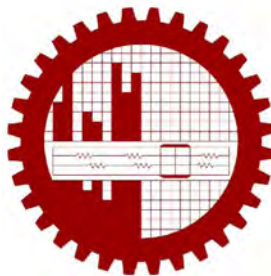


**A STUDY ON IMPLEMENTATION OF LEAN MANUFACTURING TOOLS  
AND TECHNIQUES IN THE RMG INDUSTRY**

**by  
Jahangir Parvez Masud**

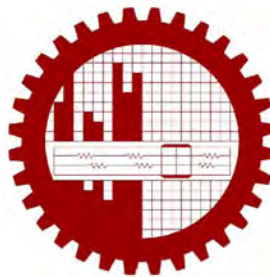


**DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING  
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY  
DHAKA, BANGLADESH  
MARCH 2010**

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AND TECHNIQUES IN THE RMG INDUSTRY**

**by  
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A thesis submitted to the Department of Industrial and Production Engineering,  
Bangladesh University of Engineering and Technology, in partial fulfillment of the  
requirements for the degree of Master of Engineering in Industrial and Production  
Engineering.



**DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING  
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY  
DHAKA, BANGLADESH  
MARCH 2010**

## **CERTIFICATE OF APPROVAL**

The thesis titled “A STUDY ON IMPLEMENTATION OF LEAN MANUFACTURING TOOLS AND TECHNIQUES IN THE RMG INDUSTRY” submitted by Jahangir Parvez Masud, Roll Number: 100508010F, Registration Number: 1005238, Session: October’ 2005 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Master of Engineering in Industrial and Production Engineering** on March’09, 2010.

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MARCH 2010**

### **CANDIDATE’S DECLARATION**

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.

Jahangir Parvez Masud

## **ACKNOWLEDGEMENT**

---

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## ABSTRACT

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Shifting customer demands, increasing variation in products and demand for perfect quality at competitive price with shortest lead time are the common difficulties faced by the manufacturers. Meeting these demands while dealing with complex distribution systems and multi-tiered chains of suppliers is better understood in light of system dynamics and finding ways to minimize their cyclical nature. In the competitive market place, most of the manufacturers tend to stay in business by optimizing the production cost through minimizing lead time and wastage of materials along with increasing employees' effective skills rather than increasing prices. In this circumstance lean manufacturing tools and techniques are becoming the most intelligent parts.

The paper is on the study of lean tools and techniques and present situation of the industry. The current state value stream mapping identifies the waste happening in frequent manner. This map shows what will be the future state map what is the possible scope of improvement. The future state map shows the possible waste reduction way that contributes to the production lead time. The analysis of 5S and change over time improve the space utilization and production loss time. There is a suggestive framework on how to implement lean techniques to get the maximum benefit from the business depending on the study feedback. To facilitate the conversion process, the studies point to three critical needs: increased receptivity to innovative process change, enhanced predictability to the likely regulatory constraints such equipment will operate under and timely responses to construction and modification actions.

Lean manufacturing as a continuous improvement program shows the way to improve the process by eliminating waste, standardizing work, and creating flexible manufacturing. Typical tools used to achieve this improvement include: line smoothing, the 5 Ss, cycle time reduction, and work area reconfiguration.

Implementing the lean methodologies is a long journey – most likely a never ending journey that must be carefully planned and frequently revised if one is willing to succeed.

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## CHAPTER ONE

### INTRODUCTION

#### 1.1 Introduction

Industrialization is the key to the economical development of the country. The Ready Made Garments (RMG) industry is the major export – base (75%) for Bangladesh and it has major impact on country's economy, as well as on society, because of large number of worker involvement. To meet the ever increasing demand of the mass population and the international demand of the textile products, the emerging and important sector of national economy, the RMG sector has the great chance and opportunity to improve the productivity. Because of being technologically labour dependent it has a large number of worker involvement and most of them are female worker so it helps in socio – economical development of the poor fraction of population of the country. So the females are playing an important role in the largest foreign exchange earning sector of our country and they are becoming conscious about women rights by their economic independency. The garments industries in Bangladesh do have the organizational structure but do not have the proper job description of the employees so the problem arises from the mid level management. Description of rules and responsibilities along with power and authority is essential for smooth production running of any organization. In today's competitive world the manufacturers needs to be conscious about time, cost, quality and delivery. To be the champion in business these four components should be given most priority along with good management skill and innovative technological aspects of modern development. The present situation of the RMG sector is not in a satisfying one and in the last year there was a massive worker agitation because of salary structure, working environment, compliance issues and other human rights. The local garment manufacturers are facing fierce competition in Quota and GSP free market as per WTO agreement and they are well behind from the competing countries like India, Sri Lanka, China, Indonesia and Vietnam etc. In order to face the challenges Bangladeshi manufacturers have to apply new methods, tools and techniques in different area of production and operation management and in other business areas.

After the World War II Japanese manufacturers, particularly in the automotive industry, were faced with the dilemma of shortages of material, financial and human resources. Eiji Toyoda and Taiichi Ohno at the Toyota Motor Company in Japan pioneered the concept of the Toyota Production System (TPS), or what is known today as “Lean Manufacturing”. Lean manufacturing is a new term defined by Womack and Jones that helps the manufacturer to produce quality product with less material, greater efficiency, shorter lead time, and in timely manner. Lean has many tools for better manufacturability and it needs proper guideline, management involvement, appropriate knowledge and overall factory transformation to the system.

The thesis addresses the application of lean manufacturing concepts to the mass production sector (RMG) with a focus on the value chain of garment industry including cutting, sewing, finishing. The objective of the study is to investigate the present status of the industry, scope of the improvement and the benefit gain by the implementation of new tools of lean manufacturing.

## **1.2 Rationale of the Study**

Many manufacturers are now critically evaluating their processes to determine their effectiveness in bringing maximum value to customers. Factory management techniques of yesterday are being replaced by more efficient methods that greatly minimize delays, reduce costs, and improve quality. Lean manufacturing is a whole – systems approach being used in enterprises from Europe to the USA and from Brazil to India that creates a culture in which everyone in the organization continuously improves processes and production. It is a system focused on and driven by customers, both internal and external.

Local manufacturers need to become aware of the benefits the Lean Management Approach can bring to their operations. Informal research has revealed that there is a lack of awareness amongst the local manufacturing community of Lean Thinking and an urgent need to address this deficiency. In order for RMG manufacturers to meet

the challenges of competition in an expanded market place, they need to be equipped with the tools to make their operations more efficient.

There is no cookbook for manufacturing to follow rigidly. Each firm has its own unique set of products, processes, people, and history. While certain principles may be immutable, their application is not. Manufacturing Strategy will always be a difficult, uncertain, and individual process. Strategy is still, largely, an art. But, that should not prevent us from bringing the available science to bear on the problem. Converting to a lean production system is a process that requires every level of an organization to develop a complete understanding to the basic tents of the concept and its execution. Companies that have fully implemented lean systems are rare, but the list of manufacturers trying to become lean is growing fast.

### **1.3 Background of the thesis**

The application of lean manufacturing concept in RMG sector is totally new in Bangladesh. So there is a great necessity to study the scope of implementation and the areas of improvement and the step by step methodology to do it in a positive and learned thinking. The industry with quality product, higher efficiency, lower cost and trained manpower is ahead in the competition. So the productivity, efficiency and effectiveness are increasingly becoming the burning issue in today's economy. To survive in the hard contest economy the industry should develop itself with systematic identification and elimination of waste, productivity improvement, cost reduction, employee benefit incentives and social welfare activities. So the necessity arises to study the scope of implementation of lean tools in different unit of RMG production sector with thorough analysis and research. Now a days the buyers are searching market for lower price and they are getting new exporter on their hand with their requirement. So the profit margin is narrowing and the competition is expanding as a result the production process and new technology is the only way to cope up the crisis. The project work tries to find out the common phenomenon to implement lean tools and the barriers to overcome.

#### **1.4 Problem Statement**

The RMG sector has its own importance because of its export base and industrialization of Bangladesh with this labour oriented easy production technology and availability of raw material helped this business to grow faster. We have the cheaper labor because of unemployment, illiteracy, lack of skill ness and over population, which is one of the important reasons to build up so many garment industries (more than 4,500) in our country. The garment industries are facing new challenges in this global economy with their productivity, quality, efficiency, lower sales price, high cost involvement, poor management, organizational inefficiency and improper resource utilization. Every production unit has some in built difficulties along with the demonstrated evidence of systematic approaches for transmission of information among the various units of the company. In garments the most basic operating units are Spinning, Knitting, Dyeing, Cutting, Printing, Embroidery, Sewing and Finishing. The communication among the several departments and reporting of the operational function of various units are a common problem and proper care is not taken in this area. Wrong information and un– time function can bring massive production loss. So new initiatives are the requirement of time to gain competitive advantage and sustainable development. The application of VSM and 5 S is justified and other tools are suggested to be implemented in different stages. VSM is helpful for high production; low variety product mixes with few components and subassemblies and dedicated equipment.

#### **1.5 Objectives of the Study**

The purpose of the proposed project is to systematically demonstrate how lean manufacturing tools, when used appropriately, can help the industry to eliminate waste, have better inventory control, better product quality and better overall financial and operational procedures. The selected industry for the application of lean manufacturing is Urmi Garments Ltd., Dhaka.

The specific objectives of the present study are:

1. to study lean manufacturing concepts and its different tools and techniques.
2. to illustrate the procedure of implementing lean tools in the selected RMG industry and to study the effect of applying lean tools in this industry.
3. to address the difficulties in application and benefits gained by the RMG industry when implementing lean tools.

The study will demonstrate that the benefit of lean system leads to higher productivity with reduced cycle time, inventory, downtime, maintenance etc. It is expected that the manufacturing process industry like RMG can be hugely benefited if lean system can be applied there properly.

## **1.6 Methodology**

The methodology of the study will be as follows:

1. Collecting data (process time, production output) for one and half months to get the current condition of a product from the selected ready-made garments manufacturing processes
2. Charting Value stream mapping to map the current state of the industry.
3. Identifying all types of waste in the value stream.
4. Identifying appropriate lean tools that can be implemented to reduce this waste.
5. Taking steps to eliminate waste by applying lean tools which is applicable in the RMG environment.
6. Developing future state map to identify and eliminate the source of waste that the current state map identifies.
7. Proposing a general methodology of implementing lean tools in RMG industry with the help of the experience gained from the current study.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

Over the past 10 years or so, lean manufacturing has been receiving an increasing amount of attention as one source for productivity improvements and cost reductions in manufacturing. Hailed by its proponents as a breakthrough means to analyze and improve production and the factory floor environment, lean manufacturing is a broad collection of principles and practices that can improve corporate performance. Lean Manufacturing is the latest buzzword in manufacturing circles. It is not especially new. It derives from the Toyota Production System or Just In Time Production, Henry Ford and other predecessors.

The lineage of Lean manufacturing and Just In Time (JIT) Production goes back to Eli Whitney and the concept of interchangeable parts.

#### 2.2 Historical Background

##### *2.2.1 Early Developments*

While Eli Whitney is most famous as the inventor of the cotton gin, the gin is a minor accomplishment compared to his perfection of the concept of interchangeable parts. Whitney developed this about 1799 when he took a contract from the U.S. Army for the manufacture of 10,000 muskets at the unbelievably low price of \$13.40 each.

For the next 100 years manufacturers primarily concerned themselves with individual technologies. During this time system of engineering drawings developed, modern machine tools were perfected and large scale processes such as the Bessemer process for making steel held the center of attention.

As products moved from one discrete process to the next through the logistics system and within factories, few people concerned themselves with:

What happened between processes, how multiple processes were arranged within the factory, how the chain of processes functioned as a system, and how each worker went about a task.

The eighteenth century economist Adam Smith is not usually thought of as an industrial engineer. However, his 1776 discussion in *An Inquiry into the Nature and Causes of the Wealth of Nations* regarding the division of labor in the manufacture of pins was one of the first formal examples of how to improve efficiency in production.

This changed in the late 1890's with the work of early Industrial Engineers. Frederick W. Taylor began to look at individual workers and work methods. The result was Time Study and standardized work. He called his ideas Scientific Management. The concept of applying science to management was sound but Taylor simply ignored the behavioral sciences.

Frank Gilbreth [1] added Motion Study and invented Process Charting. Process charts focused attention on all work elements including those non-value added elements which normally occur between the "official" elements. Lillian Gilbreth brought psychology into the mix by studying the motivations of workers and how attitudes affected the outcome of a process.

### *2.2.2 The Ford System*

Starting about 1910, Ford and Charles E. Sorensen [2], fashioned the first comprehensive Manufacturing Strategy. They took all the elements of a manufacturing system-- people, machines, tooling, and products-- and arranged them in a continuous system for manufacturing the Model T automobile. Ford is considered by many to be the first practitioner of Just In Time and Lean Manufacturing.

Ford's success inspired many others to copy his methods. But most of those who copied did not understand the fundamentals.

For example, Ford production [3] depended on a labor force that was so desperate for money and jobs that workers would sacrifice their dignity and self esteem. The prosperity of the 1920's and the advent of labor unions produced conflict with the Ford system. Product proliferation also put strains on the Ford system.

At General Motors, Alfred P. Sloan took a more pragmatic approach to production and developed business strategies for managing very large enterprises and dealing with variety. By the mid 1930's General Motors had passed Ford in domination of the automotive market.

### *2.2.3 Just In Time and The Toyota Production System*

The Allied victory and the massive quantities of material behind it caught the attention of Japanese industrialists. They studied American production methods with particular attention to Ford practices and the Statistical Quality Control practices of Ishikawa, Edwards Deming, and Joseph Juran. At Toyota Motor Company, Taichii Ohno and Shigeo Shingo, began to incorporate Ford production, Statistical Process Control and other techniques into an approach called Toyota Production System or Just In Time [4]. They recognized the central role of inventory.

The Toyota people also recognized that the Ford system had contradictions and shortcomings, particularly with respect to employees. With General Douglas MacArthur [5] actively promoting labor unions in the occupation years, Ford's harsh attitudes and demeaning job structures were unworkable in post-war Japan. Toyota soon discovered that factory workers had far more to contribute than just muscle power. This discovery probably originated in the Quality Circle movement. Ishikawa, Deming, and Juran all made major contributions to the quality movement. It culminated in team development and cellular manufacturing.

Another key discovery involved product variety. Shingo, at Ohno's suggestion, went to work on the setup and changeover problem. Reducing setups to minutes and seconds allowed small batches and an almost continuous flow like the original Ford concept.

All of this took place between about 1949 and 1975. To some extent it spread to other Japanese companies. When the productivity and quality gains became evident to the outside world, American executives traveled to Japan to study it. They brought back, mostly, the superficial aspects like kanban cards and quality circles. Most early attempts to emulate Toyota failed because they were not integrated into a complete system and because few understood the underlying principles [1].

#### *2.2.4 World Class Manufacturing*

By the 1980's some American manufacturers, such as Omark Industries, General Electric and Kawasaki were successful with this method. Consultants took up the campaign and acronyms sprouted like weeds: World Class Manufacturing (WCM), Stockless Production, Continuous Flow Manufacturing (CFM), and many other names all referred to systems that were, essentially, Just In Time Production.

#### *2.2.5 Lean Manufacturing*

Liker and Wu [6] define “lean” as “a philosophy of manufacturing that focuses on delivering the highest-quality product at the lowest cost and on time. It is a system of production that also takes a value stream focus. The ‘value stream’ consists of all the steps in the process needed to convert raw material into the product the customer desires.”

Although lean manufacturing has its origins in the automobile manufacturing sector, other industries have adopted the practices to improve their own operations. Womack and Jones [7] offer several case studies of firms making radically different products, including stretch-wrapping machines, wire management systems and power

protection devices, and aircraft engines, among others. Liker [8] reports improvements for a tannery, a maker of sealing components, a scientific products company, a maker of outdoor cedar products (including birdhouses), a manufacturer of seismic exploration equipment, and companies in the automobile supply chain.

In the late 1980s, the International Motor Vehicle Program (IMVP) at the Massachusetts Institute of Technology (MIT) studied automobile manufacturers and compared the United States, Europe, and Japan, to learn the source of the Japanese advantage. The book that was published from this project, *The Machine that Changed the World*, [9] introduced the term “lean manufacturing” to the United States. The authors argued that rather than one or another particular cultural factor, process improvement, or organizational technique being responsible for Japan’s success, it was the manufacturing system as a whole. They found that a comprehensive system based on, among other things, maintaining minimal inventories and very high quality, was the basis for the success of the Japanese manufacturers, particularly Toyota. There are many overlaps with the total quality management (TQM) system, although the authors never mention this (Babson, 1995).

Indeed, a number of books written prior to the work of Womack and his associates addressed many of the same concepts. Ohno wrote *Toyota Production System: Beyond Large-Scale Production* in 1978 [10], Shingo’s *A Study of the Toyota Production System from an Industrial Engineering Viewpoint* was first translated into English in 1981, Monden wrote *Toyota Production System* in 1983, Goldratt and Cox published the first edition of *The Goal* in 1984, Schonberger penned *World Class Manufacturing* in 1986, and Suzaki wrote *The New Manufacturing Challenge* in 1987 [11].

However, *The Machine that Changed the World* [9] was an enormously popular book with managers and was a tremendous sales document for the lean manufacturing system. A second book by two of the same authors, Womack and Jones, *Lean*

Thinking [7], has offered another take on lean manufacturing, and provides examples of companies outside the automobile sector that had successfully adopted the system.

More recently, two books – Running Today's Factory (1999) by Charles Standard and Dale Davis and The Toyota Way [8] by Jeffery Liker – have provided a more clear description of Lean Manufacturing Principles and how to apply them.

A research work carried out on “Analysis of Apparel Production Systems to Support Quick Response Replenishment” by Russel E. King (Team Leader), Thom J. Hodgson (NCSU Engineering); Trevor Little, Carol Carrere (NCSU Textiles); Michelle Benjamin, Tim Currin (Textile Clothing Technology Corporation). The goal of this project was to determine the structure and operational policies of apparel supply systems to best support rapid replenishment to retail in order to maximize performance and productivity.

A paper named “An Integrated Methodology for More Effective Setup Reduction” was presented at the IIE Solutions 2001 conference organized by the Institute of Industrial Engineers, in Dallas, TX (21-23 May 2001). This paper describes how setup time is being reduced when different types of IE Techniques and SMED are combined together.

## CHAPTER THREE

### LEAN TOOLS AND TECHNIQUES

#### 3.1 Introduction

In order for local manufacturers to meet the challenges of competition in an expanded market place, they need to be equipped with the tools to make their operations more efficient. The continued progress of any enterprise largely depends on its ability to optimally and judiciously allocate and utilize its resources so as to provide desired products and / or services at the right time, place, price, quality and quantity to the community. Several lean tools provide the system to gain all the business benefits from three main business functions finance, production and marketing.

#### 3.2 Lean Manufacturing

Lean manufacturing is a whole-systems approach that creates a culture in which everyone in the organization continuously improves processes and production. It is a system focused on and driven by customers, both internal and external.

Lean manufacturing isn't just the latest industry buzzword or quick-fix alternative. Increasing competition demands a continuous focus on minimal costs, maximum customer options, fast delivery, and high-quality products and services. Today's manufacturers must be innovative while focusing on waste reduction, improved lead-time, maximized flexibility, and upgraded quality. Lean manufacturing concepts are proven strategies to help manufacturers obtain these attributes.

National Institute of Standards and Technology Manufacturing Extension Partnership (NIST-MEP) Lean Network defined Lean Manufacturing [12] as:

"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."

It is also known as continuous flow, or synchronous flow manufacturing, one piece or piece part flow manufacturing, just-in-time manufacturing, demand flow technology, world class manufacturing, or Toyota Production System [13].

A systematic method to continually improve the manufacturing operation at little capital expense by involving all employees in solving problems, eliminating wasteful costs, reducing lead times, and improving quality [9].

It is the systematic elimination of waste from all aspects of an organization's operations, including customer relations, product design, production management, services, and supplier networks where waste is viewed as any use or loss of resources that does not lead directly to creating the product or service a customer wants when they want it.

In the volume, *Lean Thinking* [7], James P. Womack and Daniel T. Jones distilled these lean principles to five:

- Specify the value desired by the customer.
- Identify the value stream for each product providing that value and challenge all of the wasted steps currently necessary to provide it.
- Make the product flow continuously through the remaining, value-added steps.
- Introduce pull between all steps where continuous flow is possible.
- Manage toward perfection so that the number of steps and the amount of time and information needed to serve the customer continually falls.

### 3.2.1 *Lean Thinking*

#### Eliminating Waste with the Goal of Creating Value

- Customer-focused: Customer needs and expectations “pull” enterprise activities
- Knowledge-driven: Draws upon knowledge and innovation from everyone - workers, suppliers

- Eliminating waste: Stresses elimination, not just reduction, of all types of waste
- Creating value: Puts premium on “growing the pie”, not just reducing costs, to benefit all stakeholders
- Dynamic and continuous: Pursues on-going systemic as well as incremental improvement - both innovation and continual improvement

In their recent article for the Harvard Business Review on Lean Consumption, Womack and Jones have set out six additional principles of what they call lean consumption that correspond closely with those of lean production.

1. Solve the customer’s problem completely by ensuring that all the goods and services work, and work together
2. Don’t waste the customer’s time
3. Provide exactly what the customer wants
4. Provide what’s wanted exactly where it’s wanted
5. Provide what’s wanted where it’s wanted exactly when it’s wanted
6. Continually aggregate solutions to reduce the customer’s time and hassle.

### 3.2.2 *Insights of Lean*

Lean provides positively-reinforcing concepts, practices and tools delivering just-in-time: **pull based production**

- Striving for perfect quality: Completely defect-free parts must flow to each subsequent process; quality designed-in, not based on inspection, mistake proofing
- Flexibility and responsiveness: Small processing sizes and quick set-up times; ability to respond to shifts in demand
- Trust-based relationships: Mutual commitments and obligations, internally and externally with suppliers
- Continuous improvement Kaizen: Continuous improvement through work standardization, productive maintenance, root cause analysis, and worker training and empowerment [14].

### *3.2.3 Objective of the Lean manufacturing*

- Primary focus is the elimination of waste
- The goal is to build the highest quality product at the most competitive cost in the shortest possible time
- The philosophy is that quality should be ensured in the production process itself so that defects are not passed on or overlooked
- The approach is to create simple rules that make it very easy for people on the shop floor to follow
- One plan for improvement
- Top management involvement

### *3.2.4 Lean Manufacturing Characteristics*

Customer, simplicity, visibility, regularity, synchronization, prevention, improvement, partnership, variation, participation, made to order, single piece production, just in time supplies, pull scheduling, short cycle times, highly flexible equipment, highly flexible and responsive processes, quick changeovers, continuous flow (work balancing, cells), high first-pass yields, significantly less waste and defects, collocated equipment, tools, people, compressed space, multi-skilled employees [15].

## **3.3 Value Stream Mapping**

A value stream is all the actions (both value and non-value added) required to bring a product, or group of products that use many of the same resources in much the same way, through the main flow essential to every product – from raw material to the arms of the customer. VSM is a pencil and paper visualization tool that shows the flow of material and information as a product makes its way through the value stream [16] serves as a starting point to help management, engineers, suppliers, and customers recognize waste and its sources. Value stream mapping is done in two steps.

The first step is to draw the current state value stream map to take a snapshot of how things are being done now, and the second step is to draw the future state map to show how things ought to be done. Value stream mapping provides both a picture of the current state of affairs as well as a vision of how we would like to see things work. Identifying the differences in the current and future states yields a roadmap for improvement activities.

The value stream is the set of all the specific actions required to bring a specific product through the critical management tasks of any business: the problem-solving task running from concept through detailed design and engineering to production launch, the information management task running from order-taking through detailed scheduling to delivery, and the physical transformation task proceeding from raw materials to a finished product in the hands of the customer [17]. Identifying the entire value stream for each product is the next step in lean thinking, a step which firms have rarely attempted but which almost always exposes enormous, indeed staggering, amounts of waste [18].

- A means of understanding where we are adding value and how to do so more effectively.
- A paper and pencil tool to help us visualize and understand the flow of material and information as a product or customer makes its way through the system.

### *3.3.1 Importance of VSM*

Value stream mapping helps to –

- Visualize the whole process
- See the sources of waste
- Provides a common language for improvement
- Makes decisions about flow apparent
- Ties together lean techniques

- Forms the basis of an improvement plan
- Shows linkage between information and material flows

### 3.3.2 *Takt Time*

Takt time is a German word meaning meter or rhythm. It dictates the rate of production or units per hour. It is a calculation based on customer demand and available productive time. If every operation and sub operation works at the same rate as customer requirement, then there can be no excess WIP.

## 3.4 5S

Based on Japanese words that begin with ‘S’, the 5 S Philosophy focuses on effective work place organization and standardized work procedures. 5 S simplifies work environment, reduces waste and non – value activity while improving quality efficiency and safety.

5S is a powerful method to create stability and repeatability (often called “industrial housekeeping”).

1) Seiri – put things in order / remove what is not needed and keep what is needed (Sort out)

2) Seiton – proper arrangement/ place things in such a way that they can be easily reached whenever they are needed (Set in order/ Systematize)

3) Seiso – clean / keep things clean and polished; no trash or dirt in the workplace (Sweep, scrub, shine)

4) Seiketsu – purity / maintain cleanliness after cleaning – perpetual cleaning (Standardize)

5) Shitsuke – commitment/ actually it is not a part of ‘4S’, but a typical teaching and attitude towards any undertaking to inspire pride and adherence to standards established for the four components (Sustain)

### 3.4.1 1<sup>st</sup> S –Sort Out

Remove all items from the workplace that are not needed for current production or tasks. An effective visual method to identify these unneeded items is called red tagging.

It looks for:

- Broken or deteriorated items, dusty items, items with no clear location, items loose in drawers, outdated signs and notices, unused management boards, outdated posters and slogans, returned goods, scrap, over-runs, jobs that have been sitting for a long time
- Items that are rarely used.
- Items with a quantity on hand much larger than will soon are used.

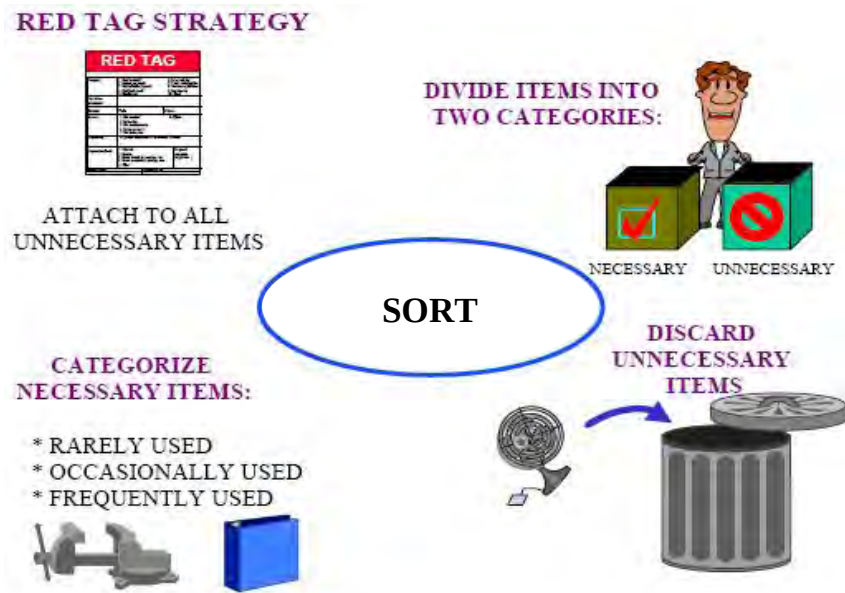


Figure 3.1 Sorting the necessary items

### 3.4.2 2<sup>nd</sup> S –Set In Order

It focuses on efficient and effective storage methods. Ensures what is needed for a job is in place and easy to find, use, and put back, and find ways to prevent the need for future cleaning.

How can equipment and materials be rearranged for:

Less walking, less crowding, less bending, climbing, stretching, reaching, less searching, less obstacles to flow

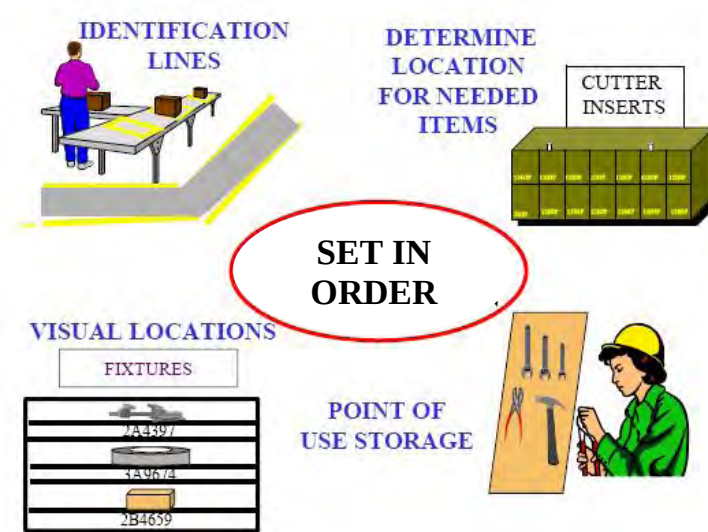


Figure 3.2 Set in Order

### 3.4.3 3<sup>rd</sup> S –Shine, Scrub, Sweep, Straighten, Safety

Cleanliness: get the areas looking clean and new.

#### 3<sup>rd</sup> S Mess

- Clutter spreads like the flu! From one cluttered area an epidemic soon results.
- Maintaining the standard is for everybody, everyday.
- Set locations make clutter and foreign material clear at a glance.

#### 3<sup>rd</sup> S “Straighten” for Setup

- Clean and ordered tool crib eliminates frustration or searching for tools

#### 3<sup>rd</sup> S for Setup

- Preparing for set-up can take extra time if tools are not easily located.
- Sometimes it's faster to get (or make) a new tool.
- Customer doesn't want to pay for this waste.

#### 3.4.4 4<sup>th</sup> S –Standardize

Creating a consistent way of implementing the tasks performed daily, including Sort, Set in order, and Shine.

#### 3.4.5 5<sup>th</sup> S –Sustain

This takes discipline on everyone's part. Sustain, make it a habit to follow the procedures. The goal of this tool is stability and repeatability



Figure 3.3 Sustain

#### 3.4.6 The necessity of 5S

5s is the prime urgency to implement lean for the following reasons –

- To eliminate the need to work around, walk around and trip over obstacles that aren't needed in our jobs.
- To shorten steps and reaching.
- To eliminate bending or stretching
- To create a safer work environment.

- To reduce errors caused by excess tools and material.
- To eliminate searching for tools and jigs
- To organize all needed items for “stress-less” use.
- To reduce “crowding.”
- To enable better organization of the items we do need to do our jobs
- To reduce the total number things we need to keep track of.

### 3.5 Focus on Waste

Waste is anything other than the minimum amount of equipment, materials, parts, space, and worker’s time which are absolutely essential to add value to the product. - Shoichiro Toyota, President, Toyota

Need to include: **Energy Waste, Resource Waste, Process Waste and Solid Waste**



Figure 3.4 Different Wastes in Manufacturing

#### 3.5.1 Main types of waste

The main wastes are – Overproduction, Waiting, Inventory or Work in Process (WIP), Processing waste, Transportation, Motion, Making defective products, Underutilizing people, Lack of system discipline, and Limited IT resources.

Nearly every waste in the production process can fit into at least one of these categories. 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.

### **3.6 Push System**

In a push system, the demand (often forecast because the lead times are so long) is converted to a schedule for each operation. The material is released to the first operation, as dictated by the schedule, and it is progressed ("pushed") through the subsequent operations.

### **3.7 Pull System**

In a pull system, the demand (often customer demand as lead times are usually short) is the production schedule of the last operation. This operation asks the previous operation for work only when it needs it to fulfill the customer demand. The previous operation then asks the one before it and so on. The fundamental rule is that material is only worked on if the customer demands it. In this way material is "pulled" through the previous operations [19].

### **3.8 Kanban**

Kanban is the Japanese word for card or signal. In terms of card, a kanban is used to make issues like inventory status, parts location and production status more visible. In terms of signal, a kanban authorizes the previous stage of production to make more parts.

A kanban uses a designated workspace between operations to balance supply with demand. It means a visible record. Kanban triggers mechanism to make or move material. The result is that kanbans create a simple to operate, visible control system that offers the opportunity to delegate routine material control transactions to the shop floor. It is simple and inexpensive. It sets priority, limits inventory, and exposes problems [4].

### 3.9 Kaizen

Kaizen is a Japanese hybrid word. “Kai” means change and “Zen” means good (for the better). Basically kaizen is for small incremental improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. It needs no or little investment. The principle behind is that “a very large number of small improvements are more effective in an organizational environment than a few improvements of large value.

### 3.10 TPS

The T also stands for “Thinking”. An environment where people have to think brings with it wisdom, and this wisdom brings with it *kaizen* (continuous improvement), Perhaps the greatest strength of the Toyota Production System is the way it develops people. The Toyota Production System should actually be called the Thinking Production System [18].

### 3.11 Quick Changeover

Tool changeover is the time between the last good part from one series and the first good part of the next series. Quick changeover means the reduced time to get the new quality product after changing the setup as early as possible. It has two points to be noted – the internal operations (operations that can only be performed with the machine at a standstill) and external operations (operations that can only be performed with the machine running)

#### 3.11.1 Advantage of set – up reduction

Reduction of change – over costs, production of smaller lot sizes combined with an increased number of change over, Trial – runs are minimized, urgent orders can be quickly produced, improved productivity (increased efficiency, less waste, less machine defects), set – up becomes easy, reduction of intermediate inventory, improved flexibility, reduced work in progress.

### **3.12 Total Productive Maintenance (TPM)**

TPM is a scientific company – wide approach in which every employee at every level in the organization is concerned about the maintenance, the quality and efficiency of their equipment.

A comprehensive system for reducing breakdowns and improving quality – by involving all employees in the elimination of waste of time and resources caused by production equipment [20].

### **3.13 POKA YOKE**

Yokeru (avoid) Poka (mistake)

Applying mistake proofing concepts to process or product improvements allow you to take a proactive approach to eliminating errors at their source before they become defects. Sorts "Good" from "Bad" practices / services, reduces problems before they are seen by customers, does not stop source of problems, does not prevent work defects, does not prevent defects from getting to the customer, feedback very slow, often non-existent

### **3.14 Lean Manufacturing Benefits**

Organized and ‘visual’ workplace, Lower space/facility requirements, Improved use of floor space, Allows more strategic management focus, Improved knowledge retention, New employees fit in more quickly with less training, Cross-trained employees, Flexible work cells with flexible people, Small batch operations more cost effective, Productivity / Capacity increase, Inventory reduction, Cost reduction, Improved efficiency, Improved communication, Improved profit margins, Improved customer relations, Quality improvement, Improved vendor support and quality, Higher labor efficiency and quality, Reduced scrap and waste, Reduced cycle time, Reduced obsolescence, High quality and reliability, Lower overall costs, Self-directed work teams, Lead time reduction, Fast market response, Longer machine life, Improved flexibility in reacting to changes, Increased shipping and billing frequencies [21]

## **CHAPTER FOUR**

### **PROBLEM AREA**

#### **4.1 Introduction**

A shift is occurring in manufacturing around the world. Manufacturers throughout industries from automotive to aircraft to paint to computers to furniture and on and on are moving to a different system of production called Lean Manufacturing. We are not talking about adding some new techniques onto how we now build products, but actually changing the way we think about manufacturing. The ready-made garments (RMG) industry – the country’s foremost export sector – has experienced impressive success and growth in recent years. It is important to keep in mind – is the fact that RMG is not a skill – intensive sector and it has little or no learning effect. Excessive reliance on RMG exports may consequently depress the demand for skills and by extension, the demand for education. There is the potential danger that over – dependence on the RMG sector may trap the economy in a “low – skill, low – value added equilibrium”, undermining future efforts to reduce poverty. But for the improvement and sustainability in the present situation modern manufacturing techniques and technological advancement must be added in the system.

#### **4.2 Company Profile**

The selected ready made garment industry is the Urmi Garments Ltd. The company started its business in the year 1985. It is located at (Head Office and Factory) 235/B, Tejgaon Industrial Area, Dhaka, Bangladesh. It has a multistoried building with different construction – like one part is 4<sup>th</sup> storied and another part is 8<sup>th</sup> storied. Now it has raised its business in other section (knit) of RMG and trying to be the composite knit manufacturer in the recent future.

The Urmi Group member units are:

- 1) Urmi Garments Ltd. – Knit Garments Manufacturer
- 2) Attires Manufacturing Company Ltd. – Knit Garments Manufacturer
- 3) Fakhruddin Textile Mills Ltd. – Knit fabric Manufacturer

**The main products are:**

Men's, Ladies, Boy's, Girls and Infant – Polo Shirt, T-Shirt, Tank Tops, Shorts, Trouser, Fleece Jacket, Vest etc.

**The Main Customers:**

U.K. : Regatta, Empire Store, The Out Door group  
 France : La-Redoute, Vertbaudet, Etam, Umbro, Movitex  
 Germany : Tchibo, Aldee, Jebsen & Jessen, S'Oliver, Heusel  
 Belgium : Hanes, Wilford.  
 Spain : Losan  
 Sweden : Ellos

**Manpower of Urmi and Attires:**

|                           |                |
|---------------------------|----------------|
| Merchandising dept        | : 09           |
| Sewing dept               | : 650          |
| Pattern and Sampling dept | : 17           |
| Cutting dept              | : 90           |
| Quality dept              | : 135          |
| Finishing dept            | : 120          |
| Commercial dept           | : 10           |
| Administration dept       | : 25           |
| Social compliance dept    | : 5            |
| Accounts dept             | : 10           |
| Floor Space               | : 76,000 Sq Ft |

**Sewing Line:**

Total Line at present – 20

|                     |            |
|---------------------|------------|
| Polo Shirt          | : 4 in no. |
| T-Shirt + Tank Tops | : 8 in no. |
| Fleece Jacket       | : 4 in no. |

**Production Capacity:**

|                        |                     |
|------------------------|---------------------|
| Pique Polo Shirt       | : 5000 Pcs per day  |
| T-Shirt + Tank Tops    | : 14000 Pcs per day |
| Fleece Shirts + Jacket | : 3500 Pcs per day. |

**Machineries of Urmi and Attires:**

Plain Machine with and without Auto Trimmer, Double Needle, Over Lock (4 Thread / 5 Thread), Flat Lock (Flat Bed, Cylinder Bed), Button Hole (Auto), Button stitched (Auto), Bar tack, Pecoating Machine, Lettuce Machine, Back tape Machine, Rib Cutting Machine, Layer end Cutter Machine, Fabric Cutting Machine, Vacuum Table, Steam Iron Boiler (Capacity-4000 kg) are supplier named Juki, Pegasus, Siruba, Brother, Kansai, Idel, Tsm, East man, Noamoto, Uzo, KM, Modern of different countries like Japan, Thailand, USA, Taiwan, Bangladesh

**Special Equipment:**

The special equipments are –

Conveyor Type metal Detector (Lock - U.K.), Conveyor Fusing Machine (Hashima – U.K.), Spot Lifting Machine with (Netmac – Italy), Compressor and Air Dryer (Fini – Italy), Lectra Cad System (Lectra – France), Fabric Inspection Machine (UZU – Thailand), Standby Generator (500 KW) (Petbow - U.K.) Color Shade Matching Cabinet (Verivide - U.K.) Washing Machine (Sharp – Japan), 9 Color 20Head (Haina - China)

**4.3 Company Facilities**

Urmi Group has the following facilities for smooth operation –

Stand by Generator to run the full factory, fire protection system, sufficient volume of water reservoir at underground and overhead, Quality electrical cable with circuit breakers, Separate toilets for male and female workers, Sufficient ventilation is provided by installing ceiling fans, exhaust fans, large windows, Factory premises is always kept neat and clean, It does not have any child labor, Doctor and Nurse are

provided to take care of workers health, Canteen for workers, Day care center, Work study center

#### **4.4 Present Status**

The company is a rising manufacturing industry. From the very beginning it is doing its business very smoothly and it is expanding in a rapid space. It has a new unit with textile, dyeing and sewing in Sreepur, Gazipur. According to its business volume it may be categorized in the mid level industry in our country.

It is developing its internal system with the standard mechanism. Now it is not implementing lean manufacturing tools and techniques. It has some difficulties and chance of improvements in every section to be the front line manufacturer in the country.

##### *4.4.1 Problem found*

The main area to implement lean is in the fabric store, cutting, sewing and inventory. The other sections are not taken under consideration because of limited scope. There are some strong rules and regulations inside the working floor. It is very hard to change the established working process in a single day and conveyance the people in a very short period. So the study reveals some problems and suggested some solutions which may lead to the benefit for the company but to implement these lean tools and techniques need a systemize working process and a great deal of high level management involvement with a team based learning process that will find and implement new technologies in different manufacturing sections with the support and eagerness of working people to be the best in business.

#### **4.5 Store**

Store receives the fabric from the supplier (FTML), which is its own group member unit. Here the fabric is in housed by the merchandiser booking reference according to the buyer, style, colour, GSM, shipment priority. Fabric is checked after receiving in the store before sending to the cutting section which is not up to date.

Fabric store is in a complex situation because there is no enough shelf to keep all the in coming fabric according to the production requirement. It is not maintaining 5S in case of storing the fabric. It is not clean enough, furnished enough and equipped enough for a good inventory system. It is keeping fabric with a grouping (A, B, C etc) by the store officer on the challan sheet which is cumbersome for finding out from the storing space when it is needed.

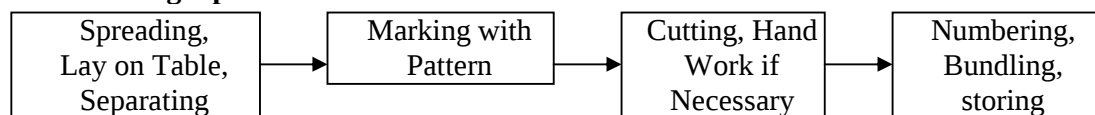
The store record keeping is not up to date. The studied style with which research is done found a big fabric missing. Cutting received from store about 13,648 kg (fabric) and 879 (Rib) while store computer show 10, 904 kg and 724 kg.

The system may be standardized with new inspection machineries and space to check at the time of fabric arrival to make the immediate delivery to the cutting where it needs now two days or more prior notice to sending to the cutting section. Another process may be implied is that the fabric checking or inspection may be done in the knitting unit (FTML) which can save the transport and time waste for the company.

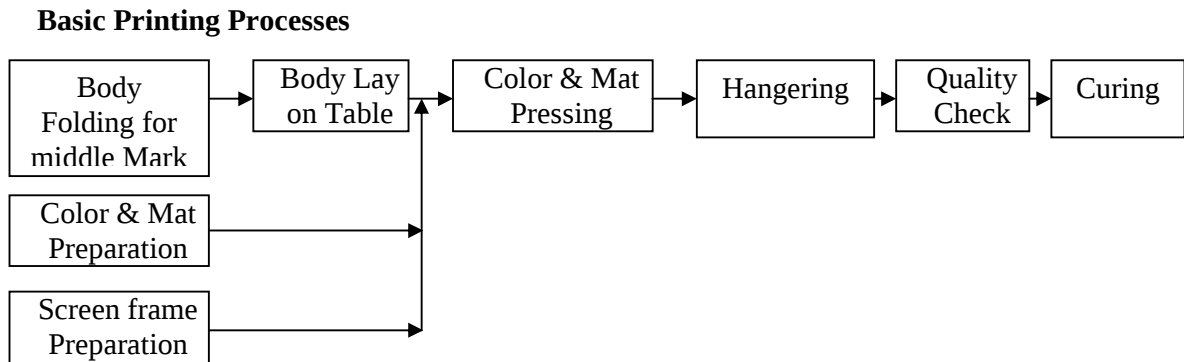
#### 4.6 Cutting Section

Cutting is running to its capacity but it is always keeping an inventory. If the standard procedure and proper planning is applied the cutting inventory will be very less. Some times it is cutting much before the sewing input schedule for some unavoidable reasons like fabric fault (found at the time of delivery from store to cutting), unavailability, and change of schedule.

##### Basic Cutting Operation



CAD department is not providing all the patterns for cutting because of manpower shortage and the system is not functioning to its full space.



Printing is performed in another factory but it is done under cutting responsibility. The cut pieces are sent from cutting section and returned to cutting after processing.

#### 4.7 Sewing Section

Sewing is working at its own motion and pre standard setting. The floor layout needs to further checking because it does not have enough spacing between lines and the starting and ending of a long line is in the middle of it for making it in two lines. The first and foremost observed matter is that everybody is not working with his / her own speed or skill. They had no hurry or it may be said lack of motivation to the positive working speed. Same operation is done by two workers with two timings that are very different. The skill level may be not the same but will be closer to one other. The helper is more than the requirement. Line balance is not proper and layout is not finalized before the production running. It was changed several times. All accessories (label) were not available prior to the start of production. So there was lot of inventory in the side of sewing line. Surplus worker was assigned in different operations in different times. They were doing any kind of job without planning or layout sequence. They were gossiping, making the line populated, and making worker lazy and demoralizing to their sharing mentality and speed of work. Setting of target is not proper. It is done in a way that the actual line condition, worker capacity / capability / skill and motivation are not perfect for the fixed target. So the production report is not perfect. It is calculated one and do not show the actual production output.

#### **4.8 Inventory**

Finished goods inventory is keeping on the ground floor and sometimes on the sewing or finishing floor. So to keep the inventory less planning should be maintained properly and the production unit must have the enough capability to running with the planned schedule. In line inventory and finished goods or cartoon in sewing floor hamper the production, working environment, lessen the working space and finally de-motivate the worker to utilize their maximum effort. The working people must consider the facts behind this miss happening and proper importance should be given to the problem identification and root cause analysis. Management of all levels should give consideration to maintain the planning accurately or properly.

## **CHAPTER FIVE**

### **DATA ANALYSIS AND FINDINGS**

#### **5.1 Introduction**

The garment industry is an example of discrete assembly type manufacturing system with no stock before order processing. It is highly labour oriented industry with different kinds of problem in different section. This chapter includes the analysis of collected data from the various departments for the calculation of current state value stream mapping and finding out the scope of improvement to draw the future state value stream mapping. Data is collected walking through the departments and following the target piece of garment. Here the data is relevant for only the selected industry and the specific style where the process may vary for different style and buyer.

#### **5.2 The common problems Identified**

The larger lead time is a great problem. The supply of fabric was made in a small quantity basis in different phases with a larger period of time involvement on that processing so the manufacturer enjoys difficulties in material plan or scheduling. Accessories were not available. The label was collected after eight days of production running. So the uncompleted finished goods were making inventory beside the sewing line. The change over time was larger. The problem with the machine was big at the starting. Maintenance people were taking time to solve the problem. There is no preventive maintenance schedule. The storing spaces and the floor production spaces are not enough, the midway is not sufficient. There was random stocking policy in finishing section and sewing floor. The supervision is poor and the motivation is not functioning properly. On job training is not found. The lack of multi skill operator is visible. The production record system is no accurate; flow of production in the line is slow. In line inventory is very common and they are not taking it as a serious matter. Cutting and sewing efficiencies are considerably low because of poor skill, poor maintenance, poor method and lack of proper incentive

plan. Line balancing is done after several days' observation but it could be done earlier. MIS and hourly production report is not up to date and available for all.

### **5.3 Causes of Office Waste**

Departments (Functional Organization), too many controls and approvals (six challan copies to send materials outside for subcontract purposes), outdated process design, no back-up or cross-training, unbalanced workload, disorganized workplace without visual controls, obsolete or poorly designed forms for reporting, changing management priorities, no updated data records for every section, MIS report with all section related to the business.

### **5.4 Common Barriers to Flow**

Too many hand offs, fluctuations / variations in work requirements (job size, complexity, due dates), fluctuations in pace of work, waiting for decisions / approvals and accessories, early production, long queues, interruptions, rework, in line WIP, worker inefficiency and motivation to work

### **5.5 The Problem behind Larger Lead Time**

The current state value stream mapping needs to follow the material and information flow of selected product. This is done from the very beginning of the value chain. The material is taken under consideration after reaching in factory premises. Then the following tables show their flow and the VSM data table shows the listing of activities happened on the product to make it as a finished according to the buyer's specification.

Table 5.1 Fabric received in Store

| Date     | Challan No.     | Batch No.        | S/J (GSM 140) |         | Rib (GSM 230) |         |
|----------|-----------------|------------------|---------------|---------|---------------|---------|
|          |                 |                  | Received      | Balance | Received      | Balance |
| 21/08/07 | 18077/<br>18076 | 2767 /<br>2728 B | 1224          | 11706   | 35            | 596     |
| 24/08/07 | 18079           | 2767             | 0             | 11706   | 84            | 512     |
| 30/08/07 | 18192           | 2791             | 0             | 11706   | 44            | 468     |
| 04/09/07 | 18213           | 2957             | 402           | 11304   | 30            | 438     |
| 05/09/07 | 18216           | 2855             | 633           | 10671   | 0             | 438     |
| 24/09/07 | 18510           | 2728 A           | 0             | 10671   | 43            | 395     |
| 25/09/07 | 18472           | 2791             | 668           | 10003   | 0             | 395     |
| 26/09/07 | 18516           | 2847             | 628           | 9375    | 43            | 352     |
| 28/09/07 | 18523           | 2741             | 613           | 8762    | 0             | 352     |
| 28/09/07 | 18523           | 2842             | 622           | 8140    | 39            | 313     |
| 29/09/07 | 18530           | 2941             | 653           | 7487    | 42            | 271     |
| 01/10/07 | 18500           | 2806             | 627           | 6860    | 0             | 271     |
| 02/10/07 | 18752/18754     | 2806             | 637           | 6223    | 82            | 189     |
| 04/10/07 | 18765           | 2853             | 628           | 5595    | 42            | 147     |
| 05/10/07 | 18768           | 2792             | 597           | 4998    | 40            | 107     |
| 06/10/07 | 18770           | 2892             | 630           | 4368    | 44            | 63      |
| 06/10/07 | 18770           | 2942             | 384           | 3984    | 30            | 33      |
| 06/10/07 | 18770           | 2819             | 628           | 3356    | 42            | -9      |
| 07/10/07 | 18773           | 2802             | 633           | 2723    | 38            | -47     |
| 31/10/07 | 19068           | 3909             | 697           |         | 46            | -93     |
|          |                 |                  | <b>10904</b>  |         | <b>724</b>    |         |

The fabric requisition was made at 25/07/07 and received the first quantity at 21/08/07. This means the time required is about 27 working days. So this may be improved in a shorter period. The knitting is company's own unit so they may arrange it shorter lead time. If the factory can confirm the lead time for fabric delivery it is quite easy to reduce the inventory and make the use of resources optimized. The ordering process will get a basic idea that how long before they must order or for the execution of an order what will be their time consideration in respect of shipment lead time. If we want to reduce the production lead time we need to be concerned about the production process, production time, order processing, documentation and other required data processing and communication.

Table 5.2 Fabric transport from Store to Cutting

| Date                          | Batch no.    | No. of Roll | Fabric (KG)  | PO | Rib        | No. of Roll | Date     |
|-------------------------------|--------------|-------------|--------------|----|------------|-------------|----------|
| 29/08/07                      | 2674         | 19          | 641          | 25 | 43         | 1           | 01/09/07 |
| 05/09/07                      | 2957         | 20          | 393          | "  | 30         | 1           | 05/09/07 |
| 07/09/07                      | 2715         | 20          | 605          | "  | 44         | 1           | 07/09/07 |
| 15/09/07                      | 2767         | 18          | 598          | "  | 48         | 2           | 25/09/07 |
| 19/09/07                      | 2728 B       | 18          | 584          | "  | 32         |             | 25/09/07 |
| 21/09/07                      | 2728 A       | 06          | 205          | "  | -          |             | -        |
|                               | <b>Total</b> | <b>101</b>  | <b>3026</b>  |    | <b>197</b> | <b>5</b>    |          |
| 23/09/07                      | 2728 A       | 15          | 453          | 26 | 46         | 2           | 27/09/07 |
| 25/09/07                      | 2711         | 25          | 643          | "  | 43         | 2           | 27/09/07 |
| 26/09/07                      | 2791         | 18          | 672          | "  | 45         | 2           | 27/09/07 |
| 27/09/07                      | 2847         | 22          | 657          | "  | 43         | 1           | 27/09/07 |
| 29/09/07                      | 2741         | 33          | 625          | "  | 42         | 1           | 02/10/07 |
| 30/09/07                      | 2842         | 26          | 650          | "  | 40         | 1           | 02/10/07 |
| 03/10/07                      | 2818         | 20          | 654          | "  | 45         | 1           | 06/10/07 |
| 03/10/07                      | 2855 / 2630  | 24          | 693          | "  | 44         | 1           | 06/10/07 |
| 06/10/07                      | 2792         | 17          | 602          | "  | 40         | 2           | 06/10/07 |
| 07/10/07                      | 2883         | 26          | 617          | "  | 41         | 2           | 07/10/07 |
|                               | <b>Total</b> | <b>226</b>  | <b>6266</b>  |    | <b>429</b> | <b>15</b>   | -        |
| 08/10/07                      | 2892         | 19          | 594          | 27 | 38         | 2           | 08/10/07 |
| 10/10/07                      | 2942         | 18          | 470          | "  | 28         | 1           | 10/10/07 |
| 10/10/07                      | 2819         | 22          | 663          | "  | 33         | 1           | 10/10/07 |
| 20/10/07                      | 2853         | 20          | 628          | "  | 42         | 1           | 20/10/07 |
| 23/10/07                      | 2806         | 19          | 630          | "  | 28         | 1           | 23/10/07 |
| 24/10/07                      | 2802         | 18          | 670          | "  | 38         | 1           | 24/10/07 |
| 01/11/07                      | 3909         | 22          | 701          | "  | 46         | 2           | 05/11/07 |
| 03/11/07                      | 3909         | 5           |              |    |            |             |          |
|                               | <b>Total</b> | <b>143</b>  | <b>4356</b>  |    | <b>253</b> | <b>9</b>    |          |
| <b>Total (25 +26 +27/T07)</b> |              |             | <b>13648</b> |    | <b>879</b> |             |          |

In store the fabric was received at 21/08/07 and sent to cutting at 29.08.07, so there is one week delay. In lean system this is unnecessary to make the material waiting without any reason.

This delay contributes to the larger production lead time and the process occupies the resources for longer period of time. The store has to keep inventory for long which can be reduced with proper planning and capacity building. Thus the space utilization can be increased and improved which is one of the goals of resource utilization.

Table 5.3 Cutting production report

| Serial | Date     | Order  | Cut No. | No. of Lay | Batch  | Cut |
|--------|----------|--------|---------|------------|--------|-----|
| 01     | 31/08/07 | 25/T07 | 1       | 100        | 2674   | 300 |
| 02     | 03/09/07 | "      | 2       | 100        | "      | 600 |
| 03     |          | "      | 3       | 100        | "      | 600 |
| 04     |          | "      | 4       | 100        | "      | 600 |
| 05     | 04/09/07 | "      | 5       | 100        | "      | 600 |
| 06     | 05/09/07 | "      | 6       | 73         | "      | 438 |
|        |          | "      | 7       | 100        | "      | 600 |
|        |          | "      | 8       | 101        | 2957   | 606 |
| 07     | 07/09/07 | "      | 9       | 67         | "      | 402 |
|        |          | "      | 10      | 65         | "      | 413 |
| 08     | 08/09/07 | "      | 11      | 99         | 2715   | 594 |
| 09     |          | "      | 12      | 104        | "      | 624 |
| 10     | 14/09/07 | "      | 13      | 101        | "      | 606 |
|        |          | "      | 14      | 101        | "      | 606 |
| 11     | 15/09/07 | "      | 15      | 99         | "      | 594 |
|        |          | "      | 16      | 101        | 2767   | 606 |
| 12     | 17/09/07 | "      | 17      | 104        | 2767   | 624 |
|        |          | "      | 18      | 112        | "      | 672 |
| 13     | 18/09/07 | "      | 19      | 96         | "      | 576 |
|        |          | "      | 20      | 104        | "      | 624 |
|        |          | "      | 21      | 102        | 2728 B | 612 |
|        |          | "      | 22      | 104        | "      | 624 |
| 14     | 21/09/07 | "      | 23      | 101        | 2728 B | 606 |
|        |          | "      | 24      | 103        | "      | 618 |
| 15     | 22/09/07 | "      | 25      | 100        | 2728 A | 600 |
|        |          | "      | 26      | 100        | "      | 600 |
|        |          | "      | 27      | 100        | "      | 600 |
|        |          | "      | 29      | 113        | "      | 226 |

In cutting the first cut was done at 31/08/07 at morning and it was sent to the printing that day. But sewing input was made at 24/09/07. The printing work was not so difficult that has to take so much time for the operation. The quality and shipment schedule is the main concern in the garment industry. Here the quality factor is not in the highest priority because of buyer negotiation. So this time delay should be removed and the proper scheduling, work consistency and without undue occurrences may lead to the shorter lead time.

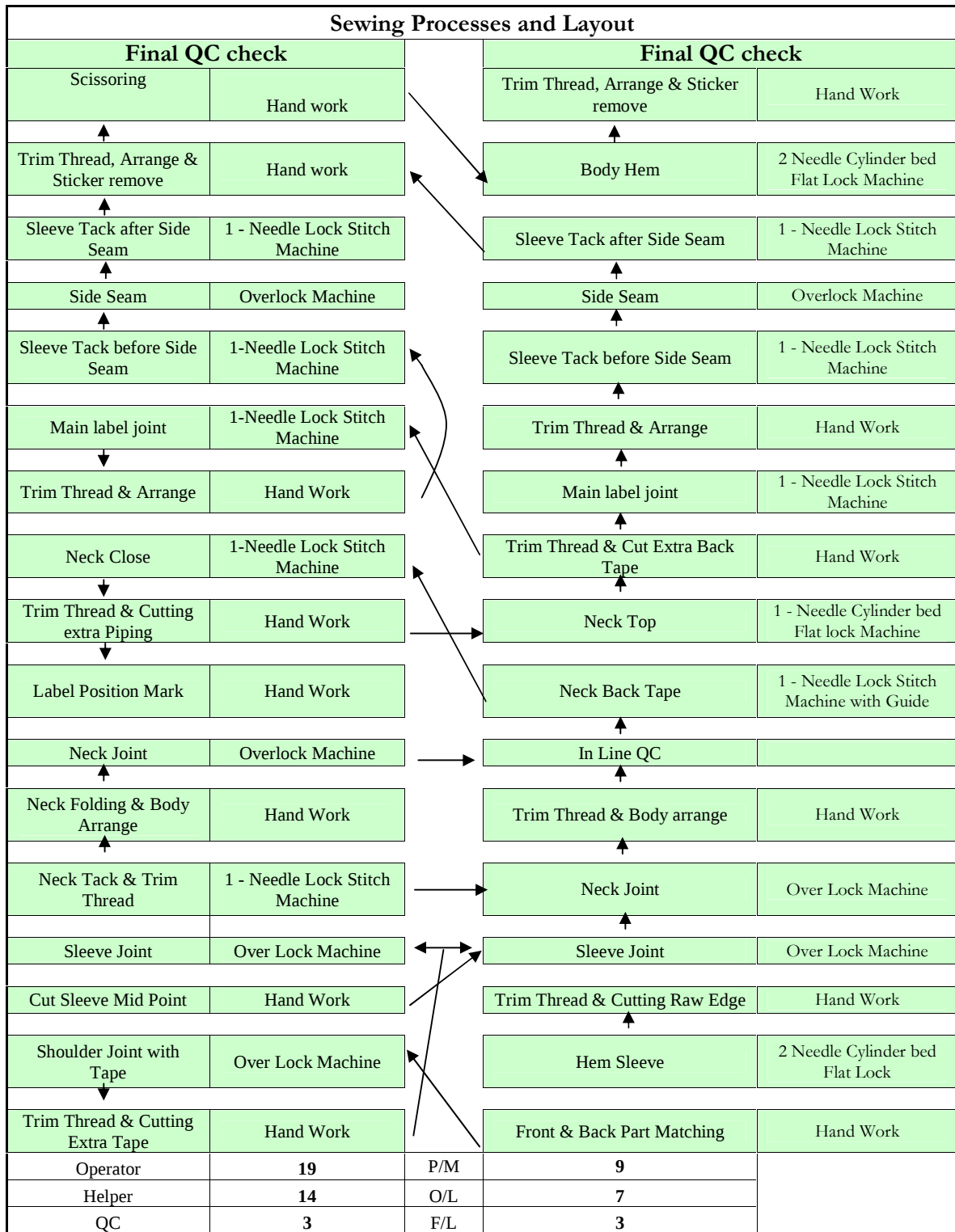


Figure 5.1 Process Layout

| Final QC check               |         | Final QC check               |            |
|------------------------------|---------|------------------------------|------------|
| Scissoring                   | HW      | TT, Arrange & Sticker remove | HW         |
| TT, Arrange & Sticker remove | HW      | Body Hem                     | 2N CB F/L  |
| Sleeve Tack after Side Seam  | 1N L/S  | Sleeve Tack after Side Seam  | 1N L/S     |
| Side Seam                    | O/L     | Side Seam                    | O/L        |
| Sleeve Tack before Side Seam | 1N L/S  | Sleeve Tack before Side Seam | 1 N L/S    |
| Main label joint             | 1N L/S  | Trim Thread & Arrange        | HW         |
| Trim Thread & Arrange        | HW      | Main label joint             | 1 N L/S    |
| Neck Close                   | 1N L/S  | TT & Cut Extra Back Tape     | HW         |
| TT & Cutting extra Piping    | HW      | Neck Top                     | 1N CB F/L  |
| Label Position Mark          | HW      | Neck Back Tape               | 1N L/S     |
| Neck Joint                   | O/L     | In Line QC                   |            |
| Neck Folding & Body Arrange  | HW      | Trim Thread & Body arrange   | HW         |
| Neck Tack & Trim Thread      | 1 N L/S | Neck Joint                   | O/ L       |
| Sleeve Joint                 | O/ L    | Sleeve Joint                 | O/L        |
| Cut Sleeve Mid Point         | HW      | TT & Cutting Raw Edge        | HW         |
| Shoulder Joint with Tape     | O/ L    | Hem Sleeve                   | 2N CB F/ L |
| TT & Cutting Extra Tape      | HW      | Front & Back Part Matching   | HW         |

Figure 5.2 Simplified Process Layout

| Final QC check               |         | Final QC check                |            |
|------------------------------|---------|-------------------------------|------------|
| Scissoring                   | HW      | TT, Arrange & Sticker remove  | HW         |
| TT, Arrange & Sticker remove | HW      | Body Hem                      | 2N CB F/L  |
| Sleeve Tack after Side Seam  | 1N L/S  | Sleeve Tack after Side Seam   | 1N L/S     |
| Side Seam                    | O/L     | Side Seam                     | O/L        |
| Sleeve Tack before Side Seam | 1N L/S  | Sleeve Tack before Side Seam  | 1 N L/S    |
| Trim Thread & Arrange        | HW      | Trim Thread & Arrange         | HW         |
| Main label joint             | 1N L/S  | Main label joint              | 1 N L/S    |
| Label Position Mark          | HW      | TT, Cut Extra Back Tape& Mark | HW         |
| TT & Cutting extra Piping    | HW      | Neck Top                      | 1N CB F/L  |
| Neck Close                   | 1N L/S  | Neck Back Tape                | 1N L/S     |
| Neck Joint                   | O/L     | In Line QC                    |            |
| Neck Folding & Body Arrange  | HW      | Trim Thread & Body arrange    | HW         |
| Neck Tack & Trim Thread      | 1 N L/S | Neck Joint                    | O/ L       |
| Sleeve Joint                 | O/ L    | Sleeve Joint                  | O/L        |
| Cut Sleeve Mid Point         | HW      | TT & Cutting Raw Edge         | HW         |
| Shoulder Joint with Tape     | O/ L    | Hem Sleeve                    | 2N CB F/ L |
| TT & Cutting Extra Tape      | HW      | Front & Back Part Matching    | HW         |

Figure 5.3 Improved Sewing Processes and Layout

### Table 5.4: Time Study

| Time Study of Sewing Floor            |                                          |                                                                             |               |                 |          |          |                |               |                 |          |          |                |               |                 |          |          |        |       |        |
|---------------------------------------|------------------------------------------|-----------------------------------------------------------------------------|---------------|-----------------|----------|----------|----------------|---------------|-----------------|----------|----------|----------------|---------------|-----------------|----------|----------|--------|-------|--------|
| Activity Name                         | M/C or Hand work                         | Performed Date                                                              |               |                 | 08.10.07 |          | Performed Date |               |                 | 03.10.07 |          | Performed Date |               |                 | 25.09.07 |          |        |       |        |
| FRONT & Back                          |                                          | Worker/Helper                                                               | Observed Time | Parallel Worker | SPT      | Capacity | Worker/Helper  | Observed Time | Parallel Worker | SPT      | Capacity | Worker/Helper  | Observed Time | Parallel Worker | SPT      | Capacity |        |       |        |
| Front & Back Part Matching            | Hand work                                | 1                                                                           | 9             |                 | 11.25    | 320      | 1              | 8.2           |                 | 10.25    | 351.22   | 1              | 7.8           |                 | 9.75     | 369.23   |        |       |        |
| SLEEVE                                |                                          |                                                                             |               |                 |          |          |                |               |                 |          |          |                |               |                 |          |          |        |       |        |
| Hem Sleeve                            | 2-Needle Flatbed Coverstitch Machine     | 2                                                                           | 14            |                 | 17.5     | 205.71   | 2              | 14.56         |                 | 18.2     | 197.8    | 2              | 20.8          |                 | 26       | 138.46   |        |       |        |
| Trim Thread                           | Hand work                                | 3                                                                           | 11            |                 | 13.75    | 261.82   | 3              | 13            |                 | 16.25    | 221.54   | 3              | 6.8           |                 | 8.5      | 423.53   |        |       |        |
| Cut Sleeve Mid Point                  | Hand work                                | 4                                                                           | 10            |                 | 12.5     | 288      | 4              | 12            |                 | 15       | 240      | 4              | 6.8           |                 | 8.5      | 423.53   |        |       |        |
| NECK                                  |                                          |                                                                             |               |                 |          |          |                |               |                 |          |          |                |               |                 |          |          |        |       |        |
| Neck Tack & Trim Thread               | 1-Needle Lockstitch m/c                  | 5                                                                           | 15            |                 | 18.75    | 192      | 5              | 15            |                 | 18.75    | 192      | 5              | 15.2          |                 | 19       | 189.47   |        |       |        |
| Neck Folding & Body Arrange           | Hand work                                | 6                                                                           | 13.6          |                 | 17       | 211.76   | 6              | 14            |                 | 17.5     | 205.71   | 6              | 21.8          |                 | 27.25    | 132.11   |        |       |        |
| ASSEMBLY                              |                                          |                                                                             |               |                 |          |          |                |               |                 |          |          |                |               |                 |          |          |        |       |        |
| Shoulder Joint                        | Overlock Machine                         | 7                                                                           | 11.5          |                 | 14.38    | 250.43   | 7              | 12.6          |                 | 15.75    | 228.57   | 7              | 20            |                 | 25       | 144      |        |       |        |
| Trim Thread & Cutting extra tape      | Hand work                                | 8                                                                           | 14            |                 | 17.5     | 205.71   | 8              | 13.5          |                 | 16.88    | 213.33   | 8              | 17            |                 | 21.25    | 169.41   |        |       |        |
| Sleeve Joint                          | Overlock Machine                         | 9, 10                                                                       | 31.75         | 33.5            | 30       | 39.69    | 181.42         | 9, 10         | 33.65           | 35.58    | 31.72    | 42.06          | 171.17        | 9, 10           | 39.315   | 46.83    | 31.8   | 49.14 | 146.51 |
| Neck Joint                            | Overlock Machine                         | 11, 12                                                                      | 20.9          | 23.5            | 18.3     | 26.13    | 275.6          | 11, 12        | 22.135          | 22.85    | 21.42    | 27.67          | 260.22        | 11              | 17.8     |          | 22.25  | 323.6 |        |
| Trim Thread & Body arrange            | Hand work                                | 13                                                                          | 16            |                 | 20       | 180      | 13             | 17.6          |                 | 22       | 163.64   |                | x             |                 |          |          |        |       |        |
| Neck Back Tap                         | 1-Needle Lockstitch m/c                  | 14                                                                          | 10            |                 | 12.5     | 288      | 14             | 10.21         |                 | 12.76    | 282.08   | 12             | 18.5          |                 | 23.13    | 155.68   |        |       |        |
| Neck Close                            | 1-Needle Lockstitch m/c                  | 15                                                                          | 16            |                 | 20       | 180      | 15             | 15.66         |                 | 19.58    | 183.91   | 13             | 26.4          |                 | 33       | 109.09   |        |       |        |
| Trim Thread & Cut Extra Back Tap      | Hand work                                | 16                                                                          | 14            |                 | 17.5     | 205.71   | 16             | 14.14         |                 | 17.68    | 203.68   | 14             | 24.33         |                 | 30.41    | 118.37   |        |       |        |
| Neck Top                              |                                          | 17                                                                          | 11.5          |                 | 14.38    | 250.43   | 17             | 12.25         |                 | 15.31    | 235.1    | 15             | 14.8          |                 | 18.5     | 194.59   |        |       |        |
| Trim Thread & Arrange                 | Hand work                                | 18                                                                          | 16            |                 | 20       | 180      | 18             | 12            |                 | 15       | 240      | 16             | 16            |                 | 20       | 180      |        |       |        |
| Label Position Mark                   | Hand work                                | 19                                                                          | 10            |                 | 12.5     | 288      | 19             | 12.16         |                 | 15.2     | 236.84   |                | x             |                 |          |          |        |       |        |
| Main label joint                      | 1-Needle Lockstitch m/c                  | 20, 21                                                                      | 21.31         | 21.9            | 20.72    | 26.64    | 270.3          | 20, 21        | 22.315          | 22.8     | 21.83    | 27.89          | 258.12        |                 | x        |          |        |       |        |
| Trim Thread & Arrange                 | Hand work                                | 22, 23                                                                      | 28.71         | 31.12           | 26.3     | 35.89    | 200.63         | 22, 23        | 32.9            | 36.8     | 29       | 41.13          | 175.08        | 17              | 32.9     | 36.8     | 29     | 41.13 | 175.08 |
| Sleeve Tack before Side Seam          | 1-Needle Lockstitch m/c                  | 24, 25                                                                      | 31.76         | 32.6            | 30.92    | 39.7     | 181.36         | 24, 25        | 32.745          | 34.16    | 31.33    | 40.93          | 175.9         | 18              | 33.165   | 32.33    | 34     | 41.46 | 173.68 |
| Trim Thread & Arrange                 | Hand work                                |                                                                             | x             |                 |          |          |                |               | x               |          |          |                | 19            | 14              |          | 17.5     | 411.43 |       |        |
| Side Seam                             | Overlock Machine                         | 26, 27                                                                      | 37.5          | 45              | 30       | 46.88    | 153.6          | 26, 27        | 39.3            | 46.6     | 32       | 49.13          | 146.56        | 20, 21          | 50       | 63.5     | 36.5   | 62.5  | 115.2  |
| Sleeve Tack after Side Seam           | 1-Needle Lockstitch m/c                  | 28, 29                                                                      | 33.6          | 35.2            | 32       | 42       | 171.43         | 28, 29        | 34              | 36.8     | 31.2     | 42.5           | 169.41        | 22, 23          | 35.08    | 36.16    | 34     | 43.85 | 164.2  |
| Trim Thread, Arrange & Sticker remove | Hand work                                | 30                                                                          | 20            |                 | 25       | 144      | 30             | 19.66         |                 | 24.58    | 146.49   | 24             | 23.5          |                 |          | 29.38    | 122.55 |       |        |
| Scissoring                            | Hand work                                | 31                                                                          | 16            |                 | 20       | 180      | 31             | 17.04         |                 | 21.3     | 169.01   | 25             | 13.75         |                 |          | 17.19    | 209.45 |       |        |
| Body Hem                              | 2-Needle Cylinderbed Coverstitch Machine | 32                                                                          | 16.5          |                 | 20.63    | 174.55   | 32             | 17.66         |                 | 22.08    | 163.08   | 26             | 16.33         |                 |          | 20.41    | 176.36 |       |        |
| Trim Thread & Arrange                 | Hand work                                | 33                                                                          | 16.35         |                 | 20.44    | 176.15   | 33             | 17            |                 | 21.25    | 169.41   | 27, 28         | 24            | 23              | 25       | 30       | 120    |       |        |
|                                       |                                          |                                                                             | 465.98        |                 | 582.48   |          |                | 485.285       |                 | 606.61   |          |                | 516.07        |                 |          | 645.09   |        |       |        |
|                                       |                                          | SPT Improvement from 25.09 to 03.10 = 5.96% and from 03.10 to 08.10 = 3.98% |               |                 |          |          |                |               |                 |          |          |                |               |                 |          |          |        |       |        |

Table 5.5 Production Record

## URMI GROUP

DEPARTMENT OF WORK STUDY AND PLANNING, Style No. - 1102, Buyer - Losan, SMV - 5.7 - 6.54

| Line No. - 3D1 |        |    |     |        |       |            |      |         |      |               |              |         |            |     |     |     |     |     |     |     |     |     |      |       |          |         |             |        |           |            |           |
|----------------|--------|----|-----|--------|-------|------------|------|---------|------|---------------|--------------|---------|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-------|----------|---------|-------------|--------|-----------|------------|-----------|
| Date           | Actual |    |     |        |       | Normal Hrs |      | OT Hrs. |      | TTL Spend hrs | Produced hrs | TGP/Hrs | Daily Tgt. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10   | Total | Cum Prod | OP Days | Target Per% | Eff. % | Flr Eff % | Fac. Eff % | Fac. Tgt% |
|                | Emp.   | MO | Hel | App UC | Q./Un | Wrks       | Hrs. | Wrks    | Hrs. |               |              |         |            |     |     |     |     |     |     |     |     |     |      |       |          |         |             |        |           |            |           |
| 24/09/07       | 37     | 22 | 12  | 0      | 3     | 34         | 8    | 34      | 2    | 340           | 83.1         | 77      | 852        | 85  | 85  | 90  | 80  | 85  | 100 | 90  | 90  |     |      | 875   | 875      | 1       | 103%        | 24%    | 35%       | 31%        | 94%       |
| 25/09/07       | 34     | 21 | 10  | 0      | 3     | 31         | 8    | 31      | 2    | 310           | 120.2        | 158     | 1263       | 100 | 110 | 130 | 135 | 130 | 130 | 130 | 140 |     |      | 1265  | 2140     | 2       | 100%        | 39%    | 33%       | 29%        | 100%      |
| 26/09/07       | 36     | 20 | 12  | 0      | 4     | 32         | 8    | 32      | 2    | 312           | 140.6        | 185     | 1478       | 150 | 150 | 150 | 130 | 130 | 130 | 170 |     |     | 1480 | 3620  | 3        | 100%    | 45%         | 38%    | 32%       | 93%        |           |
| 27/09/07       | 34     | 20 | 8   | 2      | 4     | 28         | 8    | 28      | 2    | 252           | 121.6        | 160     | 1280       | 160 | 170 | 150 | 130 | 130 | 110 | 150 |     |     | 1280 | 4900  | 4        | 100%    | 48%         | 36%    | 34%       | 89%        |           |
| 28/09/07       | 32     | 20 | 8   | 0      | 4     | 28         | 8    | 28      | 2    | 280           | 144.8        | 191     | 1524       | 160 | 165 | 160 | 160 | 150 | 140 | 150 | 150 | 150 |      | 1524  | 6424     | 5       | 100%        | 52%    | 42%       | 32%        | 87%       |
| 29/09/07       | 33     | 20 | 9   | 0      | 4     | 29         | 8    | 29      | 0    | 232           | 125.4        | 163     | 1300       | 140 | 160 | 160 | 160 | 160 | 160 | 170 |     |     | 1320 | 7744  | 6        | 102%    | 54%         | 45%    | 35%       | 92%        |           |
| 30/10/07       | 35     | 22 | 9   | 0      | 4     | 31         | 8    | 31      | 2    | 310           | 166.7        | 192     | 1532       | 145 | 155 | 110 | 160 | 160 | 145 | 150 | 140 |     |      | 1532  | 9276     | 7       | 100%        | 54%    | 40%       | 32%        | 91%       |
| 01/10/07       | 36     | 22 | 9   | 0      | 5     | 31         | 8    | 31      | 2    | 310           | 145.0        | 208     | 1666       | 150 | 175 | 140 | 110 | 155 | 105 | 145 | 200 |     |      | 1500  | 10776    | 8       | 90%         | 47%    | 35%       | 28%        | 88%       |
| 02/10/07       | 36     | 22 | 8   | 1      | 5     | 30         | 8    | 30      | 2    | 300           | 149.8        | 212     | 1694       | 150 | 110 | 155 | 150 | 175 | 150 | 165 | 170 |     |      | 1550  | 12326    | 9       | 91%         | 50%    | 40%       | 31%        | 89%       |
| 03/10/07       | 34     | 20 | 10  | 0      | 4     | 30         | 8    | 30      | 2    | 300           | 159.5        | 212     | 1694       | 160 | 175 | 160 | 170 | 175 | 150 | 175 |     |     | 1650 | 13976 | 10       | 97%     | 53%         | 36%    | 33%       | 97%        |           |
| 04/10/07       | 35     | 19 | 10  | 1      | 5     | 29         | 8    | 29      | 2    | 261           | 145.0        | 196     | 1570       | 150 | 160 | 150 | 145 | 170 | 150 | 190 | 190 |     |      | 1500  | 15476    | 11      | 96%         | 56%    | 29%       | 29%        | 91%       |
| 05/10/07       | 34     | 20 | 9   | 0      | 5     | 29         | 8    | 29      | 2    | 290           | 170.1        | 219     | 1755       | 170 | 170 | 190 | 170 | 180 | 180 | 180 |     |     | 1760 | 17236 | 12       | 100%    | 59%         | 40%    | 34%       | 98%        |           |
| 06/10/07       | 36     | 20 | 10  | 1      | 5     | 30         | 8    | 30      | 0    | 240           | 139.2        | 180     | 1440       | 175 | 143 | 190 | 180 | 180 | 120 |     |     |     | 1440 | 18676 | 13       | 100%    | 58%         | 44%    | 35%       | 96%        |           |
| 07/10/07       | 35     | 20 | 9   | 1      | 5     | 29         | 8    | 29      | 2    | 275.5         | 150.8        | 214     | 1715       | 170 | 130 | 135 | 200 | 130 | 140 | 225 | 180 | 150 |      | 1560  | 20236    | 14      | 91%         | 55%    | 38%       | 27%        | 91%       |
| 08/10/07       | 35     | 21 | 8   | 1      | 5     | 29         | 8    | 29      | 2    | 275.5         | 145.5        | 214     | 1710       | 130 | 105 | 151 | 153 | 163 | 200 | 160 | 200 |     |      | 1505  | 21741    | 15      | 88%         | 53%    | 38%       | 33%        | 88%       |
| 09/10/07       | 34     | 20 | 9   | 0      | 5     | 29         | 8    | 29      | 0    | 217.5         | 123.7        | 169     | 1350       | 170 | 170 | 180 | 170 | 160 | 135 |     |     |     | 1280 | 23021 | 16       | 95%     | 57%         | 38%    | 35%       | 95%        |           |
| 10/10/07       | 35     | 21 | 8   | 1      | 5     | 29         | 8    | 29      | 0    | 174           | 96.7         | 135     | 1080       | 140 | 180 | 180 | 190 |     |     |     |     |     |      | 1000  | 24021    | 17      | 93%         | 56%    | 34%       | 30%        | 79%       |
| 11/10/07       | 32     | 22 | 6   | 0      | 4     | 28         | 7    | 28      | 0    | 196           | 113.6        | 168     | 1175       | 110 | 150 | 180 | 170 | 180 | 170 |     |     |     | 1175 | 25196 | 18       | 100%    | 58%         | 33%    | 30%       | 83%        |           |
| 22/10/07       | 32     | 22 | 6   | 0      | 4     | 28         | 8    | 28      | 2    | 282           | 174.0        | 225     | 1800       | 150 | 170 | 180 | 170 | 180 | 190 | 180 | 190 | 80  |      | 1800  | 26996    | 19      | 100%        | 62%    | 37%       | 34%        | 88%       |
| 23/10/07       | 35     | 20 | 10  | 0      | 5     | 30         | 8    | 30      | 2    | 300           | 168.2        |         |            | 155 | 160 | 160 | 180 | 180 | 146 | 190 |     |     | 1740 | 28736 | 20       | 97%     | 56%         | 43%    | 39%       | 96%        |           |
| 24/10/07       | 37     | 22 | 9   | 1      | 5     | 31         | 8    | 31      | 2    | 310           | 164.3        |         |            | 130 | 170 | 170 | 145 | 150 | 180 | 155 | 180 | 180 |      | 1700  | 30436    | 21      | 94%         | 53%    | 40%       | 39%        | 93%       |
| 25/10/07       | 39     | 25 | 8   | 1      | 5     | 33         | 8    | 33      | 2    | 330           | 164.3        |         |            | 170 | 170 | 140 | 150 | 120 | 155 | 150 | 110 | 180 |      | 1700  | 32136    | 22      | 94%         | 50%    | 42%       | 39%        | 100%      |
| 26/10/07       | 36     | 23 | 7   | 1      | 5     | 30         | 8    | 30      | 0    | 242           | 129.5        | 180     | 1440       | 160 | 170 | 170 | 170 | 150 | 180 | 180 | 160 |     |      | 1340  | 33476    | 23      | 93%         | 54%    | 36%       | 35%        | 97%       |
| 27/10/07       | 36     | 22 | 8   | 1      | 5     | 30         | 8    | 30      | 2    | 300           | 169.2        | 225     | 1800       | 150 | 170 | 180 | 180 | 180 | 170 | 180 | 175 | 180 |      | 1750  | 35226    | 24      | 97%         | 56%    | 42%       | 37%        | 100%      |
| 29/10/07       | 37     | 23 | 8   | 1      | 5     | 31         | 8    | 31      | 0    | 248           | 130.5        | 180     | 1440       | 170 | 170 | 110 | 160 | 160 | 180 | 180 | 185 |     |      | 1350  | 36576    | 25      | 94%         | 53%    | 44%       | 32%        | 92%       |
| 30/10/07       | 38     | 23 | 9   | 1      | 5     | 32         | 8    | 32      | 0    | 256           | 139.2        | 180     |            | 180 | 180 | 170 | 175 | 180 | 180 | 180 | 190 |     |      | 1440  | 38016    | 26      | 100%        | 54%    | 34%       | 28%        | 89%       |
| 31/10/07       | 37     | 21 | 10  | 1      | 5     | 31         | 8    | 31      | 0    | 248           | 125.7        | 180     |            | 170 | 180 | 175 | 180 | 150 | 180 | 160 | 105 |     |      | 1300  | 39316    | 27      | 90%         | 51%    | 33%       | 27%        | 91%       |
| 01/11/07       | 36     | 20 | 10  | 1      | 5     | 30         | 8    | 28      | 2    | 300           | 72.5         | 100     | 800        | 130 | 120 | 100 | 80  | 80  | 60  | 60  | 60  | 145 |      | 750   | 40066    | 28      | 94%         | 24%    | 36%       | 26%        | 93%       |

| Date                                                                                                                                                              | Actual |      |     |        |      | Normal Hrs |      | OT Hrs. |      | TTL Spend hrs | Produced hrs | TGP/ Hrs | Daily Tgt | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | Total | Cum Prod | OP Days | Targt Per% | Eff. % | Hr Eff % | Fac. Eff % | Fac. Tag% |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------|------|------------|------|---------|------|---------------|--------------|----------|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|----------|---------|------------|--------|----------|------------|-----------|------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
|                                                                                                                                                                   | Emp.   | MO   | Hel | App UC | Q/Un | Wrks       | Hrs. | Wrks    | Hrs. |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line No. - 3B2                                                                                                                                                    |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 22/10/07                                                                                                                                                          | 30     | 18   | 9   | 0      | 3    | 27         | 8    | 27      | 2    | 272           | 155.2        | 229      | 1828      |     |     |     |     |     |     |     |     |     |     |       | 490      | 490     |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 23/10/07                                                                                                                                                          | 34     | 17   | 10  | 3      | 4    | 27         | 8    | 27      | 2    | 270           | 140.2        | 170      | 1450      | 125 | 170 | 120 | 125 | 145 | 140 | 140 |     |     |     |       | 1450     | 1940    | 2          | 100%   | 52%      | 43%        | 39%       | 96%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 24/10/07                                                                                                                                                          | 31     | 17   | 7   | 3      | 4    | 24         | 8    | 24      | 2    | 240           | 140.2        | 170      | 1600      | 130 | 100 | 175 | 160 | 160 | 160 | 160 | 140 | 140 |     |       | 1450     | 3390    | 3          | 91%    | 58%      | 40%        | 39%       | 93%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25/10/07                                                                                                                                                          | 33     | 19   | 8   | 3      | 3    | 27         | 8    | 27      | 2    | 270           | 140.2        | 200      | 1600      | 130 | 140 | 140 | 120 | 120 | 140 | 140 | 155 | 140 |     |       | 1450     | 4840    | 4          | 91%    | 52%      | 42%        | 39%       | 100% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 26/10/07                                                                                                                                                          | 35     | 19   | 9   | 3      | 4    | 28         | 8    | 28      | 2    | 288           | 150.3        | 200      | 1600      | 160 | 160 | 160 | 160 | 160 | 165 | 65  | 130 | 180 |     |       | 1555     | 6395    | 5          | 97%    | 52%      | 36%        | 35%       | 97%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 27/10/07                                                                                                                                                          | 35     | 18   | 10  | 3      | 4    | 28         | 8    | 28      | 2    | 280           | 147.9        | 191      | 1530      | 140 | 150 | 145 | 130 | 140 |     |     |     |     |     |       | 650      | 7045    | 6          | 100%   | 53%      | 42%        | 37%       | 100% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 01/11/07                                                                                                                                                          | 31     | 18   | 9   | 0      | 4    | 27         | 8    | 25      | 2    | 270           | 87           | 113      | 900       | 0   | 35  | 90  | 90  | 90  | 90  | 95  | 95  | 160 |     |       | 900      | 7945    | 7          | 100%   | 32%      | 36%        | 27%       | 93%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 02/11/07                                                                                                                                                          | 33     | 18   | 10  | 1      | 4    | 28         | 8    | 26      | 2    | 280           | 148.5        | 192      | 1536      | 130 | 140 | 160 | 155 | 160 | 160 | 154 | 160 | 160 |     |       | 1536     | 9481    | 8          | 100%   | 53%      | 36%        | 30%       | 101% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 03/11/07                                                                                                                                                          | 33     | 18   | 10  | 1      | 4    | 28         | 8    | 26      | 2    | 280           | 162.4        | 210      | 1680      | 150 | 160 | 180 | 170 | 160 | 170 | 170 | 165 |     |     |       | 800      | 10281   | 9          | 100%   | 58%      | 34%        | 31%       | 90%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 06/11/07                                                                                                                                                          | 32     | 18   | 9   | 1      | 4    | 27         | 8    | 25      | 2    | 351           | 186.2        | 250      | 2000      |     |     |     |     |     |     |     |     |     |     |       | 1150     | 11431   | 10         | 105%   | 53%      | 39%        | 39%       | 94%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line No. - 3B1                                                                                                                                                    |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 05/11/07                                                                                                                                                          | 34.5   | 18.5 | 11  | 0      | 5    | 29.5       | 8    | 27.5    | 2    | 383.5         | 160.5        | 221      | 1768      |     |     |     |     |     |     |     |     |     |     |       | 440      | 440     | 1          | 100%   | 42%      | 37%        | 34%       | 87%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 06/11/07                                                                                                                                                          | 34     | 19   | 10  | 0      | 5    | 29         | 8    | 27      | 2    | 377           | 197.8        | 239      | 1910      | 160 | 156 | 138 | 150 | 150 | 140 | 150 | 125 | 100 | 100 |       | 1860     | 2300    | 2          | 102%   | 52%      | 39%        | 39%       | 94%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line No. - 6B                                                                                                                                                     |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 05/11/07                                                                                                                                                          | 31     | 18   | 8   | 0      | 5    | 26         | 8    | 26      | 2    | 334           | 14.9         |          |           |     |     |     |     |     |     |     |     |     |     |       | 0        | 0       | 1          | 0%     | 6%       | 20%        | 29%       | 91%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 06/10/07                                                                                                                                                          | 38     | 23   | 12  | 0      | 3    | 35         | 8    | 35      | 2    | 490           | 87           | 72       | 576       | 100 | 100 | 100 | 125 | 160 | 140 |     |     |     |     |       | 900      | 900     | 2          | 156%   | 18%      | 20%        | 34%       | 98%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 07/10/07                                                                                                                                                          | 38     | 23   | 12  | 0      | 3    | 35         | 8    | 35      | 0    | 280           | 31.2         | 72       | 280       |     |     |     |     |     |     |     |     |     |     |       | 190      | 1090    | 3          | 100%   | 11%      | 21%        | 35%       | 96%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line No. - 7 A                                                                                                                                                    |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 23/10/07                                                                                                                                                          | 37     | 24   | 9   | 0      | 4    | 33         | 8    | 33      | 2    | 330           | 59.5         | 191      | 530       | 30  | 30  | 50  | 60  | 80  | 100 | 100 |     |     |     |       | 555      | 555     | 1          | 114%   | 18%      | 23%        | 39%       | 96%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 24/10/07                                                                                                                                                          | 37     | 24   | 9   | 0      | 4    | 33         | 8    | 33      | 2    | 330           | 100.5        | 116      | 931       | 80  | 80  | 100 | 100 | 100 | 110 | 100 | 100 | 90  |     |       | 1040     | 1595    | 2          | 112%   | 30%      | 35%        | 39%       | 93%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25/10/07                                                                                                                                                          | 34     | 18   | 10  | 2      | 4    | 28         | 8    | 28      | 2    | 280           | 125.7        | 155      | 1241      | 100 | 105 | 115 | 120 | 120 | 110 | 120 | 110 | 120 |     |       | 1300     | 2895    | 3          | 105%   | 45%      | 38%        | 39%       | 100% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 26/10/07                                                                                                                                                          | 33     | 18   | 11  | 1      | 3    | 29         | 8    | 29      | 2    | 290           | 135.3        | 175      | 1397      | 110 | 115 | 120 | 125 | 120 | 130 | 135 | 150 | 150 |     |       | 1400     | 4295    | 4          | 100%   | 47%      | 41%        | 35%       | 97%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 27/10/07                                                                                                                                                          | 34     | 17   | 13  | 0      | 4    | 30         | 8    | 30      | 0    | 240           | 107.3        | 115      | 920       | 110 | 115 | 130 | 125 | 120 | 110 | 120 | 120 |     |     |       | 1110     | 5405    | 5          | 121%   | 45%      | 50%        | 37%       | 100% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line No. - 7 B                                                                                                                                                    |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 23/10/07                                                                                                                                                          | 28     | 16   | 8   | 0      | 4    | 24         | 8    | 24      | 2    | 240           | 74.1         |          |           |     |     |     |     |     |     |     |     |     |     |       | 135      | 135     | 1          | 169%   | 31%      | 23%        | 39%       | 96%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 24/10/07                                                                                                                                                          | 28     | 16   | 8   | 0      | 4    | 24         | 8    | 24      | 2    | 240           | 100.5        | 116      | 931       | 100 | 100 | 100 | 105 | 80  | 90  | 100 | 100 | 80  |     |       | 1040     | 1175    | 2          | 112%   | 42%      | 35%        | 39%       | 93%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25/10/07                                                                                                                                                          | 36     | 20   | 12  | 0      | 4    | 32         | 8    | 32      | 2    | 365           | 119          | 150      | 1200      | 120 | 100 | 105 | 110 | 120 | 100 | 100 | 140 | 100 |     |       | 750      | 1925    | 3          | 127%   | 33%      | 38%        | 39%       | 100% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 26/10/07                                                                                                                                                          | 33     | 17   | 9   | 3      | 4    | 26         | 8    | 26      | 2    | 308           | 111.1        | 188      | 1500      | 120 | 120 | 120 | 75  | 125 | 125 | 150 | 150 | 150 |     |       | 1500     | 3425    | 4          | 100%   | 36%      | 41%        | 35%       | 97%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 27/10/07                                                                                                                                                          | 36     | 16   | 13  | 3      | 4    | 29         | 8    | 29      | 2    | 280           | 154.7        | 188      | 1500      | 150 | 150 | 160 | 150 | 160 | 160 | 170 | 170 |     |     |       | 1600     | 5025    | 5          | 107%   | 55%      | 50%        | 37%       | 100% |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 29/10/07                                                                                                                                                          | 36     | 19   | 11  | 1      | 5    | 30         | 8    | 30      | 2    | 290           | 193.8        | 233      | 1862      | 150 | 150 | 150 | 180 | 180 | 180 | 190 | 200 |     |     |       | 2005     | 7030    | 6          | 108%   | 67%      | 33%        | 32%       | 92%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 30/10/07                                                                                                                                                          | 34     | 20   | 10  | 0      | 4    | 30         | 8    | 28      | 2    | 290           | 51.9         | 69       | 550       | 100 | 100 | 30  | 30  | 30  | 10  | 30  |     |     |     |       | 300      | 7330    | 7          | 84%    | 18%      | 12%        | 29%       | 89%  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total Production                                                                                                                                                  |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       | 67622    |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Emp =Employee, MO = m/c operator , Hel= Helper, App. Un =Approved uncounted man power, Q/Un = Quality Instructor Uncounted (variation of Attendance and In line), |        |      |     |        |      |            |      |         |      |               |              |          |           |     |     |     |     |     |     |     |     |     |     |       |          |         |            |        |          |            |           |      |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

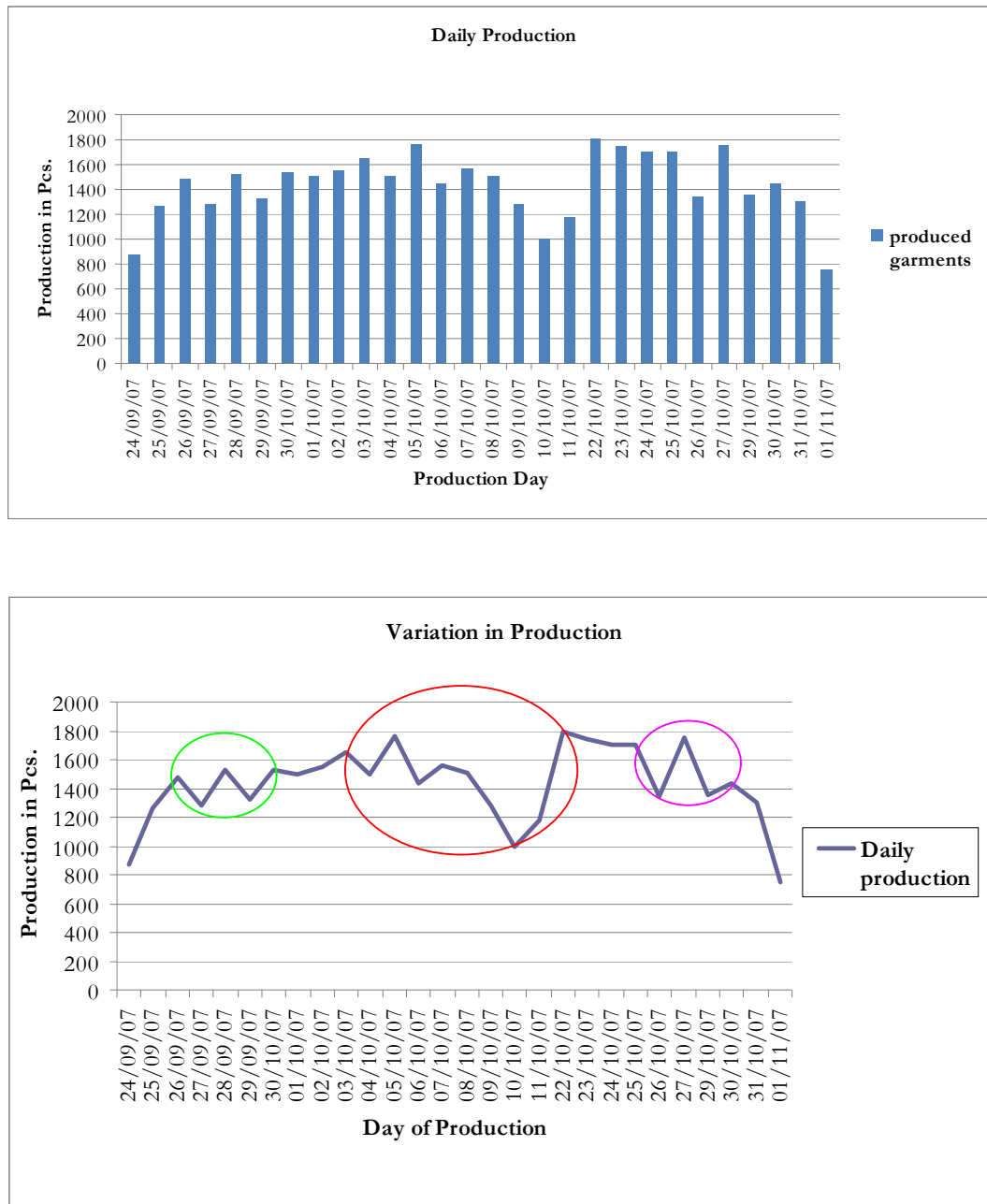


Figure 5.4 Production Variation in line 3D1

The figure clearly depicts the variation in the sewing line. The reasons behind this variation are accessories problem, machine problem, Eid Vacation, size mistakes, wrong report, in line WIP.

Date wise material flow in the production system

| Material Flow |          |          |          |          |           |          |
|---------------|----------|----------|----------|----------|-----------|----------|
| Order Confirm | Store    | Cutting  | Printing | Sewing   | Finishing | Shipment |
| 24/07/07      | 21/08/07 | 31/08/07 | 01/09/07 | 24/09/07 | 03/10/07  | 09/10/07 |

**Total Produced hour** = (SMV X Total Production) / 60 or SAH X Total Production

$$= 5.7 \times 875 / 60 \quad \text{Or} \quad 0.095 \times 875$$

$$= 83.125$$

[Data from first day production of line 3D1]

**Total Spend Hour** = (Normal Worker X Working Hour + Overtime Worker X OT)

$$= 34 \times 8 + 34 \times 2 = 340$$

**Line Efficiency** = (Production X SMV) / (M/P X W/H X 60) X 100

Or (Production X SMV) / Total Spend Hours X 100

$$= \{(875 \times 5.7) / 340\} \times 100$$

$$= 24.44\%$$

**Cut Ship Ratio:** The quantity shipped (in pcs) expressed as a percentage of quantity cut (in pcs) computed in respect of each delivery. The objective of this measure is to compute the process loss arising from defects in fabric cutting, printing, sewing, finishing and missing garments.

Cut Ship Ratio = (Total Shipped Quantity in Pcs / Total Cut Quantity in Pcs) X 100

$$= 67750 / 70374 \times 100$$

$$= 96.27\%$$

**Receive to Ship Ratio:** The quantity of fabric shipped expressed as a percentage of fabric received for the reporting period.

## 5.6 Analysis of 5S

Five S philosophy focuses on effective work place organization and standardized work procedures and it simplifies work environment, reduces waste and non value adding activity while improving quality efficiency and safety.

**Sort** – the first S focuses on eliminating unnecessary items, removing broken tools, getting rid of dust and oil etc. from the workplace. An effective visual method to identify these unneeded items is called red tagging [Appendix-4].

**Set In Order** – this second S focuses on efficient and effective storage methods. Strategies for effective Set In Order are painting floors, outlining work areas and locations, shadow boards and modular shelving and cabinets for needed items such as trash cans, baskets and buckets. Ergonomics are taken in consideration for storing items within easy reach, reducing the need for bending, stretching and excessive asking.

**Shine** – once the clutters and junks, which clog areas, have been eliminated and identified and located the necessary items, the next step is to thoroughly clean the work area. Daily follow up cleaning is necessary in order to sustain this improvement.

**Standardize** – after achieving first 3 S, the next step should be to concentrate on standardizing best practice in the work area. It is necessary to allow all employees to participate in the development of such standards.

**Sustain** – this focuses on defining a new status quo and standard of work place organization. This is by far the most difficult S to implement and achieve because of human nature resistance to change [22].



Figure 5.5 Oil on Machine Table

Table 5.6 5S Audit Checklist

| Date: 26/09/07                                     |                                                                                                                                                                              | Target Area: Sewing floor |                                  | Performed by: Masud |  |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|----------------------------------|---------------------|--|
| 5S element                                         | Initiative                                                                                                                                                                   | Score                     | Notes for next level improvement |                     |  |
| Sort                                               | Eliminate the clutter, sort out what is not needed                                                                                                                           |                           |                                  |                     |  |
| When doubt, sort it out                            | 01) Necessary items are sorted from those that are unnecessary                                                                                                               | 2                         |                                  |                     |  |
|                                                    | 02) Items are present in aisle ways, stairways, corner.                                                                                                                      | 2                         | Proper placing                   |                     |  |
|                                                    | 03) Excess/ unneeded inventory, supplies, parts or materials are in area.                                                                                                    | 1                         | Supply                           |                     |  |
| Straighten                                         | Organize and label, set boundaries and limits                                                                                                                                |                           |                                  |                     |  |
| A place for everything and everything in its place | 04) Items are organized to permit easy access to materials and tools with the “return addresses”.                                                                            | 1                         | Space requirement                |                     |  |
|                                                    | 05) An access system is in place with labels and color code to identify.                                                                                                     | 1                         | Proper placing                   |                     |  |
|                                                    | 06) Proper position of tools, materials, and objects.                                                                                                                        | 2                         |                                  |                     |  |
|                                                    | 07) Materials or objects are always in their designated position.                                                                                                            | 1                         |                                  |                     |  |
| Shine                                              | Clean everything inside and out                                                                                                                                              |                           |                                  |                     |  |
| Inspection through cleaning                        | 08) Floors, walls, stairs, conveyance equipment, and surfaces are dirty, oily, greasy and / or shiny and stainless.                                                          | 1                         | Clean timely                     |                     |  |
|                                                    | 09) Appropriate cleaning materials are not available in the area.                                                                                                            | 1                         | When need                        |                     |  |
|                                                    | 10) Other cleaning problems are present in the workplace                                                                                                                     | 1                         | Space                            |                     |  |
|                                                    | 11) Actions have been developed to remove sources of wastes.                                                                                                                 | 1                         |                                  |                     |  |
| Standardize                                        | Keep checklists and standards to maintain the first 3 S’s                                                                                                                    |                           |                                  |                     |  |
| Everything in a state of readiness                 | 12) Procedures are set to work on sort, straighten, and scrub.                                                                                                               | 1                         | Charting                         |                     |  |
|                                                    | 13) Standards are not visible in the area and known to area stakeholders.                                                                                                    | 1                         | Board                            |                     |  |
|                                                    | 14) 5 S is run on a daily basis.                                                                                                                                             | 1                         | Make habit                       |                     |  |
|                                                    | 15) Quantities and limits can not easily be seen.                                                                                                                            | 1                         | Check list                       |                     |  |
|                                                    | 16) Working environment is healthy and pleasant.                                                                                                                             | 2                         |                                  |                     |  |
| Sustain                                            | Maintain discipline through systems and a supportive culture                                                                                                                 |                           |                                  |                     |  |
| Training , reinforcement and measurement           | 17) Standards are set and followed.                                                                                                                                          | 1                         | Publish                          |                     |  |
|                                                    | 18) Workers in area have not been trained in 5S                                                                                                                              | 1                         | Training                         |                     |  |
|                                                    | 19) Personal belongings can be easily stored                                                                                                                                 | 3                         |                                  |                     |  |
|                                                    | 20) Goals of 5S have been achieved.                                                                                                                                          | 1                         | Practice                         |                     |  |
|                                                    | 1 = little / no apparent (<20%), 2= Meets Minimal 5S Requirements (40%), 3= Meets Several 5S Requirements (60%), 4= Meets Most 5S Requirements (80%), 5= 5S Compliant (100%) | Total Score : 26          | Divided by 20 = 1.3 avg. score   |                     |  |

After doing same analysis in cutting section the total score is 31 and average is 1.55, store section the data shows the total score 28 and the average score is 1.4 and in finishing section it is 35 and 1.75 respectively.



Figure 5.6 Store Present Situations

The figure shows the present situation in store section. Here the finished fabrics are kept here and there without any traceability when required. But it could be kept in self or in floor like the following figure with some traceable number on the poly of finished rule.



Figure 5.7 Store Condition after 5'S

These are the situation after making them aware about the 5'S practices. They had the equipment and space to furnish and keep the goods in proper place in right way. The Store location chart helps them to find out where the goods are kept. So the loss time and the anxiousness to trace the required goods were reduced. If they can arrange some other rack to keep the goods in a marked position and list them regularly the store management will function more effectively.



Figure 5.8 Sewing WIP



Figure 5.9 Sewing line after 5'S

The sewing lines are disturbed with in line WIP because of imbalanced line or some other reason like accessories problem. It destroys the productivity and working environment. Make the worker disturbed about his remaining work.



Figure 5.10 Finished Goods in Finishing Section



Figure 5.11 Finishing Accessories after 5'S

The picture shows the clean environment after implementing 5' S in finished goods inventory. Finished goods are always making WIP in finishing section. If the accessories are available then the cartoon must be stored in finished goods inventory section. Finishing accessories are small and easy to be lost. If they are kept in a self like the previous figure those will not be lost and excess requirement of accessories will be reduced. Sometimes hang tags, price tags etc are lost by finishing people and for this reason short shipment is a common factor. By keeping in a visible place with some identified or marked position this problem can be solved easily.



Figure 5.12 Finished goods after 5'S

Table 5.7 5S Audit Sheet after implementation

| 5S Audit Checklist                                 |        |                                                                                                                     | Sewing      |             | Store       |           | Finishing   |             |
|----------------------------------------------------|--------|---------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------------|-----------|-------------|-------------|
| 5S element                                         | Serial | Initiative                                                                                                          | Score       | New Score   | Score       | New Score | Score       | New Score   |
| Sort                                               |        | <b>Eliminate the clutter, sort out what is not needed</b>                                                           |             |             |             |           |             |             |
| When doubt, sort it out                            | 1      | 01) Necessary items are sorted from those that are unnecessary                                                      | 2           | 3           | 2           | 3         | 3           | 3           |
|                                                    | 2      | 02) Items are present in aisle ways, stairways, corner.                                                             | 2           | 3           | 1           | 2         | 1           | 2           |
|                                                    | 3      | 03) Excess/ unneeded inventory, supplies, parts or materials are in area.                                           | 1           | 2           | 1           | 2         | 2           | 3           |
| Straighten                                         |        | <b>Organize and label, set boundaries and limits</b>                                                                |             |             |             |           |             |             |
| A place for everything and everything in its place | 4      | 04) Items are organized to permit easy access to materials and tools with the "return addresses".                   | 1           | 1           | 2           | 3         | 2           | 3           |
|                                                    | 5      | 05) An access system is in place with labels and color code to identify.                                            | 1           | 1           | 1           | 2         | 2           | 2           |
|                                                    | 6      | 06) Proper position of tools, materials, and objects.                                                               | 2           | 3           | 2           | 2         | 2           | 3           |
|                                                    | 7      | 07) Materials or objects are always in their designated position.                                                   | 1           | 2           | 2           | 2         | 2           | 2           |
| Shine                                              |        | <b>Clean everything inside and out</b>                                                                              |             |             |             |           |             |             |
| Inspection through cleaning                        | 8      | 08) Floors, walls, stairs, conveyance equipment ,and surfaces are dirty, oily, greasy and / or shiny and stainless. | 1           | 2           | 2           | 2         | 2           | 3           |
|                                                    | 9      | 09) Appropriate cleaning materials are not available in the area.                                                   | 1           | 2           | 1           | 2         | 2           | 2           |
|                                                    | 10     | 10) Other cleaning problems are present in the workplace                                                            | 1           | 1           | 2           | 2         | 2           | 2           |
|                                                    | 11     | 11) Actions have been developed to remove sources of wastes.                                                        | 1           | 2           | 1           | 1         | 1           | 2           |
| Standardize                                        |        | <b>Keep checklists and standards to maintain the first 3 S's</b>                                                    |             |             |             |           |             |             |
| Everything in a state of readiness                 | 12     | 12) Procedures are set to work on sort, straighten, and scrub.                                                      | 1           | 2           | 1           | 2         | 2           | 2           |
|                                                    | 13     | 13) Standards are not visible in the area and known to area stakeholders.                                           | 1           | 1           | 1           | 1         | 2           | 2           |
|                                                    | 14     | 14) 5 S is run on a daily basis.                                                                                    | 1           | 2           | 1           | 2         | 1           | 2           |
|                                                    | 15     | 15) Quantities and limits can not easily be seen.                                                                   | 1           | 1           | 2           | 2         | 2           | 2           |
|                                                    | 16     | 16) Working environment is healthy and pleasant.                                                                    | 2           | 3           | 1           | 2         | 2           | 3           |
| Sustain                                            |        | <b>Maintain discipline through systems and a supportive culture</b>                                                 |             |             |             |           |             |             |
| Training , reinforcement and measurement           | 17     | 17) Standards are set and followed.                                                                                 | 1           | 1           | 1           | 2         | 1           | 1           |
|                                                    | 18     | 18) Workers in area have not been trained in 5S                                                                     | 1           | 1           | 1           | 2         | 1           | 1           |
|                                                    | 19     | 19) Personal belongings can be easily stored                                                                        | 3           | 3           | 2           | 2         | 1           | 1           |
|                                                    | 20     | 20) Goals of 5S have been achieved.                                                                                 | 1           | 2           | 1           | 2         | 2           | 2           |
|                                                    |        | <b>Total Score:</b>                                                                                                 | <b>26</b>   | <b>38</b>   | <b>28</b>   | <b>40</b> | <b>35</b>   | <b>43</b>   |
|                                                    |        | <b>Aerage score (Total Score/20)</b>                                                                                | <b>1.30</b> | <b>1.90</b> | <b>1.40</b> | <b>2</b>  | <b>1.75</b> | <b>2.15</b> |

1 = little / no apparent (<20%), 2= Meets Minimal 5S Requirements (40%), 3= Meets Several 5S Requirements (60%), 4= Meets Most 5S Requirements (80%), 5= 5S Compliant (100%)

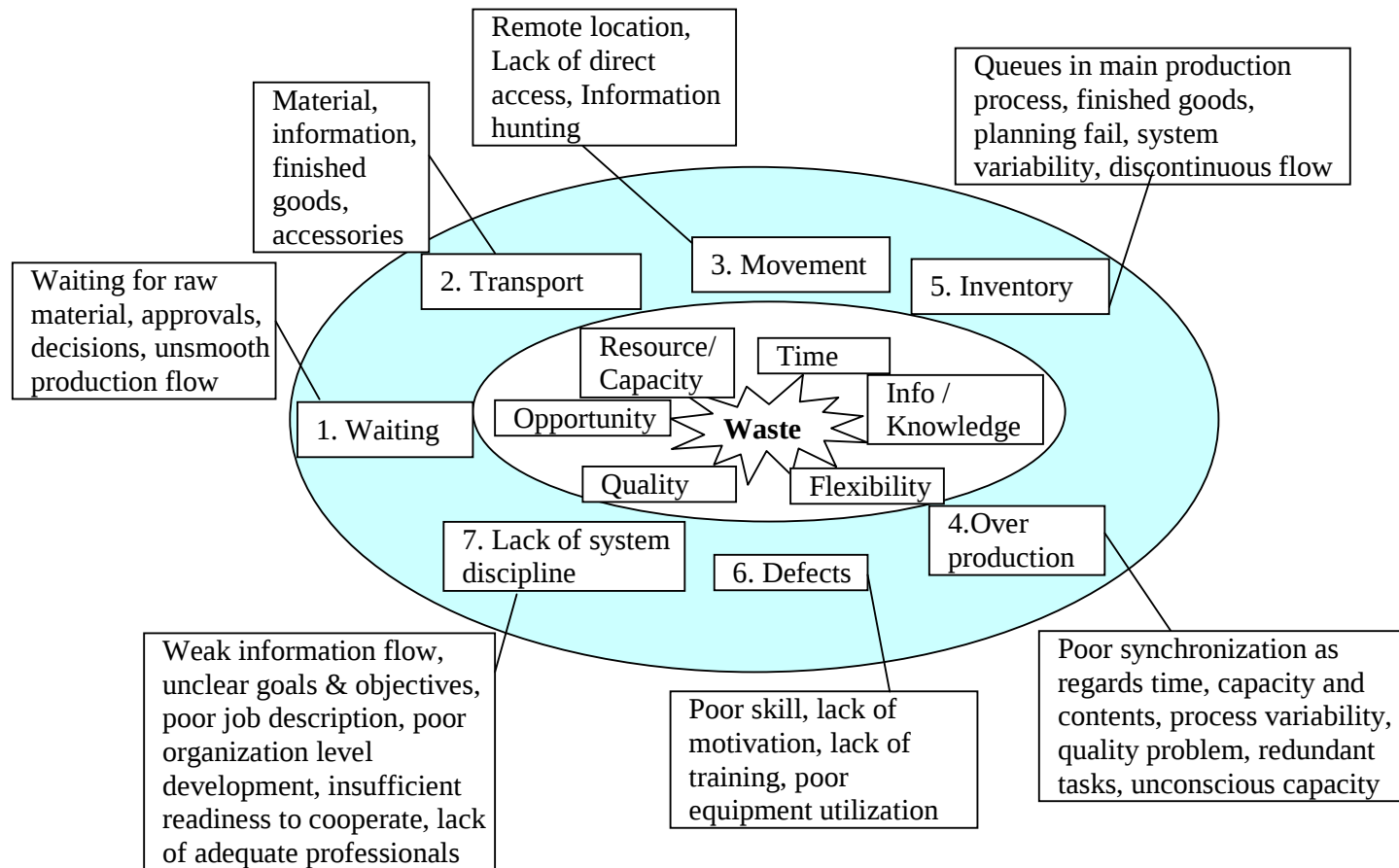


Figure 5.13 Identified Causes of Waste

## 5S Management Walk to Sustain

### 1. Objective

- a. Support employees, b. New role for manager.

### 2. Method

- a. Direct observation, b. Visual management, c. Leave feedback card.

### 3. Key Points

- a. Employees need this support, b. Cannot be effective without 2S first, c. Learn to protect any gains that are made.

## 5.7 Changeover Time

Changeover is the total process of changing a production line from running one product to another and the changeover time is the elapsed time between the last good previous product, and the first good next product at the right speed.

It is expressed as,  $\text{Changeover time} = \text{Setup time} + \text{Startup time}$

Setup time is the time to adjust or replace machine parts to accommodate the new product and the startup time is the time to bring the process up to right speed and quality.

Most often the changeover happens like dismount tools – change tools – adjustments (machine stopped) – trials, when the last part from production batch is processed. Machine is stopped and changeover operations all happen, machine will start again after completion of trials.

### 5.7.1 Advantage of set-up reduction

Trial – runs are minimized, urgent orders can be quickly produced, improved productivity (increased efficiency, less waste, less machine defects), set – up becomes easy, reduction of intermediate inventory, improved flexibility, reduced work in progress, first output, early fault finding and quality problems are found earlier, early start up and smooth production running.

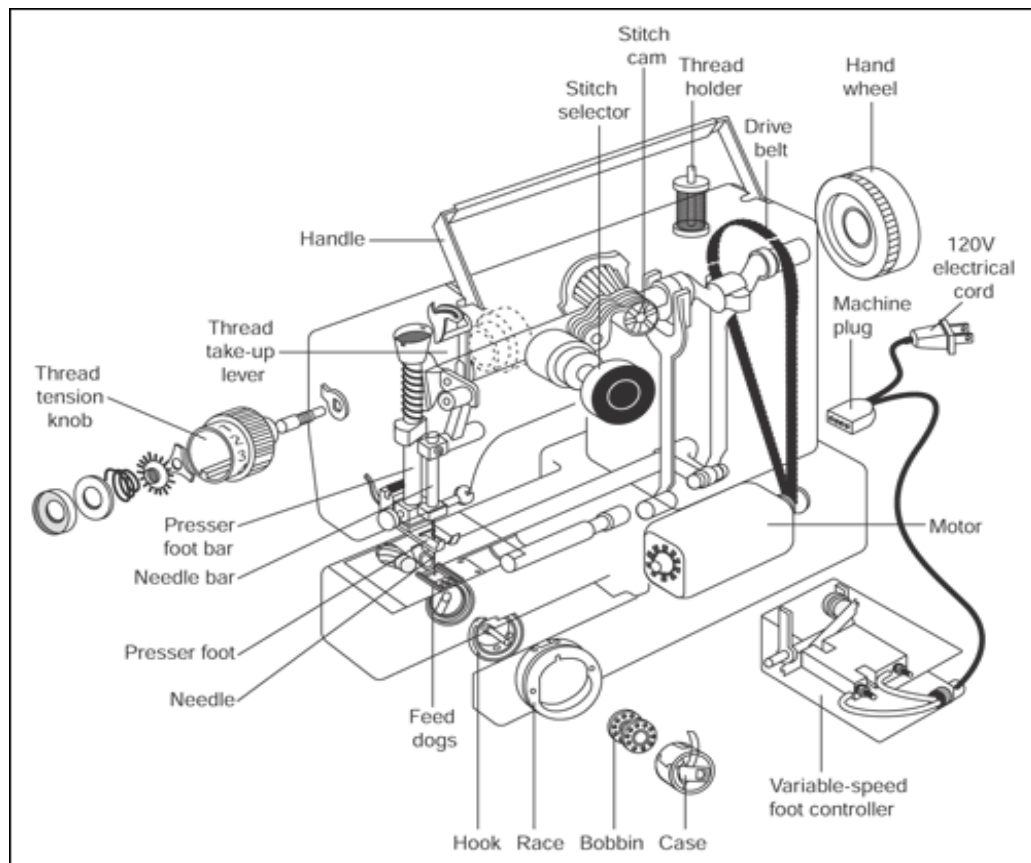
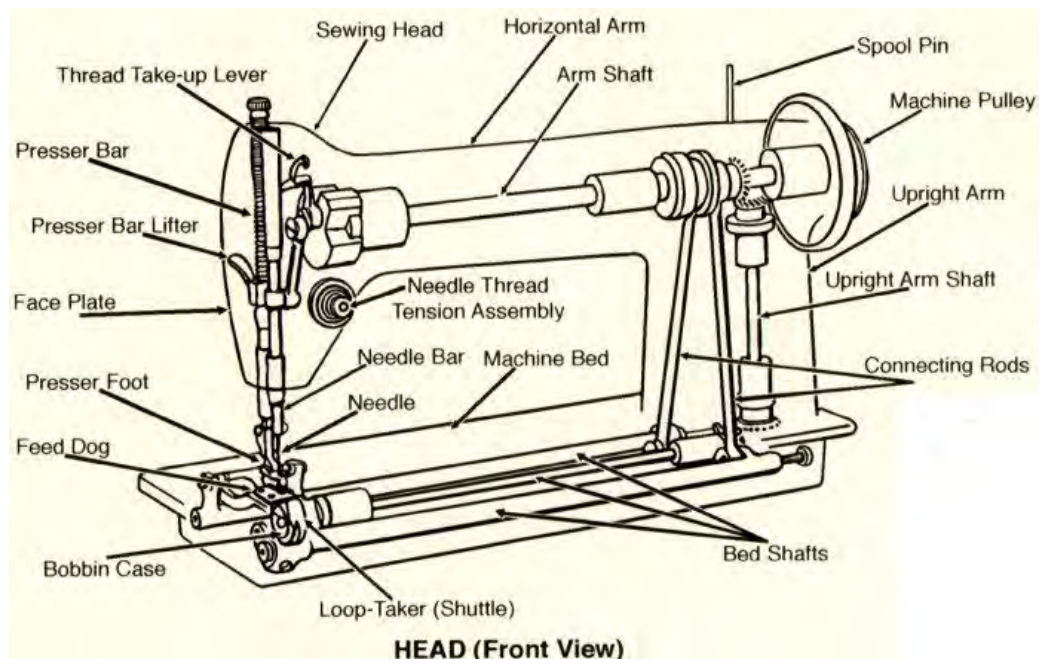


Figure 5.14 Simplified Machine Construction

### 5.7.2 Key elements of change over

#### 1. Internal Activities:

Must be performed while the machine / process is stopped i.e. not making parts

Examples are – Removing work from the machine, Removing tools, Cleaning down the work surfaces, Fixing new tools in place, Fixing the new work piece in place, Trial run and adjustment the machine.

#### 2. External Activities

Can be performed whilst the machine or process is running i.e. making parts.

Examples are – Getting instructions for the next job, Layout or Line balance sheet, Measurement chart, Operation chart, 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.

While applying the technique in factory consideration should be given to In Process (IP) and Not In Process (NIP), Run Time Activities (RTA) and Stop Time Activities (STA), Critical Change – Time (CCT) and Non – Critical Change – Time (NCT)

Table 5.7 Changeover Time

| Changeover time is the elapsed time between the last good previous product, and the first good next product at the right speed |                       |                               |                  |      |                                |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------|------------------|------|--------------------------------|
| Measurement Keys                                                                                                               | Waste                 | Activities Happened           | Time Requirement |      | Remarks                        |
| Order Changeover                                                                                                               | Machines Adjustment   | m/c allocation                | 1800             |      | supervisor involvement         |
|                                                                                                                                |                       | m/c problem                   | 1500             |      | maintenance problem            |
|                                                                                                                                |                       | thread tension                | 1500             |      | mechanic                       |
|                                                                                                                                |                       | lubrication                   | 600              |      | need care                      |
|                                                                                                                                |                       | m/c not working               | 2700             |      | no immediate solution found    |
|                                                                                                                                | Operators movement    | m/c setup                     | 2400             |      | to help the mechanic           |
|                                                                                                                                |                       | m/c layout                    | 2400             |      | good practice                  |
|                                                                                                                                |                       | m/c folder / guide collection | 1800             |      | for back tape & shoulder joint |
|                                                                                                                                | Machines Movement     | m/c layout                    | 2400             |      | inevitable                     |
|                                                                                                                                |                       | m/c change                    | 1200             |      | from different line            |
|                                                                                                                                | Waiting / not working |                               |                  | 8100 |                                |
|                                                                                                                                | Training              |                               | n/a              |      | at the time of setting         |
| <b>Total Changeover Time</b>                                                                                                   |                       |                               | 26400            | sec  | 5 hrs is reducible by 50%      |
| It is for only sewing floor. The Start up time was not considered here.                                                        |                       |                               |                  |      |                                |

Table 5.8 Changeover Time of different lines

| Changeover time is the elapsed time between the last good previous product, and the first good next product at the right speed |                     |                     |                  |       |       |       |                        |                                |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|------------------|-------|-------|-------|------------------------|--------------------------------|
| Measurement Keys                                                                                                               | Waste               | Activities Happened | Time Requirement |       |       |       |                        | Remarks                        |
| Line No.                                                                                                                       |                     |                     | 3D1              | 3B2   | 6B    | 7A    | 7B                     |                                |
| Order Changeover                                                                                                               | Machines Adjustment | m/c allocation      | 1800             | 1800  | 2100  | 1800  | 1500                   | supervisor involvement         |
|                                                                                                                                |                     | m/c problem         | 1500             | 1320  | 1800  | 1500  | 1200                   | maintenance problem            |
|                                                                                                                                |                     | thread tension      | 1500             | 1200  | 1200  | 1080  | 1200                   | mechanic                       |
|                                                                                                                                |                     | lubrication         | 600              | 600   | 0     | 900   | 0                      | need care                      |
|                                                                                                                                |                     | m/c not working     | 2700             | 1800  | 1800  | 1500  | 0                      | no immediate solution found    |
|                                                                                                                                | Total time in sec   |                     | 8100             | 6720  | 6900  | 6780  | 3900                   |                                |
|                                                                                                                                | Operators movement  | m/c setup           | 2400             | 2400  | 2100  | 2700  | 2100                   | to help the mechanic           |
|                                                                                                                                |                     | m/c layout          | 2400             | 2100  | 1800  | 1800  | 1500                   | good practice                  |
|                                                                                                                                |                     | m/c folder / guide  | 1800             | 1800  | 2100  | 1620  | 1500                   | for back tape & shoulder joint |
|                                                                                                                                | Total time in sec   |                     | 6600             | 6300  | 6000  | 6120  | 5100                   |                                |
|                                                                                                                                | Machines Movement   | m/c layout          | 2400             | 1800  | 1500  | 1500  | 1500                   | inevitable                     |
|                                                                                                                                |                     | m/c change          | 1200             | 1800  | 1800  | 1200  | 1200                   | from different line            |
|                                                                                                                                | Total time in sec   |                     | 3600             | 3600  | 3300  | 2700  | 2700                   |                                |
|                                                                                                                                | Waiting not working |                     | 8100             | 3600  | 2400  | 1800  | 1200                   |                                |
|                                                                                                                                | Total time in sec   |                     | 8100             | 3600  | 2400  | 1800  | 1200                   |                                |
| Training                                                                                                                       |                     | n/a                 | 1200             | 1200  | 1200  | 1200  | at the time of setting |                                |
| Total time in sec                                                                                                              |                     | 0                   | 1200             | 1200  | 1200  | 1200  |                        |                                |
| Total Changeover Time in sec                                                                                                   |                     |                     | 26400            | 21420 | 19800 | 18600 | 14100                  |                                |
| It is for only sewing floor. The Start up time was not considered here.                                                        |                     |                     |                  |       |       |       |                        |                                |

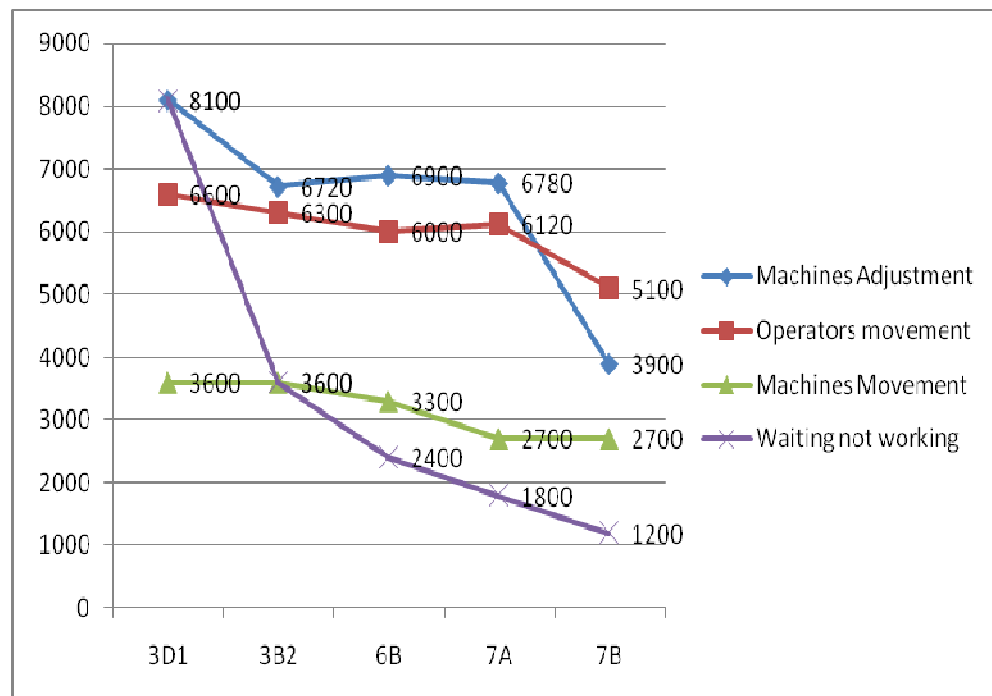
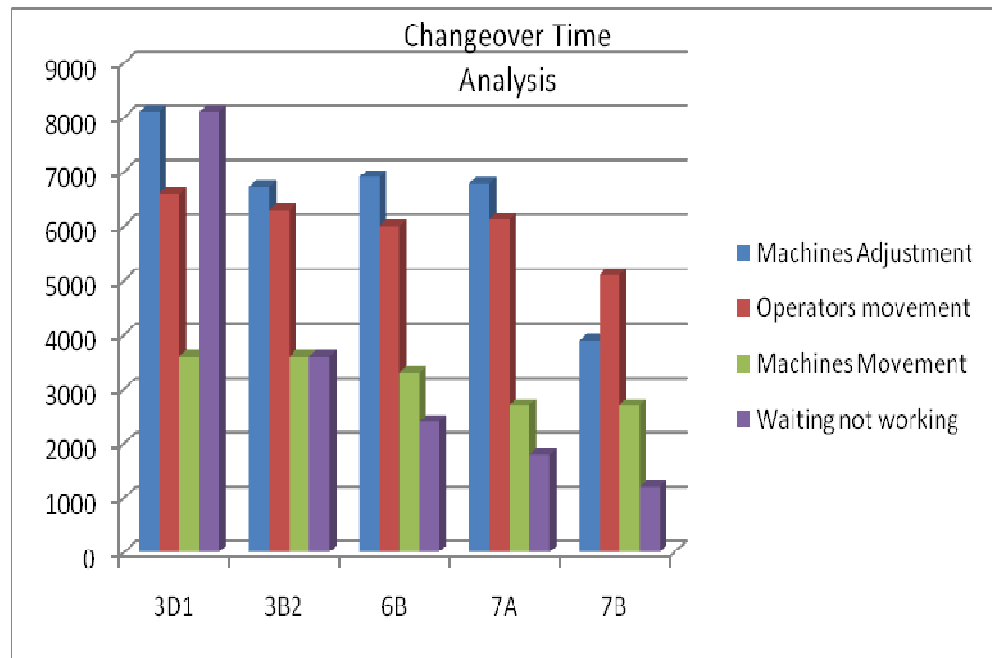


Figure 5.15 Changeover Time variations in different Lines

### 5.7.3 *The reason behind excess changeover time*

Changeover operation is performed when new styles are entered in the line.

A lot of time is wasted due to the following problems:

Guide adjustment, Lopper adjustment, Trim adjustment, Tension Adjustments (upper thread tension assembly and bobbin case), Knotting or breaking thread, Skipped stitches, Feed dog height and timing, Pendulum timing (zigzag machines), Needle position, Presser bar height and pressure,

Amateur mechanics are assigning to solve the problem.

Start up time is more because of unavailability of various accessories at that time.

Some times operator makes delay without any reason.

More time is spent for trial operation and for adjustment till the machines is good enough for production.

The application of Change Over technique is like the following way –

Observe, describe and map the change over processes, determine all activities in the change over process, think which internal and external elements are. Differentiate internal and external activities and prepare in advance for the Change Over, simplify and standardize the process / tools, reduce effort, motions or distances, simultaneous operations, teamwork to quickly hit the set-up activities, establish user friendly systems e.g. sign-off procedures, determine optimum storage locations

### 5.7.4 *Guide lines for changeover time reduction*

#### **A. For streamlining internal activities**

Start the setup operation before the day of new style operation, assign the expert mechanics at the right time to solve the adjustment problem or any machine problem, implement parallel operation for quicker setup, optimize the start-up time by eliminating trials and adjustment, eliminating trials and adjustments is done by making good settings before the operator startup the machine for new operation.

**B. For streamlining external activities**

Make sure that all accessories are available when it is needed, make sure that all accessories and equipments are arranged properly in store and maintenance department, so all these things can bring at a right speed without much time spends.

**C. To reduce the changeover time need to follow the following steps**

Measure and record changeover times, put the pressure on reducing and keeping the setup times, involve the team in analysis, make a video, and get operators to record the critique.

**5.8 Possible Improvement in the value chain****Operational Improvements**

A reduction in lead time, an increase in productivity, a reduction in work-in-process inventory, an improvement in quality, a reduction in space utilization

**Administrative Improvements**

Reduction in order processing errors, streamlining of customer service functions so that customers are no longer placed on hold, reduction of paperwork in office areas, reduced staffing demands, allowing the same number of office staff to handle larger numbers of orders, documentation and streamlining of processing steps, enabling non critical functions to be outsourced and allowing the company to focus its efforts on customers' needs, reduction in turnover and the resulting costs of attrition, implementation of job standards and pre-employment profiling, ensuring the hiring of only above-average performers

**Strategic Improvements**

Reduced lead time, reduced costs, and improved quality provide opportunities for new marketing campaigns, allowing the company to gain market share from competitors that are slower, have higher costs, or have poorer quality.

## CHAPTER SIX

# VALUE STREAM MAPPING

### 6.1 Introduction

Value stream mapping is the paper pencil work to show the material and information flow from the customer order placing to the supply of finished goods with the visualization of waste and the scope of improvement in the process.

### 6.2 Mapping the present state

A Present State Map shows work processes as they currently exist. This is vital both to understand the need for change and to understand where opportunities lie. A broad-based team should perform this exercise. It is done by simply following the steps for a family of related products that, essentially, use the same processes and sequence. The steps are like the followings –

First the customer, supplier and production control icons are drawn. Customer requirements per month and per day are entered. Outbound and inbound shipping icon and truck with delivery frequency are drawn. Process boxes are added in sequence, left to right and data boxes below. Process attributes are added to data boxes [23].

Operator symbols and numbers are added. Inventory locations and levels in days of demand and graph are placed at bottom. Push, pull and FIFO icons, working hours, cycle and lead times are added to show the clear description.

Using these symbols the current state VSM (figure 6.2) is drawn. The figure shows the description of every process involved in the production lead time. The figure 6.3 shows the simplified version of the figure 6.2 which has the main processes only.

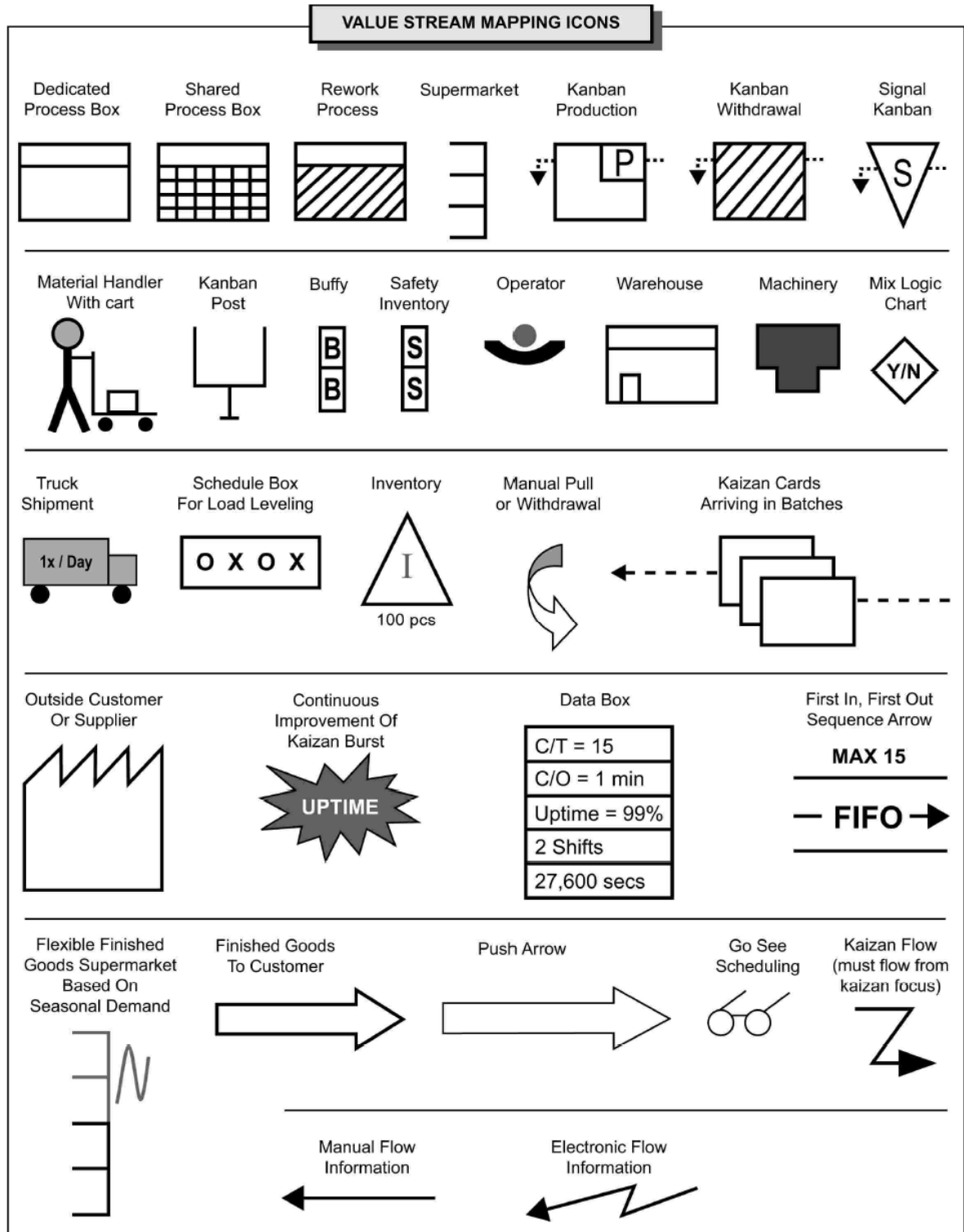
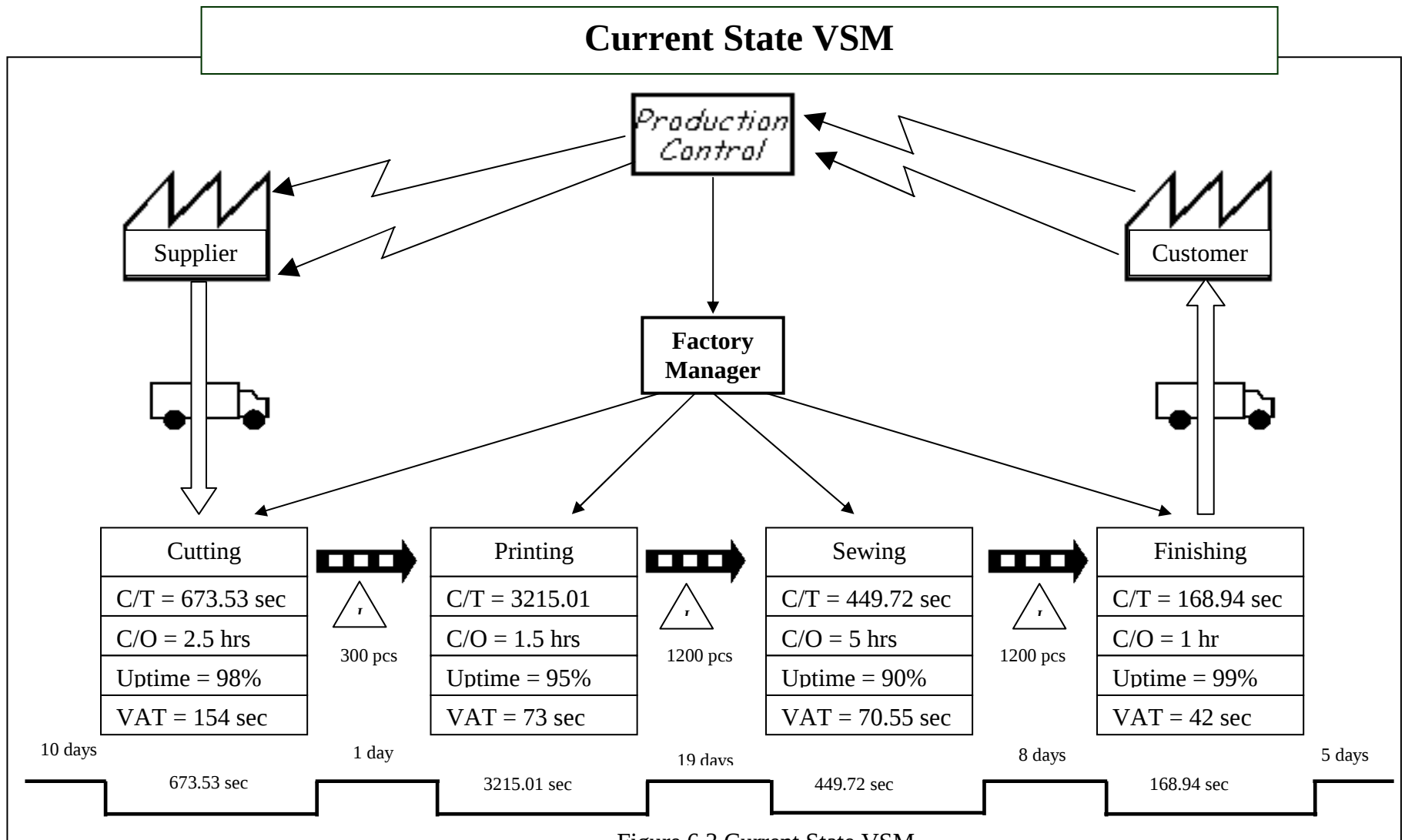
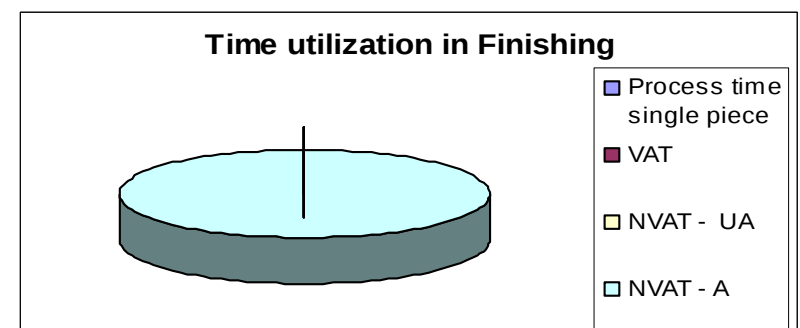
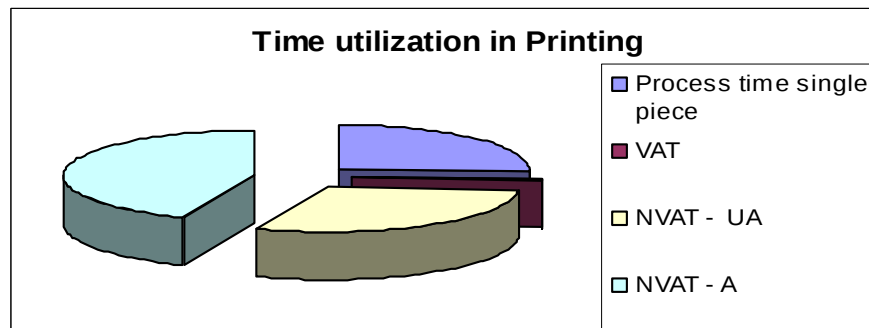
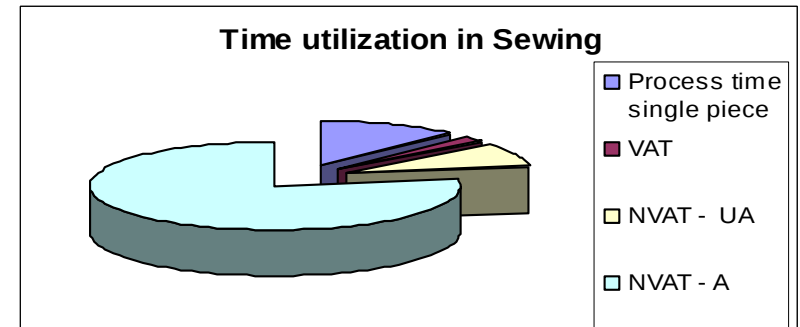
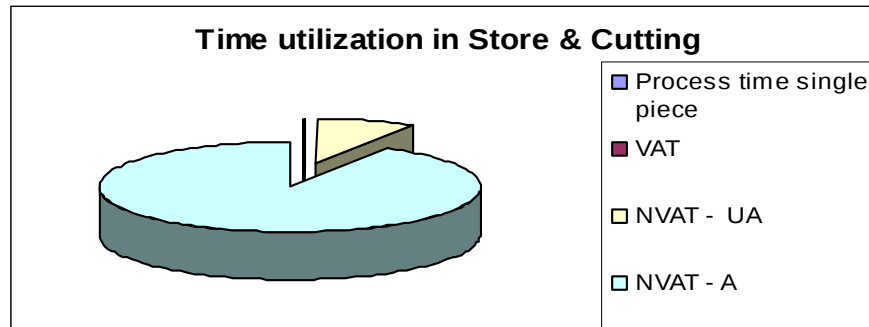


Figure 6.1 VSM symbols [23]







| Activity Name   | Process time single piece (PT) | VAT           | VAT % of PT | NVAT - UA       | % of Activity | NVAT - A         | % of Activity | Total Activity Time |
|-----------------|--------------------------------|---------------|-------------|-----------------|---------------|------------------|---------------|---------------------|
| Store & Cutting | 673.53                         | 154.00        | 22.86       | 22536.40        | 8.25          | 249840.00        | 91.50         | 273049.93           |
| Printing        | 3215.01                        | 73.00         | 2.27        | 3740.00         | 29.98         | 5520.00          | 44.25         | 12475.01            |
| Sewing          | 449.72                         | 70.55         | 15.69       | 308.23          | 8.55          | 2845.14          | 78.96         | 3603.09             |
| Finishing       | 168.94                         | 42.00         | 24.86       | 126.94          | 0.04          | 290147.00        | 99.90         | 290442.88           |
| <b>Total</b>    | <b>4507.20</b>                 | <b>339.55</b> | <b>7.53</b> | <b>26711.57</b> | <b>4.61</b>   | <b>548352.14</b> | <b>94.61</b>  | <b>579570.91</b>    |

Figure 6.4 Pie Chart Showing the Value Added, Non VA and Process time

### 6.3 Future state value stream Mapping

Key questions and trade offs for the future state include to

Reviewing the present state map, calculating the takt time, designing the production system such that it is being produced to finished goods supermarket from which the customer pulls, or directly to shipping.

It needs to decide at which point the production should be scheduled and notifying the production mix at the “pacemaker process”,

Finally the processes that will be necessary for the value stream to flow in accordance to the Future-State Map is identified.

Here the future state VSM suggests a supermarket with kanban in the stage between cutting and sewing section. The lead time is larger for unwanted delay at every section. The JIT is not applicable in this situation but pull is applicable. The plan must not suggest long retention time in any stage. If there is so much doubt in capability then every section needs to be structured in the same capacity building criteria. The store and cutting inventory needs more observation. Sewing WIP should be removed in future state VSM. If we simply eliminate the Non Value Added Avoidable time (NVA - A) and arbitrarily select one day safety time between every processes the lead time will definitely decrease by 38 days. The other process improvement techniques will further develop the main business function.

Cutting may develop using required manpower and following the processes accordingly. Waiting time must be eliminated; some works like quality checking and number sticker adding may be done in parallel situation.

Sewing improvement is done by layout correction, line balancing, worker motivation, skill development, maintenance support, proper input, close supervision and monitoring. So that the SMV is decreased and the rate production increased.

Finishing and ironing improvement is done by maintain a smooth flow and reducing the waiting time. The finishing accessories were supplied properly.

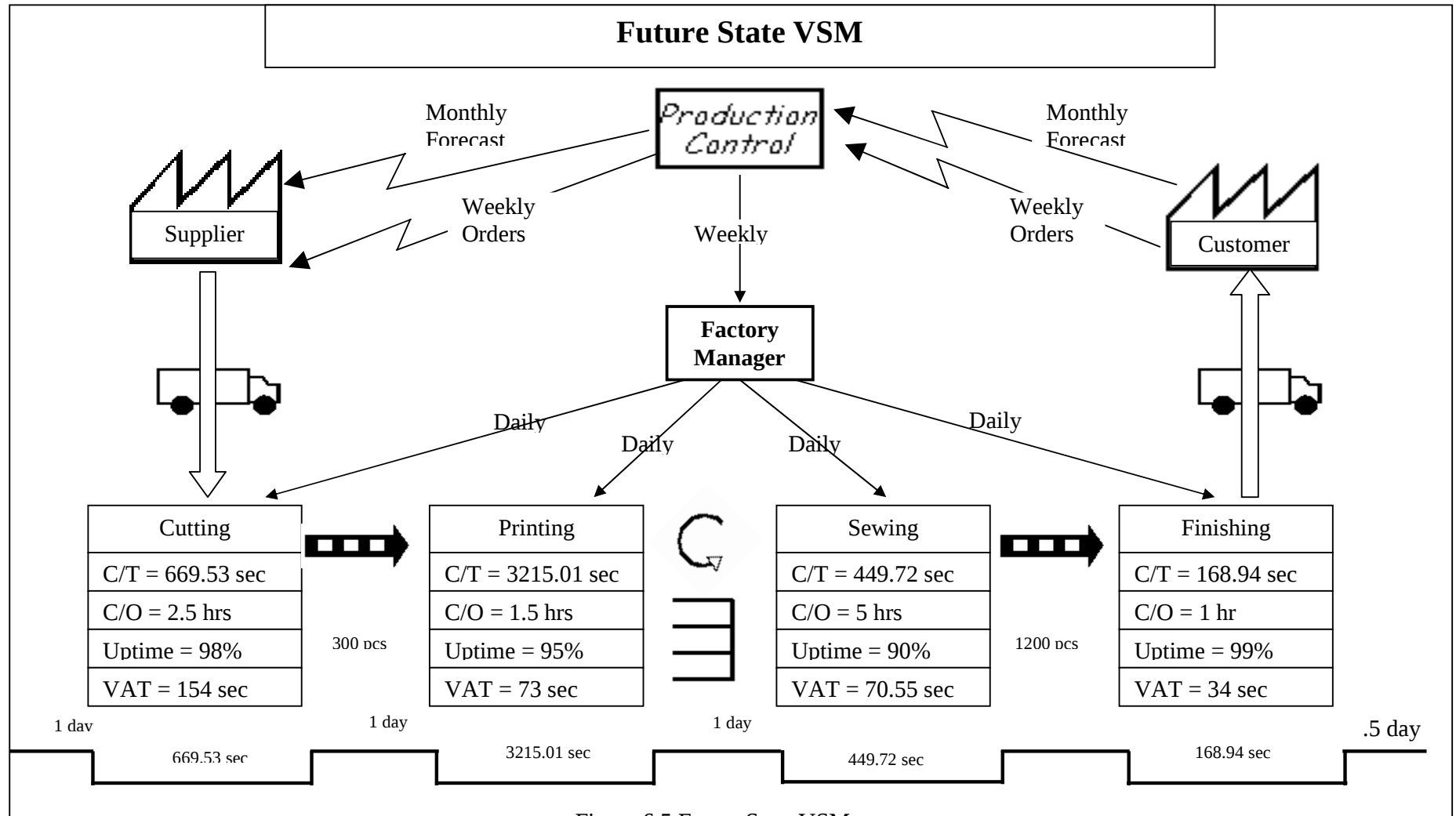


Figure 6.5 Future State VSM

The new Future State VSM is drawn by following the steps identified in the previous Current State VSM and proposed Future state VSM. The Production unit needs to work with the required rate of production and to maintain the quality and efficiency. The process time is shortened by the proper follow up and motivation, delay time is removed by proper planning and caring and the schedule is maintained with the help of all related and concerned people.

The main problem was to perform the scheduled job according to the demand and making all actions in time to supply the materials to the definite work centre.

After considering the urgency and all respective personnel engagement the unwanted and unexpected circumstances happened to this style are the accessories and approval problem.

The size label with definite size and care label was not sufficient. According to the plan the sewing section was to receive 5% extra label but they could not keep the exact calculation of these labels.

The thread shortage and shading problem was another crisis. The line was to re – cone the thread because of quantity breakdown of the order.

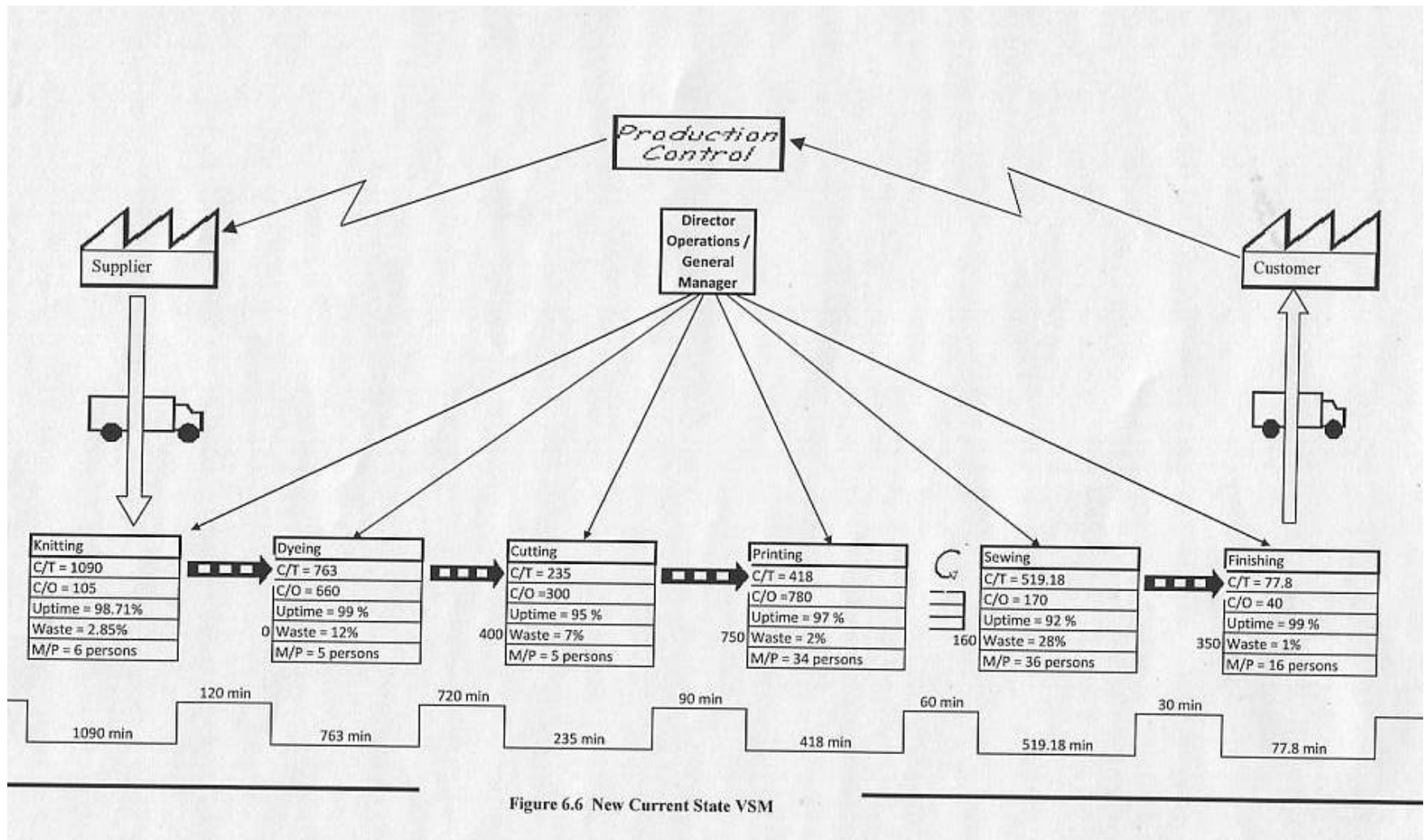
The fabric supply from the Dyeing section was not perfect. They were supplying at the last moment of their schedule and the cutting section suffered with relaxation time and the cutting plan.

## 6.4 Practical Work

After all these discussion, an order was followed and some lean techniques and decision was applied, then the VSM became as like the next figure. Here the process time is taken in minute. The value adding time and non value adding time avoidable and unavoidable shows the improvement as the result of following the order in every step. The step by step follow up made lead time shorter and the non value adding avoidable time is decreased then the previous study.

Table 6.1 Process Time, VAT, NVA, NVU time

| Knitting                   |          |               |               |               | Dyeing                             |            |            |            |            | Cutting                      |           |           |            |            |
|----------------------------|----------|---------------|---------------|---------------|------------------------------------|------------|------------|------------|------------|------------------------------|-----------|-----------|------------|------------|
| C/T = 1090                 |          |               |               |               | C/T = 763                          |            |            |            |            | C/T = 235                    |           |           |            |            |
| C/O = 105                  |          |               |               |               | C/O = 660                          |            |            |            |            | C/O = 300                    |           |           |            |            |
| Uptime = 98.71%            |          |               |               |               | Uptime = 99 %                      |            |            |            |            | Uptime = 95 %                |           |           |            |            |
| Waste = 2.85%              |          |               |               |               | Waste = 12%                        |            |            |            |            | Waste = 7%                   |           |           |            |            |
| M/P = 6 persons            |          |               |               |               | M/P = 5 persons                    |            |            |            |            | M/P = 5 persons              |           |           |            |            |
|                            |          |               |               |               |                                    |            |            |            |            |                              |           |           |            |            |
|                            |          |               |               |               |                                    |            |            |            |            |                              |           |           |            |            |
| Knitting                   |          |               |               |               | Dyeing                             |            |            |            |            | Cutting                      |           |           |            |            |
| Process                    | Time     | VAT           | NVA           | NVU           | Process                            | Time       | VAT        | NVA        | NVU        | Process                      | Time      | VAT       | NVA        | NVU        |
| M/C set up                 | 105      | 0             | 25            | 80            | Turning Fabric                     | 8          | 0          | 0          | 8          | Sstoring                     | 30        | 0         | 0          | 30         |
| Waiting                    | 10       |               | 10            |               | Order placement                    | 15         | 0          | 0          | 15         | Relaxing                     | 780       | 0         | 60         | 720        |
| Yarn fitting               | 15       | 15            |               |               | M/C sheduleing                     | 20         | 0          | 0          | 20         | Spreading                    | 86        | 0         | 0          | 86         |
| M/C run                    | 780      | 770           | 0             | 10            | Receipe preparation                | 25         | 25         | 0          | 0          | Marking                      | 15        | 15        | 0          |            |
| Fabric unloading           | 7        | 0             | 0             | 7             | M/C loading                        | 10         | 0          | 0          | 10         | Cutting                      | 47        | 38        | 0          | 9          |
| Transport to quality table | 3        | 0             | 0             | 3             | dyeing                             | 450        | 450        | 0          | 0          | Numbering                    | 28        | 0         | 0          | 28         |
| Quality check              | 30       | 30            | 0             | 0             | Fabric unloading                   | 15         | 0          | 0          | 15         | Bundling                     | 19        | 0         | 0          | 19         |
| Store                      | 10       |               |               | 10            | dewatering                         | 30         | 30         | 0          | 0          | Waiting                      | 13        | 0         | 13         | 0          |
| Waiting                    | 120      | 0             | 80            | 40            | Finishing                          | 155        | 155        | 0          | 0          | Transport                    | 2         | 0         | 0          | 2          |
| Transport to dyeing        | 10       | 0             | 0             | 10            | QC                                 | 35         | 28         | 0          | 7          | QC                           | 25        | 25        | 0          | 0          |
|                            | 1090     | 815           | 115           | 160           |                                    | 763        | 688        | 0          | 75         |                              | 1045      | 78        | 73         | 894        |
|                            |          | <b>74.77%</b> | <b>10.55%</b> | <b>14.68%</b> |                                    |            | <b>90%</b> |            | <b>10%</b> |                              |           | <b>7%</b> | <b>7%</b>  | <b>86%</b> |
| Total processing Time      | 1090     |               |               |               | Total processing Time              | 763        |            |            |            | Total processing Time        | 1045      |           |            |            |
| Total M/P                  | 6        |               |               |               | Total M/P                          | 5          |            |            |            | Total M/P                    | 25        |           |            |            |
| Inventory                  | 0        |               |               |               | Inventory                          | 400        |            |            |            | Inventory                    | 750       |           |            |            |
| Uptime                     | 98.71%   |               |               |               | Uptime                             | 99%        |            |            |            | Uptime                       | 95%       |           |            |            |
| Waste                      | 2.85%    |               |               |               | Waste                              | 12%        |            |            |            | Waste                        | 7.30%     |           |            |            |
| Duration                   | 24/07/08 | 28/07/08      |               |               | Duration                           | 29/07/08   | 31/7/08    |            |            | Duration                     | 06/08/08  | 10/08/08  |            |            |
|                            |          |               |               |               |                                    |            |            |            |            |                              |           |           |            |            |
| Printing                   |          |               |               |               | Sewing                             |            |            |            |            | Finishing                    |           |           |            |            |
| Process                    | Time     | VAT           | NVA           | NVU           | Process                            | Time       | VAT        | NVA        | NVU        | Process                      | Time      | VAT       | NVA        | NVU        |
| Input                      | 10       | 0             | 0             | 10            | Transport                          | 7          | 0          | 0          | 7          | Transport & Input            | 3         | 0         | 0          | 3          |
| Counting                   | 30       | 0             | 0             | 30            | Waiting                            | 40         | 0          | 25         | 15         | Ironing, QC, Poly, CTN (SMV) | 4.8       | 4.8       | 0          | 0          |
| Design & Frame Making      | 134      | 80            | 22            | 32            | M/C layout                         | 105        | 45         | 0          | 60         |                              |           |           |            |            |
| Colour Making              | 68       | 40            | 15            | 13            | SMV                                | 12.18      | 12.18      | 0          | 0          | Waiting                      | 70        | 0         | 60         | 10         |
| Spreading                  | 50       | 0             | 15            | 35            | Waiting                            | 306        | 0          | 269.46     | 36.54      |                              |           |           |            |            |
| Printing                   | 57       | 45            | 0             | 12            | QC                                 | 43         | 35         | 8          | 0          |                              |           |           |            |            |
| Drying                     | 17       | 17            | 0             | 0             | Transport                          | 6          | 0          | 0          | 6          |                              |           |           |            |            |
| Hanging                    | 26       | 26            | 0             | 0             |                                    |            |            |            |            |                              |           |           |            |            |
| QC                         | 12       | 12            | 0             | 0             |                                    |            |            |            |            |                              |           |           |            |            |
| Transport                  | 14       | 0             | 0             | 14            |                                    |            |            |            |            |                              |           |           |            |            |
|                            | 418      | 220           | 52            | 146           |                                    | 519.18     | 92.18      | 302.46     | 124.54     |                              | 77.8      | 4.8       | 60         | 13         |
|                            |          | <b>53%</b>    | <b>12%</b>    | <b>35%</b>    |                                    |            | <b>18%</b> | <b>58%</b> | <b>24%</b> |                              |           | <b>6%</b> | <b>77%</b> | <b>17%</b> |
| Total processing Time      | 418      |               |               |               | Total processing Time              | 519.18     |            |            |            | Total processing Time        | 77.8      |           |            |            |
| Total M/P                  | 34       |               |               |               | Total M/P                          | 29+2+3+1+1 |            |            |            | Total M/P                    | 16        |           |            |            |
| Inventory                  | 160      |               |               |               | Inventory                          | 350        |            |            |            | Inventory                    | 200       |           |            |            |
| Uptime                     | 97%      |               |               |               | Uptime                             | 92%        |            |            |            | Uptime                       | 98%       |           |            |            |
| Waste                      | 2%       |               |               |               | Waste                              | 28%        |            |            |            | Waste                        | 40%       |           |            |            |
|                            |          |               |               |               | Op/H/L/L/C Sup, QC,Mechanics,Store |            |            |            |            |                              |           |           |            |            |
| Duration                   | 9/8/2008 | 10/8/2008     |               |               | Duration                           | 10/8/2008  | 14/8/2008  |            |            |                              | 11/8/2008 | 14/8/2008 |            |            |



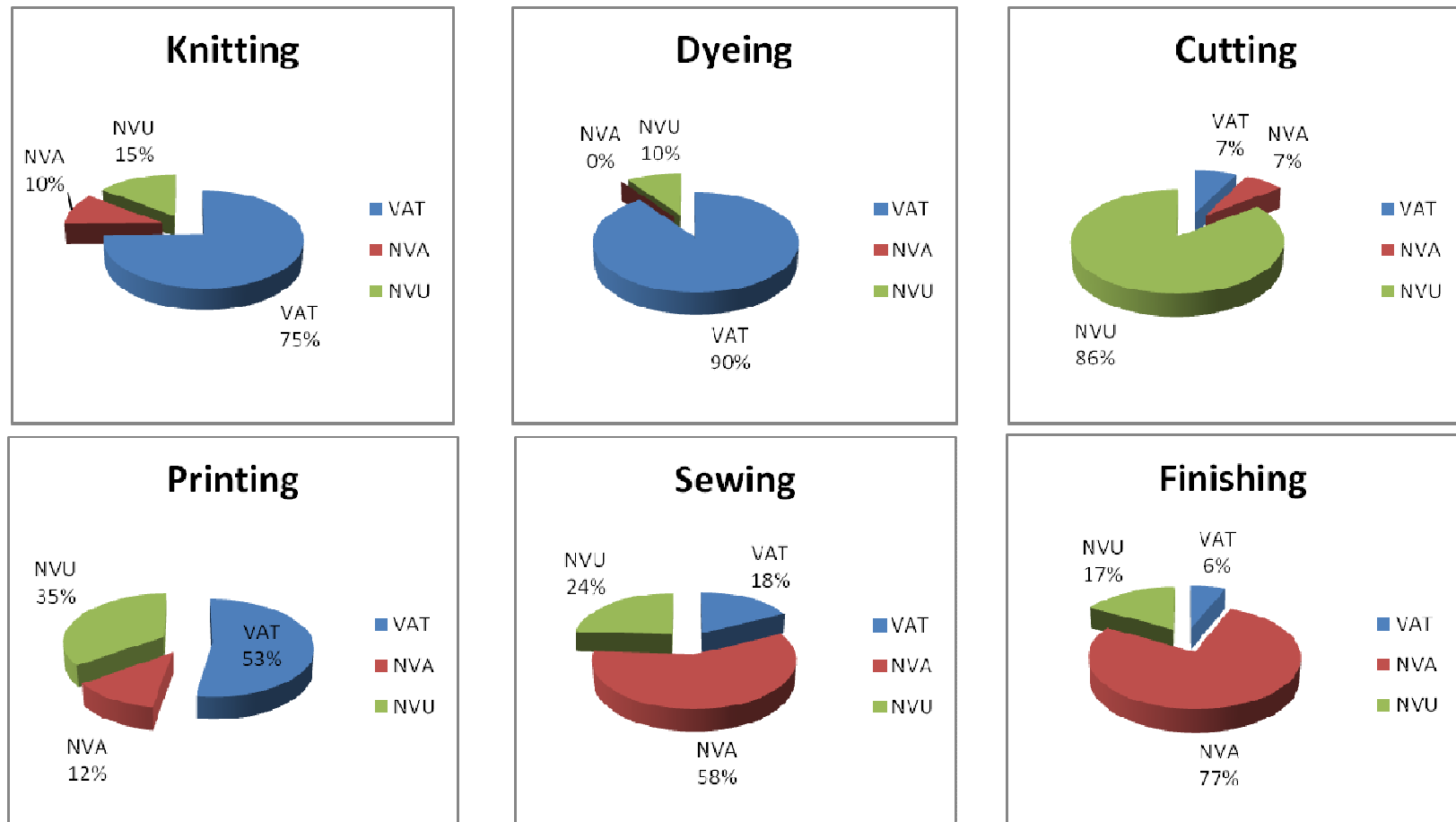


Figure 6.7 Percentage of VAT, NVA &amp; NVU

## CHAPTER SEVEN

### LEAN IMPLEMENTATION FRAME WORK

#### 7.1 Introduction

The implementation of lean tools and techniques need better study, analysis and experimentation because of unavailability of lean organization in our RMG sector. The different industry is trying to implement several tools like VSM, cellular manufacturing, supermarket, 5'S, pull system, set up reduction (SMED). The full implementation may take several years to transform from traditional to lean organization. Here an implementation frame work is shown with the present study experience. Seventeen years ago, the International Motor Vehicle Program needed a label to describe the phenomenon they were observing in their study of Toyota. It finds that Toyota needed less human effort to design, make, and service products, required less investment for a given amount of production capacity, created products with fewer delivered defects and fewer in-process turn-backs, utilized fewer suppliers with higher skills, went from concept-to-launch, order-to-delivery, and problem-to-repair in less time with less human effort, could cost-effectively produce products in lower volume with wider variety to sustain pricing in the market while growing share, needed less inventory at every step from order to delivery.

#### 7.2 Lean Manufacturing

Lean manufacturing is a performance-based process used in manufacturing organizations to increase competitive advantage. Lean manufacturing techniques are based on the application of five principles to guide management's actions toward success:

1. Value: The foundation for the value stream that defines what the customer is willing to pay for.
2. The Value Stream: The mapping and identifying of all the specific actions required to eliminate the non-value activities from design concept to customer usage.

3. Flow: The elimination of all process stoppages to make the value stream “flow” without interruptions.

4. Pull: The ability to streamline products and processes from concept through customer usage.

5. Perfection: The ability to advocate doing things right the first time through the application of continuous improvement efforts.

It is an overall methodology that seeks to minimize the resources required for production by eliminating wastes that inflate costs, lead times and inventory requirements.

To produce the right product at the right time in the right quantity for the customer and to produce exactly what you need and nothing more... [5]

Lean is a business system for organizing and managing product development, operations, suppliers, and customer relations using systematic change and continuous improvement.

### 7.2.1 *Lean Principles*

Lean has the following principles to be adopted for becoming lean organization -

1. Eliminate Waste, 2. Learn Constantly, 3. Delay Commitment, 4. Deliver Fast, 5. Build Integrity In, 6. Empower the Team, 7. See the Whole [24].

Again Implementing Lean manufacturing the following key terms need to be ensured – Continuous Flow, Lean Machines Simplicity, Workplace organization, Parts Presentation, Reconfigurability, Product Quality, Maintainability, Ease of Access, Ergonomics

Lean deals with - production planning, factory automation, capital asset management, focus on the processes, human resource optimization, plant engineering, warehouse management, logistics, plant floor business intelligence, plant floor communications, operations, energy, health, safety, and environmental standards [14].

### 7.2.2 *Lean implementation program*

The lean implementation program may include the following steps:

1. Senior management to agree and discuss their lean vision
2. Management brainstorm to identify project leader and set objectives
3. Four stages of transactional Lean – Opportunity Identification,  
Solution design,  
Implementation,  
Continuous improvement
4. Communicate plan and vision to the workforce
5. Findings of volunteers to form the Lean Manufacturing Implementation Team  
(5-7 works best, all from different departments) and appointing them.
6. Training for the Implementation Team in the various lean tools
7. Selection of a Pilot Project – 5S is a good place to start
8. Run the pilot for 2-3 months - evaluate, review and learn from mistakes  
happened during the pilot run.
9. Rolling out of successful pilot to other factory areas
10. Evaluation of results, encouragement for feedback
11. Once one is satisfied that he has a habitual program, consider introducing the  
next lean tool [25].

There is [26] a ten steps process, taken from hundreds of successful functional manufacturing systems conversions to lean manufacturing, to implement lean. The steps are numbered and the order of implementation should exactly follow the step order.

The ten steps are given below:

Step 01: Reengineering the Manufacturing System

Step 02: Setup or Changeover time Reduction and Elimination

Step 03: Integrate Quality Control into Manufacturing

Step 04: Integrate Preventive Maintenance into Manufacturing

Step 05: Level, Balance, Sequence and Synchronize processes

Step 06: Integrate Production Planning and Control into Manufacturing

Step 07: Reduce Work-In-Process (WIP), Idle Time, Loss Time

Step 08: Integrate Suppliers in the Production System Analysis

Step 09: Autonomation with effective cost analysis and return on investment

Step 10: Computer-Integrated Manufacturing and Computer Aided Design

### 7.3 Five S

This is the tool which is easy to apply and needs no or little investment but gives the 25% to 50% space savings, missing items located, safety and quality improvement, capital equipment sales, new floor layout possibilities, conveyance aisles opened, full persons time saved (reduced motion), factory engaged, good working environment and makes visual control easier. First we need to identify the opportunity for improvement, so the every section of the factory needs to be taken under consideration and then the scope of implementation is found out and proper steps should be taken.

#### 5 S Improvement Opportunity

*I visited the area and noticed some opportunities for improvement:*

- ☐ 1S – Area is cluttered or messy
- ☐ 1S – Extra or unneeded items in area
- ☐ 2S – Tools not located with home and address
- ☐ 2S – Area not organized for least motion
- ☐ 3S – Area not clean
- ☐ 3S – Contaminants present
- ☐ 3S – Unsafe condition

Comments:

Initials

Date:

Figure 7.1 5'S Opportunity Identification

### 7.4 Current State Value Stream Mapping (CSVSM)

Mapping the present state needs detailed process walk

- Collection of present state data for each process:  
Cycle time: observed and effective, changeover time and frequency, % availability to demand, number of operators, working time, % quality level (first-pass yield), batch size

- Collection of present state working inventory data:  
Collect snapshot in actual units, every WIP (work in process) inventory location needs to be assessed, convert to time based on effective cycle time of downstream process.
- Collection of customer demand data and information-flow data
- Watch the process and needs to talk to the operators and gain their trust and support.
- State the facts as they are and nothing should be overlooked.

Drawing the current state map is the first step for waste identification and seeing the chances of improvement. It is a simple paper pencil work and understandable to all. Steps are like following - always collect information while walking the actual process, begin with a quick door-to-door walk, begin with shipping and work upstream, bring your stopwatch and do not rely on information that you do not personally obtain, map the whole value stream yourself, always draw by hand and in pencil.

### **7.5 Future State Value Stream Mapping (FSVSM)**

The FSVSM is drawn by analyzing the CSVSM. The scope of improvement, value added activities, cycle time improvement and the delays found in the total flow from supplier to customer is visible in the map, so where the pull or supermarket is possible are designed.

After the future state mapping it will be the current state for that time new current state mapping will be drawn thus the process goes on and on which means the continual improvement function.

### **7.6 The four thrusts of Lean Manufacturing**

Lean manufacturing organizations focus on four thrusts to support their lean manufacturing designs:

### 7.6.1 *Solid leadership*

Leadership that Communicates the vision, facilitates and models the behaviors of lean manufacturing, sets the standards for the organization, assists the workforce in adapting to the change, builds trust and inspires commitment, coaches and develops the workforce, find out the best performance of his team, constantly challenges the system.

### 7.6.2 *Team-based cultures*

Team culture that uses project-oriented team-based structures that focus on empowerment concepts, leverage knowledge by using highly skilled workers, Promote employee accountability and responsibility for work, advocate the continual development of the workforce, value diversity, believe that employee ownership of the final product is shared throughout the process.

### 7.6.3 *Communication systems*

Communication systems that advocate and develop processes to identify critical design issues as early in the process as possible, encourage “on-the-spot” decision-making processes that use the fewest resources to resolve critical design issues, promote knowledge sharing between hourly workers, management, and design personnel, drive the behaviors of internal operations, as well as focus on the behaviors of suppliers and customers, accept formal and informal communication behaviors.

### 7.6.4 *Simultaneous development and continuous improvement processes*

Simultaneous development and continuous improvement that design the product right the first time, use continuous improvement processes to identify the non-value-added problems, drive commitment to eliminating problems (controlling them is not enough), advocate just-in-time material control systems, promote constant improvement throughout the supply chain, leverage the knowledge of the organization with the knowledge bases of suppliers and customers, continually train

and develop highly skilled workers, use scoreboards or measurement systems to monitor progress

## **7.7 Implementation of Lean with time consideration**

### **The First Six Months: (Building Organizational Awareness)**

- Senior leaders clarify the business case for using lean manufacturing techniques and ensure that lean manufacturing techniques are consistent with the organization's long-term vision.
- Management assesses the organization's readiness to make the transition to lean manufacturing and management defines baseline measures of success.
- The organization defines a timetable consisting of communication, objectives, and scope of implementation.
- The vision of the redesigned organization strongly supports the linkage of business strategy to cultural strategy and it includes the alignment of the organization's communication, accountability, skills, processes, and systems.

### **Six Months to Year Two: (Creating the New Organization)**

- Redesign the organization to use lean manufacturing techniques
- Implement training and development processes to assist the transition
- Help leaders and employees make the transition to their new roles

### **Years Three through Four: (Aligning the Systems)**

- Continuous improvement processes are driven from bottom-up versus top-down and all organizational support systems are in alignment.
- Ongoing measurement and process monitoring systems are ingrained in the new culture.
- The bottom line is meeting the favorable expectations identified in the business case from the first six months.

### **Year Five: (Completing the Transformation)**

- The transformation to Lean Manufacturing Techniques is completed.
- Integration of Lean Manufacturing Techniques with suppliers begins.
- Ongoing continuous improvement and organizational development is a way of life.

### **7.8 Roadblocks to implementing lean manufacturing**

- Complacency; no reason to change
- Using lean manufacturing to facilitate downsizing efforts
- Role clarity issues from senior management
- Opposition from middle management
- Poorly defined measurement systems
- Short-term versus long-term thinking
- Inadequate union involvement
- Lack of commitment and ability to “just-do-it”

### **7.9 Team Concepts**

As lean principles are based on the team approach to decision-making and cross-functional cooperation, training in the team approach identifies the effective design of work within process teams, team leadership and issue resolution.

#### **General organization or team processes –**

- Problem Solving techniques – Pareto analysis, root cause analysis, and fishbone diagramming;
- Effective Meeting Management – encompassing agenda development, time constraints, headlining/dashboards, issue resolution, offline/ take away work;
- Operations objectives and service level agreements - between internal teams / processes and also between internal and external functions
- Benchmarking – collection and comparison of performance results, both internally and externally, and “best-in-class”;
- Key Performance Measures - visible and clearly understood;
- Surveys /assessments.

### 7.10 Visual Management

Visual Management systems enable factory workers to be well informed about production procedures, status, other important information for them to do their jobs as effectively as possible.

#### Visual Management Pyramid

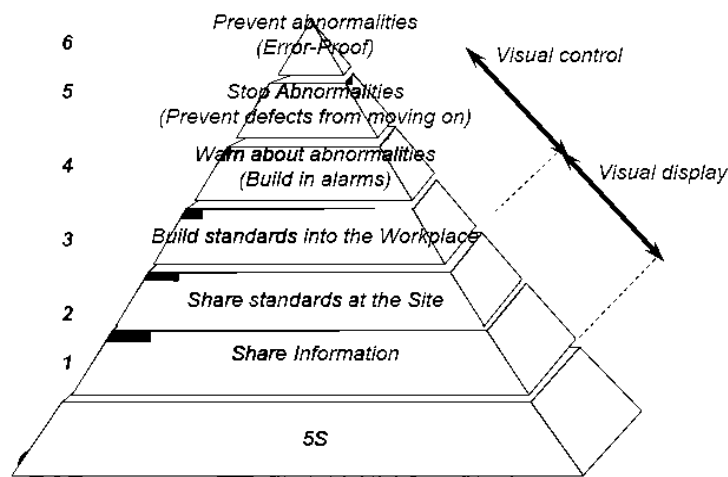


Figure 7.2 Visual Management Pyramid [27]

It is a technique that helps management to see the whole process clearly and large visual displays are generally much more effective means of communication to workers on the factory floor than written reports and guidelines.

### 7.11 Basic Spirit for improvement

The spirits that lead in the way of improvements are -

1. Throw out fixed ideas about how to do things.
2. Think of how the new method will work-not how it won't.
3. Don't accept excuses.
4. Don't seek perfection.
5. Correct mistakes the moment they're found.

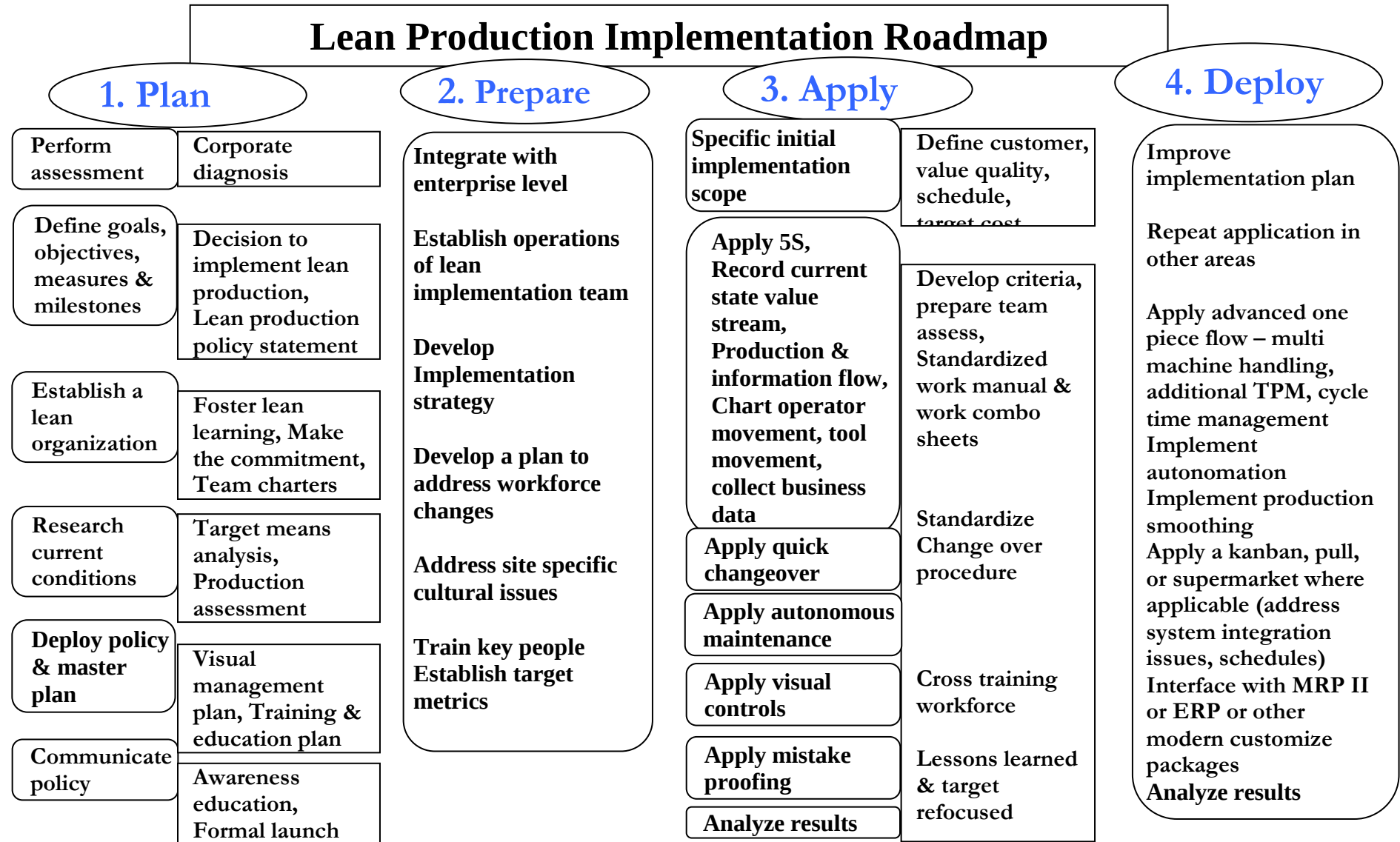
6. Money alone can not bring improvements.
7. Problems give you a chance to use your brain.
8. Ask “Why?” at least 5 times until the ROOT cause is found.
9. 10 people’s ideas are better than one person’s idea.
10. Improvement has no limits.

### **7.12 Reasons behind failure**

Successful implementation of lean tools and techniques is not an easy job and it’s a time consuming process to get result out of it. The success is the only way to get benefit from the new methodology. The lean program may fail for following reason - lack of commitment from senior managers or lack of management support, selection of the wrong lean experts / champions, selection of the wrong projects, resistance to change from supervision and workforce, not able to sustain initial efforts, not expanding improvement from the initial efforts to other departments, improvements in one area seemed to have negative impacts in others, lack of commitment from finance community, inability to capture savings from projects, little or non impact on profitability, lack of time given for projects, lack of communication about programme, lack of effective coordination and integration of the programme, lack of training in effective change management for lean expert, poor metrics.

### **7.13 Lean Implementation Roadmap**

Road map is the pathway to follow the steps for successful implementation of lean methodology in the industry. After all the study and analysis the common important steps are added here to follow and listed below in short point form.



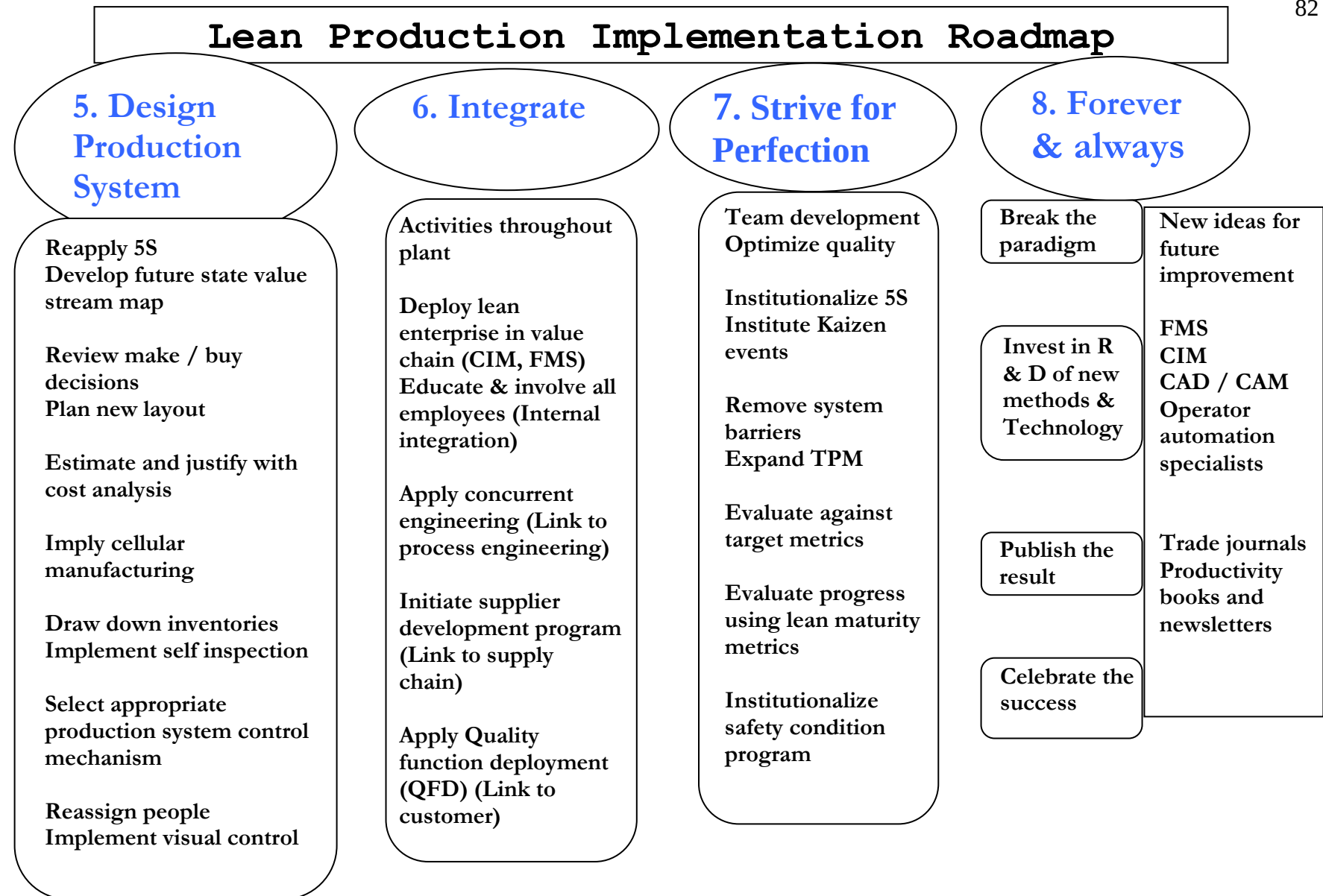


Figure 7.3 Lean Implementation Roadmap [6,16 and 25]

#### **7.14 Conclusion**

In conclusion, a core of training and education can enhance the effectiveness and value derived from utilizing lean principles. As organizations become comfortable in operating with lean principles, advanced and customized approaches and tools may be developed inside the organization. Effective education and training, whether for standard or customized approaches, ensures consistency of content, process and results. Lean principles highlight clarity, communications, and teamwork; the benefits of training on these techniques span across processes in the organization. Formalized training programs incorporating, goals and objectives, reason for change, foundational learning, practical application with clear roles and responsibilities tied to meaningful measuring sticks is the true way to ensure sustainable successful learning. Successful implementation needs all levels involvement in a true sense and strong commitment of the upper level management.

## Appendix 1: 5S's Audit Sheet

# 5S's Audit sheet

|                    |                              |
|--------------------|------------------------------|
| <b>Area:</b>       |                              |
| <b>Audited By:</b> | <b>Date:</b>                 |
| <b>Score:</b>      | <b>Previous Audit Score:</b> |

| 5S                     | No. | Check item                                     | Description                                                                        | Score |   |   |   |   |
|------------------------|-----|------------------------------------------------|------------------------------------------------------------------------------------|-------|---|---|---|---|
|                        |     |                                                |                                                                                    | 0     | 1 | 2 | 3 | 4 |
| Sort                   | 1   | Materials or parts                             | Does the inventory include any unneeded materials or parts?                        |       |   |   |   |   |
|                        | 2   | Machines or other equipment                    | Are there any unused machines or equipment around?                                 |       |   |   |   |   |
|                        | 3   | Tools and equipment                            | Are there any unused tools or equipment around?                                    |       |   |   |   |   |
|                        | 4   | Visual control                                 | Is it obvious which items have been marked as unnecessary?                         |       |   |   |   |   |
|                        | 5   | Written standards                              | Has establishing the 5 S's left behind any useless standards?                      |       |   |   |   |   |
| Sub total              |     |                                                |                                                                                    |       |   |   |   |   |
| Set Locations & limits | 1   | Location indicators                            | Are storage areas marked with location indicators and addresses?                   |       |   |   |   |   |
|                        | 2   | Item indicators                                | Do locations have signboards showing which item goes where?                        |       |   |   |   |   |
|                        | 3   | Quantity indicators                            | Are the maximum and minimum allowable quantities indicated?                        |       |   |   |   |   |
|                        | 4   | Identification of walkways and inventory areas | Are lines etc. used to clearly indicate walkways and storage areas?                |       |   |   |   |   |
|                        | 5   | Tools and equipment                            | Are tools and equipment arranged rationally for retrieval etc?                     |       |   |   |   |   |
| Sub total              |     |                                                |                                                                                    |       |   |   |   |   |
| Shine & Sweep          | 1   | Floors                                         | Are floors kept clean and free of waste and oil etc?                               |       |   |   |   |   |
|                        | 2   | Machines                                       | Are machines kept clean and free of oil and scrap etc?                             |       |   |   |   |   |
|                        | 3   | Cleaning and checking                          | Is equipment inspection combined with maintenance?                                 |       |   |   |   |   |
|                        | 4   | Cleaning responsibilities                      | Is there a person responsible for overseeing cleaning operations?                  |       |   |   |   |   |
|                        | 5   | Habitual cleanliness                           | Do operators habitually clean up without being told?                               |       |   |   |   |   |
| Sub total              |     |                                                |                                                                                    |       |   |   |   |   |
| Standardise            | 1   | Improvement memos                              | Are improvement memos being regularly generated?                                   |       |   |   |   |   |
|                        | 2   | Improvement ideas                              | Are improvement ideas being acted on?                                              |       |   |   |   |   |
|                        | 3   | Key procedures                                 | Are standard procedures written clearly and actively used?                         |       |   |   |   |   |
|                        | 4   | Improvement plan                               | Are future standards being considered, with a clear improvement plan for the area? |       |   |   |   |   |
|                        | 5   | The first 3 S's                                | Are the first 3 S's being maintained?                                              |       |   |   |   |   |
| Sub total              |     |                                                |                                                                                    |       |   |   |   |   |
| Sustain                | 1   | Training                                       | Is everyone trained in standard procedures and practices?                          |       |   |   |   |   |
|                        | 2   | Tools and equipment                            | Are tools and equipment being stored correctly?                                    |       |   |   |   |   |
|                        | 3   | Stock controls                                 | Are stock controls being adhered to?                                               |       |   |   |   |   |
|                        | 4   | Procedures                                     | Are procedures up to date and regularly reviewed?                                  |       |   |   |   |   |
|                        | 5   | Activity boards                                | Are activity boards up to date and regularly reviewed?                             |       |   |   |   |   |
| Sub total              |     |                                                |                                                                                    |       |   |   |   |   |

0 = Very bad

1 = Bad

2 = Average

3 = Good

4 = Very good

## Appendix – 2A: 5S Audit Sheet

### 5S Audit Checklist for Store Section (Based on E.J. Sweeny, 2003 and MEP MSI KFM 40)

| 5S element                                         | Serial | Initiative                                                                                                      | Score      | Notes for next level improvement |
|----------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------|------------|----------------------------------|
| <b>Sort</b>                                        |        | <b>Eliminate the clutter, sort out what is not needed</b>                                                       |            |                                  |
|                                                    | 1      | Necessary items are sorted from those that are unnecessary                                                      | 2          | Visible                          |
| When doubt, sort it out                            | 2      | Items are present in aisle ways, stairways, corner.                                                             | 1          | Proper placing                   |
|                                                    | 3      | Excess/ unneeded inventory, supplies, parts or materials are in area.                                           | 1          | Maintain space                   |
| <b>Straighten</b>                                  |        | <b>Organize and label, set boundaries and limits</b>                                                            |            |                                  |
|                                                    | 4      | Items are organized to permit easy access to materials and tools with the “return addresses”.                   | 2          | Space requirement                |
| A place for everything and everything in its place | 5      | An access system is in place with labels and color code to identify.                                            | 1          | Proper placing                   |
|                                                    | 6      | Proper position of tools, materials, and objects.                                                               | 2          |                                  |
|                                                    | 7      | Materials or objects are always in their designated position.                                                   | 2          |                                  |
| <b>Shine</b>                                       |        | <b>Clean everything inside and out</b>                                                                          |            |                                  |
|                                                    | 8      | Floors, walls, stairs, conveyance equipment ,and surfaces are dirty, oily, greasy and / or shiny and stainless. | 2          | Clean timely                     |
| Inspection through cleaning                        | 9      | Appropriate cleaning materials are not available in the area.                                                   | 1          | When need                        |
|                                                    | 10     | Other cleaning problems are present in the workplace                                                            | 2          | Space                            |
|                                                    | 11     | Actions have been developed to remove sources of wastes.                                                        | 1          |                                  |
| <b>Standardize</b>                                 |        | <b>Keep checklists and standards to maintain the first 3 S's</b>                                                |            |                                  |
|                                                    | 12     | Procedures are set to work on sort, straighten, and scrub.                                                      | 1          | Charting                         |
|                                                    | 13     | Standards are not visible in the area and known to area stakeholders.                                           | 1          | Board                            |
| Everything in a state of readiness                 | 14     | 5 S is run on a daily basis.                                                                                    | 1          | Make habit                       |
|                                                    | 15     | Quantities and limits can not easily be seen.                                                                   | 2          | Check list                       |
|                                                    | 16     | Working environment is healthy and pleasant.                                                                    | 1          |                                  |
| <b>Sustain</b>                                     |        | <b>Maintain discipline through systems and a supportive culture</b>                                             |            |                                  |
| Training ,                                         | 17     | Standards are set and followed.                                                                                 | 1          | Publish                          |
| reinforcement                                      | 18     | Workers in area have not been trained in 5S                                                                     | 1          | Training                         |
| and                                                | 19     | Personal belongings can be easily stored                                                                        | 2          |                                  |
| measurement                                        | 20     | Goals of 5S have been achieved.                                                                                 | 1          | Practice                         |
| <b>Total Score:</b>                                |        |                                                                                                                 | <b>28</b>  |                                  |
| <b>Average score (Total Score/20)</b>              |        |                                                                                                                 | <b>1.4</b> |                                  |

1 = little / no apparent (<20%), 2= Meets Minimal 5S Requirements (40%), 3= Meets Several 5S Requirements (60%), 4= Meets Most 5S Requirements (80%), 5= 5S Compliant (100%)

## Appendix – 2B: 5 S Audit Sheet

| 5 S Audit checklist for Cutting Section                                                                                                                                      |        |                                                                                                                 |             | Notes for next level improvement |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------|-------------|----------------------------------|
| 5S element                                                                                                                                                                   | Serial | Initiative                                                                                                      | Score       |                                  |
| <b>Sort</b>                                                                                                                                                                  |        | <b>Eliminate the clutter, sort out what is not needed</b>                                                       |             |                                  |
| When doubt, sort it out                                                                                                                                                      | 1      | Necessary items are sorted from those that are unnecessary                                                      | 3           | Shelfing                         |
|                                                                                                                                                                              | 2      | Items are present in aisle ways, stairways, corner.                                                             | 2           | Proper placing                   |
|                                                                                                                                                                              | 3      | Excess/ unneeded inventory, supplies, parts or materials are in area.                                           | 2           | Remove                           |
| <b>Straighten</b>                                                                                                                                                            |        | <b>Organize and label, set boundaries and limits</b>                                                            |             |                                  |
| A place for everything and everything in its place                                                                                                                           | 4      | Items are organized to permit easy access to materials and tools with the “return addresses”.                   | 3           | Space requirement                |
|                                                                                                                                                                              | 5      | An access system is in place with labels and color code to identify.                                            | 2           | Proper placing                   |
|                                                                                                                                                                              | 6      | Proper position of tools, materials, and objects.                                                               | 2           |                                  |
|                                                                                                                                                                              | 7      | Materials or objects are always in their designated position.                                                   | 2           |                                  |
| <b>Shine</b>                                                                                                                                                                 |        | <b>Clean everything inside and out</b>                                                                          |             |                                  |
| Inspection through cleaning                                                                                                                                                  | 8      | Floors, walls, stairs, conveyance equipment ,and surfaces are dirty, oily, greasy and / or shiny and stainless. | 1           | Clean timely                     |
|                                                                                                                                                                              | 9      | Appropriate cleaning materials are not available in the area.                                                   | 1           | When need                        |
|                                                                                                                                                                              | 10     | Other cleaning problems are present in the workplace                                                            | 1           | Space                            |
|                                                                                                                                                                              | 11     | Actions have been developed to remove sources of wastes.                                                        | 1           |                                  |
| <b>Standardize</b>                                                                                                                                                           |        | <b>Keep checklists and standards to maintain the first 3 S's</b>                                                |             |                                  |
| Everything in a state of readiness                                                                                                                                           | 12     | Procedures are set to work on sort, straighten, and scrub.                                                      | 1           | Charting                         |
|                                                                                                                                                                              | 13     | Standards are not visible in the area and known to area stakeholders.                                           | 2           | Board                            |
|                                                                                                                                                                              | 14     | 5 S is run on a daily basis.                                                                                    | 1           | Make habit                       |
|                                                                                                                                                                              | 15     | Quantities and limits can not easily be seen.                                                                   | 2           | Check list                       |
| <b>Sustain</b>                                                                                                                                                               | 16     | Working environment is healthy and pleasant.                                                                    | 1           |                                  |
|                                                                                                                                                                              |        | <b>Maintain discipline through systems and a supportive culture</b>                                             |             |                                  |
|                                                                                                                                                                              | 17     | Standards are set and followed.                                                                                 | 1           | Publish                          |
|                                                                                                                                                                              | 18     | Workers in area have not been trained in 5S                                                                     | 1           | Training                         |
| Training , reinforcement and measurement                                                                                                                                     | 19     | Personal belongings can be easily stored                                                                        | 1           |                                  |
|                                                                                                                                                                              | 20     | Goals of 5S have been achieved.                                                                                 | 1           | Practice                         |
| <b>Total Score:</b>                                                                                                                                                          |        |                                                                                                                 | <b>31</b>   |                                  |
| <b>Average score (Total Score/20)</b>                                                                                                                                        |        |                                                                                                                 | <b>1.55</b> |                                  |
| 1 = little / no apparent (<20%), 2= Meets Minimal 5S Requirements (40%), 3= Meets Several 5S Requirements (60%), 4= Meets Most 5S Requirements (80%), 5= 5S Compliant (100%) |        |                                                                                                                 |             |                                  |

## Appendix 2C: 5S Audit Sheet

### 5S Audit Checklist for Finishing Section

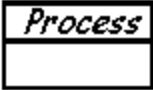
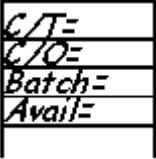
| 5S element                                         | Serial | Initiative                                                                                                      | Score       | Notes for next level improvement |
|----------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------|-------------|----------------------------------|
| <b>Sort</b>                                        |        | Eliminate the clutter, sort out what is not needed                                                              |             |                                  |
| When doubt, sort it out                            | 1      | Necessary items are sorted from those that are unnecessary                                                      | 3           |                                  |
|                                                    | 2      | Items are present in aisle ways, stairways, corner.                                                             | 1           | Proper placing                   |
|                                                    | 3      | Excess/ unneeded inventory, supplies, parts or materials are in area.                                           | 2           | Remove                           |
| <b>Straighten</b>                                  |        | <b>Organize and label, set boundaries and limits</b>                                                            |             |                                  |
| A place for everything and everything in its place | 4      | Items are organized to permit easy access to materials and tools with the “return addresses”.                   | 2           | Space requirement                |
|                                                    | 5      | An access system is in place with labels and color code to identify.                                            | 2           | Proper placing                   |
|                                                    | 6      | Proper position of tools, materials, and objects.                                                               | 2           |                                  |
|                                                    | 7      | Materials or objects are always in their designated position.                                                   | 2           |                                  |
| <b>Shine</b>                                       |        | <b>Clean everything inside and out</b>                                                                          |             |                                  |
| Inspection through cleaning                        | 8      | Floors, walls, stairs, conveyance equipment ,and surfaces are dirty, oily, greasy and / or shiny and stainless. | 2           | Clean timely                     |
|                                                    | 9      | Appropriate cleaning materials are not available in the area.                                                   | 2           | When need                        |
|                                                    | 10     | Other cleaning problems are present in the workplace                                                            | 2           | Space                            |
|                                                    | 11     | Actions have been developed to remove sources of wastes.                                                        | 1           |                                  |
| <b>Standardize</b>                                 |        | <b>Keep checklists and standards to maintain the first 3 S's</b>                                                |             |                                  |
| Everything in a state of readiness                 | 12     | Procedures are set to work on sort, straighten, and scrub.                                                      | 2           | Charting                         |
|                                                    | 13     | Standards are not visible in the area and known to area stakeholders.                                           | 2           | Board                            |
|                                                    | 14     | 5 S is run on a daily basis.                                                                                    | 1           | Make habit                       |
|                                                    | 15     | Quantities and limits can not easily be seen.                                                                   | 2           | Check list                       |
|                                                    | 16     | Working environment is healthy and pleasant.                                                                    | 2           |                                  |
| <b>Sustain</b>                                     |        | <b>Maintain discipline through systems and a supportive culture</b>                                             |             |                                  |
| Training , reinforcement and measurement           | 17     | Standards are set and followed.                                                                                 | 1           | Publish                          |
|                                                    | 18     | Workers in area have not been trained in 5S                                                                     | 1           | Training                         |
|                                                    | 19     | Personal belongings can be easily stored                                                                        | 1           |                                  |
|                                                    | 20     | Goals of 5S have been achieved.                                                                                 | 2           | Practice                         |
| <b>Total Score:</b>                                |        |                                                                                                                 | <b>35</b>   |                                  |
| <b>Average score (Total Score/20)</b>              |        |                                                                                                                 | <b>1.75</b> |                                  |

1 = little / no apparent (<20%), 2= Meets Minimal 5S Requirements (40%), 3= Meets Several 5S Requirements (60%), 4= Meets Most 5S Requirements (80%), 5= 5S Compliant (100%)

### Appendix – 3: Symbols for Value Stream Mapping

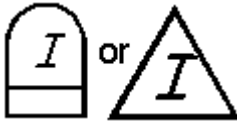
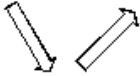
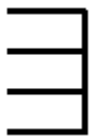
Value Stream Mapping symbols are not standardized and there are many variations. Here are the most common symbols. We may also wish to create our own symbols for specialized applications.

#### VSM Process Symbols

|                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><b>Customer/Supplier</b> | <p>This icon represents the Supplier when in the upper left, the usual starting point for material flow. The customer is represented when placed in the upper right, the usual end point for material flow.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <br><b>Dedicated Process</b> | <p>This icon is a process, operation, machine or department, through which material flows. Typically, to avoid unwieldy mapping of every single processing step, it represents one department with a continuous, internal fixed flow path.</p> <p>In the case of assembly with several connected workstations, even if some WIP inventory accumulates between machines (or stations), the entire line would show as a single box. If there are separate operations, where one is disconnected from the next, inventory between and batch transfers, then use multiple boxes.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <br><b>Shared Process</b>  | <p>This is a process operation, department or work center that other value stream families share. Estimate the number of operators required for the Value Stream being mapped, not the number of operators required for processing all products.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <br><b>Data Box</b>        | <p>This icon goes under other icons that have significant information/data required for analyzing and observing the system. Typical information placed in a Data Box underneath FACTORY icons is the frequency of shipping during any shift, material handling information, transfer batch size, demand quantity per period, etc. Typical information in a Data Box underneath MANUFACTURING PROCESS icons:</p> <ul style="list-style-type: none"> <li>· C/T (Cycle Time) - time (in seconds) that elapses between one part coming off the process to the next part coming off,</li> <li>· C/O (Changeover Time) - time to switch from producing one product on the process to another</li> <li>· Uptime - percentage time that the machine is available for processing</li> <li>· EPE (a measure of production rate/s) - Acronym stands for "Every Part Every___".</li> <li>· Number of operators - use OPERATOR icon inside process boxes</li> <li>· Number of product variations</li> <li>· Available Capacity</li> <li>· Scrap rate</li> <li>· Transfer batch size (based on process batch size and material transfer rate)</li> </ul> |

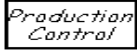
|                                                                                                       |                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><b>Work cell</b> | <p>This symbol indicates that multiple processes are integrated in a manufacturing work cell. such cells usually process a limited family of similar products or a single product. Product moves from process step to process step in small batches or single pieces.</p> |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### VSM Material Symbols

|                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><b>Inventory</b>       | <p>These icons show inventory between two processes. While mapping the current state, the amount of inventory can be approximated by a quick count, and that amount is noted beneath the triangle. If there is more than one inventory accumulation, use an icon for each. This icon also represents storage for raw materials and finished goods.</p>                                                                                      |
| <br><b>Shipments</b>       | <p>This icon represents movement of raw materials from suppliers to the Receiving dock/s of the factory. Or, the movement of finished goods from the Shipping dock/s of the factory to the customers</p>                                                                                                                                                                                                                                    |
| <br><b>Push Arrow</b>     | <p>This icon represents the “pushing” of material from one process to the next process. Push means that a process produces something regardless of the immediate needs of the downstream process.</p>                                                                                                                                                                                                                                       |
| <br><b>Supermarket</b>   | <p>This is an inventory “supermarket” (kanban stock point). Like a supermarket, a small inventory is available and one or more downstream customers come to the supermarket to pick out what they need. The upstream work center then replenishes stocks as required.</p> <p>When continuous flow is impractical, and the upstream process must operate in batch mode, a supermarket reduces overproduction and limits total inventory.</p> |
| <br><b>Material Pull</b> | <p>Supermarkets connect to downstream processes with this "Pull" icon that indicates physical removal.</p>                                                                                                                                                                                                                                                                                                                                  |
| <br><b>FIFO Lane</b>     | <p>First-In-First-Out inventory. Use this icon when processes are connected with a FIFO system that limits input. An accumulating roller conveyor is an example. Record the maximum possible inventory.</p>                                                                                                                                                                                                                                 |
|                          | <p>This icon represents an inventory “hedge” (or safety stock) against problems such as downtime, to protect the system against sudden fluctuations in customer orders</p>                                                                                                                                                                                                                                                                  |

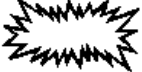
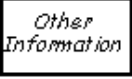
|                                                                                                               |                                                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Safety Stock</b>                                                                                           | or system failures. Notice that the icon is closed on all sides. It is intended as a temporary, not a permanent storage of stock; thus; there should be a clearly-stated management policy on when such inventory should be used. |
| <br><b>External Shipment</b> | Shipments from suppliers or to customers using external transport.                                                                                                                                                                |

### VSM Information Symbols

|                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><b>Production Control</b>  | This box represents a central production scheduling or control department, person or operation.                                                                                                                                                                                                                                                   |
| <br><b>Manual Info</b>         | A straight, thin arrow shows general flow of information from memos, reports, or conversation. Frequency and other notes may be relevant.                                                                                                                                                                                                         |
| <br><b>Electronic Info</b>     | This wiggly arrow represents electronic flow such as electronic data interchange (EDI), the Internet, Intranets, LANs (local area network), WANs (wide area network). You may indicate the frequency of information/data interchange, the type of media used ex. fax, phone, etc. and the type of data exchanged.                                 |
| <br><b>Production Kanban</b> | This icon triggers production of a pre-defined number of parts. It signals a supplying process to provide parts to a downstream process.                                                                                                                                                                                                          |
| <br><b>Withdrawal Kanban</b> | This icon represents a card or device that instructs a material handler to transfer parts from a supermarket to the receiving process. The material handler (or operator) goes to the supermarket and withdraws the necessary items.                                                                                                              |
| <br><b>Signal Kanban</b>     | This icon is used whenever the on-hand inventory levels in the supermarket between two processes drops to a trigger or minimum point. When a Triangle Kanban arrives at a supplying process, it signals a changeover and production of a predetermined batch size of the part noted on the Kanban. It is also referred as “one-per-batch” kanban. |
| <br><b>Kanban Post</b>       | A location where kanban signals reside for pickup. Often used with two-card systems to exchange withdrawal and production kanban.                                                                                                                                                                                                                 |
|                              | This icon represents a pull system that gives instruction to subassembly processes to produce a predetermined type and quantity of product, typically one unit,                                                                                                                                                                                   |

|                                                                                                                |                                                                                                            |
|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Sequenced Pull</b>                                                                                          | without using a supermarket.                                                                               |
| <br><b>Load Leveling</b>      | This icon is a tool to batch kanbans in order to level the production volume and mix over a period of time |
| <br><b>MRP/ERP</b>            | Scheduling using MRP/ERP or other centralized systems.                                                     |
| <br><b>Go See</b>             | Gathering of information through visual means.                                                             |
| <br><b>Verbal Information</b> | This icon represents verbal or personal information flow.                                                  |

### VSM General Symbols

|                                                                                                          |                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><b>Kaizen Burst</b> | These icons are used to highlight improvement needs and plan kaizen workshops at specific processes that are critical to achieving the Future State Map of the value stream. |
| <br><b>Operator</b>   | This icon represents an operator. It shows the number of operators required to process the VSM family at a particular workstation.                                           |
| <br><b>Other</b>      | Other useful or potentially useful information.                                                                                                                              |
| <br><b>Timeline</b>   | The timeline shows value added times (Cycle Times) and non-value added (wait) times. Use this to calculate Lead Time and Total Cycle Time.                                   |

## Appendix 4: Red Tag

| RED TAG              |                                                                                                                                                                                                         |                                |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Category             | 1. Raw material<br>2. In-process stock<br>3. Semi-finished goods<br>4. Finished goods<br>5. Equipment<br>6. Dies and jigs<br>7. Tools and supplies<br>8. Measuring devices<br>9. Documents<br>10. Other |                                |
| Item name and number |                                                                                                                                                                                                         |                                |
| Quantity             | Units                                                                                                                                                                                                   | \$ Value                       |
| Reason               | 1. Not needed<br>2. Defective<br>3. Not needed soon<br>4. Scrap material<br>5. Use unknown<br>6. Other                                                                                                  |                                |
| Disposal by:         | Department/Business Unit/Product Center                                                                                                                                                                 |                                |
| Disposal method:     | 1. Discard<br>2. Return<br>3. Move to red-tag storage site<br>4. Move to separate storage site<br>5. Other                                                                                              | Disposal complete (signature ) |
| Posting date:        |                                                                                                                                                                                                         | Disposal date:                 |











### Appendix 6: Sewing Time Study

| Sewing Time Study                     |                                            |    |    |         |       |       |
|---------------------------------------|--------------------------------------------|----|----|---------|-------|-------|
| <b>FRONT &amp; Back</b>               |                                            | 1  | 2  | Average | 1     | 2     |
| Front & Back Part Matching            | Hand work                                  | 1  |    |         | 8.2   |       |
|                                       |                                            |    |    |         |       |       |
| <b>SLEEVE</b>                         |                                            |    |    |         |       |       |
| Hem Sleeve                            | 2-Needle Flatbed Cover stitch Machine      | 2  |    |         | 14.56 |       |
| Trim Thread                           | Hand work                                  | 3  |    |         | 13    |       |
| Cut Sleeve Mid Point                  | Hand work                                  | 4  |    |         | 12    |       |
|                                       |                                            |    |    |         |       |       |
| <b>NECK</b>                           |                                            |    |    |         |       |       |
| Neck Tack & Trim Thread               | 1-Needle Lockstitch Machine                | 5  |    |         | 15    |       |
| Neck Folding & Body Arrange           | Hand work                                  | 6  |    |         | 14    |       |
|                                       |                                            |    |    |         |       |       |
| <b>ASSEMBLY</b>                       |                                            |    |    |         |       |       |
| Shoulder Joint                        | Overlock Machine                           | 7  |    |         | 12.6  |       |
| Trim Thread & Cutting extra tape      | Hand work                                  | 8  |    |         | 13.5  |       |
| Sleeve Joint                          | Overlock Machine                           | 9  | 10 | 33.65   | 35.58 | 31.72 |
| Neck Joint                            | Overlock Machine                           | 11 | 12 | 22.14   | 22.85 | 21.42 |
| Trim Thread & Body arrange            | Hand work                                  | 13 |    |         | 17.6  |       |
| Neck Back Tap                         | 1-Needle Lockstitch Machine                | 14 |    |         | 10.21 |       |
|                                       |                                            |    |    |         |       |       |
| Neck Close                            | 1-Needle Lockstitch Machine                | 15 |    |         | 15.66 |       |
| Trim Thread & Cut Extra Back Tap      | Hand work                                  | 16 |    |         | 14.14 |       |
| Neck Top                              |                                            | 17 |    |         | 12.25 |       |
| Trim Thread & Arrange                 | Hand work                                  | 18 |    |         | 12    |       |
| Label Position Mark                   | Hand work                                  | 19 |    |         | 12.16 |       |
| Main label joint                      | 1-Needle Lockstitch Machine                | 20 | 21 | 22.32   | 22.8  | 21.83 |
| Trim Thread & Arrange                 | Hand work                                  | 22 |    |         | 36.8  |       |
| Sleeve Tack before Side Seam          | 1-Needle Lockstitch Machine                | 23 | 24 | 32.75   | 34.16 | 31.33 |
|                                       |                                            |    |    |         |       |       |
| Side Seam                             | Overlock Machine                           | 25 | 26 | 39.3    | 46.6  | 32    |
| Sleeve Tack after Side Seam           | 1-Needle Lockstitch Machine                | 27 | 28 | 34      | 36.8  | 31.2  |
| Trim Thread, Arrange & Sticker remove | Hand work                                  | 29 |    |         | 19.66 |       |
|                                       |                                            |    |    |         |       |       |
| Scissoring                            | Hand work                                  | 30 |    |         | 17.04 |       |
| Body Hem                              | 2-Needle Cylinder bed Cover stitch Machine | 31 |    |         | 17.66 |       |
| Trim Thread & Arrange                 | Hand work                                  | 32 |    |         | 17    |       |

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## A Study on Implementation of Lean Manufacturing Tools and Techniques in the RMG Industry

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## Background

- Industrialization is the key – economic development
- Major export base of the country
- Easy technology & technologically labour oriented
- No need for high skilled operator or high educational background
- Ever increasing demand of textile – emerging & important sector

## Background

- Present situation – Lean new in Bangladesh
- Scope of implementation & improvement
- Thinking issues – quality, cost, delivery, trained m/p
- Critically evaluating – productivity, efficiency, effectiveness, employee benefits & social welfare
- Increasing competition, narrow profit margin
- So production Process & new technology will get importance

## Objectives:

The specific objectives of the present study are:

- to study lean manufacturing concepts and its different tools and techniques.
- to illustrate the procedure of implementing lean tools in the selected RMG industry and to study the effect of applying lean tools in this industry.
- to address the difficulties in application and benefits gained by the RMG industry when implementing lean tools.

## Lean Manufacturing

- A systematic method
  - continually improve manufacturing operation,
  - add little capital expense
  - involves all employees
  - eliminates wasteful costs
  - reduces lead times and improves quality
- Customer-focused, Knowledge - driven, Eliminating waste, Creating value, Dynamic and continuous

## Lean Tools & Techniques

- VSM
- 5'S
- SMED
- Pull System
- Kanban
- Kaizen
- TPM
- TPS
- TQM
- FMS

## Value Stream Mapping

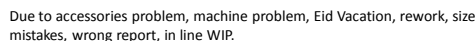
- A value stream is all the actions (both value and non-value added) required to bring a product, or group of products – from raw material to the arms of the customer.
- VSM is a pencil and paper visualization tool that shows the flow of material and information as a product makes its way through the value stream.

## Importance of VSM:

Value stream mapping helps to –

- Visualize the whole process
- See the sources of waste
- Provides a common language for improvement
- Makes decisions about flow apparent
- Ties together lean techniques
- Forms the basis of an improvement plan
- Shows linkage between information & material flows

| Time Study of Sewing Floor  |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
|-----------------------------|--------------------------------------|---------------|---------------|-----------------|------|----------|---------------|---------------|-----------------|------|----------|---------------|---------------|-----------------|-------|----------|------------|--------|--|--|--|
| Activity Name               | M/C or Hand work                     | BLM07         |               |                 |      |          | BLM08         |               |                 |      |          | Potomac Dam   |               |                 |       |          | 25.00' off |        |  |  |  |
|                             |                                      | Welder/Halter | Observed Time | Parallel Worker | SPT  | Capacity | Welder/Halter | Observed Time | Parallel Worker | SPT  | Capacity | Welder/Halter | Observed Time | Parallel Worker | SPT   | Capacity |            |        |  |  |  |
| <b>FRONT &amp; Back</b>     |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
| Front & Back Fire           | Hand work                            | 1             | 9             |                 |      | 11:25    | 50            | 1             | 8.2             |      |          | 8:25          | 351.22        | 1               | 7.8   |          | 5.75       | 500.2  |  |  |  |
| <b>ELBOW</b>                |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
| Fire Blows                  | 17" Double Fluted Cast/Grind Machine | 2             | 14            |                 |      | 15:15    | 205.75        | 2             | 14.86           |      |          | 18:4          | 197.4         | 2               | 20.8  |          | 26         | 344.4  |  |  |  |
| Fire Blows                  | Hand work                            | 1             | 10            |                 |      | 11:15    | 115           | 1             | 10              |      |          | 12:15         | 5.3           | 1               | 9.2   |          | 5.2        | 123.2  |  |  |  |
| Grind Machine Mid Fire      | Hand work                            | 4             | 30            |                 |      | 12:1     | 200           | 4             | 32              |      |          | 1:1           | 240           | 4               | 48    |          | 3.4        | 825.2  |  |  |  |
| <b>NECK</b>                 |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
| Neck Yoke & Tail            | 17" Double Fluted Cast/Grind Machine | 4             | 15            |                 |      | 16:75    | 322           | 4             | 15              |      |          | 16:75         | 322           | 4               | 15.2  |          | 19         | 1047.4 |  |  |  |
| Neck Finishing & Body       | Hand work                            | 6             | 15.6          |                 |      | 17:1     | 212.75        | 6             | 14              |      |          | 15:5          | 205.75        | 6               | 14.8  |          | 27.25      | 321.1  |  |  |  |
| <b>ASSEMBLY</b>             |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
| Assembly Line               | Unskilled Machine                    | 7             | 11.5          |                 |      | 14:30    | 280.47        | 7             | 12.4            |      |          | 15:5          | 285.57        | 7               | 12.5  |          | 29         | 144    |  |  |  |
| Assembly Line & Lining      | Hand work                            | 8             | 14            |                 |      | 15:15    | 205.75        | 8             | 15.5            |      |          | 16:30         | 243.55        | 8               | 16.5  |          | 28.25      | 349.4  |  |  |  |
| Assembly Line               | Hand work                            | 10            | 17.5          | 15.5            | 30   | 20:2     | 315           | 10            | 16.5            | 15.5 | 30       | 21:15         | 330           | 10              | 20.5  | 17.5     | 640.1      |        |  |  |  |
| Assembly Line               | Hand work                            | 11            | 17.5          | 15.5            | 30   | 20:2     | 315           | 11            | 16.5            | 15.5 | 30       | 21:15         | 330           | 11              | 17.5  | 18       | 640.1      |        |  |  |  |
| Assembly Line               | Hand work                            | 11            | 17.5          | 15.5            | 30   | 20:2     | 315           | 11            | 16.5            | 15.5 | 30       | 21:15         | 330           | 11              | 17.5  | 18       | 640.1      |        |  |  |  |
| Assembly Line               | Hand work                            | 15            | 16            |                 |      | 20       | 180           | 15            | 17.5            |      |          | 22            | 165.64        |                 |       |          | 350        |        |  |  |  |
| <b>Back Neck &amp; Tail</b> |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 14            | 10            |                 |      | 12:5     | 240           | 14            | 10.25           |      |          | 12:75         | 252.06        | 12              | 18.5  |          | 23.5       | 155.6  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 15            | 18            |                 |      | 20       | 180           | 15            | 17.5            |      |          | 21:30         | 183.91        | 15              | 24.5  |          | 30         | 183    |  |  |  |
| Back Neck & Tail            | Hand work                            | 16            | 14            |                 |      | 17:1     | 207.75        | 16            | 14.54           |      |          | 17:30         | 205.66        | 16              | 14.55 |          | 30.45      | 118.7  |  |  |  |
| Back Neck & Tail            | Hand work                            | 17            | 11.5          |                 |      | 14:30    | 280.47        | 17            | 12.25           |      |          | 15:30         | 261.1         | 17              | 14.8  |          | 33.5       | 123.2  |  |  |  |
| Back Neck & Tail            | Hand work                            | 17            | 11.5          |                 |      | 14:30    | 280.47        | 17            | 12.25           |      |          | 15:30         | 261.1         | 17              | 14.8  |          | 33.5       | 123.2  |  |  |  |
| Back Neck & Tail            | Hand work                            | 17            | 11.5          |                 |      | 14:30    | 280.47        | 17            | 12.25           |      |          | 15:30         | 261.1         | 17              | 14.8  |          | 33.5       | 123.2  |  |  |  |
| Back Neck & Tail            | Hand work                            | 17            | 11.5          |                 |      | 14:30    | 280.47        | 17            | 12.25           |      |          | 15:30         | 261.1         | 17              | 14.8  |          | 33.5       | 123.2  |  |  |  |
| <b>Back Neck &amp; Tail</b> |                                      |               |               |                 |      |          |               |               |                 |      |          |               |               |                 |       |          |            |        |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
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| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  | 10.2     | 27.5       | 540.9  |  |  |  |
| Back Neck & Tail            | Unskilled Machine                    | 20            | 14.5          | 10.2            | 27.5 | 27:45    | 540.9         | 20            | 14.5            | 10.2 | 27.5     | 27:45         | 540.9         | 20              | 14.5  |          |            |        |  |  |  |



- **Total Produced hour** = (SMV X Total Production) / 60 or SAH X Total Production  

$$= 5.7 * 875 / 60 = 0.095 * 875 = 83.125$$
- [Data from first day production of line 3D1]
- **Total Spend Hour** = (Normal Worker X Working Hour + Overtime Worker X OT)  

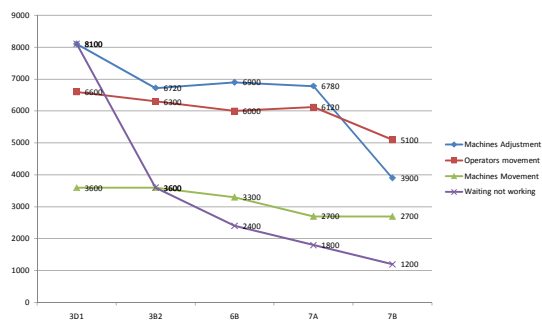
$$= 34 * 8 + 34 * 2 = 340$$
- **Line Efficiency** = (Production X SMV) / (M/P X W/H X 60) X 100  
 Or (Production X SMV) / Total Spend Hours X 100  

$$= \{(875 * 5.7) / 340\} * 100 = 24.44\%$$

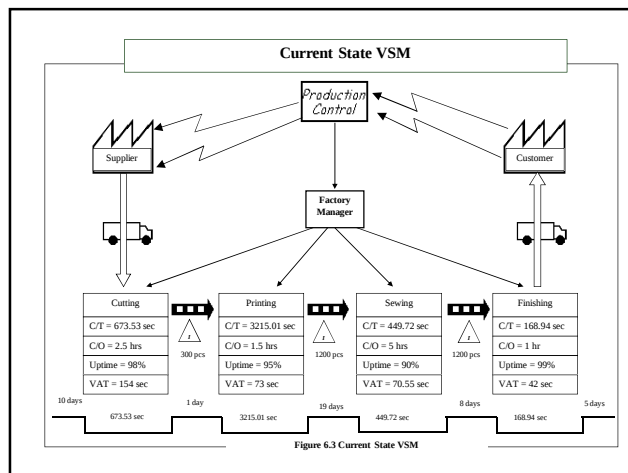
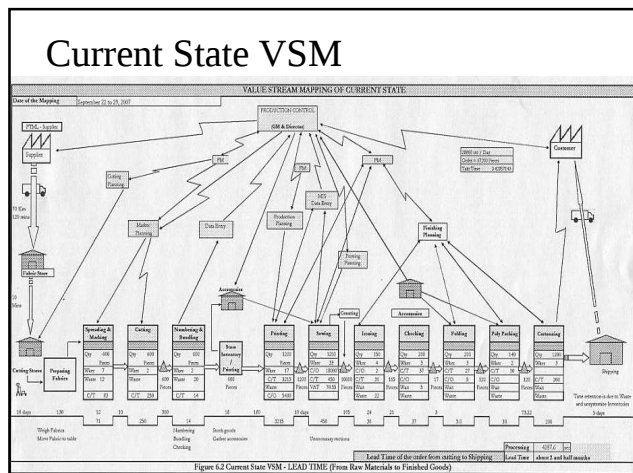
## Changeover Time

| Changeover time is the elapsed time between the last good previous product, and the first good next product at the right speed |                     |                     |                  |       |       |       |       |                                |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|------------------|-------|-------|-------|-------|--------------------------------|
| Measurement Keys                                                                                                               | Waste               | Activities Happened | Time Requirement |       |       |       |       | Remarks                        |
|                                                                                                                                | Line No.            |                     | 3D1              | 3B2   | 6B    | 7A    | 7B    |                                |
| Order Changeover                                                                                                               | Machines Adjustment | mtc allocation      | 1800             | 1800  | 2100  | 1800  | 1500  | supervisor involvement         |
|                                                                                                                                |                     | mtc problem         | 1500             | 1500  | 1800  | 1500  | 1200  | maintenance problem            |
|                                                                                                                                |                     | thermal tension     | 1500             | 1200  | 1200  | 1800  | 1200  | mechanic                       |
|                                                                                                                                |                     | lubrication         | 600              | 600   | 0     | 900   | 0     | need care                      |
|                                                                                                                                |                     | mtc not working     | 2700             | 1800  | 1800  | 1500  | 0     | no immediate solution found    |
|                                                                                                                                | Total time in sec   |                     | 8100             | 6720  | 6900  | 6780  | 3900  |                                |
|                                                                                                                                | Operator movement   | mtc setup           | 2400             | 2400  | 2100  | 2700  | 2100  | to help the mechanic           |
|                                                                                                                                |                     | mtc layout          | 2400             | 2100  | 1800  | 1800  | 1500  | good practice                  |
|                                                                                                                                |                     | mtc folder / guide  | 1800             | 1800  | 2100  | 1620  | 1500  | for back tape & shoulder joint |
|                                                                                                                                | Total time in sec   |                     | 6600             | 6300  | 6000  | 6120  | 5100  |                                |
|                                                                                                                                | Machines Movement   | mtc layout          | 2400             | 1800  | 1500  | 1500  | 1500  | inevitable                     |
|                                                                                                                                |                     | mtc change          | 1200             | 1800  | 1800  | 1200  | 1200  | from different line            |
|                                                                                                                                | Total time in sec   |                     | 3600             | 3600  | 3300  | 2700  | 2700  |                                |
|                                                                                                                                | Waiting not working |                     | 8100             | 3600  | 2400  | 1800  | 1200  |                                |
|                                                                                                                                | Total time in sec   |                     | 8100             | 3600  | 2400  | 1800  | 1200  |                                |
|                                                                                                                                | Training            |                     | na               | 1200  | 1200  | 1200  | 1200  | at the time of setting         |
|                                                                                                                                | Total time in sec   |                     | 0                | 1200  | 1200  | 1200  | 1200  |                                |
| Total Changeover Time in sec                                                                                                   |                     |                     | 26400            | 21420 | 19800 | 18600 | 14100 |                                |
| It is for only sewing floor. The Start up time was not considered here.                                                        |                     |                     |                  |       |       |       |       |                                |

## Changeover Time

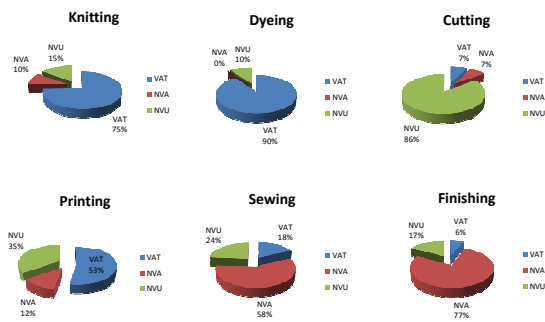


## Current State VSM





## Percentage of VAT,NVA,NVU

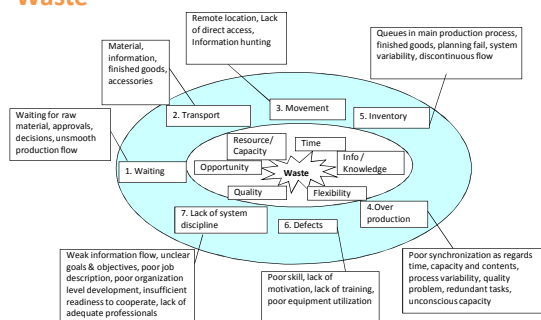


## 5S (called "industrial housekeeping")

Based on Japanese words that begin with 'S', the 5 S Philosophy focuses on effective work place organization and standardized work procedures.

1. Seiri (Sort out)
2. Seiton (Set in order/ Systematize)
3. Seiso (Sweep, scrub, shine)
4. Seiketsu (Standardize)
5. Shitsuke (Sustain)

## Waste



## 5'S Audit Checklist

|                                                                                                                                                    |                                                                                                             | 5S Audit Checklist |           | Scoring |           | Score |           | Passing |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------|-----------|---------|-----------|-------|-----------|---------|-----------|
| 5S element                                                                                                                                         | Detail                                                                                                      |                    | Indicator | Score   | Max Score | Score | Max Score | Score   | Max Score |
| Sort                                                                                                                                               | 1) Eliminates the clutter, sort out what is not needed                                                      |                    |           |         |           |       |           |         |           |
|                                                                                                                                                    | 2) 1) Materials are sorted from those that are unnecessary                                                  |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 3) 2) Items are placed in able ways, neatness, access                                                       |                    |           | 3       | 3         | 1     | 3         | 1       | 3         |
| When doing, set in order                                                                                                                           | 4) 3) Storage containers, drawers, cupboards, parts or materials are labeled                                |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
|                                                                                                                                                    | 5) 4) Known - unnecessary items, negative, parts or materials are labeled                                   |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
| Straighten                                                                                                                                         | 6) Organized and labeled, not haphazard and limits                                                          |                    |           |         |           |       |           |         |           |
|                                                                                                                                                    | 7) 5) Items are organized in preset ways, access to materials and parts is easy                             |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 8) 6) 1) Are storage systems in the plant with labels and color code to identify                            |                    |           | 3       | 3         | 1     | 3         | 1       | 3         |
| A place for everything, everything in its place                                                                                                    | 9) 2) Proper position of tools, materials, and objects                                                      |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 10) 3) Materials or objects are always in their designated position                                         |                    |           | 1       | 3         | 3     | 3         | 3       | 3         |
| Shine                                                                                                                                              | 11) Have everything inside and out                                                                          |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 12) 8) Floors, walls, items, containers, equipment and surfaces are kept clean, shiny and in good condition |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
| Inspection through visual control                                                                                                                  | 13) 9) Appropriate cleaning materials are not available in the workplace                                    |                    |           | 1       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 14) 10) 2) Cleaning activities are present in the workplace                                                 |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
|                                                                                                                                                    | 15) 11) Actions have been developed to routine sources of wastes                                            |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
| Standardize                                                                                                                                        | 16) Keep checklists and standards to maintain the 5 S's                                                     |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 17) 12) Procedures are not in work on such, straighten, and store                                           |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
| Everything is a task of maintenance                                                                                                                | 18) 13) Standards are not visible to the worker and known to work                                           |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
|                                                                                                                                                    | 19) 14) 3 S is not on a daily basis                                                                         |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
|                                                                                                                                                    | 20) 15) Quantities and limits are not easily for seen                                                       |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
|                                                                                                                                                    | 21) 16) Working environment is healthy and pleasant                                                         |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
| Sustain                                                                                                                                            | 22) Material discipline through system and a supportive culture                                             |                    |           |         |           |       |           |         |           |
|                                                                                                                                                    | 23) 17) Standards are not used followed                                                                     |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
| Training, reinforcement and measurement                                                                                                            | 24) 18) Workers in areas have been trained in 5S                                                            |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
|                                                                                                                                                    | 25) 19) Personal belongings can be easily stored                                                            |                    |           | 3       | 3         | 3     | 3         | 3       | 3         |
|                                                                                                                                                    | 26) 20) Goals of 5S have been achieved                                                                      |                    |           | 1       | 3         | 1     | 3         | 1       | 3         |
| Total Score:                                                                                                                                       |                                                                                                             |                    |           | 38      | 38        | 38    | 38        | 38      | 38        |
| Average score (Total Score/22)                                                                                                                     |                                                                                                             |                    |           | 1.73    | 1.73      | 1.73  | 1.73      | 1.73    | 1.73      |
| 1 = 100% / no apparent compliance (0%), 2 = 80% / Minimal (20%), 3 = 60% / Moderate (40%), 4 = 40% / Significant (60%), 5 = 20% / Compliance (80%) |                                                                                                             |                    |           |         |           |       |           |         |           |



Figure 5.7 Sewing WIP

## Sewing line after 5'S



## Finished Goods



Figure 5.6 Finished Goods in Finishing Section

## Finished Goods



Figure 5.7 Finishing Accessories after 5'S

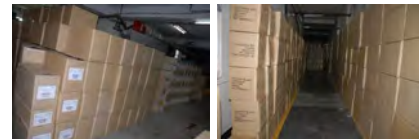


Figure 5.8 Finished goods after 5'S

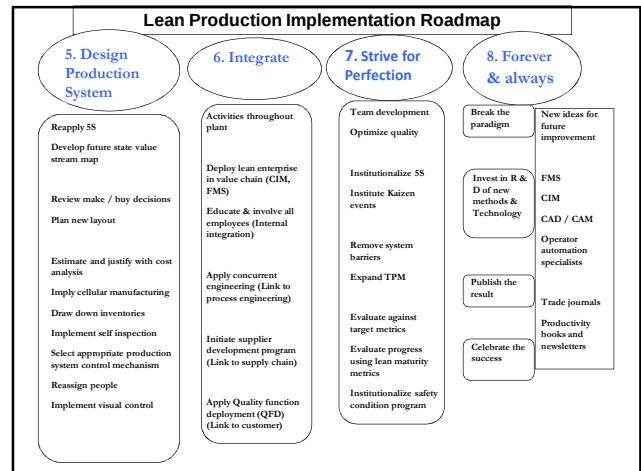
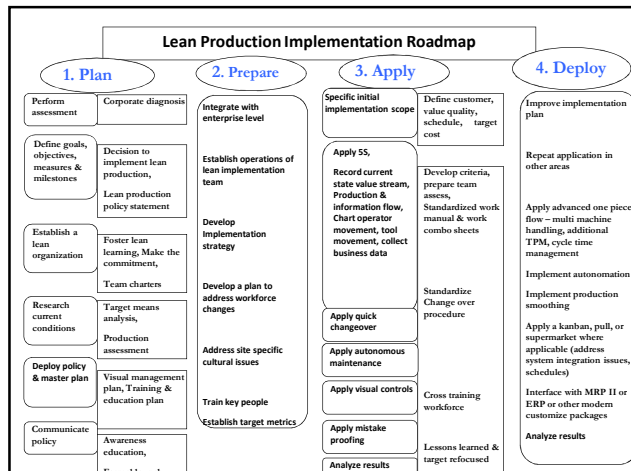
## Lean implementation program

The lean implementation program may include the following steps:

1. Senior management to agree and discuss their lean vision
2. Management brainstorm to identify project leader and set objectives
3. Four stages of transactional Lean
  - Opportunity Identification,
  - Solution design,
  - Implementation,
  - Continuous improvement

## Lean implementation program

4. Communicate plan and vision
5. Findings of volunteers to form the Team
6. Training for the Implementation
7. Selection of a Pilot Project
8. Run the pilot for 2-3 months - evaluate, review and learn from mistakes.
9. Rolling out of successful pilot to other factory areas
10. Evaluation of results, encouragement for feedback
11. Once one is satisfied that he has a habitual program, consider introducing the next lean tool.



### Reasons behind failure

The lean program may fail for following reasons –

- lack of commitment / support from senior managers
- selection of the wrong lean experts , resistance to change from supervision and workforce
- not able to sustain initial efforts
- lack of commitment from finance community, inability to capture savings from projects, little or non impact on profitability
- lack of time given for projects, lack of communication about programme, lack of effective coordination and integration of the programme, lack of training in effective change management for lean expert

### Conclusion

- The analysis of 5 S implementation shows the unnecessary items are in the walk way undesignated places and the materials are not in perfect places.
- From the 5S audit checklist the total score for Sewing 26, for Cutting 31 for Store 28 and for finishing section 35 out of 100. So there is a great chance for improvement. The new scores after implementing 5'S are Sewing 38, Store 40 & Finishing 43.

### Conclusion

- From CSVSM - VAT in Store and Cutting 22.86%, in Printing 2.27%, in Sewing 15.69%, in Finishing 24.86% which means there is a lot of chances for improvement.
- From the second work – VAT in Knitting 74.77%, in Dyeing 90%, in Cutting 7%, in Printing 53%, in Sewing 18%, in Finishing 6%.
- The changeover time (7.33 Hr) analysis shows the loss of time in machine and layout setup and the inefficient practices that should be reduced.

### Recommendation

- The project is done with a limited scope and tools.
- The future study may include different tools and techniques and in different section of the RMG sector with a view to implement lean manufacturing in Bangladesh with success.
- The process may be followed in several garment industry with different set up and facilities and then the result will be found more realistic and then the implementation framework will be justified.

### Recommendation

- By applying Lean Tools and Techniques the area of improvement may include the supply of raw materials, WIP reduction, small set up time, super market, pull system, process mapping, smooth production flow and overall management effectiveness.

Thanks