Optimization of Apparel Industry Through Industrial Engineering Concepts In Bangladesh

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Abstract—Improving productivity is the main concern of any manufacturing industry. For our study, we have chosen an outwear apparel manufacturing company in Bangladesh. As Bangladesh is the second highest apparel exporter in the world after China, we think that the knowledge sharing of Industrial Engineering in this RMG (Ready Made Garment) sector is our right choice. In this study, three of the core departments are included. They are Planning, Production and Industrial Engineering. During the study period, we observed process flows, human resource, production systems and machineries. Finally, we designed value stream map for the existing situation considering the above mentioned three departments. Furthermore, corresponding time schedules are also exists in the current state map. Eventually, some recommendations are made and designed proposed future state map. There every step has some opportunity to improve by industrial engineering knowledge, software, logistic and supply chain management. The process is continuous and for next step, proposed future state map will be the current state.

Index Terms— Industrial Engineering, Line balancing, Motion study, Productivity, Production, Plannning, Value stream mapping.

1 Background

THE purpose the study is to know the scope and application of Industrial Engineering concepts in the apparel industry in Bangladesh. The readymade garments industry acts as a catalyst for the development of Bangladesh. The "Made in Bangladesh" tag has also brought glory for the country, making it a prestigious brand across the globe. The country with its limited resources has been maintaining 6% annual average GDP growth rate and has brought about remarkable social and human development.

After the independence in 1971, Bangladesh was one of poorest countries in the world. No major industries were developed in Bangladesh, when it was known as East Pakistan, due to discriminatory attitude and policies of the government of the then West Pakistan. So, rebuilding the war-ravaged country with limited resources appeared to be the biggest challenge.

The industry that has been making crucial contribution to rebuilding the country and its economy is none other than the readymade garment (RMG) industry which is now the single biggest export earner for Bangladesh. The sector accounts for 83% of total export earnings of the country [16].As a result, in the competition of world market the industry has go through modern concepts and technology. Lean along with Industrial Engineering concepts application is the demand of time.

2 Production Planning and Control

2.1 Production Planning

Production Planning is defined as the administrative process that takes place within a manufacturing business and which involves making sure that sufficient raw materials, staff and other necessary items are procured and ready to create finished products according to the schedule specified. A typical large manufacturing business engaging in production planning will aim to maximize profitability while maintaining a satisfied consumer base.

Production engineering is a combination of manufacturing technology with management science. A production engineer typically has a wide knowledge of engineering practices and is aware of the management challenges related to production. The goal is to accomplish the production process in the smoothest, most-judicious and most-economic way. The production engineer possesses a wide set of skills, competences and attitudes based on market and scientific knowledge. These abilities are fundamental for the performance of coordinating and integrating professionals of multidisciplinary teams. The production engineer should be able to:

- Dimensional and integrate resources usually required to consider physical, human and financial resources at high efficiency and low cost, yet considering the possibility of continuous further improvement;
- Make proper use of math and statistics to model production systems during decision making process;

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- Design, implement and refine products, services, processes and systems taking in consideration that constraints and particularities of the related communities;
- Forecast and analyze demand to select among scientific and technological appropriate knowledge in order to design, redesign or improve product/service functionality;
- Incorporate concepts and quality techniques along all the productive system. Deploy organizational standards for control proceedings and auditing;
- Stay up-to-date with technological developments to enabling them to enterprises and society;
- Understand the relation between production systems and the environment which relates to the use of scarce resources, production rejects and sustainability;
- Manage and optimize flow (information and production flow).

Work opportunities are available in public and private sector manufacturing organizations engaged in implementation, development and management of new production processes, information and control systems, and computer controlled inspection, assembly and handling.

Production engineering encompasses the application of castings, machining processing, joining processes, metal cutting & tool design, metrology, machine tools, machining systems, automation, jigs and fixtures, and die and mold design and material science and design of automobile parts and machine designing and manufacturing. Production engineering also overlaps substantially with manufacturing engineering and industrial engineering.
In industry, once the design is realized, production engineering concepts regarding work-study, ergonomics, operation research, manufacturing management, materials management, production planning, etc., play important roles in efficient production processes. These deal with integrated design and efficient planning of the entire manufacturing system, which is becoming increasingly complex with the emergence of sophisticated production methods and control systems.

Production Planning directly depends on forecasting defined as the process of making statements about events whose actual outcomes (typically) have not yet been observed. A commonplace example might be estimation of some variable of interest at some specified future date. Prediction is a similar, but more general term. Both might refer to formal statistical methods employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgmental methods. Usage can differ between areas of application: for example, in hydrology, the terms "forecast" and "forecasting" are sometimes reserved for estimates of values at certain specific future times, while the term "prediction" is used for more general estimates, such as the number of times floods will occur over a long period.

Risk and uncertainty are central to forecasting and prediction; it is generally considered good practice to indicate the degree of uncertainty attaching to forecasts. In any case, the data must be up to date in order for the forecast to be as accurate as possible.

2.2 Functional Flowchart

Technical files from Merchandising first supplied to Sample Department, R & D, IE and Production Department. Sample Department then supplies Approved Sample, R & D includes Critical operations, Attachment and Special Machinery, IE provide information about Critical Path selection, Machine, Manpower and Layout of line and Production Department always tries to optimize the productivity. After combining information from these departments Product Data will be formed which includes Sample construction, Machine & Manpower information, Quantity & Delivery, Productivity and Learning curve (Minimum, Average & Maximum). Then Scheduling & Allocation is done depending on delivery date & operation, Productivity, Line allocation. Finally Complete Production plan is produced that provide Routes to execute production, new order start, Old order end, Working day hours and Manpower & Machine allocation.

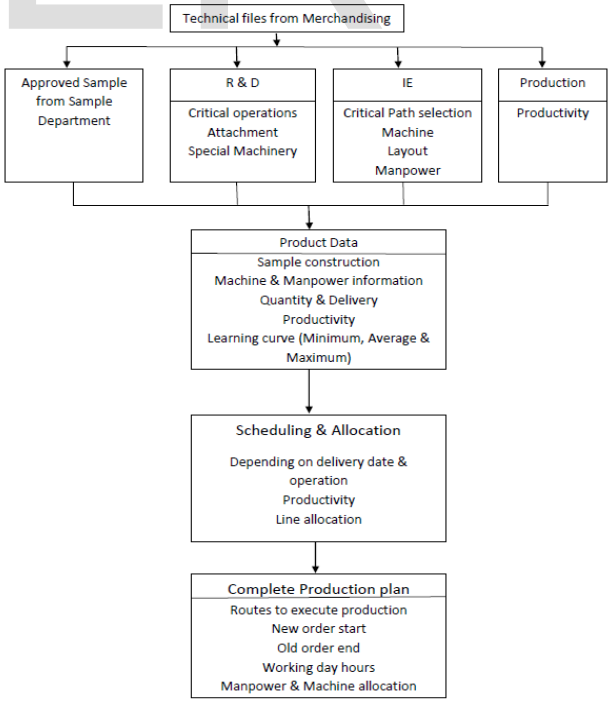

Figure 2.1: Functional Flowchart of Planning Department

2.3 Learning Curve

A learning curve is a graphical representation of the increase of learning (vertical axis) with experience (horizontal axis). Learning is the act of acquiring new, or modifying and reinforcing, existing knowledge, behaviors, skills, values, or preferences and may involve synthesizing different types of information. Experience consists of knowledge of or skill of some thing or some event gained through involvement in or exposure to that thing or event.[1]

Figure 2.2: Learning curve for a single subject, showing how learning improves with experience

Figure 2.3: A learning curve averaged over many trials is smooth, and can be expressed as a mathematical function

Figure 2.4: The metric for Learning can be increasing or decreasing

Although the curve for a single subject may be erratic (Fig 2.2), when a large number of trials are averaged, a smooth curve results, which can be described with a mathematical function (Fig 2.3). Depending on the metric used for learning (or proficiency) the curve can either rise or fall with experience (Fig 2.4).

2.4 Product Lifecycle

Product life cycle is a business analysis that attempts to identify a set of common stages in the life of commercial products. In other words the 'Product Life cycle' PLC is used to map the lifespan of the product such as the stages through which a product goes during its lifespan.[6]

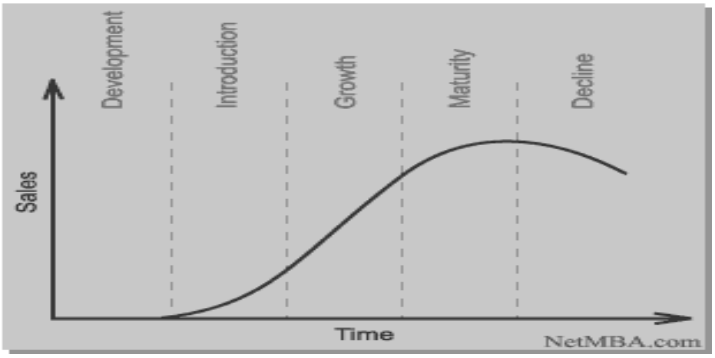

Figure 2.5: Product life cycle stages

Stages:

The product life cycle is an important concept in marketing. It includes stages that a product goes through from when it was first thought of until it is eliminated from the industry. Not all products reach this final stage. Some continue to grow and others rise and fall.

Development: In the development stage, the product goes through testing and a prototype is developed. This is after considerable market research to identify consumer needs and wants. If the product is deemed commercially viable, then the product may be put into mass production and launched. It is important to remember at this stage expenditure for the company is high. No income is being received as there are zero sales. This is the first stage of the product cycle lifespan.

Introduction: This is the stage in which a new product is first made available in the market. In the introduction stage, customers are few, competition is less, sales are low, risk is high and profits are low or nil. There are heavy distribution and promotion expenses. This stage is full of risks and uncertainties. Prices are also high because

1. Costs are high due to low level of output.
2. Technological problems in production may not have been solved, and
3. High profit margins are required to support the heavy promotion expenditure.

The product at the introduction stage requires high activity in promotion.

Growth: If the product is popular with consumers, then sales will start to rise. It may be a rapid growth or a slower one. Rapid growths that fall away just as quick are called 'Fads'. Advertising is often still heavy at this point.

Maturity: Once the product is well established and consumers are satisfied, then the product is widely accepted and growth slows down. Before long, however, a successful product in this phase will come under pressure from competitors. The producer will have to start spending again in order to defend the product's market position or introduce extension strategies. It may only be in the Maturity stage where companies will receive a return on their original expenditure and investment due to potentially high startup and development costs.

Saturation: At the very end of the Maturity stage, and where there is no further growth possible, saturation occurs. This is also referred to as Saturation Point. This is when little or no advertising is needed and sales are levelling off. This is the period of stability. During this period, the sales of the product reach the peak. There is a steady demand for the product and no possibility for growth. However, at this stage other competitors also become popular and capture the market.

Decline: Sooner or later sales fall due to changes in consumer tastes or new choices available from competitor's products.

Again, extension strategies may be open to the company to keep the product alive. The product can be declined if there is no proper growth and the later stage which has been discussed above.

2.5 Significance of Standard Allocated Minute

SAM means Standard Allocated Minutes. By knowing this value, we can measure the time needed to complete a job.
Mass manufacturing in garment industry is growing in very fast pace and at the same time technology and supporting departments are getting in place. But the real fact is - still most of the garment manufacturing companies don't have industrial engineering set up. It is not only Bangladesh, even though in India, Vietnam, Cambodia, Pakistan, Myanmar and other garment exporting countries, there are many companies those are managed without engineers.

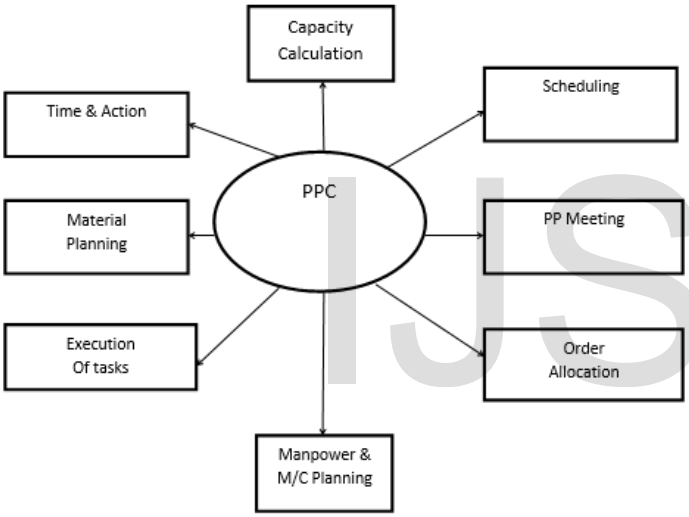

Fig 2.6: Main function of production planning and Control

Role of the SAM Value in Production Planning and Control
SAM value of a garment is defined as how much time it would take to complete a garment in sewing. This is also known as garment work content and standard minutes.

To know the role of Garment SAM in production planning, first we have to understand primary roles of a Production Planning and Control (PPC) department (or PPC personnel).

To specify the key roles of PPC department, those can't be performed without having garment SAM value.

a. Determining capacity of the factory and capacity of the individual sewing lines in terms of how many pieces (product specific) factory can make in a certain time period with existing machines capacity.
b. Order booking based on factory capacity for different types of products
c. Allocating of styles to the lines
d. Determining production lead time for each orders (styles)
e. Process scheduling
f. Production execution and monitoring

Roles of SAM Value in Production Planning includes :
1. **Line Capacity Calculation:** The scientific method of calculating production capacity of a line (in production pieces per day) is to use standard time (SAM) of a garment. So, to determine production capacity of a line (for specific products) in pieces you need to know garment SAM.
2. Lead Time Calculation: Based on the production capacity, order allocation is done for different lines. To calculate how long a style would run in a line if loaded in a single line SAM is mandatory. If you need to complete the order in less time, calculate how many lines to be considered for an order.
3. Order booking: During order booking, you need to consider capacity availability in a certain period. In such cases you can use how many minutes you need to make the new orders using garment SAM value and compare the same with how many production minutes are available in your factory for the defined period.
4. Process Scheduling: Time and action calendar or production process scheduling of each order is done by planning department. Again to schedule a list of tasks, you need to know capacity of each process per day (or a predefined period). Based on the capacity of each process you allocate no. of days for the process. Like for sewing department, you determine sewing capacity of your line (or multiple lines) and according to that you set how many days to be given to sewing department for production.
5. Order Execution and Production Monitoring: Standard minutes help planners to set target for sewing lines. Mutually agreed and calculated target given to line supervisors. On daily basis when you check production status you can compare actual production with target production. In case production is getting delayed you can push production team based on given target.
6. Labor Cost Estimation: One most important task is labor cost estimation of a specific order. To estimate how much labor cost to be considered for an order (style), you can't make labor costing without having garment SAM value.
All the above six points is proving that garment SAM plays a big role in production planning and controlling function in garment industry.

There is a way to perform production planning tasks without garment SAM value. The alternative way is calculating machine productivity to estimate line capacity as well as factory capacity. To measure machine productivity of a line we don't need any engineer. If one know the procedure and formula of

calculating productivity of the production floor, can find machine productivity easily. Later this productivity data would be considered as base of production planning.

2.6 Method of Calculating Machine Productivity

Machine productivity is defined as number of units produced per machine in a given time period. From the daily production and machine used to produce those garments you can measure machine productivity per day. Formula used to calculated machine productivity of a line

Machine productivity = (Total production of a line in a day / No. of machines in the line) pieces per day per machine
For example, for the month of July 2014 total planned production quantity is 2500 pieces with 26 working days. And total number of machine is used 547.
Machine productivity (factory) = (2500 pieces / 547)
= 4.57 pieces per day per machine

In this study we have observed in stitching floor line namely line 1. We got per day total production was 350 pieces, running with 48 machines on 12 July 2014. So the machine productivity for that specific line will be 7.3 pieces per day per machine.

Finding daily line output data and machine numbers would not be a difficult job to anyone. Style to style productivity will vary depending on work content of the style. So, we can prepare a database of the machine productivity for the previously produced styles. We can use historical data while required and update our machine productivity after each style gets over.

How to use productivity data in Production Planning:
To explain this we need to repeat few things that have been explained in earlier. Using productivity figure we can measure following things those come under production planning functions.

Factory capacity Calculation:
Factory capacity calculation formula of a given product

Factory capacity (in pieces) = (Machine productivity * No. of running machines in factory)
= 4.57 * 547 (Machine productivity=4.57 pcs/day/machine and Total running machine is 547, for the month of July 2014)
= 2500 pcs/ day
=65000 pcs / days (i.e. July working days is 26)

Other planning related tasks those can be performed using factory capacity and line capacity figures are as follows: Lead time calculation, Order booking, Order scheduling and Cost per piece

We can also measure line capacity using labor productivity data. But machine number in a factory is more stable than manpower (labor). It is preferred to use machine productivity in measuring factory capacity in term of how many pieces factory can produce in a certain time period.

2.7 Reasons for Plan Fail and Shipment Delay

Making a plan and execution of the plan is 'must do' task to meet the lead time. As a standard procedure factories make plans and do extensive follow up of tasks. Still factories do not meet their target dates for final inspection and fail to ship good on agreed shipment date. In this article we have explained the 5 most visible reasons that cause the delay in shipment.

Product development and Sampling: Product development and sampling stage fall under pre-production processes. Other pre-production processes include sample approvals, finalizing vendors and cost negotiation with raw material suppliers. Most of the factories do not consider including development stage schedule under plan. It results no control on pre-production processes. It goes long and long. When sample approval gets detailed, consequentially ordering of trims and fabric get delayed. A complete plan is done when you include sampling plan under your planning. Out of total lead time most part is consumed by pre-production functions. As a result planned cut date (PCD) gets postponed.

Delay in sourcing of raw material: Normally factory planner discuss with supplier about their lead time for sourcing goods such as fabric and trims prior to making the final production scheduling. Suppliers fail to send good on time due to too many uncertainties. Sourcing delays also consumed extra time and make it difficult to start in-house processes on time. Few export houses experienced that yet after loading of cutting and stitching, trims such as care label, laces or main label are yet to be sourced. Partly stitched garments start piling up in the line and line supervisor load another style keeping running style aside from the line until they receive trims.

Inferior quality in sourced goods: Fabrics, trims and accessories get in-housed at last. Goods are passed through quality checks before using in product or cutting. Unorganized factories mostly source fabric from power loom and face quality related problem. It may be shade variation/matching, wrong GSM quality, low quality print etc. If an inferior quality of raw material found, fabrics are send for re-processing or resourcing. It causes further day in PCD.

Production urgency: Pressure and urgency increases when factory starts production processes (such as cutting, prepara-

tory and sewing), as order has already eaten up bigger part of total time scheduled for the production processes (production to finishing). Not having much time on hand, managers push everything on fast pace. They even push their whole team on quantity production. In this stage they forget to care of quality of the product. Once they start ignoring standard procedures they get stuck on stitching quality or related problem rises. Repair and re-inspection become a main process. These process increases production time.

Delay from Sub-contracting Jobs: For high fashion product, few value added processes such as panel printing, embroidery, bead work or dyeing are needed. For these value added processes factory normally send fabric or half stitch garment to sub-contractors for job-works. Sub-contractors also come with their big commitments on delivery and quality. But when factory receives goods, they had to count some more days on their delays. This happen due to absence of planning at sub-contractor factory.

2.8 Function of Production Planning

Production planning and Control department is one of the important department for the apparel manufacturing company. In the context of the apparel manufacturing primary roles of the Production Planning and Control (PPC) department has been listed below.

Job or Task Scheduling: Preparation of time and action calendar for each order from order receiving to shipment. The job schedule contains list of tasks to be processed for the styles. Against each tasks planner mentions when to start a task and what is dead line for that task. Name of responsible person (department) for the job is being listed. For example, scheduling planned cut date (PCD), line loading date etc.

Material Resource Planning (Inventory): Preparation of Material requirement sheet according to sample product and buyer specification sheet. Consumption of material (fabric, thread, button, and twill tape) is calculated and estimated cost of each material.

Loading production: Planner defines which style to be loaded to the production line and how much quantity to be loaded.

Process selection & planning: Processes needed to complete an order vary style to style. According to the order (customer) requirement PPC department select processes for the orders. Sometime extra processes are eliminated to reduce cost of production.

Facility location: Where a company has multiple factories (facilities) for production and factories are set for specific product, planner need to identify which facility will be most suitable for new orders. Sometimes there may be a capacity shortage in a factory, in that case planner need to decide which facility will selected for that orders.

Estimating quantity and costs of production: Planner estimate daily production (units) according to the styles work content. With the estimated production figure, production runs and manpower involvement planner also estimate production cost per pieces.

Capacity planning: PPC department plays a major role during order booking. They decide (suggest) how much order they should accept according to their production capacity. Allocating of total capacity or deciding how much capacity to be used for an order out of total factory capacity. Regularly updating factories current capacity (production capacity).

Line planning: Preparing detailed line planning with daily production target for the production line. Most cases line planning is made after discussing with production team and Industrial engineers.

Follow up and execution: Whatever plan is made is executed by PPC department. PPC department keeps close look whether everything is progressing according the plan. Chasing other department heads on daily basis to keep plan on track. They update order wise completed tasks on the Time & action Calendar. When they found something is going to be late they expedite and create an alarm about the delay.

2.9 Planning Softwares in

With the time and technology advancement garment manufacturers are becoming dependent on customized ERPs and other IT based management tools. Production planning and control tools for the factory level management are very essential to manage production to deliver shipment on time. Though there is number of IT solution providers especially for the garment manufacturing. Few names that provide production planning solution with detailed scheduling.

1. **Evolve by Fast React:** Recently this product is named as Evolve. Evolve is a dynamic solution that provides clear priorities, reflects current performance and provides an early warning alert of any urgent actions required. Key features of Evolve mentioned by Fast React in the site are includes-

a. Multi-level planning at both factory and detailed line/machine level

b. Efficiency profiles & start-up allowances at product changeover

c. Management of supporting processes, specialist machines and work in progress

d. Better scheduling and communication with subcontractors
e. The plan is dynamic, so it reflects current situation including any slippage
f. Materials and critical path priorities actively 'driven' to support the latest plan
g. Flexible, management level reporting

2. Plan-IT by Gemserp: Plan-IT another Planning software has been developed Gemserp. Plan –IT is especially made for the Garment production planning. It helps merchants and production people to take decision much before in hand by using visual display of the plan on a planning board. Thus it reduces last minute fire-fighting with order processing. It brings absolute transparency inside the organization and assigns individual responsibility to the respective personnel.
User can check the critical path of an order to ensure that all development and pre-production activities are included on schedule with the plan with a shortest possible time. Helps top management to make Prompt Decision instead of searching & waiting for details. System has option for Backward Planning when it needed.

Production Planning and Control module by APPS: Key features of APPS Production Planning and Control module includes - Production Line Planning, Vendor Production Monitoring, Raw Material Consumption, Critical Path Monitoring, Quality Control Reports, Special Cutting and Lot management Screens and Summary Reports.

3. MAE by Parellax:
User uses MAE to plan at the factory and line levels. The number of available workers limits the production capacity of a factory. MAE calculates how much of the order will fit onto the production line at one time. The objective is to load plan so the production line is never idle. MAE also has semi-automated line planning capabilities. It can automatically switch an order to another line if there are work stoppages or delays. MAE displays line plans graphically in Excel format so you can easily zoom in for detail and zoom out for a high level overview of the line plan. Parellax 'Quick Response' is a production planning tool that assist work planning in all levels such as factory level, line level and worker level.

4. Stage Production Planning Management: The key features of this Planning software includes-

The planning person can plan Merchandisers' orders, cut & paste orders in part or full from one line to another by easy drag and drop method.

No data entry required on the planning board. All data are extracted from STAGE ERP dynamically and results are displayed automatically on the planning board.

utomatic Mail Shooting, integration with T & A and Expected Completion Report are additional features of STAGE PPM.

5. Pro-Plan by Methods Apparel: Pro Plan helps to establish capacity for each production section, remove holidays, add overtime, use your current efficiencies and absentee levels and your capacity is instantly available. Capacity is established for 300 days in advance, it maintains these days by adding a new day at the end day.
In Pro-plan User can reserve capacity for special customers, Change the capacity of sections as it suits your sales. Pro-plan has integrated Pre-Production Planning option. The system will tell by which date all the necessary pre-production functions must be complete if the style is to start feeding onto the line on the planned date. Those pre-production functions that are late show on the screen in red. The individual company according to their needs and experience sets lead times.

2.10 Factors Impacting Planning Performance

Time and Action (TNA) calendar is one of the most important tools for managing a project. In garment manufacturing each order is not less than a project to a merchant. Because, from order receiving to order completion involve number of tasks of various duration and requirement of resources. Few tasks come one after another and others move at the same time. Like number of processes, lots of people are involved to accomplish an order. Secondly each order is unique in terms of process and time demand. So, a detailed plan with well-defined responsibility is must for each order to finish it before time or on time.

Definition: Normally merchants prepare a plan in a spreadsheet listing down key processes in one column and planned date of action for each process is noted in another. This planning sheet is called time and action calendar. Once TNA calendar is made, merchant can easily list down her daily 'to do list' for the day and start doing work one by one. According to TNA schedule processes are executed on daily basis to track whether an order is on track or getting delayed.

Time and Action calendar: In this study two formats used for time and action planning - one is for detailed scheduling of orders with defined responsibility and another one is for quick follow up of the multiple orders. It is not necessary to use both the formats at the same time. It depends on individuals - one can use both or one out of two. The main purpose of preparing and maintaining a TNA calendar in to improve performance in managing processes as per plan. If each stage of an order is

controlled then most of time we can finish an order on time.

Line Balancing: Line Balancing is leveling of the workload across all operations in a line to remove bottlenecks and excess capacity, defined by Six Sigma Material.

When we consider mass production, garments are produced in lines or set of machines instead of single machine. A line may be assembly line, modular line or section, a line set with online finishing and packing. A line includes multiple work stations with varied work contents. Production per hour is varied depending on work content (standard minutes of particular task/operation), allocation of total manpower to a particular operation, operator skill level and machine capacity. Operation with lowest production per hour is called as bottleneck operation for that line.

A bottleneck operation in a line determines the output of the line. That is why it is very important to increase production of the bottleneck processes or operations.

Line supervisors, work study officers find ways to increase production from the bottleneck operation and implement those means one by one to level work across operations. In layman language, this is called line balancing.

Secondly Line balancing is essential as because, if excess capacity of sewing operators does not utilized production cost will be high and results in waiting and absorption of fixed cost.

Though above definition is widely accepted, I saw few factories where so called Engineers name line balancing to something else. At the time of machine/manpower planning based on work content of each operations, they prepare a sheet where operation wise manpower is calculated. Most of the cases calculated manpower gives fraction of figure but in real you can't allocate to fraction of manpower to an operation. So manpower planner decides to which operations one machinist, to which operations two machinist or where only single machinist will be allocated for two or three operations. Planner makes this decision based on calculated data.

Improving Organizational Skills:

Organizational Skills: In our daily life, it seems time is too short to complete the given tasks. It does not matter what position you are holding in the organization, if you are not organized at end of the day you will find lot of tasks uncompleted. It is only you, who can change your current situation. You can have better control of work, better productivity; you can do more and improve the quality of your life. What is required is you have to sharp up your organization skills.

In simple, organization skills are about organizing a list of tasks, organizing the various activity of the day in an effective way. These skills are involved prioritizing of tasks, scheduling and executing. They constitute techniques to execute routine task in a better way. More importantly they serve to reduce stress and improve focus. The skills are essential in every walk of life. They help you to decide what to do, when to do and how to do. This includes small choices like when to sleep and when to wake up, to major decision like the time for a career shift.

Mastering in three skills:

Prioritizing: It is one of the most important elements of organizational skills. As we will have to do several tasks in a day, list down all tasks and prioritize them according to the importance, volume and urgency of the task. We have to prioritize the task so that we can give up less important tasks and allot the time and resources for the important tasks. Prioritizing give we control on the workflow. It makes it easy to identify mistakes, correct them, and alter the execution strategy if necessary, while keeping the damages to minimum.

Scheduling: The next element of organizational skills scheduling, is about deciding on how we perform the different tasks on your list. It helps us to figure out when to do what. We learn to distinguish between the urgent and the important. It covers areas from preparing an action plan to facilitating its implementation. For instance, to be able finish a task on time, we may have first organized our desk and electronic data.

Execution: Once we are ready with an action plan, it is time to execution stage. At the execution stage, organization skills are about management and ways to deal with adverse conditions. As we gain expertise at them, we become more productive and successful.

Required:
It is natural for the individual to resist being organized. This demands commitment, persistence and discipline. Here is how we can sharpen your organizational skills:

A common mistake we commit at this stage is focusing on the top tasks on our mind. However when we start implementing our action plan, we realized that we have missed out allotting time to routine unavoidable task. Sometime even though you remember them, we ignore thinking that we can deal with them during some free time through the day. But this is not practicable. Eventually our action plan fails. So, when planning the schedule enter all the tasks into the list and then prioritize. Calculate the time required for each task. Anticipate potential obstacle and keep ready a second plan. Pad some free time in between tasks to cover slip in schedule.

Preserve your Time:
Do not procrastinate and waste our time. Resist getting complacent in the midway. Take expert advice to learn to do a job in the most efficient way. Avoid keeping backlogs so that we can start the next day with afresh mind.

Maintain a log to keep track of time spent on different activities. This can help us with figuring out the task that are consuming more time than they are worth. With this information we can decide whether to pursue the task in future or not. And if we should, we can explore more effective way of doing it.

Organizational skills are priceless skills that highlight the importance of time and help to use it effectively. So, whether we want to be a successful professional, manager or entrepreneur, hone them to accelerate our success.

3 Production Department

3.1 Introduction

The production department is responsible for converting inputs into outputs through the stages of production processes. The Production Manager is responsible for making sure that raw materials are provided and made into finished goods effectively. He or she must make sure that work is carried out smoothly, and must supervise procedures for making work more efficient and more enjoyable.

Manufacturing garments entails a lot of planning and consciousness of schedule. The coordination of contractors and their timeliness plays a large role in meeting deadlines for production. In most cases the production of garments is very time sensitive in order to ship goods to stores and boutiques for the upcoming season. A late order can reflect poorly business. Functions of Production Department in Apparel Industry are given below:

Pattern making, grading and markers are a crucial part in planning for production. Once markers of each style are based, fabric needed for production can be easily calculated and ordered.

Materials such as buttons, grommets and zippers can be ordered which are often overlooked but crucial in the production of a garment.

For Meeting with sewing contractor prior to the beginning of the time period of production completion and creating a contract with sewing contractor stating sewing prices, turnaround time, and listing contractor or company providing responsibility. Making sure to have deadlines for all these elements.

Once production has begun, checking the items regularly to make sure everything is being produced up to specified standards. The first item off the line should be given to production manager for approval.

Many sewing contractors also offer finishing services such as pressing, folding, tagging, and bagging items. If this is not the case, allot plenty of time for finishing needs.

It is commonly known that the garment industry is late with orders, while stores and boutiques expect their orders to be on time. Make sure to have a contract with sewing contractors defining the finish dates and any penalties that apply for a late production.

3.2 Stitching Section

Sewing is an important department in garments manufacturing industry. All the parts of a garment are joined here by making stitch with the help of needle and thread. Where, sewing process flow chart helps to make a complete garment easily. By maintaining sewing process flow chart, an order can be completed in timely. [18]

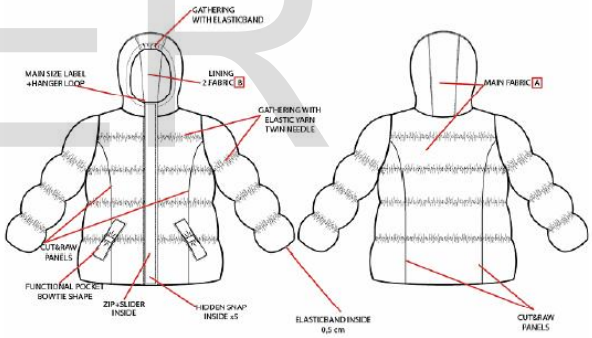

Figure 3.1: The complete overview of Jacket

Table 3.1 The process description

S/L	Process	Job
01	Product analysis	In which way, a product have to sew, it's decided here.
02	Set up target for production	Have to set a target for production on the basis of shipping schedule.
03	Set up machine layout on the basis of target	Have to prepare machine setup layout on the basis of daily target quantity.
04	Set up operator layout on the basis of target	Prepare operator layout setup on the basis of machine quantity.
05	QC check of product	Each garment must have to fulfill its right quality. So, product checking must be needed by QC.
06	Line balancing	Line balancing is a tool used for production line to capacitate the flow line of production.
07	Line setup	Line setup must be needed to achieve healthy production.
08	Distribution all the processes	All the processes of sewing must be distributed to the right person to avoid the damage of garments.
09	Cutting parts received section	A section, which received the cutting parts from the cutting department.
10	Cutting parts distribution to the operator and helper	All the cutting parts should be distributed to the operator and helper after receiving those from cutting department.
11	Complete parts making individually	By joining all the parts, a complete garment has to make here individually.
12	Online QC check	During running of garments sewing, online QC check must be needed to make fault free garments.
13	Online quality audit	An online quality audit must be needed here to show the buyer actual fault free product making process.
14	Counting output and checking with the target	Comparing with target quantity, all the output garments should be counted here to make sure achieving the target quantity.
15	Final quality check (For each Garment)	In this section, all the output garments are checked finally by maintaining one by one method to provide fault free garments into the finishing department.

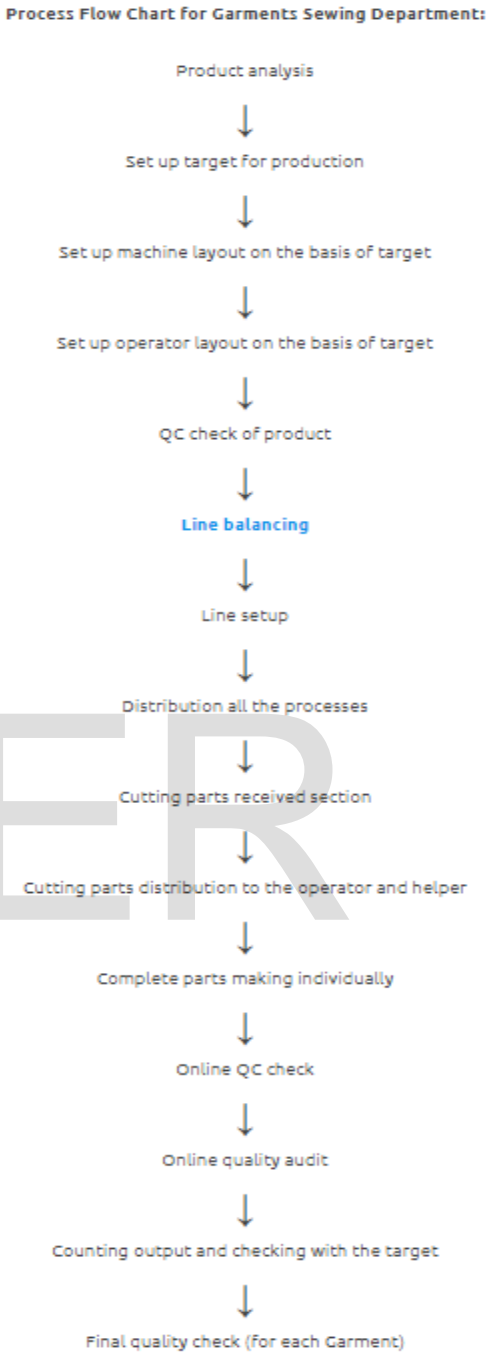

Figure 3.2: The garments process flow of stitching

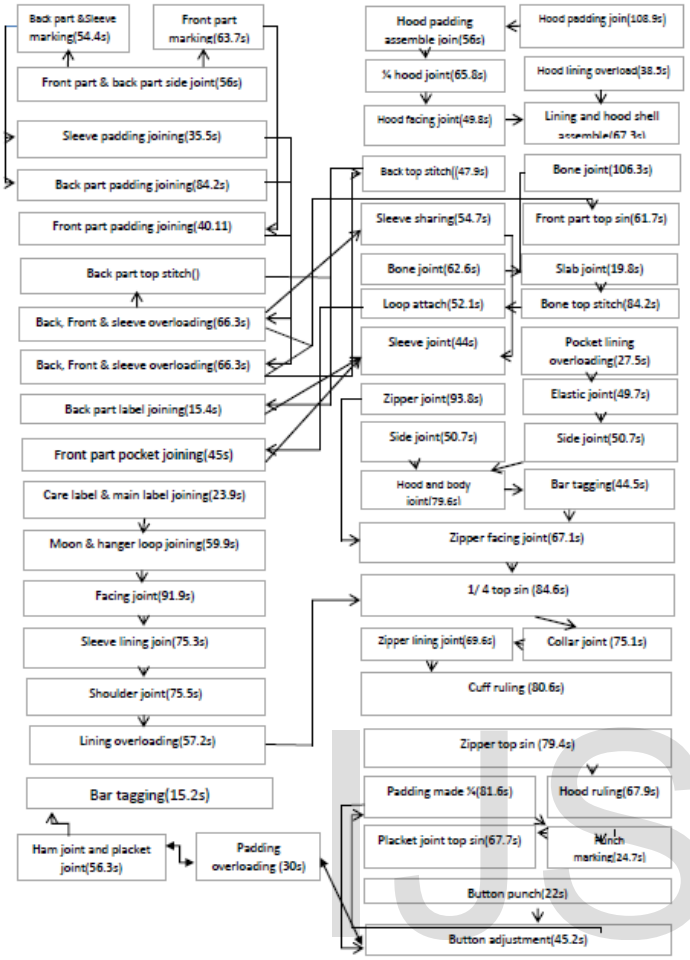

Figure 3.3: The layout of assembly line

3.3 Major Key Productivity Indicators

Key Performance Indicators (KPIs) are measured to assess where the factory currently stands and to find key focus areas where management needs to look into. Top 9 KPIs have been listed and explained below that are measured by garment manufacturers (export houses) in the apparel industry. Analysis of these KPIs is carried out monthly.

1. Factory Efficiency (%):

Factory efficiency indicates how efficiently sewing lines is run in a factory. This indicator is important because capacity planning of the factory and projected garment making cost is done based on factory efficiency. Factory efficiency includes all lines minutes produced and total hours attended by direct labor in sewing floor. Target factory efficiency varies based on the order quantity. The formula is given below:

$$\text{Efficiency} = \frac{Output}{Input} \times 100\ \%$$

$$= \frac{Quantity \times SMV}{60 \times Man \times Hours} \times 100\ \%$$

2. Man to Machine Ratio:

When it is factory's Man to Machine ratio (MMR), every employees of the factory is considered under manpower. It is defined as ratio of total head count to total number of active machine for a month. The ratio 1:1 is best score for a company but it is not actually possible. So ratio near to 1:1 is considered as best MMR.

$$\text{MMR (Man-Machine Ratio)} = \frac{Total\ head\ count}{Total\ number\ of\ active\ machine}$$

3. Cut to ship ratio:

This is a ratio of total cut quantity and total shipped quantity of an order. This indicator is measured order wise and monthly shipped orders. To keep buffer (for damaged, defective garments) factory cuts extra pieces than order quantity. This indicator is measured to control surplus quantity after shipment, reduction in extra cutting and damaged garment. Target Cut to ship ratio is 1.

$$\text{Cut-Ship Ratio} = \frac{TOTAL\ CUTTING\ QUANTITY}{SHIP-OUT\ QUANTITY}$$

4. Order to ship ratio:

Buyers expect to receive full quantity from supplier that has been ordered. This is most important factor that buyer uses for vendor evaluation. This indicator is calculated as

$$\text{Order-Ship Ratio} = \frac{TOTAL\ ORDER\ QUANTITY}{SHIP-OUT\ QUANTITY}$$

5. On time Delivery:

How much shipment did not meet target shipment date is analyzed at the end of each month? Target on time delivery of each style is to meet shipment delivery date. If not meet reasons of not meeting delivery date are analyzed. It is calculate as

$$\text{On time Delivery} = \frac{Total\ orders\ shipped\ on\ time.}{Total\ orders\ shipped\ on\ the\ month}$$

6. Average style changeover time:

Time gap between previous style over (last piece out from the line) and first piece output of the current style is known as style change over time. Shorter changeover time is considered as better performance level. It varies style to style and production systems. Time of Change over time of each style is recorded and average changeover time of the factory is measured.

7. Right First time quality:

This indicator is represented in percentages. Total audits passed in first time out of total audit conducted by auditors. First time right quality is measured in various stages of garment processing and analysis is done audit wise. Higher values (percentage) of right first time quality is considered as better performance of the factory.

8. Quality to Production:
Quality level of each department is measured in DHU and Percentage defective unit. Higher the value of DHU higher alteration time and higher cost incurred in quality.

9. Down time percentage:
Down time is one of the top most reasons for less factory efficiency. Factory analyses major down times to control and improve machine and operator utilization. Top 5 reasons for down time (also known as non-productive time, Off-standard time) are line setting, operation sitting idle, no feeding, machine breakdown and no planning for line.
Garment manufacturing business more specifically garment export business is a profitable business if factory performance is measured and management work to improve performance level step by step. Each of the above KPI plays role on production cost, factory's reputation and profit margin.

4 Industrial Engineering department

4.1 Introduction

Industrial engineering is a branch of engineering which deals with the optimization of complex processes or systems. It is concerned with the development, improvement, implementation and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, materials, analysis and synthesis, as well as the mathematical, physical and social sciences together with the principles and methods of engineering design to specify, predict, and evaluate the results to be obtained from such systems or processes. Its underlying concepts overlap considerably with certain business-oriented disciplines such as operations management.
Depending on the subspecialties involved, industrial engineering may also be known as, or overlap with, operations management, management science, operations research, systems engineering, management engineering, manufacturing engineering, ergonomics or human factors engineering, safety engineering, or others, depending on the viewpoint or motives of the user. Industrial Engineering concepts are used in garment manufacturing to fulfill the following purposes-

- Monitoring production floor and having better control over the production floor
- Improving processes and improving method of working to increase factory's overall performance and standardized garment manufacturing processes

Overall application of Industrial engineering can be explained better by describing common tasks of the IE department. Common tasks of an IE department are as following but not limited to these

- Work measurement of sewing operations, cutting room jobs and finishing jobs
- Setting standard time for sewing operations and manual operations
- Style analysis and conducting research and development (R&D) of the styles
- Improving method of work and design workstation
- Production planning and factory capacity determination
- Work aids development
- Work station designing and machine layout planning
- Labor cost estimation
- Performance measuring of workers
- Training of workers (sewing operators)
- Designing incentive scheme and calculating incentive for sewing operators
- Setting line production target of the sewing lines and chasing production from line supervisors and operators
- Application of lean tools

Factories those are using IE techniques mostly have a complete IE set up (department). An IE department consists of an IE managers (in-charge) and Industrial Engineers and juniors engineers. The strength of IE team widely varies based on the maturity level of the department and on the focus of application of Industrial Engineering. Without having enough team members, an IE department cannot work effectively.
Industrial Engineers are utilized in the following ways but not limited to those -
Factories apply all or few of the above listed functions to

- Assist line supervisors by preparing resource requirement plan (machines and equipment and manpower), line setting and line balancing etc.
- Assist production managers in target planning and production planning,
- Help merchandiser and marketing personnel by providing labor cost and production lead time,
- Help HR department by providing operator performance level, and help in operator recruitment
- Prepare MIS reports and show management team product status on daily basis and alert management team if their attention is needed

- Set up standards operating procedures for new tasks, new process required for ever changing fashion products

More than the regular jobs, IEs are also responsible for thinking of continuous process improvement. Initiation of new projects and implementation of the project that has been undertaken, showing the improvement opportunity within the factory to management team. Engineers are involved in performance improvement tasks of the cutting department and finishing department. Companies those have limited manpower in IE team, only involves engineers for routine jobs like, making operation bulletin, thread consumption, preparing daily production reports etc.

4.2 Industrial Engineering Concepts

Work Study:
Work study deals with the techniques of method study and work measurement, which are employed to ensure the best possible use of human, machine and material resources in carrying out a specified activity.

Objective: Work study is concerned with finding better ways of doing work and avoiding waste in all its forms. As such the objective of work study is to assist management to obtain the optimum use of the human, machine and material resources available to the organization for the accomplishment of the work upon which it is engaged. The objective has three aspects:

1. The most effective use of plant and equipment
2. The most effective use of human effort
3. The evaluation of human work.

Work study has two broad areas: method study and time study.

Method Study:
Method study is concerned with finding the facts about a situation and after a critical examination of these facts, developing a new and better method of doing that work. It is defined as the existing and proposed ways of doing work and the development and application of easier and more productive methods.

It is the systematic recording, analysis and critical examination of existing and proposed ways of doing work and the development and application of easier and new production methods.

Areas of application of method study: It can be applied to any field of work, but the most important areas where it plays a major role in improving productivity are as follows.

1. Improved layout of office, working areas of factories
2. Improved design of plant and equipment
3. Improved use of materials, plant, equipment and manpower
4. Most effective handling of materials
5. Improved flow of work
6. Standardized of methods and procedures
7. Improved safety standards
8. Better working conditions

Steps in Method Study:

Methods improvement involves systematic, orderly and scientific approach to problems. One should have an open mind, maintain a questioning attitude, collect all relevant facts, consult other including workers, list reasons/causes for various effects. Decision must be taken after listing all alternatives and evaluating them critically. Based on these guidelines, the steps in method study are explained below.

1. **Select:** Select the work to be studied.
2. **Record:** Record all the relevant facts of the present (or proposed) method by direct observation.
3. **Examine:** Examine the facts critically in sequence, using special critical examination sheet.
4. **Develop:** Develop the best method i.e. the most practical, economic and effective method, under prevailing circumstances.
5. **Install:** Install that method as standard practice.
6. **Maintain:** Maintain that standard practice by regular routine check.

Time Study:
Time Study is concerned with the establishment of time standards for a qualified worker to perform a specified job at a defined level of performance. This was originally proposed by Frederick Taylor and was later modified to include a performance rating (PR) adjustment. The time study is considered to be one of the most-widely used means of work-measurement. Basically, by using time study, an analyst will be taking a small sample of a single worker's activity it to derive a standard for tasks of that nature.

Steps of Time Study:
The steps of time study are as follows:

Step 1: First select the job to be studied. Breakdown the work content of the job into smallest possible elements. Then inform the worker and define the best method.

Step 2: Observe the time for appropriate number of cycles (n).

n can calculated using the following formula.

$$n = Z^2[n_1\sum(x \times x) - (\sum x)^2] / h^2 (\sum x)^2$$

n_1 = Preliminary sample size
x = recorded stopwatch times
h = half the precision interval in %
z = the standard normal statistic for the desired confidence level.

Step 3: Determine the average cycle time (CT)

$$CT = \frac{\sum Times}{No.of\ cycles}$$

Step 4: Determine the normal time (NT)

$$NT = CT\ (PR)$$

Where, PR is the performance rating
Step 5: Determine the standard time using the following formula.

$$ST = NT\ (AF)$$

$$\text{Where } AF = \frac{1}{1-\%\ Allowance}$$

AF being the allowance factor.

KAIZEN:

Kaizen is actually a life philosophy assuming that every aspect of life deserves to be constantly improved. The Kaizen philosophy lies behind many Japanese management concepts such as total quality control, quality circles, small group activities, labor relations. Kaizen literally means "Change" (Kai) to become "Good" (Zen). It is a culture of sustained continuous improvement focusing on eliminating waste in all systems and processes of an organization. The Kaizen strategy begins and ends with people. In Kaizen, an involved leadership guides people to continuously improve their ability to meet expectations of high quality, low cost and on-time delivery. Kaizen transforms companies into superior global competitors.

Kaizen oriented in Toyota Motor Company as part of lean manufacturing. Taiichi Ohno developed the Toyota Production System through Kaizen activity in the areas of quality, cost, delivery, safety, etc. Many of the concepts and tools of Kaizen came from industrial engineering and Dr. Edward Deming's teachings.

In any organization, three things, viz. Maintenance, Innovation and Kaizen should happen simultaneously for its better results. The term maintenance refers to maintaining the current status, setting the procedure and implementing standards. Innovation refers to breakthrough activities initiated by top management, buying new machines, new equipment, developing new markets, directing R&D, change of strategy, etc. In the middle, there is Kaizen which involves small steps but resulting in continuous improvement. As stated earlier, the lower/middle management and the workers with the encouragement and direction of the top should implement Kaizen. It is the responsibility of the top management to cultivate a Kaizen working climate and culture in the organization. So, Kaizen fits well in incremental change situations that require long-term change and in collective cultures.

Classification of Kaizen:

Kaizen is classified into Kaizen Workshop, Kaizen Blitz and Kaizen Event. All the tree are team-based rapid improvement workshops.

Kaizen Events and Kaizen Workshops are 5 days long; Kaizen Blitzes are shorter. Kaizen Blitz is a term used by AME (Association for Manufacturing Excellence) and others. Kaizen Events tend to involve Japanese sensei (consultants).

A Kaizen blitz is an intensive and focused approach to process improvement. In Kaizen Blitz the word Kaizen means "Continuous Improvement" and Blitz means "Lighting" Fast".

The continuous improvement technology uses lean manufacturing tools such as the 5 S's of workplace organization and standardization, cell, Pull/Kanban, Set-up reduction and line balancing. These tools incorporate team empowerment, brain storming and problem solving ro rapidly make improvements to a specific product or process.

Steps of Implementation of Kaizen Blitz:

1. **Defining the project goal and identifying the problem:** The goal of the project should be clearly spelled out as making continuous improvement wherever possible and accordingly the problem areas where improvements can be made should be identified. One can use flowcharts of the processes to discover the various constraints and locations where improvements are needed. Further this is augmented by seeking ideas from employees through suggestion box.
2. **Formation of a team:** The constitution of the team is as listed below.
   - Core of the team is the people who are involved in the specific area of study.
   - Other members of the team are the employees from other departments and even people outside the organization.
   - There should be a team leader who leads the team members to find a solution.
3. **Gathering basic information and measures:** The team leader should gather information such as how long a process takes and the steps involved in a process which will help to identify performance measures. Generally the information's are obtained through observations and/or by speaking to employees.

At this stage, the following questions should be asked.

- What happens in the specific process?
- Where does the work come from?
- Where does it go?
- How long does it take to complete the process?

4. **Performing brainstorming:** Brainstorming is the process of hunting for unconventional solution alternatives to a problem by inviting suggestions from members which prove to be superior to other solutions of the problem. The problem will be introduced to team members. Then, they brainstorm for possible few viable solution alternatives.
5. **Implementation and evaluation of viable alternatives**: Once, the solution alternatives are narrowed down to few viable solutions, they should be implemented and evaluated based on the performance measures such as time, space, resource use, ratios and costs, process quality, customer satisfaction and financial cash flow.
6. **Selection of the best alternative:** The best viable alternative solution which will bring maximum improvement for that process is to be selected and its details are to be documented.
7. **Implementation of the best solution**: the best solution which is identified in the previous step is to be implemented and its success should be shared companywide.

The above steps are to be repeated at discrete intervals to sustain continuous improvements.

Seven Wastes in Industrial Production:

The concept of seven wastes was popularized by Womack and Jones in their book "The Machine that changed the world".

Waste is the use of resources over and above what is actually required to produce the product as defined by the customer. If the customer does not need it nor will not pay for it then it waste, this includes materials, machines and labor. The seven wastes described by Ohno are:

1. Overproduction and early production producing over customer orders, producing unordered materials/goods.
2. Waiting hanging around, idle time (time when no value is added to the product).
3. Transporting handling more than once, delays in moving materials, unnecessary moving or handling.
4. Inventory – unnecessary raw materials in stores, work in process (WIP), & finished stocks.
5. Motion – movement of equipment or people that add no value to the product.
6. Over-processing - unnecessary processing or procedures (work carried out on the product which adds no value).
7. Defective units producing or reworking scarp.

While Ohno's "7 wastes" is not a tool in itself to tackle the problems whithin a company which are causing the waste in first place, they do play a valuable role in tackling inefficiency and therefore cost.

Controlling seven wastes:

The idea of 7 wastes is useful because it allows a company to categorize problems and then focus attention in the appropriate areas once they have been identified. There are many tools and techniques in the lean box which can be applied to many areas of production in order to tackle any of these wastes. A few examples are laid out below.

1. Overproduction:

Often caused by quality problems, a company knows that it will lose a number of units along the production process so produces extra to make sure that the customer order is satisfied. These kind of issue can be tackled using mistake proofing methods (Poka-yoke) and by understanding the machine process capabilities of the production equipment. Statistical process control (SPC) will also help monitor production outputs and give warning of problems before they occur.

If the reason a company is overproducing is because of small orders and economic batch sizes then Setup reduction techniques such as SMED can help. If a company can reduce its changeover time then it is then able to produce smaller batches economically. Overproduction has been said by some to be the worst of the 7 wastes as it encompasses the rest of the wastes, often the main driving force for JIT (just in time) systems.

2. Waiting:

Products waiting around in factories either as finished goods or work in progress (WIP) another major cause of waste. WIP is commonly caused by producing large batch sizes where again SMED techniques can help. Concentrating on keeping bottle neck processes going are also a good way of reducing WIP.

3. Transportation:

Factory layouts can often be the fundamental cause of excess transportation. When appropriate, re-laying out the machines within a factory from a functional to a cellular layout has been found by many companies to help not just reduce transportation waste but also reduce WIP and waiting. Excess inventory levels can also lead to wasted handling.

4. Inventory:

Many companies order and above what is required to fulfill the order, this may be due to quality problems along the production process or the often mistaken belief that is saves money by ordering larger quantities. The true cost of excess inventory levels should be carefully analyzed before ordering excess

raw materials simply because the purchase price is less. Tackling the root cause of the quality problems should also be a priority.

5. Motion:

Simple "Good Housekeeping" is a very effective way of reducing wasted movement by men and materials. 5S is a technique used by many companies to focus effort on keeping the workplace tidy with unused materials and machines disposed off so as not to create unnecessary clutter and therefore searching. Re-laying out the factory can help reduce "motion" waste.

6. Over-processing:

Rework is a typical example of over processing as discussed earlier reducing the root cause of the quality problem is solution eliminating rework. Techniques such as 5 whys, SPC and mistake proofing (Poka-yoke) are available to help identify and eliminate causes of quality defects.

7. Defective units:

This directly a quality related issue.

If one records all of the non-value added activities carried out in a typical manufacturing company does not be surprised to find out that 99% of all activities carried out are non-value adding, even the best manufactures manage 96%. The elimination of waste not just reducing it is a vital component of increasing competitiveness of organization.

PDCA Cycle:

The PDCA Cycle is a checklist of the four stages which one must go through to get from problem-faced to problem solved. The four stages are Plan-Do-Check-Act, and they are carried out in the cycle illustrated below.

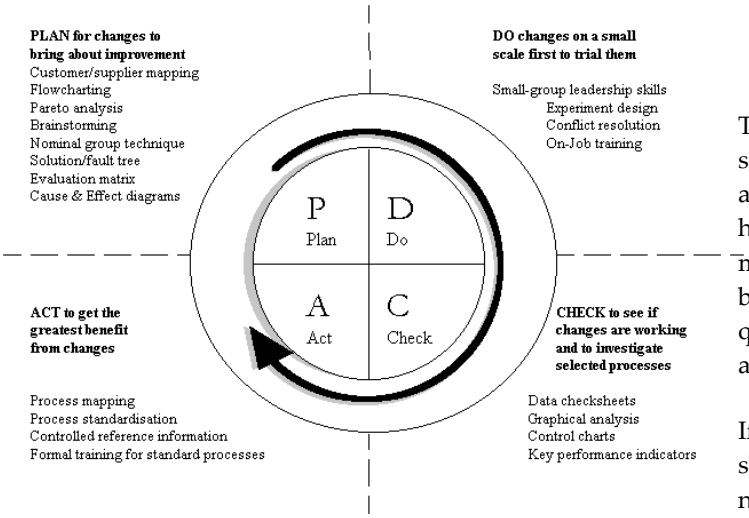

Figure 4.1: The PDCA Cycle

The concept of the PDCA Cycle was originally developed by Walter Shewhart, the pioneering satisfaction who developed statistical process control chart in the Bell Laboratories in the US during the 1930's. It is often referred to as 'The Shewhart Cycle'. It was taken up and promoted very effectively from the 1950s on by the famous Quality Management authority, W. Edwards Deming, and is consequently known by many as 'The Deming wheel'.

The PDCA Cycle is used to coordinate continuous improvement efforts. It both emphasizes and demonstrates that improvement programs must start with careful planning, must result in effective action, and must move on again to careful planning in a continuous cycle.

Steps of PDCA Cycle:

- Plan: Plan to improve operations first by finding out what things are going wrong (that is identify the problems faced), and come up with ideas for solving these problems.
- Do: Perform (implement) the changes designed to solve the problems on a small or experimental scale first. This minimizes disruption to routine activity while testing whether the changes will work or not.
- Check: Check (monitor) whether the small scale or experimental changes are achieving the desired result or not. Also, continuously 'Check' nominated key activities (regardless of any experimentation going on) and key performance indicators (KPI).
- Act: Act promptly to implement changes on a larger scale if the experiment is successful. This means making the changes a routine part of everyday activity. Also 'Act' to involve other persons (other departments, suppliers, or customers) affected by the changes and whose cooperation is needed to implement them on a larger scale, or those who may simply benefit from what are learned

This is how one can complete the cycle to arrive at 'problem solved'. Once it is solved, a new problem should be taken up at the 'Plan' stage to identify the next 'problem faced'. This is how the PDCA cycle is designed to be used as a dynamic model. The completion of one turn of the cycle flows into the beginning of the next. Following in the spirit of continuous quality improvement, the process can always be reanalyzed and a new test of change can begin.

If the experiment was not successful, the Act stage should be skipped to go back to the Plan stage to come up with some new ideas for solving the problem and go through the cycle again. Plan-Do-check-Act describes the overall stages of improvement activity, but how is each stage carried out? This is where other specific quality management, or continuous improvement, tools and techniques come into play. This diagram in figure 1 lists the tools and techniques which can be used to

complete each stage of the PDCA Cycle.

WHY-WHY Analysis

WHY-WHY analysis or 5 Whys is an iterative question-asking technique used to explore the cause-and-effect relationships underlying a particular problem.[7] The primary goal of the technique is to determine the root cause of a defect or problem. (The "5" in the name derives from an empirical observation on the number of iterations typically required to resolve the problem.)

Example: The order will not complete at right time. (Problem)

1. *Why?* - The line production target is not achieved. (first why)

2. *Why?* – Workers do not complete their operation at right time. (second why)

3. *Why?* – Worker remains idle at working hour. (third why)

4. *Why?* – Worker does not get raw material & sewing accessories properly. (fourth why)

5. *Why?* – Store fails to supply fabrics according to consumption rate of line because company has to buy these from outside. (fifth why, a root cause)

The questioning for this example could be taken further to a sixth, seventh, or higher level, but five iterations of asking why is generally sufficient to get to a root cause. The key is to encourage the trouble-shooter to avoid assumptions and logic traps and instead trace the chain of causality in direct increments from the effect through any layers of abstraction to a root cause that still has some connection to the original problem. Note that, in this example, the fifth why suggests a broken process or an alterable behavior, which is indicative of reaching the root-cause level.

It is interesting to note that the last answer points to a process. This is one of the most important aspects in the 5 Why approach - the real root cause should point toward a process that is not working well or does not exist.[8] Untrained facilitators will often observe that answers seem to point towards classical answers such as not enough time, not enough investments, or not enough manpower. These answers may be true, but they are out of our control. Therefore, instead of asking the question why?, ask why did the process fail?

Techniques:

There are two primary techniques used to perform 5 Whys:[9] the fishbone (or Ishikawa) diagram and a tabular format.[10]These tools allow for analysis to be branched in order to provide multiple root causes.

Limitation:

While the 5 Whys is a powerful tool for engineers or technically savvy individuals to help get to the true causes of problems, it has been criticized by Teruyuki Minoura, former managing director of global purchasing for Toyota, as being too basic a tool to analyze root causes to the depth that is needed to ensure that they are fixed.[11] Tendency for investigators to stop at symptoms rather than going on to lower-level root causes.

- Inability to go beyond the investigator's current knowledge - cannot find causes that they do not already know.

- Lack of support to help the investigator ask the right "why" questions.

- Results are not repeatable - different people using 5 Whys come up with different causes for the same problem.

- Tendency to isolate a single root cause, whereas each question could elicit many different root causes.

These can be significant problems when the method is applied through deduction only. On-the-spot verification of the answer to the current "why" question before proceeding to the next is recommended to avoid these issues.

Standard Operating Procedures (SOP) – A Process Management Tool for the Garment Factories:

Standard operating procedure (SOP) is not a new thing for the garment industry. SOP is well known and is widely used by many organized factories. SOP can be defined as a step-by-step written procedure about how to do a job that gives desired result and maintains consistency in results. SOP can also be defined as a checklist for the user (operator) who is going to do a particular job. SOP is a sure success method of doing a job.

More than just written instructions SOP can be also made using illustrations and flow charts. For some processes factory only needs to provide detailed instructions to perform a task, where some processes required instruction as well as decision making based on result of intermediate steps. Factories always follow a procedure to do a task, but usually such procedures are either not standardized or not written. Now it is time to standardize procedures for all routine tasks in manufacturing time; every time Importance of Standard Operating Procedures for Routine Tasks. In a factory, managers, executives and workers do routine tasks using a procedure. Procedure used for doing a task or getting required result varies from person to person. Secondly, different procedure needs different prod-

ucts (materials) for the same result. To get the same result from a process employees need to do a job same way every time. To ensure that every time an operator follows the same method of doing a task, factory needs to set up a standard procedure for operating a task and follow all standard

1. **Consistency in result:** As said on the above when SOP is followed factory will get same result every time. Consistency would result in enhanced factory performance and even if a person doing the job is changes; result would remain the same. It does not matter who is doing the job, important thing is operators should use standard procedures.
2. **Right Quality First time:** Organizations aim not just to produce a product but a quality product. When standard procedures are followed, desired result would come at the end of the process. Use of SOP reduces the chance of making mistakes for common errors. Right First time quality production has its own number of other benefits.
3. **Better concentration on work rather than asking every time how to do the job:** A well written SOP set for processes and sub-processes, gives direction to operators how to do a given task and how things will go. When there are no clear instructions and procedures, operators may follow wrong procedure and do mistakes. On the other hand managers don't need to prepare list of comments in every meetings and give instructions to their supervisors and executives. Everyone can concentrate on the task, instead of meetings for setting procedures every day.
4. **Reduced process delay:** As SOP contains detailed step by step procedure of doing a task, operator does not need to think before starting a task. Operators do not need to wait for work instructions from their managers. Operator can keep them busy in work and complete the task faster.
5. **Self-explained methods:** SOP makes it easy to train employees in new process. It will also be easy for newcomers to learn the procedures and attain objectives. Also HODs do not need to remind precautions to their subordinates while delegating works every time.
6. **Minimizes miscommunication:** Garment industry is considered as an unorganized industry. In this industry small number of professionals who can communicate effectively. A well written SOP can improve the communication gap between supervisor and workers, Managers to supervisors etc. and minimize miscommunication in work instruction and training.
7. **Work place Safety:** Work place must be safe for employees. A SOP written for how to operate a machine improves safety of the workers.

SOP Process:

- Line to be set as per line layout plan prepared by IE.
- Operations to be assigned to operators as per their skill level.
- All cutters or scissors should be tied with machines tables for safety point of view.
- Required SPI, thread tension and needle no. must be checked by supervisors and mechanic as per requirement prior to start of sewing style change.
- Line in-charge or line supervisor needs to give work instruction to the operators. And method of working an operation must be explained to each operator.
- QA, in-line QC and in-line checkers ascertain whether the quality coming out from each operation is as per the quality specification or instruction.
- No workstation would be given a go ahead for production till the time outgoing quality of that workstation is approved.
- If there is any specific quality problem, the QA Executive must inform about the same to the line in-charge and supervisor to bring about quick corrective action.
- A report is maintained by the in-line checkers and online QC for style quality progress.
- After line setting, Industrial Engineers must study each operation. If any change needs in lay out and working method for quality and production purpose, immediate action to be taken.
- At the end of line, stitched garments need to be checked by final checkers to ensure the product quality.
- Passed garments from final checking must be audited by QA as per 2.5 AQL systems.
- Passed garments to be sent to finishing department through standard documentation process.

KANBAN

Kanban (literally signboard or billboard in Japanese) is a scheduling system for lean and just-in-time (JIT) production.[13] Kanban is a system to control the logistical chain from a production point of view, and is not an inventory control system. Kanban was developed by Taiichi Ohno, at Toyota, to find a system to improve and maintain a high level of production. Kanban is one method through which JIT is achieved.[14]

Kanban became an effective tool in support of running a production system as a whole, and it proved to be an excellent way for promoting improvement. Problem areas were high-

lighted by reducing the number of kanban in circulation.[15] One of the main benefits of Kanban is to establish an upper limit to the work in progress inventory, avoiding overloading of the manufacturing system. Other systems with similar effect are for example CONWIP. [16]

Operation:

One important determinant of the success of production scheduling based on demand "pushing" is the ability of the demand-forecast to receive such a "push". Kanban, by contrast, is part of an approach where the "pull" comes from the demand. The supply or production is determined according to the actual demand of the customers. In contexts where supply time is lengthy and demand is difficult to forecast, often, the best one can do is to respond quickly to observed demand. This situation is exactly what a kanban system accomplishes, in that it is used as a demand signal that immediately travels through the supply chain. This ensures that intermediate stocks held in the supply chain are better managed, and are usually smaller. Where the supply response is not quick enough to meet actual demand fluctuations, thereby causing significant lost sales, stock building may be deemed more appropriate, and is achieved by placing more kanban in the system.

Toyota's Six Rules:

- Later process picks up the number of items indicated by the kanban at the earlier process.
- Earlier process produces items in the quantity and sequence indicated by the kanban.
- No items are made or transported without a kanban.
- Always attach a kanban to the goods.
- Defective products are not sent on to the subsequent process. The result is 100% defect-free goods.
- Reducing the number of kanban increases the sensitivity.

Optimization model

It is developed based on the overall daily performance of each worker. Due to the physical fatigue of worker, performance of worker changes with time and the label of performance of each worker do not remain same. Assumptions are continuous flow of material through the assembly lines, efficient workers are placed at bottleneck points where bottleneck point's workers are placed at less processing time taken operation's and can do that operation at its own efficiency, replaced bottleneck point workers have the capability of reaching the line target at 100% efficiency or more, one workstation can be half, one or a group, there is no effect on performance due to change in weather, variation in working environment, no effect of fatigue of data collector in collecting whole day data.

At first by using stop watch, the observed processing time and average processing of each operation has been obtained. Standard processing time of each operation is considered as factory standard. Then using average processing time of each operation of each time segment, the performance of individual worker has been found. Standard processing time of each operation is different. Then workers are assigned randomly at different workstations without considering their level of performances. Number of workers at each workstation depends on standard time of the corresponding operations. Then identify bottleneck points based on more processing time taken operations. The efficient workers are placed at bottleneck point where less efficient worker occupied by less processing time took operation. Then again the new bottleneck points are identified and the process is repeated until decreases the assembly line efficiency as well as increase the processing time at bottleneck points. The production capacity of each workstation of each time segment has been calculated based on processing time of bottleneck points. Then excess capacity has to remove by releasing inefficient worker or increasing capacity or distribute works as well as balancing assembly line. Unnecessary workers increase the production cost and the workers have no contributions in improving production capacity. Finally the optimum production capacity, loss due to fatigue, line utilization and line efficiencies are calculated. In the following figure 4.2, shows the steps necessary for optimizing productivity.

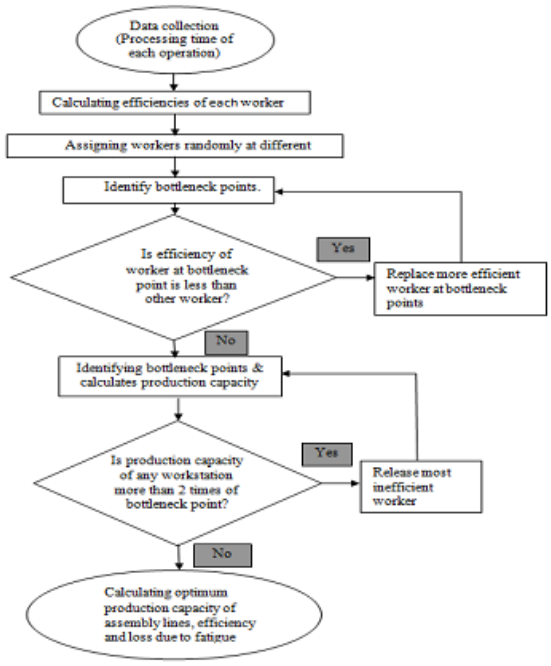

Figure 4.2: Steps for optimizing assembly line productivity.

A study shows how optimization model solve BNP by replacing worker by more efficient worker and efficiency gradually increases up to certain iterations and after that efficiency decreases.[12]

Value Stream Mapping:

Value Stream is all the actions (both value added and non-value added) currently required to bring the product through the main flows essential to every product:

- The production flow from raw material into the arms of the customer, and
- The design flow from concept to launch.

Taking a value stream perspective means working on the big picture, not just individual processes, and improving the whole, not just optimizing the parts. If one truly look at the whole and go all the way from molecules to the arms of customer, one will need to follow the value stream for the product across many firms and even more facilities. Implementing VSM not only removes wastes but also helps to know the sources of the wastes so that they would never come back.

Current state map & Future State Map:

For improving the current state, the following things can be done. They are as follows-

1. Order quantity may increase.
2. Number of vehicles can be increase for transportation.
3. Planning software (ERP) can be introduce
4. Work design through Industrial Engineering Tools to reduce processing times and delay
5. Production line can be increase when in the same time period quantity increased.
6. Development of the supplier supply chain to minimize the time.
7. Introduce technology in the bigger portion (Non value adding activities)
8. Changing mode of transportation and so on.

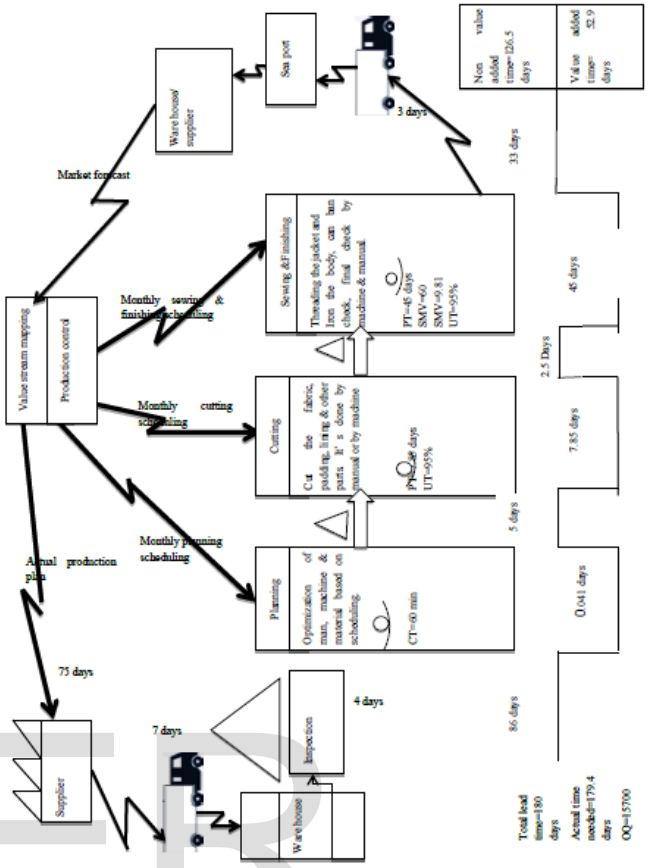

Figure 4.3: Current State (Planning to Finish)

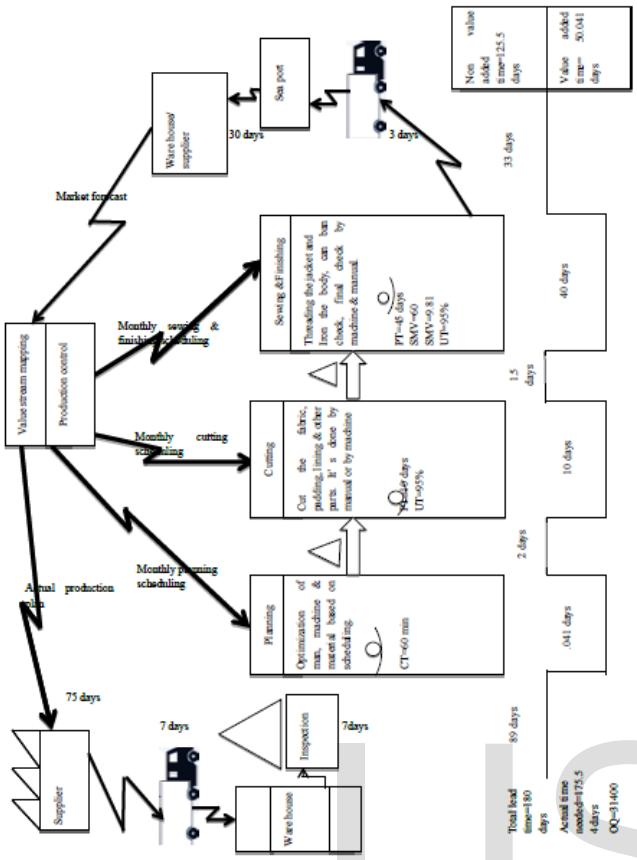

Figure 4.4: Future State (Planning to Finish)

5 Conclusion

The garment manufacturing industry faces many global challenges due to various factors including competition, increased production costs, less productivity/efficiency and labor attribution. So, there is a need to focus and concentrate on identifying the real issues, taking corrective actions suited to the specific industrial center of the unit, empowering the technical and managerial staff by enhancing their knowledge and ability, analyzing orders efficiently and deciding whether actions are viable for the company. The world economy has changed in significant ways during the past several decades, especially in the areas of international trade and industrial organization. Two of the most important new features of the contemporary economy are the globalization of production and trade. Therefore today's technological systems are characterized by orientation to productivity; this can be achieved through the apparel engineering.

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