Faculty of Engineering

Department of Textile Engineering

REPORT ON

Development and Implementation of Lean Manufacturing Tools in Garments Production

Course Title: **Project (Thesis)**

Course Code: **TE-4214**

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of **Bachelor of Science in Textile Engineering**

Advance in Apparel Manufacturing Technology

April, 2018

DECLARATION

I hereby declare that, this work has been done by me and not copied from elsewhere; I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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LETTER OF APPROVAL

It is herewith certified that **Samiul Hasan** bearing ID:**142-23-3913**, Department of Textile Engineering, Daffodil International University, Dhaka, Bangladesh, has carried out his B.Sc thesis entitled **" Development and Implementation of Lean Manufacturing Tools in Garments Production "** under my direct supervision. He have successfully carried out his research work and ready to present his dissertation, which is required in partial fulfillment of his B.Sc degree. This is an original study of the author and no part of this thesis has been to any other university or institute for any degree. The thesis contains no materials previously published or written by any other person except reference is made in the text of the thesis.

I have gone through the final draft of the thesis and recommend its submission for the degree of Bachelor of Science in Textile Engineering.

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ACKNOWLEDGEMENT

First of all I would like to express my devotion to the most gracious and the most merciful Allah, Alhamdulillah, since I have been able to finish my thesis work after four months long hardworking.

I wish to express my gratitude to my supervisor, Mousumi Rahaman Hashi, Department of Textile Engineering, Daffodil International University, for giving me the opportunity, trust and freedom that allowed me to explore in the field of my research work. It is indeed a great pleasure for me to express my sincere and profound gratitude to her for her scholastic guidance, constructive suggestions and encouragement which I received from her in order to complete this research work and to write this dissertation.

A very special gratitude goes to Dr. S.M. Mahbub Ul Haque Majumder, Founder and Professor, Department of Textile Engineering, Daffodil International University.

I am indebted to Dr. Md. Mahbubul Haque, Professor & Head, Department of Textile Engineering, Daffodil International University for his unremitting and valuable guidance and suggestions.

My deepest gratitude goes to Md. Saiful Islam, Store Manager, Biswas Group for his cooperation in completing this thesis work successfully.

I am also very much grateful to Md. Kajal Mazumder, Assistant Merchandiser, Biswas Group for his suggestion and support. Many thanks for everything.

Finally, I am grateful to all of my teachers who have helped me all over the four years in this Textile Engineering Department.

Special Thanks to my family for their unconditional support, love and inspiration which gave me incentive to complete this research work successfully. I would like to thank all of my friends with whom I have worked and to all my well-wishers for their moral support throughout this research work.

DEDICATION

It is my genuine gratefulness and warmest regard that I dedicate this work to my beloved Parents & respected Teachers.

ABSTRACT

This project is on "**Development and Implementation of Lean Manufacturing Tools in Garments Production**". The goal of this project is to investigate how the tools of lean manufacturing can be adapted from the discrete to the continuous manufacturing environment and to evaluate their benefits at garments Industry. The project hypothesizes that there are big opportunities for improvement in the garments industries if lean tools are utilized. Although the process and discrete industry share several common characteristics, there are also areas where they are very different. Both manufacturing settings have overlap, but at the extreme, each has its unique characteristics. The objective is to look at commonalities between discrete and continuous manufacturing where lean techniques from the discrete side are directly applicable, and to also examine ways to do so in other areas where this may not be quite so straightforward. The objective is to systematically demonstrate how lean manufacturing tools when used appropriately can help the Apparel industry to eliminate waste, have better inventory control, better product quality, and better overall financial and operational procedures. The ideas are tested on a garments manufacturing company Biswas Group. Value stream mapping is used to first map the current state and then used to identify sources of waste and to identify lean tools to try to eliminate this waste. To quantify the benefits gained from using lean tools and techniques in the value stream mapping.

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Chapter-1 Introduction

1.1 Introduction

Lean is to fabricate just what is required by the client, when it is required and in the amounts requested. The make of merchandise is done in a way that limits the time taken to convey the completed products, the measure of work required, and the floorspace required, and it is finished with the most noteworthy quality, and as a rule, at the least cost . This Project are addresses the utilization of lean assembling ideas to the persistent generation/process division with an attention on the Apparel business. The fundamental thought behind the framework is taking out waste. Squander is characterized as anything that does not increase the value of the finished result from the client's point of view. The essential goal of lean assembling is to help producers who want to enhance their organization's activities and turn out to be more focused through the execution of various lean assembling devices and procedures. This task is likewise secured with decreasing non esteem included work, Workplace association, boost the Efficiency, lessening the Sewing string and texture wastage concerning Lead time. The underlying advance in this venture is to efficiently contemplate and characterize the historical backdrop of the lean assembling idea and its distinctive apparatuses and methods. It will then analyze where the majority of the lean instruments and methods have been utilized. This will be trailed by a writing survey of the article of clothing industry and an investigation of the discoveries in regards to uses of lean ideas to persistent assembling, and the Clothing business specifically. To consider the impact of lean instruments in the process division the Apparel business is utilized to delineate the systems of executing lean devices at a procedure office. To begin with, esteem stream mapping is utilized to delineate current state for Biswas Group . This is utilized to distinguish wellsprings of waste and after that recognize lean apparatuses to endeavor to lessen this waste. The future state delineate at that point created for a framework with lean apparatuses connected to it. Second, a reproduction display is created for Biswas Group to evaluate the advantages picked up from utilizing lean instruments and strategies in the esteem stream mapping.

Chapter-2 Literature Review

2.1 History of Lean

Achieving accomplishment for a pieces of clothing producer on the planet today is a perplexing business. Not exclusively should organization precisely characterize the unit cost, it should likewise screen and measure each esteem included addition fir every item, way to entryway. In the meantime the organization must have strategies set up to take out waste all through the plant floor and in its data and administration framework. Generally focused on benefit essentially can't be come to or kept up. Shockingly, not very many organizations today in Bangladesh have possessed the capacity to achieve these objectives. Most processing plants are still excessively centered around here and now survival and finding new business, insufficient task are setting a sufficiently high incentive on built arrangements. However it is just through ceaseless change program in light of built frameworks that production lines can flourish today in the clothing business. Another across the board issue in Bangladesh is the genuine lack of the prepared proficient for the article of clothing industry. Despite the fact that the quantity of instructive foundations showing clothing related classes has risen, numerous courses are putting forth obsolete material which has not helped the business to advance. This hole between what schools are showing and what the business requires has given to ascend to numerous clothing industry consultancies working in Dhaka. In any case, the majority of this specialist don't completely comprehend the standard and practices of a ceaseless change culture and are rather offering one-estimate fits-all arrangements with set formulas for every one of their customers. On the in addition to side, since most laborers have effectively gained essential specialized aptitudes, processing plants can in certainty make real upgrades in their creation lines once administration and built reasoning is set up. the incongruity here is that even plant building enhances, it is the line specialists who are getting minimal acknowledgment for their commitment &hard work. In Bangladesh, specialists' wages have been solidified and administration is turning a visually impaired eye to the significance of upbeat worker. Be that as it may, processing plants supervisors get themselves caught between relentlessly rising the creation cost and item necessity and the similarly exceptional descending weight on the costs their clients will pay. In the meantime, clients are setting substantial accentuation on the social consistence of their Bangladeshi providers. So not exclusively are industrial facilities tested to execute framework that improve efficiency, they should likewise make speculation to fulfill social consistence prerequisite on a long haul premise.

Another issue identified with both profitability and social consistence is the uneven information and ability levels is diverse creation divisions, directors and line specialists,

especially in the zones of wellbeing and security mindfulness and practice, and Conflict determination/mechanical connection. Senior manufacturing plant administration should be made mindful of these inconsistencies and afterward, much more significantly, should completely focus on shutting those holes with the goal that change can be driven through the association. Lean assembling is one of activities that emphasis on cost decrease by wiping out non-esteem included exercises.

Use of Lean Manufacturing is a ceaseless procedure. Be that as it may, not very many processing plants utilize this instruments. To some degree, it has been denied this is on the grounds that such enterprises are inalienably more effective and present generally less requirement for such change exercises. A few Managers likewise overlook to embrace lean assembling devices and strategies to the persistent procedure industry in view of reasons, for example, high volume and low assortment items, vast unbendable machines, and the long setup times that portray the procedure business.

With a specific end goal to contend in the present worldwide aggressive market, the ceaseless procedure industry likewise needs to search for more approaches to pick up a focused edge.

After World War II Japanese fabricates were looked with the predicament of huge deficiencies of material, money related, and HR. The issues that Japanese producers were looked with contrasted from those of their Western partners. These

conditions brought about the introduction of the "lean" assembling idea. Toyota Motor Company, drove by its leader Toyoda perceived that American automakers of that time were out-creating their Japanese partners; in the mid-1940's American organizations were beating their Japanese partners by a factor of ten. Keeping in mind the end goal to make an advance toward change early Japanese pioneers, for example, Toyoda Kiichiro, Shigeo Shingo, and Trichy Ohio contrived another, taught, process-situated framework, which is referred to today as the "Toyota Production System," or "Lean Manufacturing." Trichy Ohio, who was given the assignment of building up a framework that would improve efficiency at Toyota is for the most part thought to be the essential power behind this framework. Ohio drew upon a few thoughts from the West, and especially from Henry Ford's book "Today and Tomorrow." Ford's moving sequential construction system of

consistently streaming material framed the reason for the Toyota Production System. After some experimentation, the Toyota Production System was created and refined in the vicinity of 1945 and 1970, is as yet developing today everywhere throughout the world. The essential basic thought of this framework is to limit the utilization of assets that increase the value of an item. So as to contend in the present furiously focused market, US makers have come to understand that the customary large scale manufacturing idea must be adjusted to the new thoughts of lean assembling. An examination that was done at the Massachusetts Institute of Technology of the development from large scale manufacturing toward lean assembling, as clarified in the book "The Machine That Changed the World", got up the US makers from their rest. The investigation underscored the colossal accomplishment of Toyota at NUMMI (New United Motor Manufacturing Inc.) and drew out the immense hole that existed between the Japanese and Western car industry. The thoughts came to be embraced in the US on the grounds that the

Japanese organizations created, delivered and disseminated items with half or less human exertion, capital speculation, floor space, instruments, materials, time, and general cost.

Efficiency is estimated by the proportion of sources of info (work, capital, and so forth.) used to yields delivered. Real enhancements can be acknowledged from the end of waste (i.e. all non-esteem included exercises) through institutionalization of work hones and effective utilization of the work power, space and apparatus.

Other generous changes (innovations)may rise up out of apparatus overhauling, quality framework improvement and receiving more efficient creation strategies. General efficiency levels of the Bangladesh RMG division are low contrasted with provincial contenders. Subsequently, there is a critical potential to build the intensity of the business.

2.2 Lean Manufacturing

Lean creation depends on a framework created via auto producer Toyota. It centers around consistent change and disposal of waste in industrial facilities with a specific end goal to enhance profitability. Lean endeavors to make a mechanical culture in which all industrial facility staff work to enhance procedures to limit delays, lessen costs and enhance quality.

Lean assembling enhances working execution by concentrating on the speedy and continuous stream of items and materials through the esteem stream. To accomplish this, the different types of assembling waste must be distinguished and dispensed with. Waste can incorporate any action, step or process that does not include an incentive for the client.

On the off chance that we endeavor to characterize Lean, at that point we can state "An efficient way to deal with recognizing and wiping out waste (Non Value included Activities) through consistent change by streaming the item at the draw of the client in quest for flawlessness".

Lean Manufacturing is a bound together, exhaustive arrangement of methods of insight, rules, rules, apparatuses, and procedures for enhancing and advancing discrete procedures.

Lean Manufacturing, regularly called Just in Time (JIT) or Agile Manufacturing, is a working methodology that looks to expand operational adequacy by making an incentive according to the end client. The attention isn't on a division, zone or process, however on the enhancement of the whole esteem stream - the arrangement of procedures between receipt of client request and conveyance of completed item. [1]

2.3 Principle of Lean Techniques

The five-advance perspective for managing the usage of lean procedures is anything but difficult to recall, however not generally simple to accomplish:

- Specify esteem from the angle of the end client by item family.
- Identify every one of the means in the esteem stream for every item family, disposing of at whatever point conceivable those means that don't make esteem.
- Make the esteem making steps happen in tight succession so the item will stream easily toward the client. As stream is presented, given clients a chance to pull an incentive from the following upstream movement.

As esteem is determined, esteem streams are distinguished, squandered advances are expelled, and stream and draw are presented, start the procedure again and proceed with it until the point that a condition of flawlessness is come to in which culminate esteem is made with no waste. [2]

Figure 2.1: Principles of Lean

2.4 Various Types of Wastes

Squander is anything that doesn't include esteem however add just cost to be item. Squander is otherwise called MUDA. Squander is the utilization of any material or asset past what the client requires and will pay for. [3]

Lean Manufacturing expects to recognize and dispose of waste to enhance the execution of the business. Shigeo Shingo recognized "Seven" types of waste. These seven (7) types of waste are demonstrated as follows:

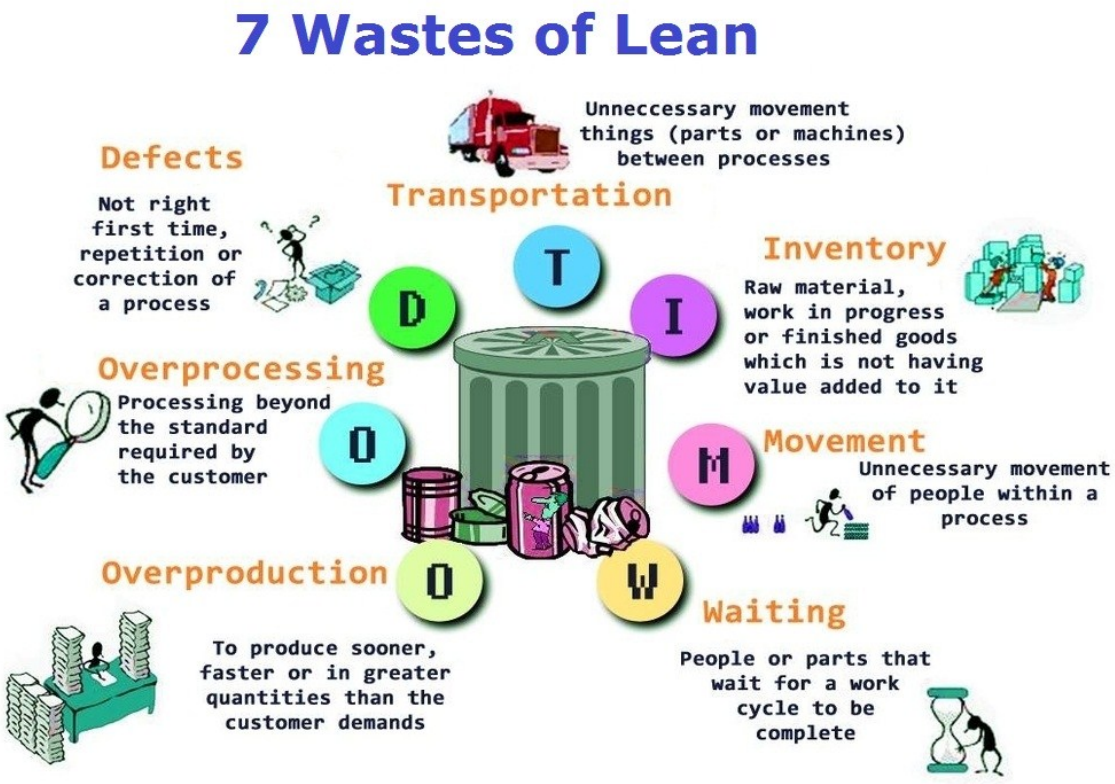

Figure 2.2: Seven Wastes

2.4.1 Over Production

Overproduction is to fabricate a thing before it is really required. Overproduction is exceedingly expensive to an assembling plant since it denies the smooth stream of materials and really corrupts quality and efficiency.

Overproduction producing is alluded to as "In the event of some unforeseen issue". [3,4]

To deliver sooner, quicker or in more noteworthy amounts than the total client request.

Assembling excessively, too soon or "In the event that something goes wrong".

Overproduction debilitates a smooth stream of products or administrations.

Removes the concentration from what the client truly needs.

Prompts over the top stock.

Different kinds of Causes:

- MRP push as opposed to Kanban pull.
- Large bunch sizes.
- Poor individuals use.
- Lack of client center, and so on.

2.4.2 Inventory

Work in Progress (WIP) is an immediate consequence of overproduction and pausing. Abundance stock tends to conceal issues on the plant floor, which must be recognized and settled to enhance working execution. Overabundance stock expands lead times, devours profitable floor space, postpones the recognizable proof of issues, and hinders correspondence.

By accomplishing a consistent stream between work focuses, numerous producers have possessed the capacity to enhance client administration and slice inventories and their related expenses. Any crude material, work in advance (WIP) or completed products which are not having esteem added to them. [3,4]

Different kinds of Causes:

- Production plan not level.
- Inaccurate guaging.
- Excessive downtime/set up.
- Large clumping.
  Unreliable providers, and so forth.

2.4.3 Motion

This waste is identified with ergonomics and is found in all occasions of twisting, extending, strolling, lifting, and coming to. These are additionally wellbeing and security issues, which in the present quarrelsome society are ending up to a greater extent an issue for associations. [3,4]

Different kinds of Causes:

- No standard working strategy.
- Poor housekeeping.
- Badly outlined cell.
- Inadequate preparing, and so forth.

2.4.4 Waiting

At whatever point products are not moving or being prepared, the misuse of holding up happens. Commonly, over 99% of an item's life in conventional cluster and-line make will be spent holding up to be prepared. A lot of an item's lead time is tied up in sitting tight for the following activity. [3,4]

Different kinds of Causes:

- Shortages and untrustworthy production network.
- Lack of multi-skilling/adaptability.
- Downtime/Breakdown/Layout time.
- Ineffective creation arranging.
- Quality, outline, building Issues, and so forth.

2.4.5 Transportation

Transporting item between forms is a cost invasion which enhances the item. Intemperate development and taking care of cause harm and are an open door for quality to crumble. Material handlers must be utilized to transport the materials, bringing about another authoritative cost that includes no client esteem. Moreover, it is frequently difficult to figure out which procedures ought to be by each other. Mapping item streams can make this simpler to picture. [3,4]

Pointless development of parts between forms

- Complex material stream ways
- Poor close coupling
- Wasted floor space
- Unnecessary material dealing with
- Potential harm to items

Different kinds of Causes:

- Badly composed process/cell.
- Poor esteem stream.
- Complex material streams.
- Sharing of hardware, and so on.

2.4.6 Over Processing

Preparing past the standard required by the client by enhancing handling proficiency we at last utilize less asset to accomplish a similar consumer loyalty.

Different kinds of Causes: [3,4]

- Out of date measures.
- Attitude - „Always done it like this".
- Not understanding the procedure.
- Lack of advancement and change.
- Lack of standard task strategies, and so on.

2.4.7 Non-Right First Time (Scrap, Rework and Defects)

Having an immediate effect to the main issue, quality deformities bringing about adjust or scrap are an enormous cost to associations. Related expenses incorporate isolating stock, re-reviewing, rescheduling, and limit misfortune. [3,4]

A deformity is a part which the client would esteem inadmissible to pass the quality standard.

- Defects lessen or dishearten consumer loyalty
- Defects must be redressed
- Rectification costs cash with respect to time exertion and materials
- Defects in the field will lose clients
- Right first time is the key

Different kinds of Causes:

- Out of control/Incapable procedures.
- Lack of aptitude, preparing and at work bolster.
- Inaccurate outline and building.
- Machine mistake.
- Black craftsmanship forms, and so on.

2.5 Lean Manufacturing Tools and Techniques

When organizations pinpoint the real wellsprings of waste, devices, for example, nonstop change, in the nick of time creation, generation smoothing, and others will manage organizations through remedial activities to take out waste. In the accompanying areas a concise portrayal of such devices is given.

2.5.1 Cellular Manufacturing

Cell fabricating is an assembling procedure that produces groups of parts inside a solitary line or cell of machines worked by mechanics who work just inside the line or cell. A cell is a little scale, unmistakably characterized generation unit inside a bigger processing plant. This unit has finish duty regarding delivering a group of like parts or an item.

Organizing individuals and hardware into cells has extraordinary preferred standpoint as far as accomplishing lean objectives. One of the benefits of cells is the one-piece stream idea, which expresses that every item travels through the procedure one unit at any given moment without sudden interference, at a pace dictated by the client's need. Expanding the item blend is another preferred standpoint of cell fabricating. This will likewise abbreviate the time required for changeover between items, which will energize creation in littler parts. Different advantages related with cell fabricating include: [5]

- Reduced transport and material taking care of.

- Better space use.

- Lead time decrease.

- Identification of reasons for deformities and machine issues.

- Improved efficiency.

- Enhanced cooperation and correspondence.

- Enhanced adaptability and perceivability.

2.5.2 Continuous Improvement

Constant change is another crucial guideline of lean assembling. Kaizen, which is the Japanese word for a ceaseless undertaking for flawlessness, has turned out to be prominent in the west as a fundamental idea driving great administration. Kaizen is a deliberate way to deal with steady, efficient, ceaseless change. In assembling settings upgrades can occur in numerous structures, for example, lessening of stock, and decrease of deficient parts. A standout amongst the best devices of constant change is 5S, which is the reason for a powerful lean organization. 5S is an in the first place, secluded advance toward genuine waste decrease. 5S comprises of the Japanese words Seri (Sort), Seaton (Straighten), Seiko (Sweep and Clean), Seekers (Systemize), and Shinseki (Standardize). The hidden idea driving 5S is to search for squander. [6]

2.5.3 “5S” Program

The expression "5s" alludes to the five Japanese words that depict the five stages .5S is a piece of lean assembling that diminishes squander and enhance quality and profitability, through tidying up and getting sorted out. Despite the fact that 5S uses presence of mind standards, kicking a 5S program off includes changing representative work propensities, and that can be troublesome.

5S is an essential, major, orderly approach for profitability, quality and security change in a wide range of business. The Five S program centers around having visual request, association, neatness and institutionalization. The outcomes you can anticipate from a Five S program are: enhanced benefit, productivity, administration and wellbeing.

5S is a framework to diminish squander and enhance efficiency through keeping up a systematic work environment and utilizing visual signals to accomplish more reliable operational outcomes. Execution of this technique "tidies up" and arranges the work environment fundamentally in its current setup, and it is normally the principal lean strategy which associations actualize. [6]

The 5S columns, Sort (Seri), Set in Order (Seaton), Shine (Seiko), Standardize (Seekers), and Sustain (Shinseki), give a procedure to arranging, cleaning, creating, and maintaining a profitable workplace. In the day by day work of an organization, schedules that keep up association and deliberateness are fundamental to a smooth and proficient stream of exercises. This lean strategy urges specialists to enhance their working conditions and causes them to figure out how to decrease squander, spontaneous downtime, and in-process stock: [7]

1. Seri-Sort - The initial phase in making things tidied up and composed.

2. Seaton-Set in Order - Organize, recognize and orchestrate everything in a work zone.

3. Seiko - Shine - Regular cleaning and upkeep

4. Seekers-Standardize - Make it simple to keep up - rearrange and institutionalize

5. Shinseki - Sustain - Maintaining what has been refined

2.5.3.1 Seri- Sort -Clean Up-Clear unnecessary materials

Arranging is the initial phase in influencing a work zone to clean. It makes it less demanding to discover the things which one we need and arranges for extra space: [7]

- Remove unused and unusable materials.
- Clear imperfect item.
- Clear pointless things.
- Remove sit without moving gear and instruments.

All these outcome in perfect and clean working environment and better workplace.

2.5.3.2 Seaton- Set in Order-Ensure good workplace keeping:

This includes in orchestrating right materials at opportune place for brisk access and transfer.

This prompts better association of materials and harmonious workplace.

Seaton result in less time in getting to materials and arranging them for creation.

This outcome is higher profitability. [7]

2.5.3.3 Seiko- Shine- Regular Cleaning-keep machine, workplace, floor etc.

Seiko prompts apparatus in great condition, working environment perfect and clean: [7]

- Fabric and pieces of clothing not filthy or ruined.
- Less working and revamp.
- Good condition.
- Higher execution.
- Productivity and quality.

There are a few stages in the cleaning procedure:

- Increase the lighting in the work region.
- Divide the region into zones.
- Define obligations regarding cleaning.
- Repair any holes on machines.
- Identify appropriate strategies and instruments for cleaning.
- Provide security for the people doing the cleaning (gloves, confront covers).
- Clean machines, floors, dividers and roofs.
- Paint machines, floors, dividers and roofs.
- Identify the wellsprings of soil.
- Try to wipe out the need to clean assess machines and apparatuses while cleaning.

2.5.3.4 Seekers- Standardize –Simplify

Institutionalize is to guarantee that the - Shine, set in Order, Sort program keep on being viable, the fourth step is to rearrange and institutionalize. One of the hardest advances is staying away from old work propensities. Utilize norms to enable individuals to work into new propensities that are a piece of your Five S program. [7]

2.5.3.5 Shinseki - Sustain - maintaining what has been accomplished

Preparing drives worker to accomplish higher aptitude and workmanship: [7]

Higher devotion and inspiration.

Better work propensities.

Higher laborer execution and profitability and quality.

2.5.4 Benefits of 5S

- Enhance wellbeing.
- Decline down time.
- Raise worker assurance.
- Recognize issues all the more rapidly.
- Create control through perceivability.
- Build up helpful work hones. [8]

2.5.5 Just in Time (JIT)

Nearly connected with lean assembling is the standard of without a moment to spare, since it is an administration thought that endeavors to wipe out wellsprings of assembling waste by creating the correct part in the perfect place at the opportune time. This tends to waste, for example, work-in-process material, imperfections, and poor planning of parts conveyed.

Stock and material stream frameworks are normally delegated either push (conventional) or pull (without a moment to spare) frameworks. Client request is the main impetus behind the two frameworks. In any case, the significant distinction is in how every framework handles client request. In the nick of time is an instrument that empowers the inner procedure of an organization to adjust to sudden changes in the request design by creating the correct item at the opportune time, and in the correct amounts.

Besides, in the nick of time is a basic instrument to deal with the outer exercises of an organization, for example, obtaining and dispersion. It can be thought of as comprising of three components: JIT generation, JIT dissemination, and JIT buying. More points of interest are given for each in the accompanying areas. [9]

2.5.5.1 Benefits of implementing Just-in-Time system

JIT (Just in Time) is world's outstanding amongst other demonstrated generation frameworks. In the event that actualized by its center standards and lessons learnt through its hypothesis and practice, an organization can effectively accomplish the accompanying advantages: [9]

- Reduction of immediate and direct work by disposing of non-esteem included exercises.
- Reduction of floor space and distribution center space per unit of yield.
- Reduction of setup time and calendar delays as the plant turns into a ceaseless generation process.
- Reduction is waste, rejects, and revise by distinguishing mistakes at the source.
- Reduction of lead time because of little part sizes, with the goal that downstream work focuses give input on quality issues.
- Better use of machines and offices.
- Better relations with providers.

- Better mix of and correspondence between capacities, for example, showcasing, buying, plan, and creation.
- Quality control incorporated with the procedure.

2.5.6 Standardization Work

A vital guideline of waste disposal is the institutionalization of laborer activities. Institutionalized work essentially guarantees that each activity is sorted out and is completed in the best way. Regardless of who is doing the activity a similar level of value ought to be accomplished. [10,11]

2.5.7 Takt time

"Propriety time‟ is the normal client request time for an article. This considers the normal profitable, working time of the assembling procedure. It is estimated in "seconds per unit". [12]

Takt Time=Total every day Operating time/Total creation necessity

Takt Time=480/100=4.8 min/Vehicles

Utilizing the above recipe, the pace of work is set by the market request. For instance, there is a force or market request of 100 vehicles for each day, this request if isolated by 480 minutes accessible in a day, will give you the quantity of units you can create to serve your clients. This implies time accessible to deliver parts or sub-gatherings of parts on each station or every get together process is 4.8 minutes.

2.5.8 Total productive maintenance

Machine breakdown is a standout amongst the most essential issues that worries the general population on the shop floor. The unwavering quality of the hardware on the shop floor is vital since on the off chance that one machine separates the whole generation line could go down. An essential apparatus that is important to represent sudden machine breakdowns is add up to beneficial upkeep. In any lean condition setting an aggregate profitable upkeep program is critical.

2.5.9 Value Steam Mapping

Value steam mapping are required to bring an item or a gathering of items that utilization similar assets through the fundamental streams, from crude material to the arms of clients. These activities are those in the general production network including both data and task stream, which are the center of any fruitful lean task. Esteem stream mapping is a venture change instrument to help with picturing the whole generation process, speaking to both material and data stream.

The objective is to distinguish a wide range of waste in the esteem stream and to find a way to attempt and kill them. Taking the esteem stream perspective means taking a shot at the comprehensive view and not singular procedures, and enhancing the entire stream and not simply streamlining the pieces. It makes a typical dialect for creation process, in this manner encouraging more astute choices to enhance the esteem. While scientists and specialists have built up various apparatuses to explore singular firms and supply chains, the vast majority of these instruments miss the mark in connecting and imagining the idea of the material and data stream in an individual organization.

At the level of the individual firm numerous associations have pushed toward getting to be lean by adjusting distinctive lean devices, for example, JIT, setup lessening, 5S, TPM, and so on. In a considerable lot of these cases firms have revealed a few advantages; be that as it may, it was clear that there was a need to comprehend the whole framework so as to increase greatest advantages.

Function	Mass production	Lean Manufacturing
Labor	Narrowly & unskilled production workers	skilled production workers
Product	High volume of homogeneous products	High volume with wide variety of products
Organization	Vertical integration or Decentralized divisions	Team oriented
Product volume	High	High
Unit production cost	Low	Low
Machinery & tools	Single-purpose machines	Flexible automated machines
Ultimate goal	Good enough	Perfection
Flexibility	Low	High
Inventory turn	Low	High
Inspection	Sampling	100% source
Scheduling	Forecast, push	Customer order, pull
Manufacturing lead time	Long	Short
Batch size	Large with queue	Small, continuous flow
Layout	Product	Product

Table 2.1: Comparison of lean manufacturing with mass production system.

Chapter 3 Methodology

3.1 Methodology:

3.1.1 Work Assessments:

Lean strategic approach:

Phase 1: Lean assessment

Phase 2: Skill enhancement
Phase3: Awareness program
Phase 4: Develop new concept

Phase 5: Implementation & trail new concept.

Phase 6: Follow up new concept.

Productivity Improvement Program & Technique:

- Low Manpower.
- Incentive: Provide sporadic rewards to teams for good performance ➢ Maintenance of machines.
- Establish communication channels.
- To ensure friendly stress-free environments.
- Make employees feel like they have a greater involvement/responsibility in their work.
- Reducing absenteeism.
- Motivation.
- ✓ Pilot project on 6 lines.
- ✓ Motivation / Learning Program. (In Line Mobile Motivation/Learning Program)
- ✓ Quality Motivation.
- ✓ Select 5s maintaining groups who may follow up the total 5s Program & Submit report on daily basis. Motivation /learning season

TR (Team Representative) & Quality ……0.25 day/month.

Operator …….0.25 days/month.

There are 4 rules are used in my working Project:

- Simplify, structure & standardized every process.
- Analyze, simplify & connect every process.
- Connect visually workers too customers & corporate objective.
- Improve continuously through work practice and experimentation with worker participation.

The three wide-ranging categories affecting the Cost and Lead Time are assessed as follows:

3.1.2 Experiment 1: Retention time in materials and information flow.

Direct Impact: Shorten and stabilize Lead Time;

Direct Impact: Enhance cash flow.

Indirect Impact: Reduce Operating Overhead Cost.

Category 1 Retention time in materials and information		Findings
Retention Time	Related to retained raw materials	•Waiting in Storage •Waiting to be cut •Waiting in Process for workers due to line balancing •Waiting in process for trims or instruction •Waiting for Finishing •Waiting for Approval •Waiting for instruction •Space Utilization •Stock turnover in days •Stock turnover ratio
Processing Time	Related to Flowing Materials	• Flowing Materials through practices

Table 3.1: Retention time in materials and information.

3.1.3 Experiment 2: Processing of manufacturing activities

Direct impact: Reduce of Cycle time.

Direct impact: Reduce Manufacturing Cost.

Category 2 Processing of manufacturing activities		Findings
Wasteful Motions	Related to work practices caused by line setups, staffing and unorganized work practices	•Excess Evacuation •Excess Handling • Hesitation Pick ups •Excess Trimming
Order Changeover	Related to line set up of new order	•Machineries movement and adjustment •Feeding and flashing the line
Unnecessary activities	Related to none value activities and motions	• Bundling • Marking • Loading • Sorting • Transport • Snickering
Rework	Related to quality failure	• Over-processing by workers • Re-inspection
Rejects	Related to damaged parts	• Cost of rejects • Cut to Ship ratio and on-time delivery

Table 3.2: Processing of manufacturing activities.

3.1.4 Experiment 3: Continuous Improvement Culture through Performance Management Policy Deployment to sustain both objectives 1 and 2.

-Pleasant work environment and conditions for workers

-Learning organization

Tools: Investigation through questioning and systems evaluation:

Category III Management Practices		Findings
Management Practices	Assess management capability, skill and systems related to performance	•Engineering •Factory and Supervisory • Workers Skill •Planning •Troubleshooting •Workplace organization and visual management •Layout and Production Set ups •Mechanics Role •Quality Policy and System

Conclusion of the three categories		Findings
Underutilized Resources	Improving the above will increase the capacity due to:	•Machineries Utilization •Labor utilization •Productivity Level •Unit Cost

Table 3.3: Management Practices.

3.1.5 Experiment 4: Minimization of Daily sewing threads Losses.

According to the lean assessment it was found there are lots of sewing thread are wastes daily respect to per line. This technique is applied to the pilot line. It is helping to achieve reduction of sewing thread in BGL.

-Confirm Order.

-Confirm the sewing thread consumption.

-Calculate the amount of sewing thread required everyday respect to the **Production Per Line**.

Let

Operation	Machine	SMV	No of Machine	No of Thread	Total no of Thread
Sleeve Hem	3T FL	0.28	1	1*3	3
Shoulder Join	4T OL	0.29	1	1*4	4
Neck V tack	SNL	0.26	1	1*1	1
Neck V make	SNL	0.27	1	1*1	1
Neck Sub tack	SNL	0.67	2	1*2	2
Neck Join	SNL	1.84	3	3*1	3
Neck O/L	4T OL	0.24	1	1*4	4
Neck Piping	3T FL	0.28	1	1*3	3

Neck Label T/s	SNL	0.57	2	2*1	2
Sleeve join	4T OL	0.72	2	2*4	8
Side Seam	4T OL	0.81	3	3*4	12
Sleeve sub tack	SNL	0.29	1	1*1	1
Sleeve Kara tack	SNL	0.26	1	1*1	1
BTM Hem	SNL	0.30	1	1*1	1
Total		7.08	21		46

Table 3.4: SMV & Thread Consumption

Now

Total SMV for these T-Shirt: 7.08 [SMV= Basic Time + Allowance; Where Basic Time = Cycle time * performance rating]

Total no of m/c=21

Total No of cone required on machine wise = 30 [Respect to No of needle Thread, Bobbin thread & Lopper thread

MP: 21+3=24

100% efficiency target for 8 hours=1627 pcs
75% efficiency target for 8 hours=1220 pcs

Let

Thread required to sewing basic T-shirt=150 m

No of cone required for each garments (T-shirt) =150/5000=0.03 cone

No of cone required for 1220 pcs=1220*0.03=37*5 %(allowance) =39

This line required 39 cones for complete 1220 pcs garments

Who receive the thread in beginning of work(Supervisor) are responsible to give the report (use of thread) after finish the work. (As like as **broken needle policy**). If we use broken needle policy, then we will able to also **use** the above 5 % allowance by **Reconing.**

Benefits:

- ✓ Easier to identify how much thread are used according to per line to meet the production target & also how much sewing thread are required to confirm the ship qty.
- ✓ Easy to identify the accuracy & Lack ness of consumption.
- ✓ Maximize the inventory system.
- ✓ Easy to Identify the Daily sewing threads uses with respect to different buyer with production.
- ✓ Increase the transparency & Accountability where everybody careful about the daily sewing threads losses.
- ✓ Easy to find out no of uses machine per day.

Next Action:

Sewing Thread Booth:

By using re coning system we may able to create a Sewing Thread Booth where a lot of threads are storage (Allowance thread which we provide during consumption) according to Color, Color code, Count, Buyer etc.

Buyer:

Count:

Color:

Color code:
No of Cone:

Chapter-4 Results & Discussion

4.1 Result & Discussion

Based on my observations, I was unimpressed by the manufacturing practices and appalled by the vast amounts of working capital tied up in inventory. To focus on mass production, low prices and economies of scale in order to reap profits made no sense for world class manufacturers and over-production is fatal for any company. However, the manufacturing process must be pulled rather than pushed the same as the supermarket only reordered and restocked goods once they had been bought or ordered by customers. This is the idea of Just in Time (JIT).

Here below, are the details of the findings split by the three wide-ranging categories demonstrating the results of the current state and highlighting the potential of the future ideal.

4.1.1 Experiment I – Retention time in Materials and Information Flow:

This part of the mapping covers the flow of the raw materials and parts from the stores up to the shipping area going through the manufacturing stages.

This part responds to objective 1 leading the analyst to the causes of the retention time.

The mapping covers the following areas:

A) Lead time.

B) Information Flow.

C) Stock turnover in days.

D) Stock turnover ratio.

E) Line Balancing.

F) Space Utilization.

A) Lead time:

The amount of time required to produce a single product, from the time of customer order to shipping. The total time a customer must wait to receive a product after placing an order. Lean manufacturing is the ultimate solution, to achieve pull production. The results and improvement potential are given below:

Lead Time (Materials Flow)						
		Before		**After**		**Achievement**
1	Processing Time	291	12%	223	36%	
2	Retention Time	2128	88%	400.00	64%	
Throughput time of 1st piece *Minutes*		**2419.00**		**623.00**		74%
Throughput time of 1st piece *Day*		**4.03**		**1.04**		(2.99)

Table 4.1: Improvement (%) of Lead time.

Here, Achievement (%)=Before-After/Before*100; Net Achievement =Before – After

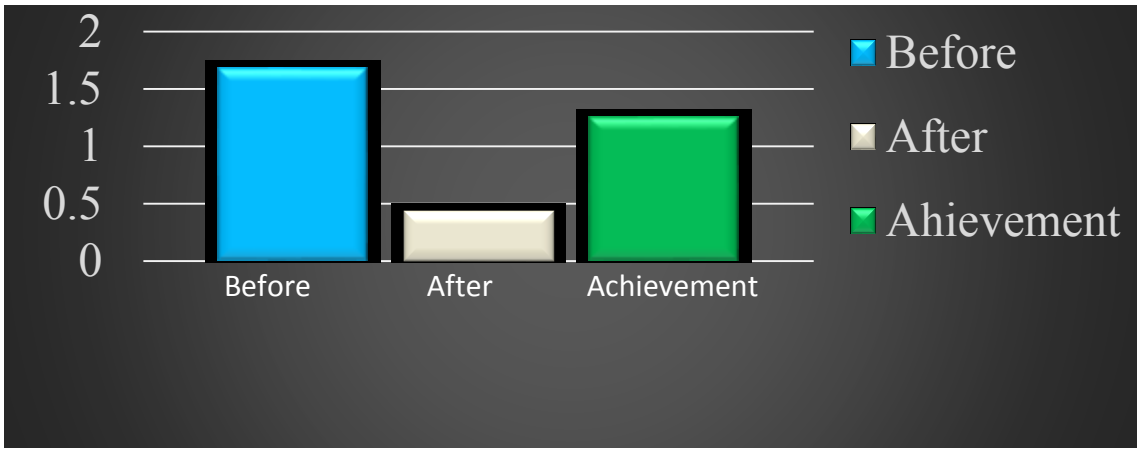

Fig 4.1: Achievement (%) of Lead time.

B) Information Flow:

The information system is longer than the operations breakdown and factory must simplify to connect workers to the information system not to isolate them. This is a big change for factory because currently the scheduling and information related to the product are really owned by the management staffs and any changes had to be approved by them. That just slowed down production, disconnect workers from corporate objectives and I wanted to make sure workers on the floor owned the information, the schedule and re- order point. The new information system improves operational efficiency and gives ownership to workers on the floor.

C) Stock turn over in days:

Monetary value of stocks as a ratio of daily overheads was not calculated due to the absence of the information related to stock value. However, I analyzed the number of days of available quantity vis-à-vis productivity capacity of the factory.

D) Stock Turnover ratio:

Stock will increase in times of expansion and decrease in times of contraction. For garment factories, a high stock turnover ratio is essential in order to make any profit.

A low stock turnover could indicate the presence of slow-moving stock, which should be disposed of rapidly resulting in large quantity in inventories and work in progress and holding capital.

E) Line balancing:

Line balancing is the assignment of work to stations in a line so as to achieve the desired output tare with the smallest number of workstation.

Line Balancing Ratio		
Before	After	Achievement
71%	90%	-27%(-19)

Table 4.2: Achievement ratio of Line balancing.

Here, Achievement (%)=Before-After/Before*100; Net Achievement =Before – After

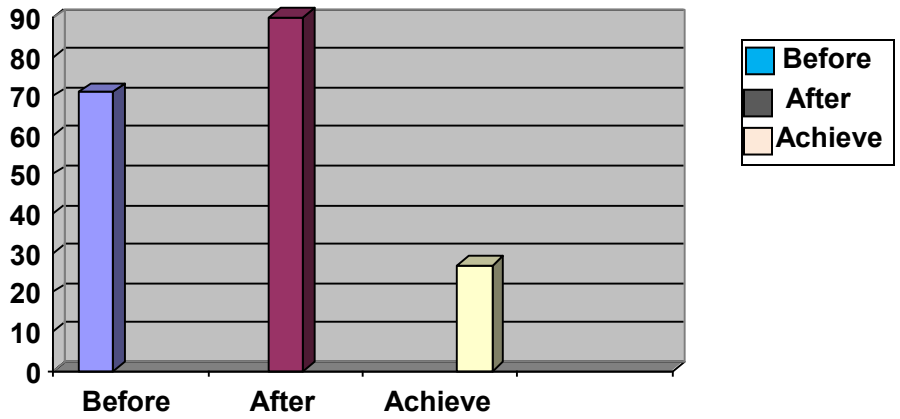

Fig 4.2: Achievement ratio of Line balancing.

Technique used to improve line balancing:

- By using proper time study & capacity for specific task on specific worker.
- By using method study on specific task.
- By using production study.
- Motivation & Training.

Tools used for line balancing:

1. Garments Stopwatch.
2. Calculator.

The main key is to reduce retention time is to eliminate overproduction by producing only what quantity and when is needed and by continuously flowing parts through the manufacturing chain without stoppage. Line balancing can be realized only when production lines are downsized and flexible, tact time is established between processes and Kanban supermarket are identified and planned.

F) Space utilization:

According to factory record, the Inventory occupies additional space of 7,540 SQFT equivalents to 410 sewing operators‟ workstations. The reduction of stock turnover in days will help in adding new capacity to the sewing lines as mentioned above. Space for shipping and stores are not included.

Space Utilization – Inventories				
	Performance Measure	**Before**	**After**	**Achievement**
1	Space for Inventories in process	7500 SQFT	3250 SQFT	56%(4250 soft)

Table 4.3: Potential Achievement of space utilization.

Here, Achievement (%)=Before-After/Before*100; Net Achievement =Before – After

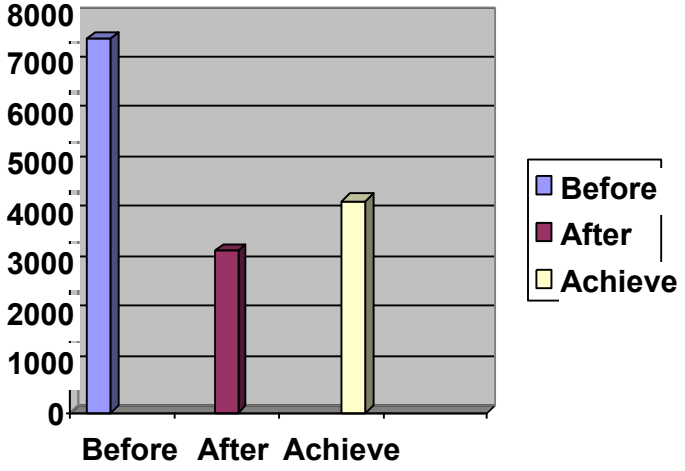

Fig 4.3: Potential Achievement of space utilization

4.1.2 Experiment II – Processing of manufacturing Activities (Cycle Time):

Wasteful activities and motions have direct impact on unit cost which is driven by cycle time. Unit cost covers the operating expenses (overhead) and the manufacturing cost of the direct labor. The lowest productivity level is the higher overhead gets and vice versa. From buyer's side, wasteful activities and motions are not considered as value added of which buyer is not willing to pay for and not part of international practices.

The reason behind Wasteful activities and motions relate to management and engineering practices caused by lack of creativity and innovation and definitely are not caused by worker's performance. The study has covered six "6" areas as follows:

A) Wasteful motion (within value added activities).

B) Order Changeover.

C) Delays (Downtimes).

D) Reworks.

E) Cut to Ship Ratio and On-time Delivery.

F) Rejects.

A)- Wasteful Motions within the value added activities:

Work practices are composed of valuable and wasteful motions. My observations demonstrated many unnecessary motions are merged with valuable motions and this is due to hesitation in pick up, excessive parts handling and evacuation caused by the existence of large number of workers in each production lines and due to lack of standardization and disorder in the workplace.

B) Order Changeover:

Order Changeover and Equipment Adjustment is extremely high averaging in 40 changeovers a month and 360 minutes of waste per worker per changeover. Workers are almost idle during the changeover creating another unavoidable delay related to labor utilization and materials retention. This concept will make it difficult if factory move into only few production hours at each workstation.

Order Changeover			
Performance Measure	Before	After	Achieve
Changeover per line / order	450 Minutes	210 Minutes	53% (240 min)

Table 4.4: Potential Achievement of Order Changeover.

Here, Achievement (%)=Before-After/Before*100; Net Achievement =Before – After

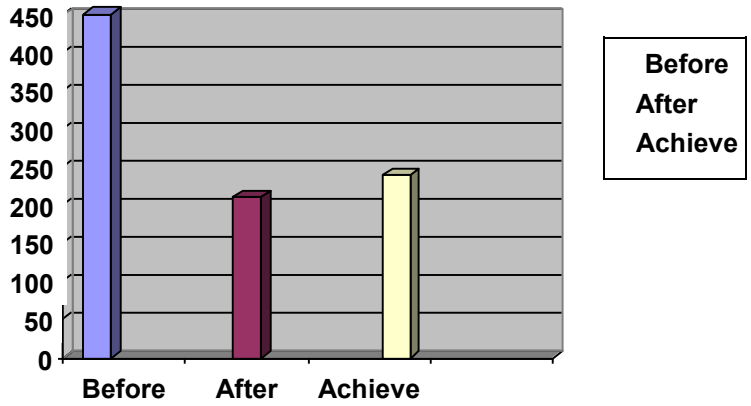

Fig 4.4: Potential Achievement of Order Changeover.

Technique Use to Order Changeover time:

Before finish the current style responsible person should to inform that they may able to finish the work within 3-4 hours with maintaining pull system.

C) Additional Delays (downtimes):

There was no data background to illustrate the details of possible delays such as: Machine breakdowns, training, lack of work and accessories, etc.; which have another impact on labor utilization.

D) Reworks:

Workers are wasting very little of their daily working minutes on rework.

E) Cut to Ship Ratio and On-time Delivery:

If a delivery is done in full quantity as ordered with right quality at agreed date, such a delivery is classified as an on time delivery. If a customer has given a delivery tolerance and the actual delivery is within that tolerance (even though it is not 100%) such a delivery too is considered as an on time delivery. But If the quantity needed to be delivered on certain date and only 99% of the order was actually delivered at the agreed date, then Cut to ship ratio or on-time delivery is zero. Factory main objective is to respond to customer demand under Just in Time Principles. A mechanism must be built to avoid failure and to reduce rejects.

F) Rejects:

Reviewing the chart above, there is some difference between cut quantity and shipped quantity, the difference is turned out as rejects. The cost of rejects is extremely high which cuts into profits,

4.1.3 Experiment III -Management Practices:

The factory is suffering from lack of engineering and factory management and standardized practices. The systems must be in place in order to implement further improvement. Here are below a summary of the consultant recommendations followed with the details.

Management Practices			
	Systems	**Weaknesses**	**Recommendations**
1	Planning	Production Plan	
2	Quality Practices	No comments, must be looked at	To Develop
3	Compliance Practices	Excellent	Need workplace organization to enhance
4	Meeting Structure and effectiveness	Average	
5	IE practices and effectiveness	Available	To Implement
6	AQL Practices	OK	To Coach sustainability
7	Procedures of Rework	Average	Require limitation in Pieces and Corrective action Plan
8	Layout design	NO	IE Practices
9	Line Balancing Techniques	NO	IE Practices
10	Work methods training	NO	IE Practices
11	Mechanics practices	Yes	
12	Factory Manager Role and Skill	Good	
13	Production Manager Role and Skill	Excellent	

14	Supervisors Skill	no knowledge of line balancing only limited to technical knowledge	Need to enhance the
			Knowledge
15	Communication between departments	No proper Information flow process	To Implement Point of Use System
16	Productivity Monitoring System	No Proper tracking	To Implement Visual

Table 4.5: Management weakness and recommendation

4.2 Potential Achievement:

Following data has Shown the Current state & future state of the Factory. It also shown the which tools may involve to get the better Improvement ratio of this factory:

	Waste affecting performance drivers	U/M	Current	Future	Improvement Ratio	Lean Tools
1	Retention Time of first bundle	Minutes	2128	600	74%	Continuous Flow Kanban / Supermarkets One-point flow One small lot flow Management Support Concept
2	Inventories and WIP	Pieces	304,200	160,000	-47%	Pull Production

3	Stock turnover in days	Days	Not estimate			Pull Production
4	Stock turnover ratio	Percent	5%	10%	90%	Pull Production
5	Line balancing	Percent	71%	90%	27%	Team function Tact Time In production Kanban
6	Processing Time Reducing Cycle Time / style	Minutes	18	13	-27%	Team Function See Unnecessary Activities Management Support Concept
7	Order Changeover Layout Time per sewing line per changeover	Minutes	450 (Almost one working day)	210	-53%	Fixed Position Strategy Layout standardization Operations Breakdown Standardization Simplification of internal and external set ups Management Support Concept
8	Throughput time in sewing (including changeover) of 1st piece	Minutes	650	240	-63%%	See Changeover One Piece Flow at feeding
9	Reworks / day / Worker	Minutes	8	3.7	53%	Quality at the Source Management Support Concept
10	Rejects / month	$	Not Estimate		-	Quality at the source Management Support Concept

11	Downtimes		Not estimate			Team Function Management Support Concept

Table 4.6: Potential Achievement after Implementation lean tools & technique.

4.3 Future Plan:

-Areas for Improvement:

Based on the root causes of lower performance of our garment industry, here are the main areas for improvement as follows:

- **Supportive Management Concept:**

Simplification in procedures and paperwork must be considered. Management concept must be designed in order to provide only the information and the adequate tools required to the workers to perform a complete task without relying on section supervisors. Every system related to operators‟ performance must be designed as per the Lean tools covering time set up reduction, layout, quality within the team, Tact time and re-orders point, Kanban requirement etc.

- **Standardization and stabilization of work practices:**

Work practices related to stores, cutting, Sewing, Finishing, packing and cartooning must be improved to ease the work of the workers and to reduce the time of handling and evacuation that will lead to maximize the utilization of the equipment and workers and stabilize the manufacturing flow. Industrial Engineering department must be set in place.

- **Throughput Time & Feeding time:**

Implement floating pieces (restricted WIP) system can eliminate totally the feeding loss and accelerate the throughput time of first piece out at the rate of the total SMV of one piece.

- **Employees Involvement:**

All innovations and improvements start with everyone in the organization becoming aware of the need for change and the role each will play in the realization of that change. The most important step is to begin by catching people's attention and raising their awareness. To sustain the changes employee's participation in decision making is a must that lead to improve the moral of the workers. It is important to implement a culture which support team work‟ involvement and empower the workforce through a support management system.

- **Visual Management:**

The intent of a visual factory is that the whole workplace is set-up with signs, labels, color-coded markings, etc. such that anyone unfamiliar with the process can, in a matter of Minutes, know what is going on, understand the process, and know what is being done correctly and what is out of place.

- **Workplace organization:**

There is no improvement without implementing 5S among the processes in order to organize the workstations to eliminate hesitation and disorder and to ease information and materials flow, workers should be able to locate for example, the WIP, the assignment, the information, the tools, etc. Lot of additional space can be saved, especially within the areas occupied by large quantity of inventory with better organized storage and visual displays. So 5S can eliminate significant amount of space generated from disorder. 5S is the foundation pf any improvement.

- **Manufacturing Concept and Planning System:**

The manufacturing processes to make one final product are split into multiple processes and planning systems adding tremendous excessive costs as relate to handling, waiting,

storing etc. manufacturing concept must be changed by downsizing and combining the entire manufacturing concept as it relates to the product making.

- **Labor utilization:**

Emphasizing team work functions by synchronizing workers pace on minimum and maximum inventory level considered as "In production Kanban". This is part of work practices standardization. Under the format of team function and tasks design, this will lead to maximize labor and equipment utilization and improve the lead time working against only what is required, when is needed for better balanced activities.

- **Changeover and Time Set-ups:**

Changeover activities must be re-analyzed, redesigned and standardized in order to eliminate all the delays incurred within the changeover activity as is the case at the plant. The changeover activities are done in unreliable manner which they are unpredictable and affecting the flow and the pace of the product. Stabilizing the position of the workers through short-term development plan to avoid dislocating workers through the production cell and make it easier on feeding new style.

- **Pay Incentive System:**

In most organizations, significant salary gains come from job-promotions that move people to a higher salary grade, not from merit increases or motivation. Studies show that, organizations that reduce pay differences between the highest- and the lowest-paid employees tend to perform much better. Conventional wisdom says that workers should be evaluated and paid based on results under their control. When Team members play a significant role in achieving corporate objectives performing complete job sharing the responsibility of producing good quality product in the time required they should share in any reward or bonus equally.

Chapter-5 Conclusion

5.1 Conclusion

The mentioned improved areas will help in reducing tremendously the operating expenses since costs related to low productivity can be eliminated and productivity can be increased generating higher profitability. The team based functions through standardization will help to reduce the time waste by workers and motivate workers to earn more incentive leading to engaging workers in continuous improvement. This kind of set up requires investment in both People and Time for tomorrow's success.

APPENDIX

Waste: Any activity that adds to cost without adding to value of the product.

Value Added: Any activity that transforms a product or service to meet the customer need.

Non Value Added: Any activity that absorbs or consumes resources (e.g. material, time, equipment, people, paper, space, etc.) without creating value to the product adding only cost which buyers won't pay.

SMV: Standards Minutes Value is a combination of several elements (Hand motions and Sewing cycle) to complete one task or operation as per the international benchmark. Applying this to the SMV for a particular garment yields the C&M cost. So Revenue is the result of total earned SMV (Minutes standards value) produced by the direct labor (sewing machine operators).

Inventory: Usually the highest cost category, inventory is all raw materials, purchased parts, work-in- progress and finished goods that are not yet sold to a customer.

Work in process (WIP): Items waiting between operation steps to be processed.

Order Changeover: Changing existing set up of a production line into new style which requires changing and adjusting machineries, training workers and Feeding the line.

Lead Time: The amount of time required to produce a single product, from the time of customer order to shipping.

Machineries Utilization: utilizing a sewing machine is based on needle dips so it calculates the time of the time needle dip functioning within a day over the time sewing machine was available.

Team based module: The arrangement of people, machines, materials and methods such that processing steps are adjacent and in sequential order so that parts can be processed one at a time (or in some cases in a consistent small batch that is maintained through the process sequence). Typically, in a U-shaped configuration where operators remain

within the cell and materials are presented to them from outside of the cell. The purpose of a cell is to achieve and maintain efficient continuous flow.

Kaizen: Continual incremental improvements which accumulate and significantly drive out waste.

Kaizen Event: A time-sensitive, rapid-deployment methodology that employs a focused, team-based approach to small but non-ending incremental improvements.

Kanban: Visual signal. Typically, a small card, sign or signboard, an instruction to produce or supply something. A re-order card or other method of triggering the pull system, based on actual usage of material. A central element to JIT system. There are two types; production and withdrawal. It should be located for use at the point of manufacturing.

Value Stream Mapping: A systematic method to identify all the activities (door-to door) required producing a product or product family. The "Map" will include both the flow of the material and the flow of information. It should first be used to describe the current state and then redone to depict the future state.

Visual Control: Creating standards in the workplace that make it obvious if anything is out of order and by displaying the status of an activity so every employee can see it and take appropriate action.

Mass Production: Mass production is the name given to the method of producing goods in large quantities at low cost per unit. But mass production, although allowing lower prices, does not have to mean low-quality production. Instead, mass-produced goods are standardized by means of precision-manufactured, interchangeable parts.

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