APPLICATION OF INDUSTRIAL ENGINEERING In Garments Sewing Floor

Sabya Sachi Roy
ID: 081-23-750
Subodh Kumar Ghosh
ID: 081-23-737
AND
Ripon Chakraborty
ID: 081-23-744

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

Supervised By

Engr. Md. Mahfuzur Rahman
Senior Lecturer
Department of Textile Engineering
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY
DHAKA, BANGLADESH
JANUARY 2012

DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Engr. Md.Mahfuzur Rahman, Senior Lecturer, Department of Textile Engineering**, Daffodil International University. We also declare that neither this project not any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

Engr. Md.Mahfuzur Rahman

Senior Lecturer

Department of Textile Engineering

Daffodil International University

Submitted by:

Sabya Sachi Roy

ID: 081-23-750

Department of TE

Daffodil International University

Subodh Kumar Ghosh

ID: 081-23-737

Department of TE

Daffodil International University

Ripon Chakraborty

ID: 081-23-744

Department of TE

Daffodil International University

Acknowledgement

We would like to thank Senior lecturer Md.Mahfuzur Rahman for his leadership and guidance in helping us find our niche in Industrial Engineer. Without his help we would not have been able to learn the intricate Subject.

We would like to thank Rajpoti Das *Asst. Manager of IE department* for his continued support and for giving us the opportunity to work on the Application of Industrial Engineering in Garments sewing floor where many of the ensuing ideas were created. We would like to thank the members of the Industrial Engineer department who kept us honest in our manufacturing idealism.

We would like to thank Devashis kumar saha *Executive Director Fakir Apparels* Ltd. and Emarat Hossain *HR admin & compliance Fakir Apparels* Ltd. whose insight and ideas helped me to see how to apply Industrial Engineering in garments sewing floor.

We would like to thank our entire course mate in Daffodil International University, who kept us sane & took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and parents.

ABSTRACT

This project is on “Application of Industrial Engineering In garments sewing floor”. Traditionally operated garment industries are facing problems like low productivity, longer production lead time, high rework and rejection, poor line balancing, low flexibility of style changeover etc. These problems were addressed in this study by the implementation of lean tools like cellular manufacturing, single piece flow, work standardization, just in time production, etc. After implementation of lean tools, results observed were highly encouraging. Some of the key benefits entail production cycle time decreased by 8%, number of operators required to produce equal amount of garment is decreased by 14%, rework level reduced by 80%, production lead time comes down to one hour from two days, work in progress inventory stays at a maximum of 100 pieces from around 500 to 1500 pieces. Apart from these tangible benefits operator multiskilling as well as the flexibility ofstyle changeover has been improved. This study is conducted in the stitching section of a shirt manufacturing company. Study includes time studies, the conversion of traditional batch production into single piece flow and long assembly line into small work cells.

ꝏ

TABLE OF CONTENTS

LIST OF TABLES **Page No**

LIST OF FIGURES **Page No**

Limitations

Time shortage & lack of information providing attitude were the major limitations. Beside these reaching the top management personnel individually was quite tough. In some cases restrictions in taking photographs & in getting specific documents were also mentionable limitation.

Chapter: 01

Introduction of Industrial Engineering

1.0 Introduction:

Present techno economic scenario is marked by increasing competition in almost every sector of economy. The expectation of the customers are on the rise and manufacturers have to design, and produce well in as many variety as possible (concept of economics of scale is no more talked off) to cater to the demands of the customers. Thus there is a challenge before the industries to manufacture goods of right quality and quantity and at right time and at minimum cost for their survival and growth. This demands the increase in productive efficiency of the organization. Industrial Engineering is going to play a pivotal role in increasing productivity. Various industrial engineering techniques are used to analyze and improve the work method, to eliminate waste and proper allocation and utilization of resources.

Industrial engineering is a profession in which a knowledge of mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop the ways to utilize economically the materials and other natural resources and focus of nature for the benefit of mankind.

American Institute of Industrial Engineers (AIIE) defines Industrial Engineering as follows:

Industrial Engineering is concerned with the design, improvement and installation of integrated system of men, materials and equipment. It draws upon specialized knowledge and skills in the mathematical, physical sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.

The prime objective of industrial engineering is to increase the productivity by eliminating waste and non-value adding (unproductive) operations and improving the effective utilization of resources [1].

1.1 Activities of Industrial Engineering [1]:

- Selection of processes and assembling methods.
- Selection and design of tools and equipment.
  Design of facilities including plant location, layout of building, machine and equipment.
- Design and improvement of planning and control system for production, inventory, quality and plant maintenance and distribution systems.
- Development of time standards, costing and performance standards.
- Installation of wage incentive schemes.
- Design and installation of value engineering and analysis system.
- Operation research including mathematical and statistical analysis.
- Performance evaluation.
- Supplier selection and evaluation.

1.2 Objectives of Industrial Engineering [4]:

- To establish methods for improving the operations and controlling the production costs.

- To develop programmers for reducing costs.

1.3 Functions of an Industrial Engineer [5]:

- Developing the simplest work methods and establishing one best way of doing the work.

- Establishing the performance standards as per the standard methods (Standard Time).

- To develop a sound wage and incentive schemes.

- To aiding the development and designing of a sound inventory control, determination of economic lot size and work in process for each stage of production.

- Development of cost reduction and cost control programmers and to establish standard costing system.

- Sound selection of site and developing a systematic layout for the smooth flow of work without any interruptions.

1.4 Techniques of Industrial Engineering [1][5]:

- **Method study:** To establish a standard method of performing a job or an operation after thorough analysis of the jobs and to establish the layout of production facilities to have a uniform flow of material without back tracking.

- **Time study (work measurement):** This is a technique used to establish a standard time for a job or for an operation.

- **Motion Economy:** This is used to analyses the motions employed by the operators do the work. The principles of motion economy and motion analysis are very useful in mass production or for short cycle repetitive jobs.

- **Value Analysis:** It ensures that no unnecessary costs are built into the product and it tries to provide the required functions at the minimum cost. Hence, helps to enhance the worth of the product.

- **Financial and non-financial Incentives:** These helps to evolve at a rational compensation for the efforts of the workers.

- **Production, Planning and Control:** This includes the planning for the resources (like men, materials and machine) proper scheduling and controlling production activities to ensure the right quantity, quality of product at predetermined time and pre-established cost.

- **Inventory Control:** To find the economic lot size and the reorder levels for the items so that the item should be made available to the production at the right time and quantity to avoid stock out situation and with minimum capital lock-up.

-
- **Job Evaluation:** This is a technique which is used to determine the relative worth of jobs of the organization to aid in matching jobs and personnel and to arrive at sound wage policy.
- **Material Handling Analysis:** To scientifically analysis the movement of materials through various departments to eliminate unnecessary movement to enhance the efficiency of material handling.

  Ergonomics (Human Engineering): It is concerned with study of relationship between man and his working conditions to minimize mental and physical stress. It is concerned with man-machine system.

1.5 IE JOB Profile [5]:

It was just a couple of years back that demand of an industrial engineer has increased many times. Reason, an Industrial engineer can do a lot to improve performance of the company. But the fresh student passed out from educational institute (Fashion institutes) acquired limited knowledge about the job profile of an Industrial engineer. Maximum works are learnt in factory by working. There is number of tools and techniques which are used in by industrial engineers to establish an effective production system in the company. Without having such tools earlier production managers and line supervisors faced difficulty in measuring work content, garment costing, and production planning correctly, even it was difficult to finalize orders. Our team has worked to find out important tasks those are important for an engineer, and needs detailed understanding of production fields, included in the following. Though job profile of an Industrial Engineer varies company to company, most of the job profile fall under following list.

- Knowledge about various sewing production systems
- Knowledge of all types of Sewing machine necessary for the company
- Time study (Cycle timing)

-
- Motion analysis of the operations
- Operation break down
- Preparation of OB (Operation bulletin)
- SAM Calculation
- M/C Layout and Work station layout
- Line Set up
  Production estimation of a line
- Work Sampling
- Method Study (Seeing Movements of an operation)
- WIP Control
- Line Balancing
- Capacity study
- Cost estimation of a garment
- Developing and Maintaining Skill Matrix
- Incentives schemes
- Calculating Thread Consumption
- Work aids, Guide and Attachment
- Performance Rating

An industrial engineer must have knowledge and skill on each tool and technique. Implementation of all tools at a time is not needed. Engineer has to go step by step. Almost all work study tools and methodology are adopted from others industries and implemented to the garment industry. So each work study tool has guaranteed benefit if it is used effectively.

1.5 Organogram Of IE department In Fakir Apparels Ltd [5].

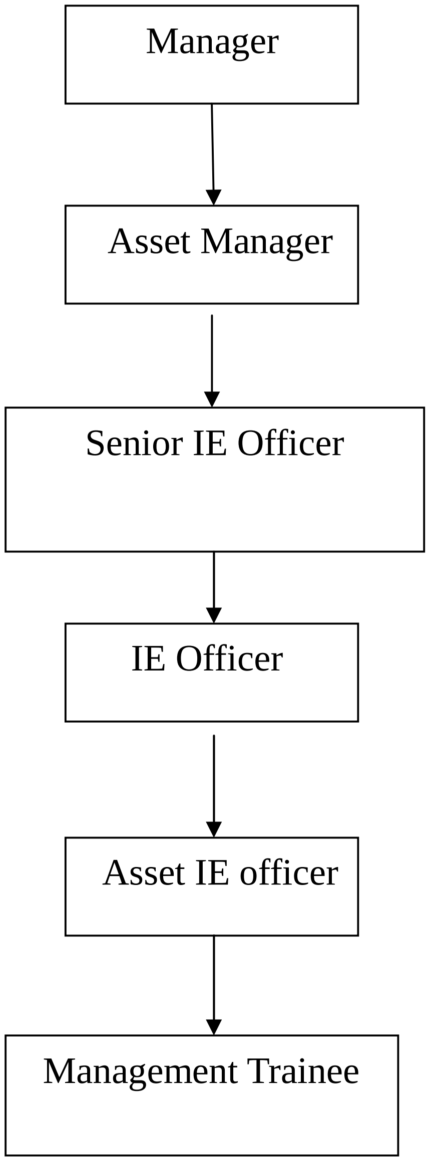


Figure 01

1.6 Industrial Engineering Tools[1]:

- Lean Manufacturing
- 5S
- JIT (Just In Time).

- Kanban.
- KAIZEN.

1.6.1 Lean Manufacturing [5]:

Lean Manufacturing, also called Lean Production, is a set of tools and methodologies that aims for the continuous elimination of all waste in the production process. The main benefits of this are lower production costs, increased output and shorter production lead times. More specifically, some of the goals include:

Defects and wastage - Reduce defects and unnecessary physical wastage, including excess use of raw material inputs, preventable defects, costs associated with reprocessing defective items, and unnecessary product characteristics which are not required by customers;

Cycle Times - Reduce manufacturing lead times and production cycle times by reducing waiting times between processing stages, as well as process preparation times and product/model conversion times;

Inventory levels - Minimize inventory levels at all stages of production, particularly works in-progress between production stages. Lower inventories also mean lower working capital requirements;

Labor productivity - Improve labor productivity, both by reducing the idle time of workers and ensuring that when workers are working, they are using their effort as productively as possible (including not doing unnecessary tasks or unnecessary motions);

Utilization of equipment and space - Use equipment and manufacturing space more efficiently by eliminating bottlenecks and maximizing the rate of production though existing equipment, while minimizing machine downtime;

Flexibility - Have the ability to produce a more flexible range of products with minimum changeover costs and changeover time.

Output – Insofar as reduced cycle times, increased labor productivity and elimination of bottlenecks and machine downtime can be achieved, companies can generally significantly increased output from their existing facilities.

Most of these benefits lead to lower unit production costs – for example, more effective use of equipment and space leads to lower depreciation costs per unit produced, more effective use of labor results in lower labor costs per unit produced and lower defects lead to lower cost of goods sold.

1.6.2 5S [5]:

5S represents 5 disciplines for maintaining a visual workplace (visual controls and information systems).

These are foundational to Kaizen (continuous improvement) and a manufacturing strategy based "Lean Manufacturing" (waste removing) concepts.

5S is one of the activities that will help ensure our company's survival.

1. Sort - All unneeded tools, parts and supplies are removed from the area

2. Set in Order - A place for everything and everything is in its place

3. Shine - The area is cleaned as the work is performed

4. Standardize - Cleaning and identification methods are consistently applied

5. Sustain - 5S is a habit and is continually improved

Also - Work areas are safe and free of hazardous or dangerous conditions.

1.6.2.1 5S Examples [4]:

1. Sort - All unneeded tools, parts and supplies are removed from the area.

2. Set in Order - A place for everything and everything is in its place.

Figure 02

See the difference

Figure 03

3. Shine - The area is cleaned as the work is performed (best) and\or there is a routine to keep the work area clean.

4. Standardize - Cleaning and identification methods are consistently applied.

Departments have weekly 5S tours. Every job has duties that use Sort, Set in Order and Shine. We all have common duties to do our part to keep all areas of the plant in shape - break room, restrooms, locker area, parking lot, etc.

5. Sustain - 5S is a habit and is continually improved

5S is a simple concept with powerful results. You will get additional information on 5S so that you will be well equipped. Our experience is that the more we do 5S the better the work environment becomes: cleaner, safer, more organized, the work is easier, less confusion and less stress. Use the 5S (work\home\play) - The more you use it the easier it becomes and life just gets better and better.

1.6.3 JIT (Just In Time)[5]:

- JIT philosophy means getting the right quantity of goods at the right place and the right time.
- JIT exceeds the concept of inventory reduction.
- JIT is an all-encompassing philosophy found on eliminating waste.
- Waste is anything that does not add value.

A broad JIT view is one that encompasses the entire organization.

1.6.3.1 Objective of JIT [1]:

- Produce only the products the customer wants.
- Produce products only at the rate that the customer wants them.
- Produce with perfect quality.
- Produce with minimum lead time.
- Produce products with only those features the customer wants.
- Produce with no waste of labor, material or equipment -- every movement must have a purpose so that there is zero idle inventory.
- Produce with methods that allow for the development of people .

1.6.4 KANBAN [5]:

KANBAN, a technique for work and inventory release, is a major component of Just in Time and Lean Manufacturing philosophy. It was originally developed at Toyota in the 1950s as a way of managing material flow on the assembly line. Over the past three decades the Kanban process, a highly efficient and effective factory production system, has developed into an optimum manufacturing environment leading to global competitiveness. Kanban stands for Kan- card, Ban- signal. The essence of the Kanban concept is that a supplier, the warehouse or manufacturing should only deliver components as and when they are needed, so that there is no excess Inventory. Within this system, workstations located along production lines only produce/deliver desired components when they receive a card and an empty container, indicating that more parts will be needed in production. In case of line interruptions, each workstation will only produce enough components to fill the container and then stop. In addition, Kanban limits the amount of inventory in the process by acting as an authorization to produce more Inventory. Since Kanban is a chain process in which orders flow from one process to another, the production or delivery of components are pulled to the production line, in contrast to the traditional forecast oriented method where parts are pushed to the line.

1.6.4.1 Advantages of Kanban Processing [5]:

Provides a simple and understandable process. Provides quick and precise information. There are low costs associated with the transfer of information. Provides quick response to changes.

There is a strict limit of over-capacity in processes. Avoids overproduction. Minimizes waste. Full control can be maintained. Delegate's responsibility to line workers.

1.6.5 KAIZEN[5]:

Kaizen is a Japanese word means, simply, Continuous Improvement.
Kai = to take a part

Zen = to make good

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

HOW DOES KAIZEN WORK [5]:

Ten basic principles for Improvement in the view of KAIZEN:

1. Throw out all of your fixed ideas about how to do things.
2. Think of how the new method will work-not how it won't.
3. Don't accept excuses. Totally deny the status quo.

4. Don’t seek perfection. A 50-percent implementation rate is fine as long as it’s done on the spot.
5. Correct mistakes the moment they’re found.
6. Don’t spend a lot of money on improvement.
7. Problems give you a chance to use your brain.
8. Ask “why” at least five times until you find the ultimate cause.
9. Ten people’s ideas are better than one person’s.
10. Improvement knows no limit.

PURPOSE OF KAIZEN [5]:

Kaizen activities focus on every operation and process in order to add value and eliminate waste.

Process: is the sequence of operations needed to design and make a product.

Operation: is one activity performed by a single machine or person on that product.

TARGET OF KAIZEN [1]:

Products (Quantity, Rejects etc.)

Equipment (Changeover, Utilization, Breakdown)

Human (Communication, Awareness, Stillness)

Processes (Waiting Time, Bottleneck, Line Balancing, VCS)

System (QC, Specification, Infection)

Chapter: 02

Work Study

2.0 Work study [5]:

Work study is a systematic technique of method analysis work measurement and setting of time standard that can be ensure the highest productivity by the optimum use of man power, equipment and material.

2.1 Father of work study [5]:

FW (Frederic Winslow) tailor who is called the father of scientific management is the founder of work study. During Second World War USA needed many arms in short time? Then Mr. FW Tailor applied work study concept to make many arm in short time and got a tremendous result. His ideas were generated as the worked for various firms and work study is being used everywhere. Now it is circumference is getting largely day by day.

2.2 Distinct discipline of work study [5]:

- **Method study**, which is concerned with the systematic way in which the tasks is carried out, and
- **Work measurement**, which is concerned with the time and effort required to carry out the task.

2.3 Work study procedure:

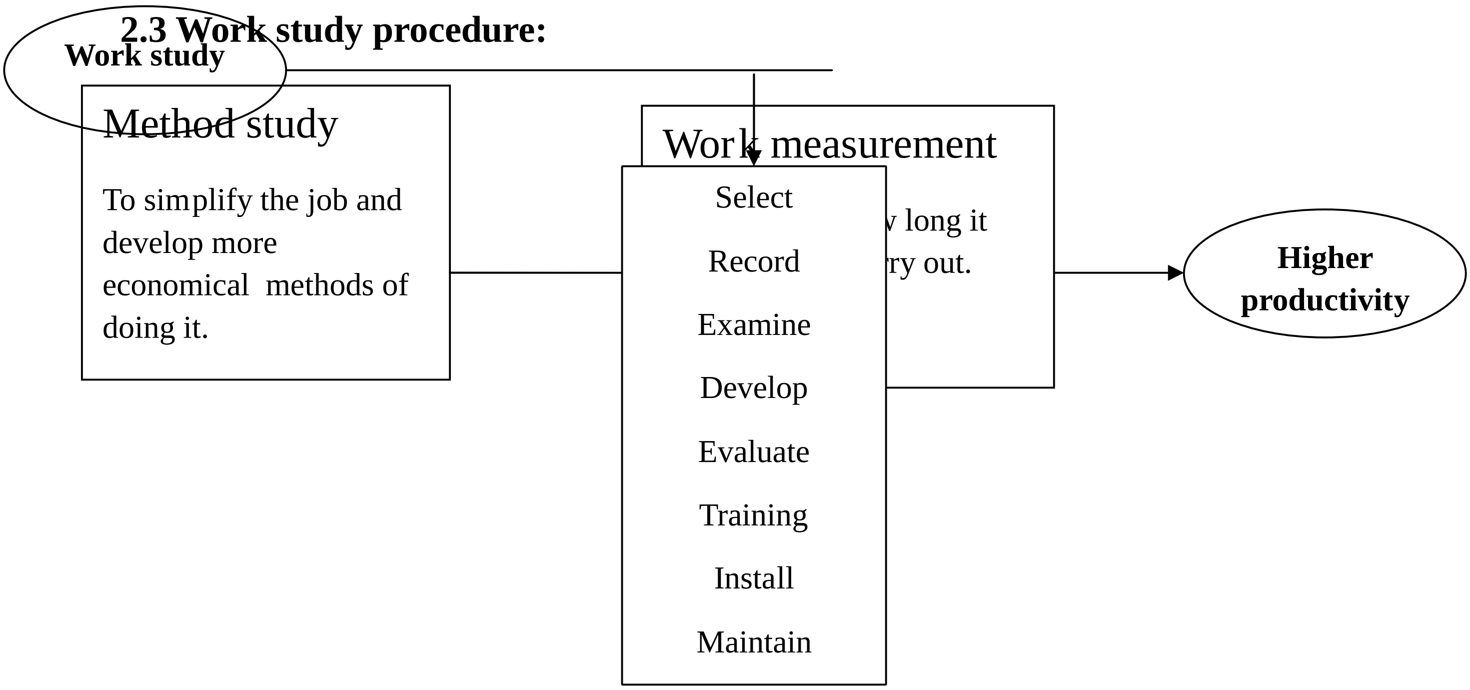


Figure 04

Work study is a systematic job procedure. There are many objects to be studied systematically to carry out the most economical result. The procedure will be continued step by step for view. Let's see the below-

- **Select**: Select the task to be studied.
- **Record**: Record or collect all relevant data about the task or process.
- **Examine:** examine the record facts critically, "the purpose of the activity, the place where it is performed, the sequence in which it is done, the person who is doing it and by which it is done".
- **Developing:** Develop the most economic method and drawing as appropriate technique on the contribution of those concerned (managers, supervisor, workers and others specialist).
- **Evaluate:** Evaluate the result attained by the new improved method comparing the cost effectiveness of the selected new method with the current method of performance.
- **Define:** define the new method and the related time and present it to all those concerned, either verbally or in writing, using demonstrations.
- **Install:** install the new method, training those involved, as an agreed practice with the allotted time of operation.

- **Maintain:** maintain the new standard practice by monitoring the results & comparing them with the original target.[5]

2.4 Characteristic of work study engineer [1]:

A work study engineer need to be educated, expert, smart, confident, personal dignity and honest. Details below-

Sincerity and Honest:

The work study person must be sincere and honest only if is the case will he she gain the confidence and respect of those with whom he or she will work.

Enthusiasm:

He she must be really keen on the job, believe in the importance of what he or she is doing and be able to transmit enthusiasm to the people round about.

Tact/Diplomacy:

Tact is dealing with people comes from understanding them and not wishing to hurt their feeling by unkind or thoughtless word, even when these may be justified. Without justified no work study person is going to get very far.

Good Appearance:

The person must be neat tidy & look efficient. This will inspire confidence among the people with whom he or she has to work.

Self- Confidence:

This can only come with good training and experience of applying work study successfully. The work study practitioner must be able to stand up to top management, supervisors or workers in defense of his opinion and finding, and to do so in such a way that will respect and not give offence.

2.5 Function Of Work Study Engineering [1]:

2.5.1 Engineering Function [1]:

Method Study: Space environment, Equipment, Machine attachment, Element study, Effective and ineffective time segregation, Handling and movement, Contingency, Improve worker performance, Find better way of work, Reduce ineffective time and Increasing needling time, Selling better method to others.

Work Measurement: Cycle check, Observed time, Rating, BMV, and SMV, Production study, Time study, setting time standard and sampling.

General Sewing Data(GSD): Method study and develop within GSD coding time by reducing unnecessary task through method study.

Breakdown and Layout: Operation breakdown, Time setting, Process sequence, tight & loose flow, Incentive or No incentive layout, Operation & workers selection.

Consumption: All measurable trims like Thread, String, Tape, Webbing, Binding, Grosgrain, and Velcro. Elastic, Z-Band/linear, fabric & other like.

Calculation: Feeding time, Produced time, Efficiency, Target setting, productivity gap, Individual performance and capacity, Potential pieces, Required production days/hours/workers, Contingency, AQL,OQL, Accuracy & confident level, Cost breakdown point, Ratio, Load range, Sewing time, Effective time, BPT, HPT,LPT,BMV,SMV.

2.6 General Function [1]:

1. **SMV and Production Plan:** SMV estimation and update production plan.
2. **Incentive Package:** Analysis and control production plan as higher performance level.

3. **Reporting:** Efficiency, Performance, Capacity, Production statement, Earning statement, Comparison, Factory/line capacity, Incentive calculation and management key information as required.
4. **Keeping History:** Standard data, Product, Earning, Efficiency, Performance, Progression, Target and target efficiency analysis.
5. **Data Centralization:** Control and centralization of all data across units.
6. **Save Material:** Protection to misuse of trims measurable like's threads. String, Binding, Tape, Velcro, Elastic, Z-band, Webbing, Grosgrain etc. and countable likes button eyelet, Stopper, Puller, Zipper etc.
7. **Multi Experience:** Basic quality procedure and acceptance level, Basic maintenance, Cutting, Marker, Pattern, Sample and packing/shipping method.
8. **Reserved Expert:** To help others section where needed as reserved expert.
9. **Motivation:** Training, Job facilities, Life standardization and techniques presentation.

2.7 STEPS INVOLVED [1]:

1. Analyze each style to determine its requirement for production.

2. Style Analysis is based on:
   - -Firm's quality standards
   - -Amount of labor required
   - -Available equipment
   - -Volume to be produced
   - -Expected "throughput time"

3. Style requirements are determined through analysis of samples and specifications

4. Apparel Engineers are concerned with:
   - -Number, complexity and sequence of Operations

-Equipment Required

-Time and Skill Required

5. Operation Breakdown: Work in each style is broken down into operations

An operation B/down is sequential list of all the operations that involved in assembling a garment used to establish the workflow for each style.

6. Apparel engineers study each operation to improve its effectiveness and efficiency and to establish methods to ensure a consistent performance by operators and consistent products.

2.8 Standard Time and Target Setting [4]:

Many companies do not use standard time systems; target setting is based on guesswork and experience. Establishment of Standard times and the development of the best method to manufacture is vitally important to improve productivity. Every company that wishes to compete in the future must realize this. This chart clearly illustrates the benefits to factory efficiency if standard times and well developed methods are used.

2.9 Method Analysis [4]:

Most of the companies are using poor methods, operators are left to establish best way to do the job, decide on the number of bursts of stitching, folding and unfolding of parts, unnecessary matching and additional handling, all of these motions add to the time it takes to manufacture the garment and should be eliminated. Method study can be implemented in any type of production system whether it is in- house or on a contract basis. Proper method analysis can improve productivity by at least 15%.

2.10 Workplace Layout [3]:

The management wants to fit as many machines in the factory as possible, reducing the scope for methods improvement. The space between machines is insufficient in many cases.

A good workplace layout will eliminate unnecessary motions and fatigue resulting in substantial increase in the efficiency of the operator.

Just look at the picture alongside and think how efficiently you will be able to work 8 hours a day sitting in that posture.

2.11 Operation Sequence [2]:

Some of the production departments work without a properly planned or written operation sequence. This is a critical step in garment production and a mistake or negligence at this stage can result into huge losses later in terms of operator time, work content and quality.

2.12 Work Aids and Attachments [2]:

Use of work aids and attachments is insufficient. Many new and inexpensive attachments and folders are being continuously developed, it is vital that these developments are known to ensure a program of constant improvement. Many new and inexpensive attachments and folders are being continuously developed, it is vital that these developments are known to ensure a program of constant improvement.

2.13 Operator Monitoring [5]:

Most of the companies surveyed do not have the means to establish their performance against standard, so they have no idea where they stand. There are no proper measurements so their efficiency levels are at best a guess, it is impossible to understand how they will be able to continue to compete unless they have proper controls in place, and have established productivity improvement programs to move forward in the future.

2.14 Cycle Checks [1]:

A simple technique aimed at establishing operator potential against their actual performance, this can be done by relatively inexperienced work study personnel and is a great aid to factory performance improvement. None of the companies perform cycle checks. The chart below shows the comparison between factories in Group A (with work study department) and Group B (without workstudy department) on various aspects of apparel production.

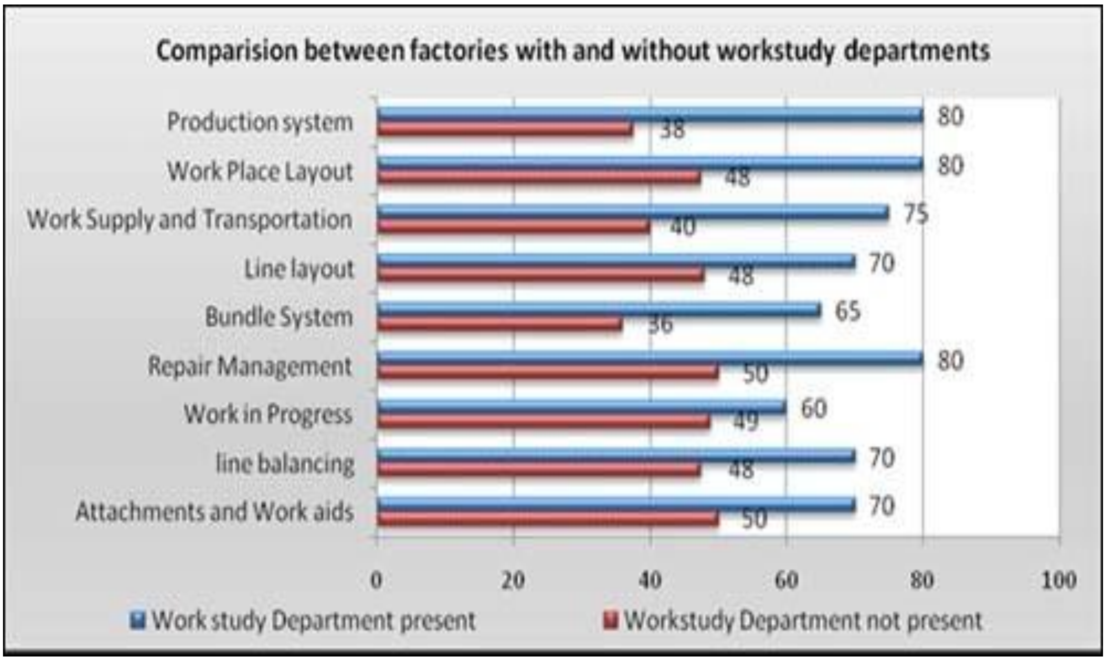


Table 01

Looking at the comparison shown below it is obvious that group A factories are more productive than the group B factories. This fact is further strengthened when the overall factory survey results are compared. The factories in group A have a combined score of 61% for overall performance whereas factories in group B achieved a score of only 48%.

Work-study is the need of the hour and it is high time that the industry stalwarts understand its importance and its contribution to profitability.

Chapter: 03

Method Study

3.0 Method Study for garment operations:

Method study is more of a systematic approach to job design than a set of techniques. It is defined as the systematic recording and critical examination of existing and proposed methods of doing work, as a means of developing and applying easier and more effective methods and reducing costs. The method involves systematically following six steps:

1. **Selection of work to be studied:** Most operations consist of many discrete jobs or activities. The first stage is to select those jobs to be studied that will give the best returns for the time spent. For example, activities with the best scopes for improvement, those causing delays or bottlenecks or those resulting in high costs.

2. **Recording of all relevant facts of current method:** Method study uses formal techniques to record the sequence of activities, the time relationship between different tasks, the movement of materials, and the movement of staff. There are many techniques used in method study.

3. **Critical examination of those facts:** This is the most important stage in method study. It is used to critically examine the current method by seeking answers to questions:

- The purpose of each element
- The place
- The sequence
- The person
- The means

4. **Development of the most practical, economic and effective method:** This stage is used to develop a new and better method of executing the task, by taking into account the results of critical examination. The new method is developed by a combination of entirely eliminating some activities, combining some parts, changing the sequence of some activities and by simplifying the content of others.

5. **Installation of new method:** This step involves project managing the changes and ensuring that everybody involved understands the changes involved. In other words they understand the new method, which is doing what, the differences compared to the old method and crucially the reason for the changes. Training is an important part of this stage particularly if the new method involves radical changes. Providing modified equipment, components and layouts may also be involved.

6. **Maintenance of new method and periodic checking:** Monitoring of how effective the new method is and how personnel have adapted is very important. One aspect that is sometimes overlooked is to check what effect the new method has on other activities. For instance, it may be that whilst the new method is successful in eliminating a bottleneck in a particular area, the bottleneck has moved elsewhere in the process. By periodic checking the new method and its effects, management can ensure that overall efficiency is improving rather than deteriorating.[1]

Chapter: 04

Time Study

4.0 Time Study for garment operations [1]:

4.1 Definition of Time Study [1]:

Time study is a method of measuring work for recording the times of performing a certain specific task or its elements carried out under specified conditions. An operator does same operation (task) throughout the day. Time study help to define how much time is necessary for an operator to carry out the task at a defined rate of performance.

Time study tools:

- A stop watch
- Time study format
- One pen or pencil

How to conduct Time Study

An operation cycle consists of material handling, positioning and aligning parts, sewing, trimming threads and tying and untying a bundle. So in the time study format, divide whole task into various elements according to the motion sequences of the operation. For example, in operation ‘collar run stitch’, task elements may be i) pick up panel to sew first seam, ii) turn collar to sew second seam, iii) turn collar to sew third seam iv) check work and dispose and v) waiting for next pieces.

Step 1: Preparation

- Ready with stationeries like time study format, stop watch (digital one) and pencil
- Select one operation for Time study
- Tell the operator that you are going measure time he/she taking to do the job.
- Observe the operation carefully and break down operation into elements.
- Fill the basic information in the time study format. Like machine category, guide or attachment used.

Step 2: Time capturing:

Now measure the time taken for completing each elements of the operation cycle by the operator. Time should be captured in seconds. Similarly, capture element timing for consecutive 5 operation cycles. During data capturing only note down reading (see following table-1) of the stop watch and later calculate element timing. If you found any abnormal time in any elements record time during time study and later discard that reading. Or you capture time for one more cycle. Abnormal time may be occurred due to bobbin change, thread break, power cut or quality issues.

Table-02 Step

3: Calculation of Basic time:

From the Reading (R) calculates time taken for each element for all five cycles just by

Time Study Sheet

Sheet No: 02	M/c Details: SNLS
Operation No: run stitch collar	Attachment used: N/A
Fabric: poplin	With/Without UBT? With UBT
Garment: Full sleeve shirt with single pocket	Style No.: #5075 (Arrow)

	Element Breakdown										Foreign Elements		
	p/u and stitch 1st line		stitch 2nd line		stitch 3rd line		check and dispose		waiting				Description
Cycle	T	R	T	R	T	R	T	R	T	R	T	R	
1		5		9		12		21		27			
2		31		38		41		49		49			
3		55		58		60		71		76			
4		82		86		89		95		95			
5		102		105		107		110		110			
Summary													

deducting previous Reading from elemental reading. Sum up times of five cycles for each element. Note, if you discard any reading than in that case no. of cycles will be four. Calculate average element times. This average time is called basic time. (In the following table-2 it is noted as average time)

Time Study Sheet		
Sheet No: 02		M/c Details: SNLS
Operation No:run stitch collar		Attachment used: N/A
Fabric: poplin		With/Without UBT? With UBT
Garment: Full sleeve shirt with single pocket		Style No.: #5075 (Arrow)

	Element Breakdown										Foreign Elements		
	p/u and stitch 1st line		stitch 2nd line		stitch 3rd line		check and dispose		waiting				Description
Cycle	T	R	T	R	T	R	T	R	T	R	T	R	
1	5	5	4	9	3	12	9	21	6	27			
2	4	31	7	38	3	41	8	49	0	49			
3	6	55	3	58	2	60	11	71	5	76			
4	6	82	4	86	3	89	6	95	0	95			
5	7	102	3	105	2	107	3	110	0	110			

Summary						
Total Time	28	21	13	37	11	
Abnormal time					11	Allowances: PF&D and M/c delay
No of cycle	5	5	5	5	5	
Avg Time	5.6	4.2	2.6	7.4	0	
Rating	100	100	100	100	100	M/c delays:
Normal Time	5.6	4.2	2.6	7.4	0	SNLS: 9%
Allowances	2	29	29	20	0	DNLS=14%
Standard T	5.712	5.418	3.354	8.88	0	O/L 3T=7% 4T=9%
S.A. Time (min)					0.3894	5T=11%

Note: T stands for Time and R stands for Reading

Table-03 **Step**

4: Calculation of Standard time:

To convert basic time to normal you have to multiply it with operator performance rating. Here for example, rating has been taken 100%. Now you have add allowances for machine allowances, fatigue and personal needs etc. Add machine allowance only to those elements where machine is running and fatigue and personal needs to all elements. Now we got standard time for each element in seconds. Sum up all elemental time and convert seconds into minutes. This is standard minutes or SAM.

4.2 Reduce line setting time for assembly line [3]:

Engineers and production managers always look for a way to improve factory's labor productivity. But they look over things that lower labor productivity. "Higher line setting time" is one of the most visible reasons at present that reduces factory's overall productivity. When it takes longer time for setting a line, most of the operators sit idle. That means operators are not utilized in producing garment and operator productivity falls resulting high labor cost. Following piece of article will help you to reduce line time.

I have seen factories where 1.5 to 2 days is spent in line setting for woven tops. When line supervisor and engineers are asked why they are taking that much time to set a 40 machines line, they give dozen of reasons. Whatever reasons line supervisor have, is the root cause for the delay. Reasons may vary time to time or style to style. Let’s discuss main points that cause longer time for line setting.

1. Factory starts loading new style to the line once all operators get free from the previous style.
2. Frequent change in line planning.
3. All trims have not been approved or not yet sourced. Until required trims are sourced all operation can’t be started.
4. Few garment components has been sent outside for printing or embroidery but did not received on time.
5. Supervisor did not fully assess the operation sequence or skill requirement for each operation.
6. Operators were not present in the initial operations or critical operations.
7. Quality issue, supervisor not able to give suitable operator for the critical operation
8. Maintenance guy do not able set machine quickly. Replacement of machine, setting guides and attachment takes longer time than it should be.
9. Planning for larger bundle size. At the first day of line setting if bigger bundle size is used then it will take huge amount of time to reach bundle at the last operator.

Now it becomes simple, to start working on reducing line setting time. Work on the above reasons and eliminate them prior to starting of line setting. Once you know the reason you can resolve it. In the following list few remedies has been explained.

1. Research and development of the style – analyze the style well before putting on the line. By doing so, you will be aware of critical operations, machine requirement, skill requirement for the operations.
2. Production file properly checked at the time of receiving from merchandising team – check whether trims are approved or not, if not sourced yet when it is expected. Plan you your line setting according availability of goods.

3. Prepare line plan with manpower requirement for specific skill categories. Ensure that operators selected for the operations are present during line setting.
4. All necessary attachments, needles, guides need to be arranged well in advance and tested in sampling or Research and development center.
5. Dedicated maintenance and quality personal to be provided during line setting.
6. Start setting a line with small size of bundles (3 to 5 pieces per bundle). Thus bundle will move fast at the end of the line. Once WIP is build up bundle size can be increased.
7. Use machine shifting device for replacing machine quickly.

DAILY LINE WISE PRODUCTION & EFFICIENCY REPORT

Date : 14-12-2011

IE	LINE	ORDER NO	STYLE NAME	BUYER	PRDN DAY	Hourly Target	B.Down SAH	B.DOWN OP.	PRESENT OP.	PRESENT HELPER	B.DOWN HELPER	TOTAL WORKER	WORK HOUR	OT (HR)	TOTAL TARGET	TARGET ACVD (7.4)	OT PRDN	TOTAL PRDN	WIP OR	CRNT NEXT OR	LINE EFFI	FLOOR EFFI		REMARKS	APM	APM TR
TANVIR AHMED	1	117280, 117283	SS R NK T SHIRT	TT	2	70	0.09	13	11	5	4	16	10		700	431		431	600		24%	28%	Per Min Output	LINE-1 166 PCS SAMPLE PRODUCTION& OR-117280 OUT PUT WITHOUT BADGE LBL. LINE-2 STOP DUE TO 361 PCS SAMPLE PD.	Kamruzzaman	
	2	119151	SS R NK T SHIRT	TT	1	70	0.12	14	9	12	13	21	10		700					500						
	3	118397	SS POLO	TT	5	50	0.45	31	18	18	22	36	10		500	300		300	400		38%		0.9			
	4	118222	SS R LADIS NK T SHIRT	TT	5	100	0.13	15	16	16	13	32	10		1000	900		900	300	1200	37%		Hourly Output			
	5	117299, 119151	SS R NK T SHIRT	TT	2	110	0.09	12	14	17	11	31	10		1100	1000		1000		400	29%					
			TOTAL				**0.88**	**85**	**68**	**68**	**63**	**136**	**50**		**4000**	**2631**		**2631**					53			
ABDUR ROB	6	2658	LS JACKET	SO	1	75	0.17	19	14	8	4	22	13	3	975	635		635	300		38%	34%	A	LINE-8 SHADING PROB.	Rassel	Shipon
	7	1439	TANK TOP	SO	17	220	0.08	10	10	14	10	24	10		2200	1715		1715	1500		57%					
	8	2658	LS JACKET	SO	2	100	0.20	21	18	18	14	36	13	3	1300	777		777	400		33%		1.1			
	9	3354	MARISA TOP	SO	3	65	0.16	24	12	16	13	28	13	3	845	437		437	400		19%		Hourly Output			
	10	7842	BOLERO	SO	3	60	0.19	23	14	15	18	29	10		600	443		443	300		29%					
			TOTAL				**0.80**	**97**	**68**	**71**	**59**	**139**	**59**	**9**	**5920**	**4007**		**4007**					68			
RONI	11	0227	SS R NK T SHIRT	SO	2	100	0.11	19	13	5	4	18	13	3	1300	700		700	1200		33%	28%	Per Min Output		Akram	Kumar
	12	118616	SS POLO	TT	7	40	0.24	21	12	18	16	30	10		400	50		50	500		4%					
	13	118222	SS R LADIS NK T SHIRT	TT	4	80	0.13	15	11	13	13	24	13	3	1040	400		400	1000		17%		0.9			
	14	117302 , 118582	SS R NK T SHIRT	TT	3	170	0.09	12	13	4	5	17	10		1700	1300		1300	800		69%					
	15	118745, 118745	SS R NK T SHIRT	TT	3	120	0.11	13	11	5	12	16	10		1200	620		620	1100		43%		Hourly Output			
			TOTAL				**0.68**	**80**	**60**	**45**	**50**	**105**	**56**	**6**	**5640**	**3070**		**3070**					55			
RONI	16	326200	TANK TOP	HM	16	190	0.08	15	10	5	9	15	8		1520	1100		1100	800		73%	39%	Per Min Output	LINE-17,19 NEW ORDER LINE-20 INPUT NEED. LINE-16 NK RIB PROB.	Akram	Jahangir
	17	303810, 0633	LS R NK T SHIRST SS R NK T SHIRT	HM, SO	2	190	0.08	13	17	15	9	32	10		1900	830		830	600		21%					
	18	7842	BOLERO	SO	11	70	0.19	23	18	18	17	36	10		700	500		500	600		26%		1.5			
	19	303810	SS R NK T SHIRT	HM	5	160	0.08	13	7	5	9	12	8		1280	930		930	1000		78%		Hourly Output			
	20	2327	SS R NK T SHIRT	SO	8	120	0.13	19	10	14	12	24	10		1200	900		900	400		49%					
			TOTAL				**0.56**	**83**	**62**	**57**	**56**	**119**	**46**		**6600**	**4260**		**4260**					92.6087			
WALIULLAH	21	84056, 84651	SS V NK T SHIRT SS R NK T SHIRT	GS	1	22	0.17	22	10	10	14	20	13	3	286	153		153	1000		10%	24%	Per Min Output	LINE-21,24,25 NEW ORDER LINE-22,23,24,25 INPUT PROB LINE-24 SHADING PROB.	Sayed	Amdad
	22	84112	SS V NK T SHIRT	GS	6	104	0.17	19	16	15	15	31	10		1040	455		455	400		25%					
	23	84112	SS V NK T SHIRT	GS	4	90	0.17	19	17	16	16	33	10		900	805		805	500		41%		0.7			
	24	303810	SS R NK T SHIRT	HM	11	190	0.08	13	12	12	12	24	8		1520					900			Hourly Output			
	25	303810	SS R NK T SHIRT	HM	11	141	0.07	12	10	3	3	13	8		1128	620		620		1800	42%					
			TOTAL				**0.66**	**85**	**65**	**56**	**60**	**121**	**49**	**3**	**4874**	**2033**		**2033**					41			

Courtesy By Industrial Engineering Dept

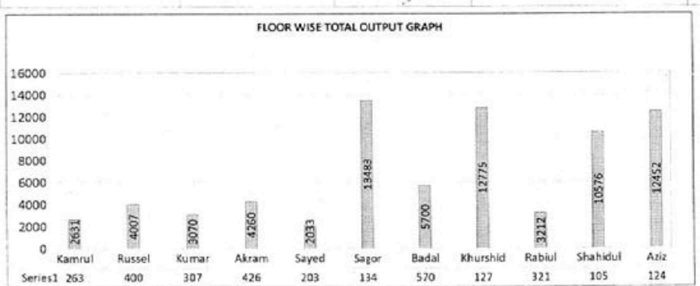
IE	LINE	ORDER NO	STYLE NAME	BUYER	PRDN DAY	Hourly Target	B.Down SAH	B.DOWN OP.	PRESENT OP.	PRESENT HELPER	B.DOWN HELPER	TOTAL WORKER	WORK HOUR	OT (HR)	TOTAL TARGET	TARGET ACVD (7-6)	OT PRDN	TOTAL PRDN	WIP OR	NEXT OR	ORNT	LINE EFFI	FLOOR EFFI		REMARKS	APM	APM TR
RUSTAM	26	3354	MARSIA TOP	SO	10	95	0.15	21	20	16	11	36	13	3	1235	660		660	400			21%					
	27/A	787243	LACE TANK TOP	HM	8	280	0.06	13	13	6	8	21	10		2800	2710		2710	500			77%		Per Min Output			
	27/B	8301-31-806	SS R NK T SHIRT	CA	43	170	0.08	13	13	3	3	16	10		1700	1480		1480	500			74%					
	28	TW-32	SS POLO	TS	6	110	0.22	23	18	22	22	40	13		1430	1200		1200				51%					
	29/A	787242	LACE TANK TOP	HM	8	270	0.06	10	13	5	3	18	10		2700	2109		2109	500			70%				Sagor	
	29/B	539861	SS R NK T SHIRT	HM	8	200	0.10	16	14	8	12	22	10		2000	1398		1398	500			64%	53%		LINE-27/A,28,29/A,30/B INPUT PROB.		
	30/A	303810	SS R NK T SHIRT	HM	45	230	0.08	13	14	8	9	22	10		2300	1535		1535	1000			56%					
	30/B	539861, 539854	SS R NK T SHIRT	HM	7	200	0.10	16	14	8	12	22	10		2000	1130		1130				51%		Hourly Output			
	31/A	331543	MARSIA TOP	HM	4	130	0.16	24	22	16	10	38	10		,1300	1261		1261	500			53%					
																								140			
			- TOTAL				1.01	149	141	94	90	235	96	3	17465	13483		13483									
ANKUR	32	539872, 84550	LS R NK T SHIRT SS POLO	HM,GS	2	130	0.11	16	14	15	12	29	10		1300	1200		1200				46%		Per Min Output			
	33	326200	TANK TOP	HM	3	232	0.08	15	12	14	9	26	6.5		1508	1300		1300				62%			LINE-32,35 INPUT PROB LINE-33 RIB PROB LINE-34 STOP FOR INPUT PROB.		
	34	539870	LS R NK T SHIRT	HM	3	145	0.11	16	12	16	12	28	7		1015	800		800				45%	48%	2.2		Badal	Akhter
	35	787041	SS R NK T SHIRT	HM	3	180	0.09	14	16	15	12	31	10		1800	1200		1200				35%		Hourly Output			
	36	539853, 787041	LS R NK T SHIRT SS R NK T SHIRT	HM	3,1	125	0.09	13	14	3	3	17	10		1250	1200		1200	500			64%					
TOTAL							0.48	74	68	63	12	131	43.5		6873	5700		5700						131			
RIPON	37/A	787242, 787243	LACE TANK TOP	HM	61	233	0.06	13	12	8	8	20	10		2330	2034		2034	1100			61%					
	37/B	295590 , 787243	LACE TANK TOP	HM	54	233	0.06	13	12	8	8	20	10		2330	979		979	600			29%		Per Min Output			
	38/A	437230	TANK TOP	HM	25	200	0.06	12	12	3	3	15	10		2000	2066		2066	500			83%					
	38/B	787243, 787243	LACE TANK TOP	HM	8	215	0.06	10	12	3	3	15	10		2150	1600		1600	1000			64%					
	39/A	303810	SS R NK T SHIRT	HM	13	235	0.08	13	12	9	9	21	8		1880	620		620	1000			30%			LINE-39/A, RIB PROB. LINE-40/A INPUT PROB. LINE-41/A QUALITY PROB.		
	39/B	331543	MARSIA TOP	HM	2	100	0.16	24	17	11	10	28	10		1000	460		460	500			26%	46%	2.0		Khurshid	Anjan
	40/A	326200	TANK TOP	HM	33	210	0.08	15	11	10	9	21	10		2100	447		447	300			17%					
	40/B	813490	TANK TOP BODY	HM	7	236	0.11	17	15	11	10	26	10		2360	2216		2216	300			94%		Hourly Output			
	41/A	117759	TANK TOP	JC STORE	4	150	0.07	11	12	9	9	21	10		1500	680		680	600			23%					
	41/B	813490	TANK TOP BODY	HM	4	200	.11	17	14	9	10	23	10		2000	1485		1485	400			71%					
	42	119970	SS R NK T SHIRT	JC STORE	1	80	.11	15	12	8	13	20	10		800	188		188	500			10%		118			
							0.74	160	141	89	92	230	108		20450	12775		12775									
SUMI	43	303810	SS R NK T SHIRT	HM	12	80	0.07	13	13	3	3	16	8		640	100		100	3000			5%		Per Min Output			
	44	787243	LACE TANK TOP	HM	3	170	0.06	13	13	12	8	25	10		1700	1306		1306	1500			31%			LINE-43,45,47 INPUT PROB& NEW ORDER. LINE-46 ACESSORIES PROB.		
	45	303810	SS R NK T SHIRT	HM	5	200	0.08	13	12	12	9	24	10		2000	986		986	1000			33%	29%	1.1		Rabiul	Baten
	46	TW-53	LS POLO	TS	5	100	0.29	34	24	22	22	46	13	3	1300	820		820	500			40%		Hourly Output			
	47	787062	SS R NK T SHIRT	HM	3	100	0.09	14	12	11	12	23	8		800				2000								
			TOTAL				0.59	87	74	60	54	134	49	3	6440	3212		3212						66			

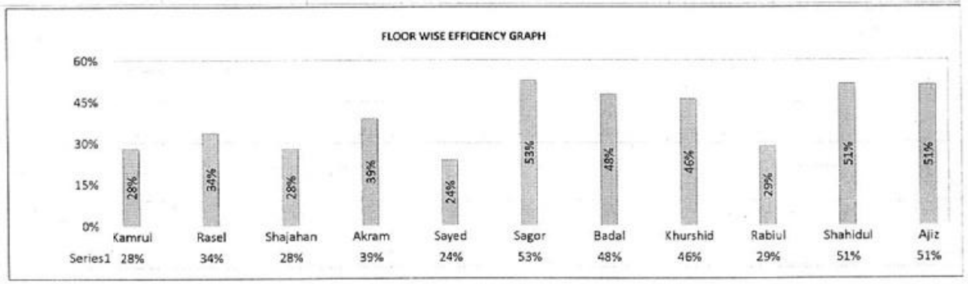
Courtesy By Industrial Engineering Dept

IE	LINE	ORDER NO	STYLE NAME	BUYER	PRDN DAY	Hourly Target	B.Down SAH	B.DOWN OP.	PRESENT OP.	PRESENT HELPER	B.DOWN HELPER	TOTAL WORKER	WORK HOUR	OT (HR)	TOTAL TARGET	TARGET ACVD (7-4)	OT PRDN	TOTAL PRDN	WIP OR	CRNT NEXT OR	LINE EFFI	FLOOR EFFI		REMARKS	APM	APM TR
TOIBUR	48	TW-50	SS POLO	TS	6	100	0.28	34	23	22	21	45	13	3	1300	1025		1025	100		49%					
	49/A	539851, 539862	SS R NK T SHIRT LS R NK T SHIRT	HM	8	153	0.10	16	13	4	12	17	10		1530	1159		1159	500		68%		Per Min Output			
	49/B	8301-31-801	SS R NK T SHIRT	CA	11	160	0.10	13	11	9	12	20	10		1600	1260		1260	50		63%					
	50/A	787062, 0227	SS R NK T SHIRT	HM, SO	1	113	0.13	19	12	9	11	21	10		1130	750		750	1000		46%		1.0			
	50/B	0228	TANK TOP	SO	17	189	0.10	13	12	9	10	21	10		1890	1100		1100			52%					
	51/A	539862	SS R NK T SHIRT	HM	62	189	0.10	16	12	9	12	21	10		1890	1169		1169	100		56%	51%	1.6	LINE-50/B,52/B,53/B INPUT PROB LINE-52/B WAS CLOSED.	Shahidul	Khaled
	51/B	331543	MARSIA TOP	HM	4	90	0.16	24	14	12	10	26	10		900	591		591	300		36%					
	52/A	0228	TANK TOP	SO	15	180	0.10	13	11	9	10	20	10		1800	1409		1409	100		70%					
	52/B	303810	SS R NK T SHIRT	HM	6	185	0.08	13	11	9	9	20	8		1480				300				Hourly Output			
	53/A	539853	LS R NK T SHIRT	HM	12	135	0.10	14	11	4	10	15	10		1350	1102		1102			73%					
	53/B	8301-31-814	SS R NK T SHIRT	CA	13	162	0.10	13	9	9	12	18	10		1620	1011		1011			56%		95.3			
							1.35	188	139	105	129	244	111	3	16490	10576		10576								
MAMUN	54/A	787242	LACE TANK TOP	HM	8	220	0.06	14	13	3	3	16	10		2200	2000		2000	1000		75%					
	54/B	787243	TANK TOP	HM	2	200	0.06	14	13	3	3	16	10		2000	1600		1600	1000		60%		Per Min Output			
	55/A	7492-49-706	LADIES T SHIRT(2 PACK)	CA	23	220	0.07	11	11	8	10	19	10		2200	1683		1683	300		62%					
	55/B	787062	SS R NK T SHIRT	HM	8	100	0.09	14	12	8	12	20	10		1000	619		619			28%		2.1			
	56/A	303812 7492-49-708	SS R NK T SHIRT LADIES T SHIRT(2	HM,CA	2.22	180	0.08	13	12	8	9	20	10		1800	1799		1799	100		72%					
	56/B	02058849 02059877	SS R NK T SHIRT	AHL	2	120	0.10	14	12	8	10	20	10		1200	796		796			40%	51%		LINE-54/B,57/A,57/B INPUT & M/C PROB.	Aziz	Shahadat
	57/A	8301-31-806	SS R NK T SHIRT	CA	4	190	0.10	13	13	8	13	21	10		1900	1781		1781	2000		85%					
	57/B	539862	SS R NK T SHIRT	HM	2	100	0.10	16	10	7	12	17	10		1000	602		602	1800		35%		Hourly Output			
	58/A	311543	MARSIA TOP	HM	3	140	0.16	24	24	16	16	40	10		1400	911		911	1000		36%					
	59	8301-31-806	SS R NK T SHIRT	CA	13	130	0.10	14	15	1	3	16	10		1300	661		661	300		41%		124.52			
							0.92	147	135	70	91	205	100		16000	12452		12452			56%					

BUYER	HM	C&A	S.OLIVER	T.TAILOR	G.STAR	AHLENS	TESCO	LEVIS	ESPRIT	JC STORE	OT(PROD)
PRODUCTION	43708	9410	9958	5001	1413	796	3045			868	

UNIT	TOTAL TARGET	TOTAL	TOTAL WORK HOUR	TOTAL MAN POWER	AVG/MIN OUTPUT	AVG PER HR OUTPUT	TOTAL SAH	
FAL - 1	22160	13968	211	499	1.10	66	2.92	
FAL - 2	88592	60231	557	1300	1.80	108	5.75	
	110,752	74,199	768	1799	1.61	97	8.67	





Courtesy By Industrial Engineering Dept

DAILY LINE WISE PRODUCTION & EFFICIENCY REPORT

Date : 15-12-2011

IE	LINE	ORDER NO	STYLE NAME	BUYER	PRDN DAY	Hourly Target	B.Down SAH	B.DOWN OP.	PRESENT OP.	PRESENT HELPER	B.DOWN HELPER	TOTAL WORKER	WORK HOUR	OT (HR)	TOTAL TARGET	TARGET ACVD (7-8)	OT PRDN	TOTAL PRDN	WIP OR	CRNT NEXT OR	LINE EFFI	FLOOR EFFI		REMARKS	APM	APM TR
TANVIR AHMED	1	117280	SS R NK T SHIRT	TT	3	100	0.09	13	11	5	4	16	10		1000	1060		1060	1500		60%		Per Min Output		Kamruzzaman	
	2	119151	SS R NK T SHIRT	TT	2	80	0.10	13	9	12	11	21	10		800	464		464	600		22%					
	3	118397	SS POLO	TT	6	30	0.45	31	18	18	22	36	10		300	200		200	400		25%	29%	1.0	LINE 1 WITHOUT BADGE LBL PROD.		
	4	118222	SS R LADIS NK T SHIRT	TT	6	110	0.13	15	14	15	13	29	10		1100	286		286			13%		Hourly Output			
	5	119151	SS R NK T SHIRT	TT	2	100	0.10	13	14	14	11	28	10		1000	1100		1100	800		39%					
			TOTAL				**0.87**	**85**	**66**	**64**	**61**	**130**	**50**		**4200**	**3110**		**3110**					62			
ABDUR ROB	6	2658	LS JACKET	SO	2	100	0.17	19	17	9	4	26	13	3	1300	927		927	400		47%		A		Rassel	Shipon
	7	1439	TANK TOP	SO	18	200	0.08	10	10	13	10	23	10		2000	1850		1850	200		64%					
	8	2658	LS JACKET	SO	3	110	0.20	19	17	17	11	34	13	3	1430	943		943	300		43%	40%	1.3			
	9	3354	MARISA TOP	SO	4	70	0.16	24	13	16	13	29	13	3	910	510		510	800		22%		Hourly Output			
	10	7842	BOLERO	SO	4	60	0.19	23	11	15	18	26	13	3	780	614		614	500		35%					
			TOTAL				**0.80**	**95**	**68**	**70**	**56**	**138**	**62**	**12**	**6420**	**4844**		**4844**					78			
RONI	11	0227	SS R NK T SH RT	SO	3	100	0.11	19	11	4	18	15	13	3	1300	530		530	1200		30%		Per Min Output		Akram	Kumar
	12	118616	SS POLO	TT	3	50	0.24	21	14	18	16	32	10		500	200		200	1200		15%					
	13	118222	SS R LADIS NK T SHIRT	TT	5	70	0.13	15	15	10	13	25	10		700	500		500	1000		26%	30%	0.9			
	14	118582	SS R NK T SHIRT	TT	4	140	0.09	11	11	4	5	15	10		1400	800		800	1000		48%					
	15	118745	SS R NK T SHIRT	TT	3	140	0.11	13	11	6	12	17	10		1400	700		700	1200		45%		Hourly Output			
			TOTAL				**0.68**	**79**	**62**	**42**	**64**	**104**	**53**	**3**	**5300**	**2730**		**2730**					52			
RONI	16	326200	TANK TOP	HM	4	170	0.08	15	12	5	5	17	10		1700	1668		1668	1000		78%		Per Min Output		Akram	Jahangir
	17	0227	SS R NK T SHIRT	SO	3	110	0.11	19	13	12	18	25	10		1100	700		700	700		31%			LINE-16 NK RIB PROB.LINE - 20CARE LBL PROB. LINE 19 NEW ORDER.		
	18	7842	BOLERO	SO	12	70	0.19	23	15	18	17	33	10		700	550		550	500		32%		1.3			
	19	1439 303810	TANK TOP SS R NK TS	SO HM	2	120	0.08	10	10	12	10	22	10		1200	863		863	1000		31%	35%	Hourly Output			
	20	2327	SS R NK T SHIRT	SO	9	120	0.13	19	12	11	12	23	10		1200	250		250	800		14%					
			TOTAL				**0.59**	**86**	**62**	**58**	**62**	**120**	**50**		**5900**	**4031**		**4031**					80.62			
WALIULLAH	21	84069	LS HENLY	GS	2	22	0.17	22	10	10	14	20	13	3	286	173		173	1000		11%		Per Min Output		Sayed	Amdad
	22	84112	SS V NK T SHIRT	GS	7	113	0.17	19	16	14	15	30	10		1130	750		750			43%			LINE 21, 24 NEW ORDER. LINE 22,23, 25 INPUT PROB.		
	23	84112	SS V NK T SHIRT	GS	5	96	0.17	19	19	18	15	37	10		960	620		620	1500		28%	23%	0.6			
	24	303810	MARISHA TOP	HM	1	41	0.16	24	15	12	10	27	10		410	103		103	1000		6%		Hourly Output			
	25	303810	SS R NK T SHIRT	HM	12	141	0.07	12	10	3	3	13	10		1410	416		416	800		22%					
			TOTAL				**0.74**	**96**	**70**	**57**	**57**	**127**	**53**	**3**	**4196**	**2062**		**2062**					39			

Courtesy By Industrial Engineering Dept

IE	LINE	ORDER NO	STYLE NAME	BUYER	PRDN DAY	Hourly Target	B.Down SAH	B.DOWN OP.	PRESENT OP.	PRESENT HELPER	B.DOWN HELPER	TOTAL WORKER	WORK HOUR	OT (HR)	TOTAL TARGET	TARGET ACVD (7-6)	OT PRDN	TOTAL PRDN	WIP OR	CRNT NEXT OR	LINE EFFI	FLOOR EFFI		REMARKS	APM	APM TR
RUSTAM	26	3354	SS R-NK	SO	11	95	0.15	21	20	16	11	36	10		950	438		438	200		18%					
	27/A	787243	LACE TANK TOP	HM	9	280	0.06	13	13	8	8	21	10		2800	2723		2723	800		78%		Per Min Output			
	27/B	8301-31-806	SS R NK T SHIRT	CA	44	170	0.08	13	13	3	3	16	10		1700	1365		1365	1000		68%					
	28	TW-32	SS POLO	TS	7	110	0.22	23	18	22	22	40	13		1430	1054		1054	400		45%					
	29/A	787242	LACE TANK TOP	HM	9	270	0.06	10	13	5	3	18	10		2700	2080		2080	1000		69%				Sagor	
	29/B	539861	SS R NK T SHIRT	HM	9	200	0.10	16	14	8	12	22	10		2000	1838		1838	200		84%	58%				
	30/A	787062	SS R NK T SHIRT	HM	46	220	0.09	14	14	8	12	22	10		2200	1961		1961	800		80%					
	30/B	539851	LEONORA	HM	8	200	0.10	14	14	8	10	22	10		2000	1484		1484	800		67%		Hourly Output			
	31/A	331543	MARISHA TOP	HM	5	130	0.16	24	22	16	10	38	10		1300	1027		1027	800		43%					
																							150			
			TOTAL				1.02	148	141	94	91	235	93		17080	13970		13970								
ANKUR	32	539872	LS R NK T SHIRT	HM	3	140	0.11	16	14	15	12	29	10		1400	248		248	500		9%		Per Min Output			
	33	326200 845620	TANK TOP MARISHA	HM	4	232	0.08	15	12	14	9	26	10		2320	900		900	800		28%					
	34	331543	LS R NK T SHIRT	HM	1	140	0.16	24	16	12	10	28	10		1400	30		30	1538		2%	19%	0.9	ALL LINE NEW ORDER.	Badal	Akhter
	35	787041 8301-31-806-002	SS R NK T SHIRT	HM CA	4 1	150	0.11	16	12	16	12	28	10		1500	750		750	1000		29%		Hourly Output			
	36	787041 787243	TANK TOP LACE TANK TOP	HM	3,1	120	0.08	13	14	3	3	17	10		1200	750		750	2000		35%					
TOTAL							0.54	84	68	60	12	128	50		7820	2678		2678					54			
RIPON	37/A	787242	LACE TANK TOP	HM	62	233	0.06	13	12	8	8	20	10		2330	1846		1846	1000		55%					
	37/B	295,590	LACE TANK TOP	HM	55	233	0.06	13	12	8	8	20	10		2330	1567		1567	1100		47%		Per Min Output			
	38/A	437230	TANK TOP	HM	26	225	0.06	12	12	3	3	15	10		2250	2001		2001	700		80%					
	38/B	787,243	LACE TANK TOP	HM	9	210	0.06	10	11	3	3	14	10		2100	1752		1752	1000		75%					
	39/A	303810	SS R NK T SHIRT	HM	14	236	0.08	13	12	9	9	21	10		2360	1063		1063	600		40%					
	39/B	331543	MARSIA TOP	HM	3	100	0.16	24	16	11	10	27	10		1000	658		658			39%	52%	2.2	LINE 39A,B & 40A INPUT PROB.	Khurshid	Anjan
	40/A	326200	TANK TOP	HM	34	210	0.08	15	11	10	9	21	10		2100	722		722	500		28%					
	40/B	813490	TANK TOP BODY	HM	8	220	0.11	17	14	10	10	24	10		2200	1805		1805	400		83%		Hourly Output			
	41/A	117759	TANK TOP	JC STORE	5	150	0.07	11	12	9	9	21	10		1500	350		350	700		12%					
	41/B	813490	TANK TOP BODY	HM	5	210	.11	17	14	9	10	23	10		2100	1575		1575	600		75%					
	42	119970	SS R NK T SHIRT	JC STORE	2	120	.11	15	12	8	13	20	10		1200	870		870	500		48%		129			
							0.74	160	138	88	92	226	110		21470	14209		14209								
SUMI	43	813490	TANK TOP BODY	HM	1	60	0.11	13	12	4	3	16	10		600	450		450	3000		31%		Per Min Output			
	44	787243	LACE TANK TOP	HM	4	220	0.06	13	11	11	8	22	10		2200	1602		1602	400		44%					
	45	2067733	SS R NK T SHIRT	AHL	1	100	0.08	12	10	11	9	21	10		1000	226		226	1400		9%	23%	1.1	LINE 43,45,47 NEW ORDER.	Rabiul	Baten
	46	TW-30	SS V NK POLO	TS	1	80	0.22	23	22	20	22	42	13	3	1040	700		700	400		28%		Hourly Output			
	47	813490	TANK TOP BODY	HM	1	90	0.01	17	16	12	10	28	10		900	651		651	1200		3%					
			TOTAL				0.48	78	71	58	52	129	53	3	5740	3629		3629					88			

Chapter: 05

Garments Sewing in Mass Production

5.0 Sewing section Organogram[5]:

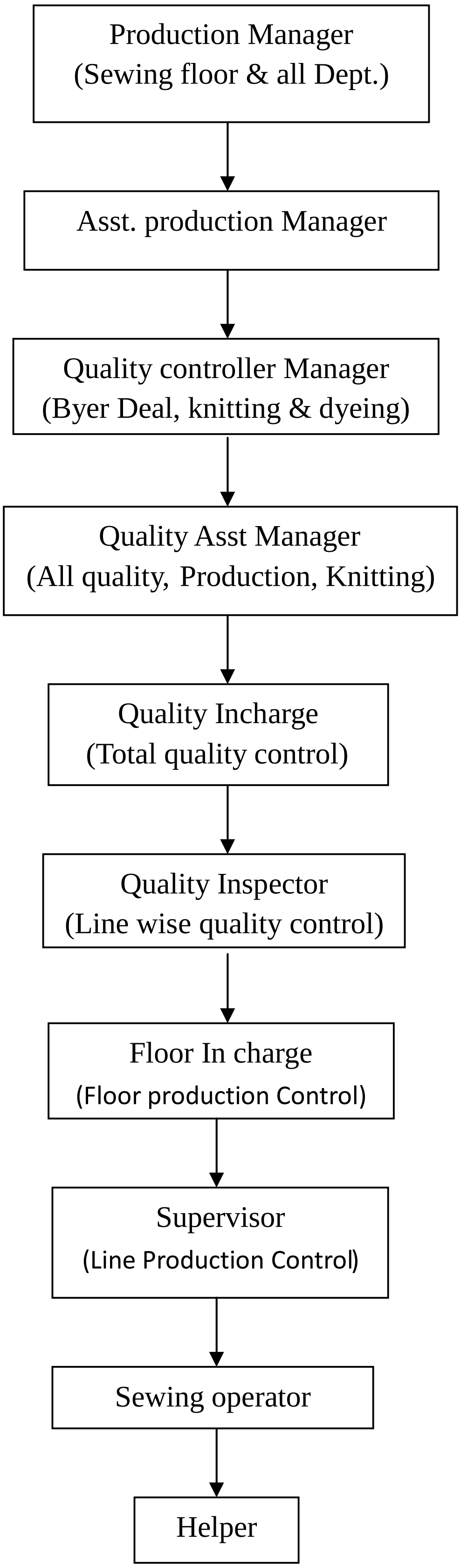


Figure 05

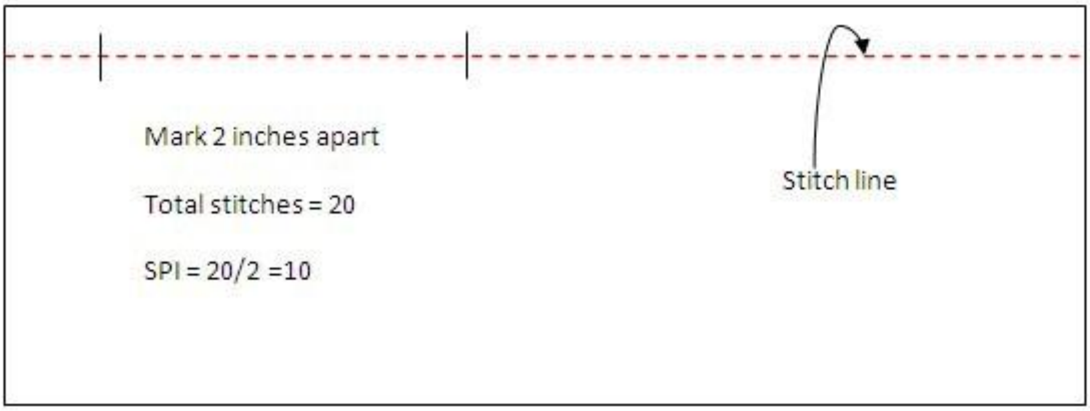
5.1 Machineries used for Garment Sewing in Mass Production [4]:

Most of the clothes we wear are sewn by sewing machines. There are several types of sewing machines used to make our clothes. When garment making was industrialized, scientists developed industrial power driven sewing machines to meet the needs of mass production. Semi-automatic and fully automatic machines were developed in different stages. Machines are classified depending of seam types, number of needle used, stitch classes, table bed etc. In the following list most of the machine those are used in garment making.

- Single/multi needle industrial lockstitch sewing machine with or without trimmer
- Blind stitch machine/Chain stitching machine.
- Flat lock machine (cylinder bed and flatbed)
- Over lock machine (3 threads/4 threads and 5 threads)
- Single/double needle chain stitch machine
- Zigzag flatbed sewing machine.
- Button stitch sewing machine.
- Button hole sewing machine
- Feed of Arm sewing machine • Label/elastic inserting machine
- Bar tacking machine.
- Hemstitch machine.
- Pin tucking machine.
- Smocking machine / Automatic multi needle shirring machine
- Collar and cuff turning and blocking machine and pressing machine
- Shoulder pad-attaching machine

5.2 Calculate or check machine SPI [3]:

The abbreviation of **SPI** is **Stitches per inch**. In the Metric System it is expressed as Stitch per centimeter (SPC). It is very easy to measure SPI of the machine or seam. To measure it, take a fabric swatch of 12 inch X 2 inch. Sew the fabric length wise in a single burst with current SPI setting. Initially use contrast thread for bobbin and needle thread. Take out the stitched fabric and lay on a flat table. Remove all creases if present on the seam line by hand. Now, take one measuring tape, place it on the stitch line on the above fabric sample and mark line 2 inches apart. See the following figure.



Now count number of total stitches in between those two lines. Divide total number of stitches by 2. The result is the SPI of that machine or seam. For SPC measurement is taken in centimeters. If your SPI requirement is less or more than the current machine SPI then rotate SPI regulator accordingly (for basic machines). After setting check SPI again in the similar method. When you get correct SPI on the sample then go ahead for production.

Example: In the above figure, the total count of the stitches is 20 (in 2 inch gap). So SPI will be 10.

5.3 Machines needed to make Basic T- Shirts [3]:

Three types of machines are generally used for making Basic Tee (Crew Neck) in mass production. Machines are Lock stitch (Single Needle), over edge (Over lock) and flat lock (Flat bed or Cylinder bed). Within the machine types there are various technology levels. A same machine is shared for multiple operations when work content is less than pitch time and machine type is same for both operations.

In the following table a machine requirement plan or layout has been shown for production of 800 Tee shirts in 8 hours shift. Machine types and machine requirement in each operation has been also given in the following table.

Figure 06 Basic T shirt

Table 05 Machine requirement plan

Seq. No.	Operations	M/c Type	No. Of Machines
1	Shoulder join	Over Lock	1
2	Neck rib Tuck	1N Lock Stitch	1
3	Neck Join	Over Lock	2
4	Label Make	1N Lock Stitch	1
5	Back Neck Binding	Flat lock/1NLS	1
6	Front Neck Top	Flat lock	1
7	Back Neck Top	1N Lock Stitch	2
8	Sleeve Hem	Flat lock	1
9	Sleeve Join	Over Lock	2
10	Side Seam	Flat lock	2
11	Sleeve tuck	1N Lock Stitch	1
12	Body Hem	Flat lock	1

Total	**16**

5.4 Calculate Machine requirement for garment to be made in an assembly line[4][1].

Follow the following steps to estimate how many machines and what types of machines you need to make your garment in an assembly line. The primary information you need to calculate number of machines are -

1. Daily production target – it means how many pieces you want to stitch per day.
2. Number of hours in a shift – How many hours you plan to work each day
3. SMV of each operation – Standard minutes for each operation
4. Present efficiency of the factory (in case you don't aware about present factory efficiency, use 50% efficiency). Efficiency is required because production will depends on how efficiently workers may do their job.

Step 1: Operation breakdown – Select a garment for which you want to calculate machine requirement. Analysis the operations required to sew the garment and list down operations in a spread sheet in a sequence. For example, see operation break down of a Crew neck Tee in following table.

Fig 07

Step 2: Identify machine type – Observe what stitch class has been used in the operations and according to those select machines against each operation.

Step 3: SMV of each operation – write down SMV or standard minutes at right column of machine type. SMV is the most important part for calculating machine requirement. You can use SAM of each operation from your database. If you don't have database for standard minutes then calculate.

Step 4: Calculate Theoretical machine requirement – Set your production target for the day (8 hours shift). Example- 400 pieces per line. Use present efficiency level of the factory. And now, calculate machine requirement using the following formula. It is called as calculated machine number. Because formula gives you fraction of machine but in real you can't able to use fraction of machine.

= (Target quantity in pieces* individual operation SMV)/ (8 hrs.*60 minutes*desired efficiency)

= (A*C)/ (B*60*D)

Step 5: Physical machine requirement – Now simply round off the machine number. Or you can club operations those use similar machine class. To do operation "Serge margin" half machine is required and the operation "sew side seam with label" required 1.4 machines. So can use first 4TOL machine to do the second job. Hence you can reduce the machine number and increase machine utilization.

Example: Operation bulletin for Tee Shirt (Crew Neck) [5]

Production target/day (8 hours) =400 pieces		Shift hours = 8 hours or 480 minutes		Plan on Efficiency =50%	
Opr. No.	**Description**	**Machine Type**	**SMV**	**No. of Calculated M/c**	**Roundoff Machine No.**
1	Make Neck Rib & Run stitch	SNLS	0.55	0.9	1
2	Join shoulders	4TOL	0.45	0.8	1
3	Insert Neck Rib	SNLS	0.45	0.8	1
4	Serge Margin	4TOL	0.31	0.5	1
5	Top stitch on Neck rib	3TFL	0.34	0.6	1
6	Attach Sleeve	4TOL	0.78	1.3	1
7	sew side seam with labels	4TOL	0.84	1.4	1
8	Hem sleeves	3TFL	0.68	1.1	1
9	Bottom Hem	3TFL	0.56	0.9	1
	TOTAL		**4.96**	**8.27**	**9**

Table 06 Operation bulletin for Tee Shirt (Crew Neck)

Machine requirement Summary:

Single Needle Lock Stitch (SNLS): 2 No.

Four thread Over lock machine (4TOL): 4 No.

Three thread Flat lock machine (3TFL): 3 No.

5. 5 Sewing Process Flow Chart for Crew neck T-Shirt [4]:

It is always easier to understand a picture than just description. How to make a T-shirt can be explained many times but students learnt it completely when they see it in the production floor. A process flow chart gives them the logic how operations follow sequence one after another.

A sewing process flow chart has been depicted in the following figure to guide learners how a T shirt is being made in a bulk production system. It is assumed that T shirt has neck tape (self-bias tape). The process flow is also showing the sequence of operations that is generally being followed. Some factory may have a slightly varied sequence.

A crew neck T shirt has six components – Front, Back, Neck rib or Collar, Neck tape and two sleeves. In the figure, on the top four sections of the garment component have been shown. The arrows show the flow of operations and inside the red circles operation sequence number and name of the operations has been written.

Figure: Sewing Process flow for T-Shirt:

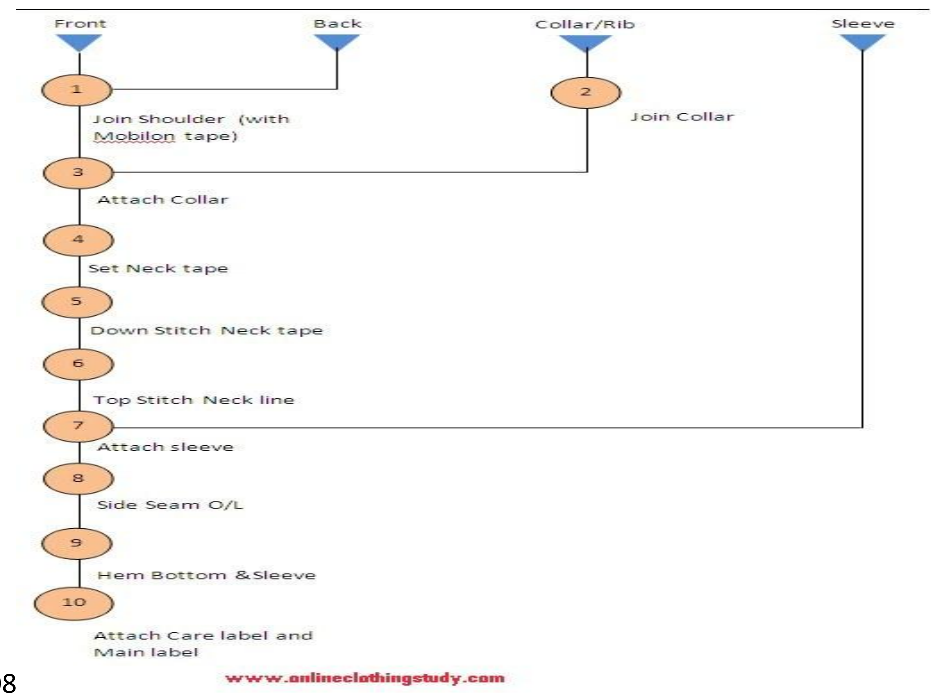


Fig:08

Chapter: 06

Garments Production and Efficiency Calculation

6.0 Estimation Of garment production [5]:

If one of the visitors asked this question that how to estimate production of a style from the line.

It is a very important question, because it is the basic knowledge about production management and each people who are working in production must know how estimated production is calculated.

Following article will clarify you the calculation procedure:

Production means total number of garment pieces produced by operators in a line/batch at a given time (for example: 8 hours day time). Production is also termed as daily output. To estimate production following information is necessary.

1. Standard allowed minutes (SAM) of the garment. It means how much time is required to make one complete garment including allowances.
2. How many operators are working in the line?
3. How many hours line will work in a day?
4. Average Line efficiency level?
5. Total break time for lunch and tea.

6.1 Formula for production estimation [5]:

Daily production = Total man minutes available in a day/SAM * Average Line efficiency
Total available man-minutes =Total no. of operators X Working hours in a day X 60

Suppose, SAM of the garment is 20 minutes, 30 operators line, works 8 hours shift day. Line works at average 50% efficiency. Operators get total 45 minutes for lunch and tea break.

So, Total available man minutes = 30 X (8 X 60 – 45) = 13050 minutes

Daily estimated production = 13050 /20 * 50% = 326 pieces
You can expect above output from that line if everything is gone well. You can see the production of a line is directly proportional to the line efficiency; no. of operators and working hours. And production is reverse proportional to the garment SAM. If efficiency of a line increases you can expect higher production. Similarly if SAM of style reduces at that also you can expect higher output.

Factors that hamper production:

Any one of the following can reduce production of assembly line. So to get estimated output, you have to take on the following areas.

1. Machine break down
2. Imbalance line (WIP control)
3. Continuous feeding to the line
4. Quality problems
5. Individual operator performance level.
6. Operator absenteeism.

6.2 Calculate SAM Or SMV Of a Garment [1]:

SAM or Standard Allowed Minute is used to measure task or work content of a garment. This term is widely used by industrial engineers and production people in the garment manufacturing industry. For the estimation of cost of making a garment SAM value plays a very important role. In past scientists and apparel technicians did research on how much time to be allowed to do a job when one follows standard method during doing the job. According to the research study minute value has been defined for each movement needed to accomplish a job. Synthetic data is available for each movements. General Sewing Data (GSD) has defined set of codes for motion data for SAM calculation. There is also other methods through which one can calculate SAM of a garment without using synthetic data or GSD.

Both method has been explained in the following.

Method 1- Using synthetic Data:

In this method 'predetermined time standard' (PTS) code are used to establish 'Standard Time' of a garment or other sewing products.

Step 1: Select one operation for which you want to calculate SAM.

Step 2: Study the motions of that operation. Stand by side of an operator (experienced one) and see the operator how he is doing it. Note all movement used by the operator in doing one complete cycle of work. See carefully again and recheck your note if all movement/motion are captured and correct. (for example motions are like - pick up parts one hand or two hand, align part on table or machine foot, realign plies, etc.)

Step 3: List down all motion sequentially. Refer the synthetic data for TMU (Time measuring unit) values. For synthetic data you can refer GSD (without license use of GSD code prohibited but for personal use and study one can refer GSD code and TMU values) or Sewing Performance Data table (SPD). Now you got TMU value for one operation (for example say it is 400 TMU). Convert total TMU into minutes (1 TMU=0.0006 minute). This is called as Basic Time in minutes. In this example it is 0.24 minutes.

Step 4: Standard allowed minutes (SAM) = (Basic minute + Bundle allowances + machine and personal allowances). Add bundle allowances (10%) and machine and personal allowances (20%) to basic time. Now you got Standard Minute value (SMV) or SAM. SAM= (0.24+0.024+0.048) = 0.31 minutes.

Method 2 - Through Time Study:

Step 1: Select one operation for which you want to calculate SAM.

Step 2: Take one stop watch. Stand by side of the operator. Capture cycle time for that operation. (cycle time – total time taken to do all works needed to complete one operation, i.e. time from pick up part of first piece to next pick up of the next piece). Do time study for consecutive five cycles. Discard if found abnormal time in any cycle. Calculate average of the 5 cycles. Time you got from time study is called cycle time. To convert this cycle time into basic time you have to multiply cycle time with operator performance rating. [Basic Time = Cycle Time X performance Rating]

Step 3: Performance rating. Now you have to rate the operator at what performance level he was doing the job seeing his movement and work speed. Suppose that operator performance rating is 80%. Suppose cycle time is 0.60 minutes. Basic time = (0.60 X 80%) = 0.48 minutes
Step 4: Standard allowed minutes (SAM) = (Basic minute + Bundle allowances + machine and personal allowances). Add bundle allowances (10%) and machine and personal allowances (20%) to basic time. Now you got Standard Minute value (SMV) or SAM. SAM= (0.48+0.048+0.096) = 0.624 minutes.

6.3 Standard Minutes (SAM or SMV) for Few Basic Garment Products [5]:

Can anybody estimate SAM (standard allowed minute) of a garment without seeing and/or analyzing the garment? No. It is not possible. To estimate SAM you have to analyze the garment carefully and check different factors that affect the SAM. SAM of a product varies according to the work content or simply according to number of operations, length of seams, fabric types, stitching accuracy needed, sewing technology to be used etc.

But still many of us inquire for approximate SAM values for basic products, like Tee Shirt, Formal shirt, Formal trouser or jacket. An estimated SAM helps in capacity planning of the factory, calculating requirement of machineries and even helps to estimate CM (cut and make) costing of a garment.

Standard minutes (SAM) of few basic products have been listed down with its SAM range according to work content variation. In actual cases garment SAM may go outside of the limit depending the above factors. This list will be updated time to time adding more products.

Table 07 SAM of few basic products

	Product	**SAM** (Average**)**	**SAM Range**
1	Crew neck T-Shirt	8	6 to 12
2	Polo Shirt	15	10 to 20
3	Formal Full sleeve shirt	21	17 to 25
4	Formal trouser	35	

5	Sweat Shirt (Hooded)	45	35 to 55
6	Jacket(Suit)	101	70 to 135
7	Women blouse	18	15 to 45
8	Bra	18	16 to 30

6.4 Calculate efficiency of a production batch or line [5]:

Like individual operator efficiency, efficiency of a production line or batch or section is important for a factory. Daily line efficiency shows the line performance. To calculate efficiency of a line for a day, you will need following data (information) from the line supervisor or line recorder.

1. Number of operators – how many operators worked in the line in a day

2. Working hours (Regular and overtime hours) – how many hours each of the operators worked or how many hours the line run in a day

3. Production in pieces – How many pieces are produced or total line output at the end of the day

4. Garment SAM – What is exact standard minute of the style (garment)

Once you have above data you have to calculate following using above information -

1. Total minutes produced by the line: To get total produced minutes multiply production pieces by SAM

2. Total minutes attended by the all operators in the line: Multiply number of operators by daily working hours.

Now, calculate line efficiency using following formula:

Line efficiency = Total minutes produced by the line/total minutes attended by all operators For example, refer following table. Data calculation formula has been given on the header row of the table.

No. of Operator (A)	Working hours (B)	line output (production) (C)	Garment SAM (D)	Total minutes attended (E=A*B)	Total Minute produced (F=C*D)	Line Efficiency (%) (F/E*100)
48	8	160	44.25	23040	7080	30.73
48	11	240	44.25	31680	10620	33.52
34	8	300	25	16320	7500	45.96
35	11	400	25	23100	10000	43.29
35	11	329	25	23100	8225	35.61
34	8	230	25	16320	5750	35.23
34	8	200	35	16320	7000	42.89
35	11	311	35	23100	10885	47.12
34	11	340	35	22440	11900	53.03

Table 08 line efficiency

6.5 Standard efficiency and overall efficiency [1]:

Efficiency of a line or an individual operator is calculated by using following formula.

Efficiency (%) = Total minutes produced / Total minutes attended at work*100

The above formula gives us overall efficiency of the operator or a line.

Operators, who work in the line whole day attend 480 minutes (shift hours), but they do not always sew garments. Lot of time, operators wait for work due to external reasons or they do off-standard jobs (operations) in the 480 minutes duration. Reasons are like waiting for work, machine break down, power failure, line setting, meeting, non-availability of trims and accessories. All these off-standards reduce operator’s real performance (efficiency level).

When operators are not working on-standard jobs they are simply not producing any garments or any minutes. That is why to know operator’s actual performance on the on standard jobs; operator’s efficiency is presented as on-standard efficiency.

Formula for calculating on-standard is same but attended time. In case of overall efficiency calculation total produced minutes is divided by total attended minutes at work. But for the on-standard efficiency calculation total produced minutes is divided by total attended minutes at on-standard jobs. Refer to the following formula.

On-standard Efficiency (%) = Total minutes produced / Total minutes attended for on standard jobs*100

6.6 The Concept of Operator's Performance Rating [1]:

6.6.1 Definition of Performance Rating:

Rating is a subjective comparison of any condition or activity to a benchmark, based upon our experience. While the mechanics of time study record the time a task did take, applying a rating will determine the time a task should take.

6.6.2 100% performance or Normal Performance

The concept of 100% performance is a critical element of time study and performance measures. Normal performance is the rate of output which qualified workers will achieves without over-exertion over the working day sifts provided they know and adhere to the specified method and provided they are motivated to apply themselves to the work. This performance is denoted as 100% on standard rating and performance scales.

A slower is performance rate, which will produce fewer pieces per hour, is recorded as a percentage below 100%. A faster performance rate that produces more pieces per hour is recorded as greater than 100%.

6.6.3 Characteristic of 100% Performance or Normal operator

- Fluid motions without hesitation
- No false starts or duplications
- Consistent, coordinated, effective rhythm
- No wasted actions or work
- Attention centered on the task

6.6.4 Accurate rating

To improve accuracy in rating an operator, observer must -

- Has knowledge of the operation and the specified method or standard operating procedures for that task.
- Concentrates on operator motions
- Is alert to fumbles, hesitations, and other lost motions- these are seldom or absent in 100% performance.
- Eliminates or ignores interruption or events not in the operator's control.
- Avoids a corrupting bias when observing fast and slow operators in succession
- Knows that increasing the number of cycles observed increases accuracy.

6.7 Calculate Operator Worker efficiency [5]:

In apparel manufacturing, skills and expertise of a sewing operator is being presented in "Efficiency" term. An operator with higher efficiency produces more garments than an operator with lower efficiency in the same time frame. When operators work with higher efficiency, manufacturing cost of the factory goes down.

Secondly, factory capacity is estimated according to the operator efficiency or line efficiency. Hence, efficiency is one of the mostly used performance measuring tools. So how do you calculate operator efficiency in factory? To calculate operator efficiency you will be needed standard minutes (SAM) of the garment and operations your operator is making. Use following formula and calculate operator efficiency.

6.7.1 Efficiency calculation formula:

Efficiency (%) = [Total minute produced by an operator/Total minute attended by him *100]

Where,

Total minutes produced = Total pieces made by an operator X SAM of the operation [minutes]

Total minutes attended = Total hours worked on the machine X 60 [minutes]

Example: An operator was doing an operation of SAM 0.50 minutes. In an 8 hours shift day he produces 400 pieces. So according to the efficiency calculating formula, that operator's overall efficiency

= (400 x 0.50) / (8 X 60)*100%

= 200/480*100%

= 41.67%

6.7.2 On-Standard Operator Efficiency:

Operator efficiency can be expressed in more specific ways, like 'On-Standard Efficiency' instead 'over-all efficiency'. An operator may be attending all hours in a shift but if he has not been given on-standard work to do in all hours, he will not be able to produce minutes as per his capability and skill level. In this case, to know operator’s on-standard efficiency following formula is used.

Operator on-standard efficiency (%) = Total minute produced /Total on-standard minute attended *100%

Where,
Total minutes produced = Total pieces made by an operator X SAM of the operation [minutes]

Total on-standard minute attended = (Total hours worked – Loss time) x 60 [minutes]

Example: An operator was doing an operation of SAM 0.50 minutes. In an 8 hours shift day he produces 400 pieces. Operator was idle ‘waiting for work’ for 30 minutes and his machine broke down for 15 minutes in hours shift. So according to the efficiency calculating formula, that operator’s on-standard efficiency
= (400 x 0.50) / {480 – (30 +15)}*100%
= 200/435*100%
= 45.98%
The above example clarifies that if an operator sits idle during shift hours his overall efficiency will go down.

6.8 Use of Takt Time in Apparel Industry [5] [1]:

Takt time is the allowable times to produce one product at the rate of customers’ demand. This is NOT the same as cycle time, which is the normal time to complete an operation on a product (which should be less than or equal to TAKT time).

Takt time is the calculated pace of production based on the average speed at which the customer is buying a product or service. The formula is net available time to produce per time period divided by customer demand per time period. For example when, Net available time = 4500 minutes / shift (10 operators total man-minutes)

Customer demand = 500 pieces / shift

Takt time = (4500÷500) = 9 minutes / piece

Important things to be noted that,

Takt time can't be measured with a stop watch.

Takt time is not the time it takes to perform a task.

Takt time is only reduced or increased by changes in production demand or net available time to work.

Takt is used to in Garment Production

As the definition says, it is the demand of customer or simply demand of following processes. To set a production assembly line takt time is taken as a base to determine work content to be given to each operator in the line.

Takt time is a very important tool for Lean Line or One Piece Flow Production.

For example, demand from production line is 60 pieces per hour. In one hour you had only 3600 seconds. So takt time for the line will be 60 seconds/pieces (3600 seconds/60 pieces). So, you know that your target of production. According to this target and garment work content (suppose men's full sleeve shirt) you have to determine how many operator should be taken to set the line. Let's assume SAM of the shirt is 20 minutes or 1200 seconds. In one minutes each operator has only 60 seconds. So to produce a pieces in 60 seconds, total number of operator required 1200/60 = 20 nos. (Consider that each operator works at 100% efficiency.)

You have to distribute all operations within 20 operators. All operations will have different work content. So to equalize work content each operator will get work of about 60 seconds work content. For this, few operators will do multiple operations with low work content.

Chapter: 07

Thread Consumption

7.0 Calculate thread consumption for garments [3]:

There is a standard formula for determining thread consumption. In the formula you will get multiplying factors according to machine type and stitching classes. To define thread consumption you just have to multiply seam length with factors. Thus, one can estimate total requirement of thread for making a garments. But actual thread consumption for a unit length of seam depends on many factors. Likes-

1. Stitch Classes
2. Stitches per inches (SPI)
3. Thickness of the seam (fabric thickness)
4. Thread tension
5. Thread count (thickness of sewing thread)

So I will advise you to calculate garment thread consumption by your own. You can develop multiplying factor according to your product categories and requirement using following simple steps.

Step 1: To calculate thread ratio, you need sewing machine, fabric and sewing thread that will be used for bulk production. For fabric and thread you can take similar thickness and same thread count in case actual is not available.

Step 2: Sew a seam of 12 cms long and take 10 cms seam out of it by trimming 1 cm from both edges.

Step 3: Unravel both needle thread and bobbin thread from the seam. Remove crimp from the unraveled thread and measure its length in cm. Generally it will be higher than the seam length. Now find the multiplying factor by dividing thread length with seam length. Assume unraveled needle thread length is 12.5 cm then needle thread multiplying factor is 12.5/10 or

1.25.

Using this method you can find out any types of machines' thread consumption factors.

Step 4: Once you have consumption factors then it is easy to calculate total thread consumption. Measure seam length of all operations of the garment and get thread requirement by multiplying thread consumption factor. Add thread wastage 5% for the thread that trim out from each ends of seam.

For quick reference you can follow the following thread consumption ratios. Source: Coats thread consumption guide.

Thread Consumption Ratios

Stitch Class	Description	Total Thread Usage (cms per cm of seam)	No. of Needles	Percentage of Needle Threads	Percentage of Looper / Under (incl. cover) Threads
301	Lockstitch	2.5	1	50	50
101	Chainstitch	4.0	1	100	0
401	2-Thread Chainstitch	5.5	1	25	75
304	Zig-Zag Lockstitch	7.0	1	50	50
503	2-Thread Overedge stitch	12.0	1	55	45
504	3-Thread Overedge stitch	14.0	1	20	80
512	4-Thread Mock-safety stitch	18.0	2	25	75
516	5-Thread Safety stitch	20.0	2	20	80
406	3-Thread Covering stitch	18.0	2	30	70
602	4-Thread Covering stitch	25.0	2	20	80
605	5-Thread Covering stitch	28.0	3	30	70

Note: The above ratios are arrived at with a stitch density of 7 stitches per cm (18 stitches per inch). Changes in stitch density will change the ratios marginally

Table 09 Thread consumption

If you want to refer readymade thread consumption factors then go to the following links. Coats thread consumption bulletin or American & Efird Inc., thread consumption.

Chapter: 08

Productivity

8.0 Productivity [1]:

The definition of **Productivity** is given as “OUTPUT” compared to “INPUT”.

According to Marsh, Brush (2002) in his article Journal of industrial technology, productivity is a measure of the efficiency and effectiveness to which organizational resources (inputs) are utilized for the creation of products and/or services (outputs). Productivity measurement is both a measure of input utilization and an assessment as to whether or not input utilization is growing faster than output.

In the case of a garment manufacturing factory, “output” can be taken as the number of products manufactured, whilst “input” is the people, machinery and factory resources required to create those products within a given time frame. The key to cost effective improvements in output – in “productivity” – is to ensure that the relationship between input and output is properly balanced. For example, there is little to be gained from an increase in output if it comes only as a result of a major increase in input. Indeed, in an ideal situation, “input” should be controlled and minimized whilst “output” is maximized.

Higher productivity provides more products from the same number of people, in the same time frame. This in turn improves “overhead recovery” related to factory costs, such as electricity and fuel, because overheads are fixed within that time frame. So, the more products produced in a given time frame the less overhead allocation per product, which, in turn, reduces the cost of each individual item and therefore improves competitive edge.

Dr. Bheda in his book "Managing Productivity in the Apparel Industry" explained the different ways of measuring productivity. Productivity can be expressed in many ways but mostly productivity is measured as lab our productivity, machine productivity or value productivity. These three term can be defined as-

- Lab our productivity - Output per labour (direct +indirect) in a given time frame (in pieces)
- Machine productivity - Output per machine in a given time frame (in pieces)
- Value productivity - Total value of output in a given time frame.

8.1 Measure Of labor productivity [5]:

Definition:

Most simply, productivity is the ratio between output and inputs.

Within a factory, industrial engineers or factory managers and line supervisors measure the number of garments produced by a line of sewing machine operators in a specific time frame. Generally factory works 10 to 12 hours a day. Total production (output pieces) of a line and total labor involved in producing those pieces is required to calculate labor productivity. See following example,

Assume that

Total production in day =1200 pieces

Total labor (operator +helpers) = 37

Working time = 600 minutes (10 hours)

So, Labor productivity per 10 hours is =Total pieces produced/ total labor input = (1200/37) Pieces =32.4 pieces.

Another productivity measure is labor efficiency, which is a comparison of the time spent working productively to the total time spent at work. These metrics are appropriate for analyzing and comparing the productivity of a particular production line or factory that turns out specific apparel products. However, comparing productivity levels across products or operating lines can be difficult because the benchmarks

Differ from one garment to another. Calculation of labor efficiency is shown below. Consider above data.

SAM (Standard allowed minutes) of the garment = 8.9

Minutes produced by each labor = (32.4 pieces X 8.9) = 288 minutes

Available minutes was 600

So, Labor efficiency = (Produced minutes/available minutes) = (288/600*100)% = 48%

To compare productivity estimates across products, factories, or even industries, economists define labor productivity as the production value added that each worker generates. In this case, labor productivity equals the value of production divided by labor input. The value of production is generally measured as value added, equal to the gross value of sales minus the value of purchased inputs such as fabric, trim, and energy. Labor input is measured by total work hours. Labor productivity can thus be estimated at the national, aggregate level and for specific industries in an economy.

Chapter: 09

Conclusion

Industrial engineering is an important and essential part of any apparel industry. We learn all the implementations of the processes which we have studied theoretically. It gives us an opportunity to compare the theoretical knowledge with practical facts and thus develop our knowledge and skills. This project also gives us an opportunity to enlarge our knowledge of textile administration, production planning, procurement system, production process, and machineries and teach us to adjust with the industrial life.

References

1. MARTAND TELSANG "Industrial Engineering and Production Management".
2. www.**fakirapparels**.com
3. M.A. Kashem "Garments & Technology"
4. www.onlineclothingstudy.com
5. Most of the information is collected from Fakir Apparels Ltd.