name-Thicboo			Order No:404T/2013		
Buyer: Thicboo			Line:404/Tichboo		
Value Stream Mapping: Current State Finding					
Categories	Cutting	Sewing	Finishing	Cartooning	Total
Total Retention Time	207.000	273.600	459.000	80.000	1019
Total Processing Time	328.000	7.505	8.225	5.130	345.86
Total Lead-time	535.000	281.105	467.225	85.130	1364.86
Total Value added Time	61%	3%	2%	6%	25%
Total non-value added Time	39%	97%	98%	94%	75%



Cutting+Sewing+Finishing	
Total Retention Time	1019.600
Total Processing Time	348.860
Total Lead time Time	1368.460
Total Value added Time	25%
Total non value addedTime	75%

Fig 5.7: Overall VSM Current State

The overall scenario is depicted in Fig-5. 7. From the figure, it is found that the total non-value added, and value added time percentages in cutting, sewing and finishing are respectively 75% and 25%.

5.3.4. Information Flow

From Value stream map all of the information flows through manual method have been found. Total time required 718 minutes and 9 workers are involved in information convey purpose.

Table 5.3: Information Flow

Type of Information	From	Responsible	To	Methods		Reasons	Workers	Time(minutes) / information	Frequency	Total time
				Manual	Electroni					
Challan	Poly factory	Store Executive	Warehouse	Yes		To fill order	1	2	1	2
Challan	Assess Foreign supply.	Store Executive	Store	Yes		To recover the order	1	3	10	30
Challan	Thread supplier.	Store Executive	Store	Yes		For sewing	1	4	9	36
Requisition	Fabric Store	Cutting In charge.	Cutting	Yes		For Cutting	1	8	10	80
Requsition	Feb Store	Cutting Incharge.	Cutting	Yes		For Cutting	1	3	1	3
According to Cutt Report	Cutting	Input Supplier	Sewing	Yes		Sewing	1	10	1	10
Requisition	Substore	Input Supplier	Sewing	Yes		Sewing	1	5	2	10
According to Register	From Sewing	Btn Attach Suppliers	Finishing	Yes		For Btn Att	1	60	10	600
Requisition	Main store	Finishing Supplier	Finishing	Yes		For Carton	1	10	1	10

5.4. CHANGEOVER DATA

In the work floor of the sewing section there are seven lines with total number of change over 24 and a total 23040 minutes waste due to that changeover in a month.

Table 5.4: Changeover Data

Working Minutes per day		**480**	**Working days per month**			**26**
Month	1 Changeover	1 sewing line	Month	Factory	Factory	
Number of Changeovers in one month *(entire factory)*	Minutes Wasted per one Changeover per one sewing Line	Workers per one sewing line	Monthly Minutes wasted for all orders changeover	Number of Lines *(Entire Factory)*	Minutes Capacity of the factory	Waste Ratio due to Changeover
24	960	40	23,040	7	2096640	0.7%
Labor Underutilized				1.85	Minutes per day-worker	

5.4.1. Existing Sewing Line Machine Layout

Existing Line consist fifteen operations and their work sequence, machine type given below.

Total Machine: Single Needle =6, Over lock=10, Flat lock=4, Iron=2, Manual Operator=18, Machine Operator=13

Table 5.5: Existing Style Man Machine Chart

S/N	Operation Name	Machine Name	M/C or Man
1	Match the Front & Back Part	Manual	1
2	Shoulder Join	O/L	2
3	Trimming	Manual	1
4	Neck Join	O/L	2
5	Trimming	Manual	1
6	Neck Top Stitch	S/N	3
7	Trimming	Manual	1
8	Back Tape	S/N	3
9	Trimming	Manual	1
10	Sleeve Matching	Manual	1
11	Sleeve Join	O/L	2
12	Trimming	Manual	1
13	Side Join	O/L	2
14	Body Hem	F/L	2
15	Sleeve Hem	O/L	2
16	Trimming	Manual	1
17	Sizing	Manual	1
18	Heat Seal Transferring	Iron	2
19	Thread Cut	Manual	1
20	Final Quality Check	Manual	2

5.5. UNNECESSARY ACTIVITIES

Due to unnecessary activities 42,530 minute are lost in the following sections in one month with ten types of task. Some of the tasks can be removed in implementation stage.

Table 5.6: Unnecessary activities

Unnecessary Activities					
Production/Year				1,546,765	Pieces
Days per year				302	Days
Activities		Department	Yearly Quantity	Minute/pc	Minute/Yr
1	Numbering	Cutting	1546765.0	0.147	227,374
2	Bundling	Cutting	1546765.0	0.157	242,842
3	Matching	Sewing	1546765.0	1.600	2,474,824
4	Trimming	Sewing	1546765.0	1.350	2,088,132
5	Marking	Sewing	1546765.0	0.950	1,469,427
6	Inside check	Finishing	1546765.0	1.760	2,722,306
7	Top side check	Finishing	1546765.0	1.800	2,784,177
8	Sizing	Finishing	1546765.0	0.300	464,029
9	Shade check	Finishing	1546765.0	0.120	185,612
10	Size sticker attach	Finishing	1546765.0	0.120	185,612
Total per year			15467650.0	8.304	12,844,335
Total per day			51217.4	0.03	42,530.91

5.6. QUALITY REWORK

Total Quality related waste time is generated 1476 minutes in month.

Table 5.7: Quality rework analysis

Quality Rework Analysis				
Total Available Labor Sewing		457		
Products	Daily Average Mistakes	Average Cycle Time per mistake (Minute)	Total Time Waste (Minutes) for all lines	Minutes Waste per Day-Worker
Men's L/S shirt	168	0.65	109	0.24
H&M(Blouse)	146	1.35	197	0.43
3/4 Shirt	297	0.6	178	0.39
KHOLS L/S Shirt	266	1.33	354	0.77
Girl's S/S 2r	210	0.68	143	0.98
PVH L/S	361	1.37	495	1.08
All product	1448	5.98	1,476	3.89

5.7. SUMMARY OF ALL TYPES OF WASTE MINUTES

Table 5.8: Summary of all types of waste minutes

Types	Minutes
Information Flow	718
Changeover	23040
Rework	1475
Unnecessary Activities	42530

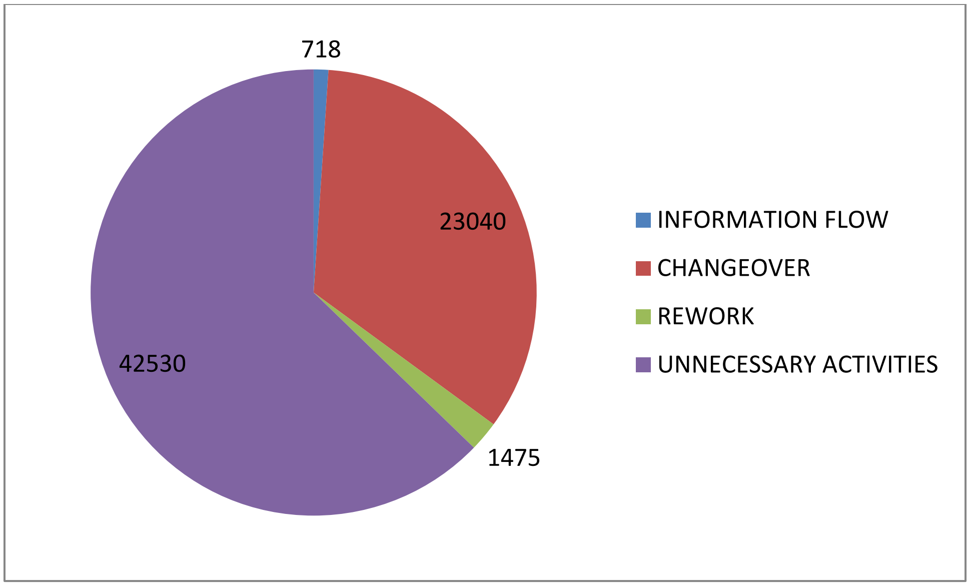


Fig 5.8: Summary of waste min

After analyzing all of the data, it can be concluded that unnecessary activities occupy most of the waste time. Changeover is second largest waste time producing work in the studied floors. Information flow and rework related time also has a little contribution in waste time. The next chapter will describe the pilot run project and further improvement.

CHAPTER SIX
IMPLEMENTATION & RESULT ANALYSIS

6.1. INTRODUCTION

Lean manufacturing is a culture of organization wide effort for better performance and business growth. It can be happened with a dedicative team work and commitment to continuous improvement. In this chapter with the help of existing data, a lean family has established by developing a lean steering committee & lean team.

6.2. SETTING UP THE LEAN FAMILY

The moving forward plan is organized, planned, monitored and implemented by the following:

- Steering committee
- Champion
- Core Implementation Team

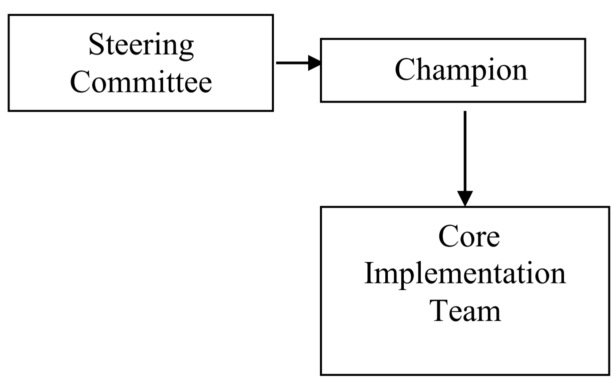


Fig 6.1: Level of responsibility

So the Lean family must be created and training related to the lean principles and tools approach must be provided to all the lean family.

6.3. ROLE AND RESPONSIBILITY OF THE LEAN FAMILY

Steering committee role is to monitor and assure project progress in addition to provide support to the champion and the core implementation team to remove any obstacles, blocks, resistance, and to provide guidance and assistance. The steering committee consists of all head departments and two workers representative (president of the employees' council). Steering committee should select the champion. Steering committee is led by the General Manager.

Roles of Steering Committee Members

- Make strategic decisions related to project implementation.
- Participate in decision making
- Develop supportive systems for better run of the project.
- Coordinate and communicate with supportive departments and personnel.
- Assure commitment and support from relevant departments is in place.
- Provide assistance to remove conflicts, resistance and roadblocks.
- Provide technical guidance and assistance for the project implementation.
- Identify training need and provide training assistance and dissemination of knowledge required.
- Prepare and follow up project plan, provide guidance and assistance in implementation.
- Identify deviation from the plan and take corrective actions as required.
- Disseminate project achievements and failures to relevant authorities and take corrective actions.

Champion: Is someone with the authority and the responsibility to allocate the organization's resources. In small organization it may be the general manager, the factory manager or the production manager. In large organization it may be the chief engineer or the Industrial Engineering in charge.

The champion should possess the following attributes:

- A sense of Project ownership
- Authority to make change happen across functions and departments
- Authority to select the implementation core team

- Authority to commit resources

Core Implementation Team: Factories lack supportive conditions for improvement activities. An employee suggestion system must be established. So factories need to build more team enthusiasm. At step one team members must understand how team activities serve their own desires for personal improvement and self-actualization.

In addition to the champion, it is important to assemble a core implementation team for managing and realizing the improvements. The core implementation team follows the directions of the champion. The team will create plans, communicate to all levels within the organization, make sure people are trained, and implement the value stream process. It is critical for team members to work together, because every aspect of the value stream mapping requires a high degree of collaboration – especially designing the concept or the tool that will lead to the future state.

Formulating the team:

- The team should consist of three to seven members from the same workplace.
- The leader guides discussions and consensus.
- The team determines roles for each member in implementing improvements.

The core team should follow basic teaming guidelines:

- Identify team members' role such as: Leader, timekeeper, facilitator, trainer, etc.
- Establish team norms
- Respectfully the work calendar

The team leader should reinforce the commitment to lean principles and tools by explaining the difference between any existing system and the lean approach. The team leader performs several key functions, at meetings and in between:

- Supports team members through the process
- Schedules frequent, short meetings during work hours. Stand-up meetings keep things brief and focused.
- Prepares the agenda

- Communicates with the champion and the general manager
- Brings people with additional expertise into the team process on a regular basis
- Addresses nonparticipation early and privately.

Core Team members can be: Garment technician, Quality staff, Industrial engineers, staffs from cutting, stores and etc.

6.4. SELECTION OF A PILOT LINE

A pilot line selected named 404/Thicboo for lean manufacturing. At first 40 worked, two line supervisors, one production manager select for lean transformation team.

Work steps:

- Arrange two hour lone seven training session for all team member.
- All team member Familiarized with lean tools & techniques.
- Select ten sewing operator for intensive machine practice about coming garments style.
- Make sure the entire member about waste and value.
- Train up how to and which element should be converted external to internal elements.
- Search all kind of unnecessary activities and how to eliminate those from process.

6.5. PREPARATION FOR CHANGEOVER

6.5.1. Transforming Internal in to External Activities

Pre-Production Meeting: Before starting test cutting & sewing Pre-Production Meeting will held to make sure everyone is aware of all about the style and execute the style respecting all quality points and to minimize communication gaps and to get a know-how of the order starting from cutting section to finishing section. The meeting will attended by Quality Assurance Manager, Cutting & sewing-In-Charge and respective line Mechanic.

During the meeting following points have discussed as per the agenda mentioned the following.

- Introduction of the style - Assistant General Manager / Factory Manager

- Fabric & Accessories status – Store-In-Charge
- Pattern, Cut marks etc. – Pattern In Charge
- Quality points – QA Manager
- Special Operations – Technical Manager
- Line Layout, Allocation of workers, Target setting, Line balancing – IE Dept.
- Ironing, Folding & Packing – Finishing-In-Charge
- Meeting minutes are recorded & circulated to all concerns

Trial Production: Trial production is done for the purpose of checking mainly product quality & some of product special specification such as size measurement, sewing quality, and stitch tension etc. During trial production instruction is given that what's wrong and what's right. Production managers, Quality manager, Floor in charge are responsible for trial production.
In Redesign process all of the product specification, quality specification and others necessary specification provided to the responsible persons Quality controller, floor in charge, line Chief, and supervisors at least 2 or 3 days ago before final production.

Layout preparation: In previous system the production peoples are responsible for layout preparation. In their layout there were some of problems for consuming more time. That was:

- No process sequence.
- Product not smooth flow.
- Products are not totally forward flow.
- Straight layout
- Product transportation waste was high
- Consume more space
- Manpower & Machine allocation was not limited way
- Process layouts are frequently changed.

Redesign system Layout preparation is done according to PMTS analysis which was totally helpful for SMV calculation, Man & Machine allocation, Target setting & Efficiency calculation & also preventive for these problems of process sequence, space, product transportation, man & machine allocation, layout change.

Needle change: To reduce the change over time Needle clamping system should be more reliable & less time consuming event. According to existing system Needle is push into upper position to hold it the needle holder then tighten the supporting screw. Redesign system implemented Electromagnetic clamping needle clamping system.

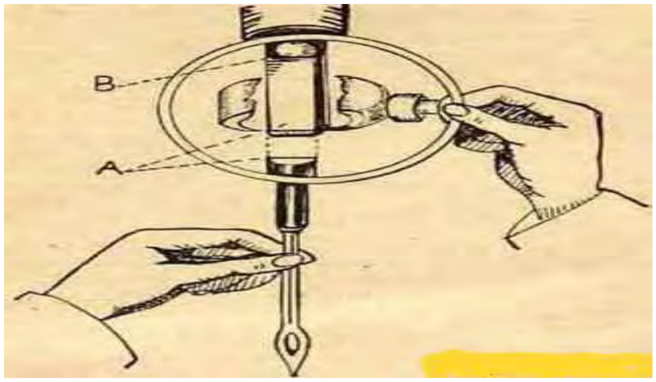


Fig 6.2: Needle clamping system

Thread Change: It's one of the most common internal activities in sewing line. Each sewing Machine have required only one thread stand with one running style color thread and the thread stand is attached in front of the sewing table with a handle. When a new style is introduced into the sewing line then thread stand is filled by another color thread in the basis of style color. Redesign system will be that each thread stand must be separated into two sections. One section will contain running style color thread and another section contains upcoming style color thread. When running style production will be finished then it will not need to change thread stand, just move the thread stand to the sewing machine with a suitable operating length.

6.5.2. Improvement Internal Activities Minimization

Some of internal activities can be improved by using 5S method. These are

- Cleaning Machine surface
- Cleaning work surface
- Stitch adjustment
- Stitch measurement
- Trim adjustment
- Fixing new tools

- Guide adjustment
- Nose change

6.5.3. External Activities Improvement

- All of the external activities (mention above) are possible to improvement by 5S implementation.
- Placing visual markings for easier and faster identification
- Using check list to prevent unpredictable events in resources preparation (5S)
- "At hand" tool organization (5S)
- Work place organization that decreases tool search time (5S)
- Use OEE & TPM in every process.
- Develop standard time for all tasks.

6.6. CONVERTED TASK LIST

Table 6.1: Internal & External Elements

Internal Elements	External Elements
• Cleaning work surface • Stitch adjustment • Stitch measurement • Guide adjustment • Nose change • Looper adjustment • Tension adjustment • Thread change • Needle positioning • Trim adjustment • Fixing new tools	• Pre-Production Meeting. • Layout preparation • Trial production • Cleaning Machine surface • Cleaning Machine surface • Needle change • Needle change • Provision of trim card. • Getting cut panel from cutting section. • Getting threads & accessories from store. • Getting instruction about new style from supervisors. • Provision of Layout and line balancing

	sheet. • Provision of production sheet. • Getting instruction for next job. • Getting material for the next job from stores. • Getting tools for the next job from tool stores. • Returning tools for the last job to tool stores.

After Converting Internal elements to external elements and introducing standard time assignment for each element changeover time become 960 to 63 minutes. It's around 93% improvement in changeover time reduction.

6.7. CHANGEOVER STYLE MACHINE& OPERATION LIST

To implement SMED we compare old and new style machine number and type. Based on this analysis some of the machine replaced from old line to studied line and rest of the machine install from machine room. In Previous chapter we found that Single Needle =6, Over lock=10, Flat lock=4, Iron=2, Manual Operator =14, Machine Operator =20 but new line required Single Needle =9, Over lock=12, Flat lock=4. Our primary task starts with first operation which is similar machine, so there is no need to change this machine from line. Just change the thread, time, and clean-up to start operation. Than look forward to next machine and compare with old to new. If two machine are not similar than replace by required machine which is already prepared for operation. One by one we have to set up full line. We have eliminated most of the manual operation. New style operation sequence gives below.

Table 6.2: New Style Man & Machine Chart

Sl. No	Operation	M/C	M/C Op.	Manual
1	Back &Front Part Match	M		1
2	Shoulder Join with Tap	O/L	1	
3	Neck Rib Tack	P/M	1	
4	Neck Rib Join	O/L	2	
5	Main & Size Label Attach	P/M	2	
6	Neck Top Stitch	F/L	2	
7	Sleeve Match	M		1
8	Sleeve Join	O/L	2	
9	Care & Name Label Make	P/M	1	
10	Side Seam	O/L	3	
11	Cuff Make	P/M	2	
12	Cuff Fold	M	1	
13	Cuff Attach	O/L	2	
14	Bottom Rib Make	P/M	1	
15	Bottom Rib Attach	O/L	2	1
16	Bottom Rib Top Stitch	F/L	2	
17	Hanger Tap Attach	P/M	2	
Total Machine/Manual operator			25	3

6.8. IMPROVED CHANGEOVER TIME

Table 6.3: Improved changeover time

Working Minutes per day		480	Working days per month		26
Month	1 Changeover	1 sewing line	Month	Factory	Factory
Number of Changeovers in one month *(entire factory)*	Minutes Wasted per one Changeover per one sewing Line	Workers per one sewing line *(including sewing operators and helpers)*	Monthly Minutes wasted for all orders changeover	Number of Lines *(Entire Factory)*	Minutes Capacity of the factory
24	63	40	1512	7	3,494,400
Labor Underutilized				0.21	Minutes per day-worker

Previous Waste time was 42,530, after implementing SMED it's become 1512 minute. It is 96% improvement in change over time reduction.

6.9. UNNECESSARY TASK ELIMINATION

Introducing small size bundle method and auto thread cutter machine we eliminate Matching, Trimming and marking process. All of those processes save 20487 min a day to entire factory. It's around 40% improvements.

Table 6.4: Unnecessary activities after elimination

Unnecessary Activities After Elimination					
Production/Year				1,546,765	Pieces
Days per year				302	Days
Activities		Department	Yearly Quantity	Minute/pc	Minute per year
1	Numbering	Cutting	1546765.0	0.147	227,374
2	Bundling	Cutting	1546765.0	0.157	242,842
3	Inside check	Finishing	1546765.0	1.760	2,722,306
4	Top side check	Finishing	1546765.0	1.800	2,784,177
5	Sizing	Finishing			
6	Shade check	Finishing	1546765.0	0.120	185,612
7	Size sticker attach	Finishing	1546765.0	0.120	185,612
	Total per year		9280590.0	4.104	6,347,924
	Total per day		30730.4	0.01	417.61

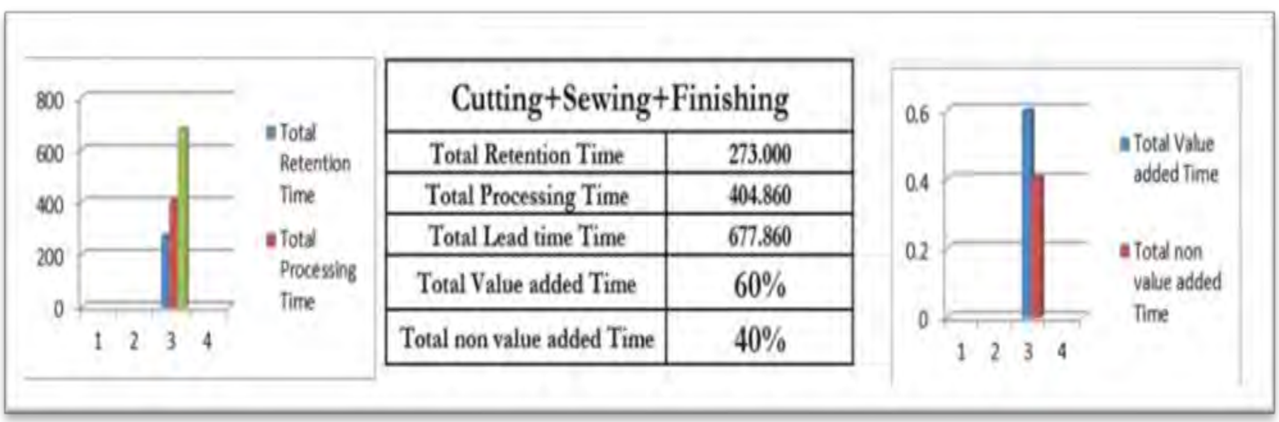
6.10. OTHER LEAN TOOLS EFFECT ON VSM

After applying 5S in the store, cutting, sewing, finishing section, the organization can organize the workplace. It is found that the hand tape, sticker, gum, poly, stapler and some hand tools are not placed in a particular location. This causes a problem to the uses to find them at right time. Significant amount of time is wasted just for this. By applying 5s tool, non-value added time can be reduced notably.

Our study also reveals that machine malfunctions and machine breakdowns are frequently caused problem in the studied organization because of the improper maintenance plan and practice, the organization is incurring remarkable amount of non-value-added time. Total Productive Maintenance (TPM) application in sewing floor could reduce 35.09 min of waiting time in a day.
Work-in process (WIP) is found a notable problem in the organization that adds significant amount of non-value added time. Minimizing WIP with the application of JIT philosophy, the organization could save waiting time for materials in the workstations.

- 5S or work place organization method.
- Total Preventive Method.
- Multi-skill worker development for higher time utilization.
- Implement total quality management system
- Use Kanban system for cutting & sewing section

By applying all of the lean tools and techniques, the organization reduce its non-value-added time, thereby its production leads time. In An overall future stage value stream mapping depicted Fig showed value added time has increased up to 60% and retention time become 40% and finally lead time also decreased.



Cutting+Sewing+Finishing	
Total Retention Time	273.000
Total Processing Time	404.860
Total Lead time Time	677.860
Total Value added Time	60%
Total non value added Time	40%

Fig.6.3: VSM future state

6.11. SUMMARY OF RESULT

Table 6.5: Summary of result

Task	Previous (Month)	After (Month)
Changeover Time	23040	1512
Unnecessary Activities	42530	30730.4
Value-Added Activities (VSM)	25%	60%
Non-Value added	75%	40%

This chapter described all of the unnecessary task elimination, Changeover elements conversion internal to external. Implemented methodology outcome also shown. Next Chapter will describe the comparative result after and before the Lean manufacturing implementation.

CHAPTER SEVEN
CONCLUSION & RECOMMENDATION

7.1. CONCLUSIONS

This research has extracted an overall scenario of the cutting, sewing and finishing section of the selected garments company in the context of productivity, quality, waste as well as effectiveness, efficiency.

The improvement of any manufacturing organization depends on various issues such as waste minimization, productivity improvement, quality management as well as labor efficiency, resource utilization etc. This research analysis has extracted based on the basis of different lean tools: value stream mapping analysis, Changeover time analysis and 5S analysis. Before this analysis various types of wastes were identified and the reasons behind all these wastes have been analyzed. The analysis shows that in most of the time human resource is responsible for the creation of waste.

Firstly, Single Minute Exchange of Die Method becomes blessing in changeover method. After implementing SMED waste reduce 42,530 to 1512 minutes in month. It is 96% of time reduction in changeover process.

Secondly, Value stream mapping has provided a clear picture about material & information flow time. Initially value stream mapping depicted the value added time percentages in cutting, sewing and finishing totally respectively 75% and 25%. In implementation stage value added time has increased up to 60% and retention time become 40% and finally lead time also decreased.

Thirdly, Elimination of some process like matching parts, trimming and marking process which was treated as unnecessary activities and introducing down size bundle system. Result of this change saved 20487 min a day to entire factory. It’s around 40% improvements in unnecessary task elimination.

7.2. RECOMMENDATION

1. This research work is done in a knit composite industry; so further study can be done in woven and other types of apparel industry

2. This research work is concentrated only the sewing section of the selected garments industry, so further study can be done in other section of the selected industry such as knitting, dying, cutting, finishing and packing section.

3. This research work analysis is mainly divided into three dimensions which are changeover time analysis, value stream mapping 5S & OEE analysis but further study can be performed by using other lean tools such as Value stream mapping, kanban system.

4. The changeover time analysis is done only in sewing section to show the impact of changeover time on productivity, lead time, WIP stock, defect but further study can be performed in other section by using SMED method to reduce changeover time.

5. Various types of wastes are identified according to lean theory but in future this waste can be represented in terms of money, which can help the organization to know about the loss of money and lead them to think about how to overcome this loss.

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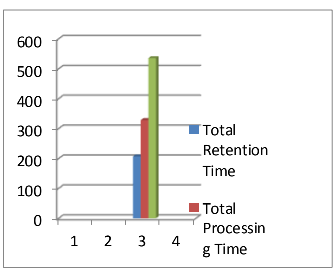
Appendix A

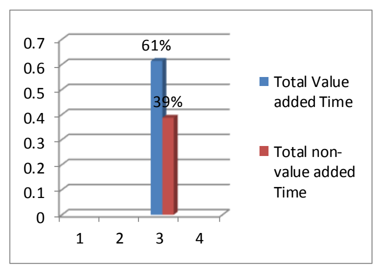
Cutting Section VSM Data Sheet

Cutting Section Data Collection Logsheet(Current)

	Factory	Masco Knitware Ldt									Time (minutes)	
	Champion	Md. Abdul Halim										
	Department	Cutting										
SL.NO.	Activities	Area	Work Station	QTY	**Simultaneous activities**	Time (Minutes) for all activities	Nbre workers	Distance (feet)	Space (area)	Equipment (type and qty)	Cycle time	non Value Added
1	**Waiting- As the laying was not started.**	Cutting	On the laying table	1,476		5	4					
2	Marker Setting-1 Lay	Cutting	1	12		10	9		120 sft		7.500	
3	Laying	Cutting	1	1,464		120	9		120 sft		0.738	
7	Waiting-**Due to absence of the cutter man**	Cutting		1,476		32						
8	Cutting	Cutting	1	1,476		73	2		120 sft		0.099	
9	Numbering	Cutting	1	1,476		85	1		120 sft		0.058	
10	Bundling	Cutting	1	1,476		25	2		120 sft		0.034	
11	Send the bundle into the reck	Cutting	1	1,476		15	2		50 sft		0.020	
12	**Waiting- As the cut pieces are not sent to**	Cutting		1,476		170						



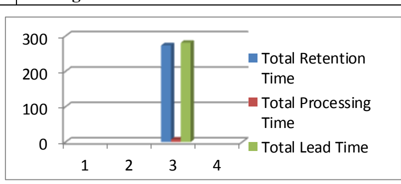
Total Retention Time	**207.000**
Total Processing Time	**328.000**
Total LeadTime	**535.000**
Total Value added Time	**61%**
Total non-value added Time	**39%**



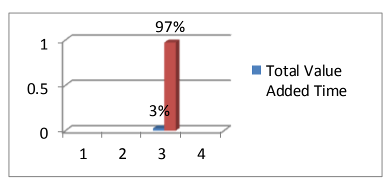
Appendix B

Sewing Section VSM Data Sheet

#	Activities	Area	WorkStation	QTY	Simultaneous activities	Time (Minutes) for all activities	Nbre workers	Distance (feet)	Space (area)	Equipment (type and qty)	Cycle time	non Value Added
Data Collection Log sheet For Sewing Section												
	Factory	Masco Knitwear Ltd.									Time (minutes)	
	Champion	Md. Abdul Halim										
	Department	Sewing										
	Waiting	Sewing		1		40.000						
1	Match the front 'n back part	Sewing	1	520		0.168	1		9 Sft		0.168	
	Waiting	Sewing		1		10.000						
2	Shoulder Join	Sewing	2	80		0.311	1		5 Sft	OL-1	0.311	
2	Trimming	Sewing	2	80		0.136	1		5 Sft		0.136	
	Waiting	Sewing		1		10.000						
3	Neck Join	Sewing	3	100		0.240	1		6 Sft	OL-1	0.240	
3	Trimming	Sewing	3	100		0.347	1		6 Sft		0.347	
	Waiting	Sewing		1		85.000						
4	Neck Top Stitch	Sewing	4	100		0.078	1		6 Sft	FL-1	0.078	
4	Trimming	Sewing	4	100		0.248	1		6 Sft		0.248	
	Waiting- As there were WIP of different color	Sewing		1		85.000						
5	Back Tape	Sewing	5	400		0.199	1		20 Sft	TM-1	0.199	
5	Trimming	Sewing	5	400		0.163	1		20 Sft		0.163	
	Waiting	Sewing		1		12.000						
6	Sleeve Matching	Sewing	6	100		0.178	1		6 Sft		0.178	
	Waiting	Sewing		1		10.000						
7	Sleeve Join	Sewing	7	80		0.352	2		5 Sft	OL-2	0.352	
7	Trimming	Sewing	7	80		0.392	2		5 Sft		0.392	
	Waiting	Sewing		1		10.000						
8	Side Join	Sewing	8	80		0.385	2		5 Sft	OL-2	0.385	
8	Trimming	Sewing	8	80		0.487	2		5 Sft		0.487	
	Waiting	Sewing		1		10.000						
9	Body Hem	Sewing	9	100		0.283	2		6 Sft	FL-2	0.283	
9	Trimming	Sewing	9	100		0.405	2		6 Sft		0.405	
	Waiting	Sewing		1		10.00						
10	Sleeve Hem	Sewing	10	120		0.331	2		9 Sft	FL-2	0.331	
10	Trimming	Sewing	10	120		0.641	2		9 Sft		0.641	
	Waiting	Sewing		1		10.000						
11	Sizing	Sewing	11	50		0.075	1		4 Sft		0.075	
	Waiting	Sewing		1		8.000						
12	Heat Seal Transfering	Sewing	12	150		0.640	1		12 Sft	HTM-1	0.640	
	Waiting	Sewing		1		8.000						
13	Thraed Cut	Sewing	13	280		0.696	1		16 Sft		0.696	
	Waiting	Sewing		1		5.600						
14	Q/C	Sewing	14	100		0.750	2		9 Sft		0.750	
	Waiting	Sewing		1		365.000						



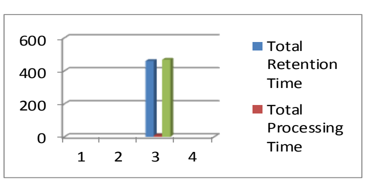
Total Retention Time	**273.600**
Total Processing Time	**7.505**
Total Lead Time	**281.105**
Total Value Added Time	**3%**
Total Non Value Added Time	**97%**

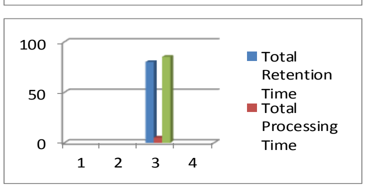


Finishing & Cartooning VSM Data

ıen there is "Waiting" You need to write the reason in the activities column

Factory	Masco Knitwear Ltd									Time (minutes)	
Champion	Md. Abdul Halim										
Department	Finishing										
Activities	Area	WorkStation	QTY	**Simultaneous activities**	Time (Minutes) for all activities	Nbre workers	Distance (feet)	Space (area)	Equipment (type and qty)	Cycle time	non Value Added
Waiting	Finishing		1		5.000						
Inside check	Finishing	1						50			
Hem	Finishing	1	55		0.121	3				0.121	
Waiting	Finishing		1		11.00						
Side Seam	Finishing	1	65		0.146	3				0.146	
Waiting	Finishing		1		13.00						
Sleeve	Finishing	1	70		0.196	3				0.196	
Waiting	Finishing		1		12.00						
Neck	Finishing	1	65		0.16	3				0.155	
Waiting	Finishing		1		53.000						
Thread Sucking	Finishing	2	250		0.120	3		50		0.120	
Waiting	Finishing		1		15.000						
Arrange To send to the Pressing	Finishing	2	300		0.300	3		30		0.300	
Waiting- There were huge WIP behind the Pressing Area	Finishing		1		93.000						
Pressing	Finishing	3	400		0.650	13		120		0.650	
Waiting	Finishing		1		18.000						
Outside check	Finishing	4	160		0.750	12		40		0.750	
Waiting	Finishing		1		13.000						
Get up & Measurement	Finishing	5	150		1.333	8		36		1.333	
Waiting-There were WIP at the operation	Finishing		1		53.000						
Lot Pass	Finishing	6	500		0.160	2		20		0.160	
Waiting	Finishing		1		50.000						
Hang Tag Attach	Finishing	7	160		0.250	4		40		0.250	
Waiting	Finishing		1		8.000						
Needle Detecting	Finishing	8	50		0.100	1		15		0.100	
Waiting	Finishing		1		11.000						
Folding	Finishing	9	200		2.250	10		36		2.250	
Waiting	Finishing		1		38.000						
Size Sticker Attach	Finishing	9	180		0.222	4		20		0.222	
Waiting	Finishing		1		10.000						
Sticker & Hang Tag Check	Finishing	9	150		0.133	2		20		0.133	
Waiting	Finishing		1		14.000						
Shade Check	Finishing	10	200		0.200	2		20		0.200	
Waiting	Finishing		1		14.000						
Sizing	Finishing	10	100		0.200	2		20		0.200	
Waiting	Finishing		1		15.000						
Assortment	Finishing	10	150		0.267	2		30		0.267	
Waiting	Finishing		1		18.000						
Poly	Finishing	10	300		0.672	8		50		0.672	
Waiting- There were huge WIP into the Packing area for	Finishing		1		80.000						
Cartoning	Packing	11	700		5.130	10		50		2.565	
Waiting	Packing				9.000						





Finishing	
Total Retention Time	**459.000**
Total Processing Time	**8.225**
Total Lead time Time	**467.225**
Total Value added Time	**2%**
Total non value addedTime	**98%**

Cartoning	
Total Retention Time	**80.000**
Total Processing Time	**5.130**
Total Lead time Time	**85.130**
Total Value added Time	**6%**
Total non value addedTime	**94%**