Process Improvement in Sewing Section of a Garments Factory – A Case Study

MD. ALAUDDIN

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

DHAKA – 1000, BANGLADESH

MARCH, 2018

Process Improvement in Sewing Section of a Garments Factory – A Case Study

BY

MD. ALAUDDIN

A Thesis is Submitted to the

Department of Industrial and Production Engineering

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

In Partial Fulfillment of the Requirement for the Degree of

MASTER OF ENGINEERING IN INDUSTRIAL AND PRODUCTION ENGINEERING

March, 2018

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

DHAKA – 1000, BANGLADESH

CERTIFICATE OF APPROVAL

The thesis titled "**Process Improvement in Sewing Section of a Garments Factory – A Case Study**" submitted by Md. Alauddin, Student No.: 0412082012P, Session – April, 2012 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Master of Engineering in Industrial and Production Engineering on 13 March, 2018.

BOARD OF EXAMINERS

Dr. Sultana Parveen — **Chairman (Supervisor)**
Professor
Department of Industrial and Production Engineering (IPE)
Bangladesh University of Engineering and Technology, Dhaka

Dr. Syed Mithun Ali — **Member**
Associate Professor
Department of Industrial and Production Engineering (IPE)
Bangladesh University of Engineering and Technology, Dhaka

Dr. Shuva Ghosh — **Member**
Assistant Professor
Department of Industrial and Production Engineering (IPE)
Bangladesh University of Engineering and Technology, Dhaka

CANDIDATE'S DECLARATION

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

Md. Alauddin

Date: 13th March, 2018

To the Almighty

To my Family

ACKNOWLEDGEMENT

First of all, I am grateful to the almighty Allah, the beneficial, the merciful for granting me to bring this research work into light.

I would like to express my gratitude towards my thesis supervisor, Dr. Sultana Parveen, Professor, Department of Industrial and Production Engineering (IPE), Bangladesh University of Engineering and Technology (BUET), Dhaka, for the continuous support and guidance throughout the process of this dissertation research, for her patience, encouragement and valuable advice. I would like to express my sincere gratitude to Dr. Syed Mithun Ali, Associate Professor, Department of IPE, BUET, Dr. Shuva Ghosh, Assistant Professor, Department of IPE, BUET for their constructive remarks and for kindly evaluating this research.

I would also like to thank the employees of East West Industrial Park Limited, Gazipur for providing necessary support and data for the analysis part of this research.

Also, I would like to thank my parents who provided their continuous inspiration, support and encouraged me to complete the research work successfully.

Finally, I would like to express my thanks to all the people who have been in one way or another involved in the preparation of this thesis.

ABSTRACT

This case study represents the use of some tools and techniques for improving sewing section efficiency, productivity, defects per hundred units (DHU), overall labor effectiveness, overall equipment effectiveness throughout the production process. Now a day's garments manufacturing companies are trying to develop their current production system and situation and continuously looking for new production tools and techniques in order to keep swiftness with the rapid changes of trend in consumers of apparel products. To deal with the recent problems & challenges industries have to improve production efficiency & productivity; ensuring proper quality requirements. There is no doubt that sewing section in an apparel industry is the most momentous and teeming department that plays a vital role in the whole firm. To improve the existing situation of this section and increasing productivity training program and sewing section line balancing based on worker capacity are very effective technique. To enhance operational efficiency, the organization set the training program and provide the training to employees means top to floor management and workers, where the training topics are selected quality policy, department wise goal & designation wise job responsibility, which can increase their efficiency and productivity in completing their daily work tasks. In capacity study, Standard Minute Value (SMV) has been calculated for each operation or job. Based on this technique each operator capacity is measured and balanced to eliminate the bottlenecks. Here, by applying these techniques significant improvements in the sewing section have been achieved such as SMV, man power, bottleneck, production/hour, line efficiency, DHU, OLE and OEE. The findings can be extended to similar garments factory in the future.

TABLE OF CONTENTS

ABSTRACT vii

LIST OF THE TABLES x

LIST OF FIGURES xi

LIST OF APPENDIX xii

CHAPTER 1: INTRODUCTION……....01

1.1 Introduction ……....01

1.2 Project Background and Present State of the Problem ……...01

1.3 Objective with Specific Aim & Possible outcome ……02

CHAPTER 2: LITERATURE REVIEW……...…03

2.1 Introduction ……03

2.2 Literature Review ……...……03

2.2.1 Line layout ……..……03

2.2.2 Progressive bundle system ……..……04

2.2.3 Efficiency ……...05

2.2.4 Defect per hundred units ……....06

2.2.5 Overall labor effectiveness ……..……06

2.2.6 Overall equipment effectiveness ……...06

CHAPTER 3: METHODOLOGY ……..……07

3.1 Introduction ……07

3.2 Outline of Methodology……..07

3.3 Organization Overview & Product Choosing.……...……..08

3.4 Data Collection ……...……11

3.5 Implementation Plan ……....……11

CHAPTER 4: DATA ANALYSIS & RESULT ……....……13

4.1 Introduction ……13

4.2 Training Program ……..……..…13

4.2.1 Training summary ……..…16

4.3 Calculation ……..……16

4.4 Reduction of SMV, Manpower, Productivity & Line Efficiency……..…32
4.5 Month wise Organization Efficiency & DHU ……....33
4.6 Ranking of Different Non-productive Time ……..…..36
4.7 Month wise Organization OLE ……..……38
4.8 Month wise Organization OEE ……...……..….38

CHAPTER 5: CONCLUSION ……40
5.1 Conclusion ……..…40
5.2 Further work ……..……40

REFERENCE ……....……41

LIST OF TABLES

Table No.	Title	Page No.
4.1	Example (1) of Training content	14
4.2	Example (2) of Training content	15
4.3	Month wise training summary with respective department (Year: 2016)	16.
4.4	Time study chart before worker capacity balancing	16
4.5	Machine summary of existing layout of sewing section	24
4.6	Time study chart after worker capacity balancing	24
4.7	Comparison of smv, manpower before & after balancing the sewing line	33
4.8	Average working hour, average smv, average manpower & total production of sewing section (Year: November, 2015)	34
4.9	Defect per hundred units (DHU) of sewing section (Year: Nov, 2015)	35
4.10	Average working hour, average smv, average manpower & total production of sewing section (Year: July, 2016)	35
4.11	Defect per hundred units (DHU) of sewing section (Year: July, 2016)	36
4.12	Average working hour, average smv, average manpower & total production of sewing section (Year: December, 2016)	37
4.13	Defect per hundred units (DHU) of sewing section (Year: Dec, 2016)	38
4.14	Month wise efficiency & DHU of sewing section (Year: 2015, 2016)	38
4.15	Ranking based on NPT (%) of contribution (Year: November, 2015)	39
4.16	Ranking based on NPT (%) of contribution (Year: July, 2016)	40
4.17	Ranking based on NPT (%) of contribution (Year: December, 2016)	41
4.18	Different month wise OLE of sewing section	41
4.19	Month wise performance rate (%) of sewing section	42
4.20	Different month wise availability, performance, quality of sewing section (Year: 2015, 2016)	42

LIST OF FIGURES

Figure No. **Title** **Page No.**

3.1 Overall steps of the study……..9

4.1 OEE comparison of Nov – 2015, Jul – 2016, Dec – 2016……..…42

LIST OF APPENDIX

Appendix No	Title	Page No
1	Questionnaire for Employee……..……..46	

CHAPTER 1

INTRODUCTION

1.1 Introduction

Globalization and Quick access to information, products and services has brought world so closer that it is very difficult to sustain in the market without making innovations in work practices to gain competitive advantage over others. Now a day's apparel manufacturing industries are trying to develop their current production system and situation and continuously looking for new production tools and techniques in order to keep swiftness with the rapid changes of trend in consumers of apparel products. To survive in global competitive market most manufacturing companies focus their manufacturing strategies on minimizing their production costs, increasing productivity, improving product quality, resources utilization, and increasing customer satisfaction. In manufacturing industry high productivity through appropriate distribution of these resources and adequate operational procedures becomes a priority. The textile industry is important in the business sector of Bangladesh and it has to face cut throat competition in market through international brands having cheaper rate with good quality products. The problem of Bangladeshi garment industry currently facing are unskilled manpower, improper use of resources. This paper represents the use of some tools and techniques for improving apparel sewing section efficiency, OLE & OEE throughout the production process.

1.2 Background and Present State of the Problem

Garment manufacturing is a traditional industry with global competition. The most critical manufacturing process is sewing, as it generally involves a great number of operations. Measurement performance is the first step that leads to control and eventually to improve it. It is important to know where the strengths and weaknesses of an organization lie, and as part of the plan-do-check-act cycle, measurement plays a key role in process improvement activities.

For a manufacturing company to be competitive in the international market place, process planning must be logical, rational, economical and cost of products, sub-assemblies and components must be accurately estimated, in order to secure business, it's costing must also be accurate, to correctly determine the profitability of the various

product manufactured [1]. Performance measures are the life blood of organizations, since without them no decisions can be made [2]. Measurement is the first step that leads to control and eventually to improve. If you can't measure something, you can't understand it. If you can't understand it, you can't control it, you can't improve it [3]. Efficiency is the comparison of what is actually produced or performed with what can be achieved with the same consumption of resources [4]. Overall Labor Effectiveness (OLE) measures the utilization, performance, and quality of the workforce and its impact on productivity [5]. OEE is usually formulated as a function of a number of mutually exclusive components such as availability efficiency, performance efficiency, and quality efficiency in order to quantify various types of productivity losses, such as breakdown, setup and adjustment, idling and minor storage and quality defect and rework [6].

1.3 Objectives with Specific Aims and Possible Outcome

The objectives and possible outcomes of this research are to find out the followings:

a) To measure efficiency and DHU (Defects per hundreds units) of sewing section.
b) To measure overall labor effectiveness (OLE) & overall equipment effectiveness (OEE).
c) To identify root cause of production loss & non-productive time.
d) To improve process and develop the system of sewing section.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is to explore and gather all information in order to understand clearly about the sewing line efficiency, Defect per hundred units (DHU), Non-productive time, overall labor effectiveness (OLE), overall equipment effectiveness (OEE). The information's is come from reference books, journals and thesis. These sections are mainly concern about related knowledge about line balancing what are the efficiency & productivity after balance the line as well as the training program of the organization which reflect the process improvement of the sewing section. This particular area is discussed to give better understanding on what is purpose of this research.

2.2 Literature Review

Process Improvement is the proactive task of identifying, analyzing and improving upon existing business processes within an organization for optimization and to meet new quotas or standards of quality. It often involves a systematic approach which follows a specific methodology but there are different approaches to be considered. Productivity is measured by achievement toward established goals based on relationships between inputs and outputs [7]. Generally in sewing section line balancing means allotment of operations or jobs based on the objective of minimizing the throughput time as well as the work in process and thus increasing productivity. In sewing room, the breakdown of the total work content of a garment into operations has traditionally included long, medium and short operations, the actual length being influenced by the amount of work content in the garment, predicted quantity of output of an individual style, and the number employed in the organization manufacturing it, with the consequent potential for specialization among its operators and managers. In this case an operation was the amount of the work content of a garment that was undertaken by one operator [8]. An operation is one of the steps in a process that must be completed to convert materials into a finished garment. An operation breakdown is a sequential list of all the operations involved in cutting, sewing and finishing a garment, component or style [7].

2.2.1 Line layout

A line layout operates on the principle that each unit is produced exactly the same and those operations are performed in a specified sequence. Work often flows from the back of the layout to the front and from workstation to work station until the garment is completed. Line layout is most efficient with long runs (high volume of identical products) when the sequence of operations and equipment does not have to be changed frequently [9]. Depending on the volume required, a plant may have several lines making the same style or several lines each making different styles. Line layout does not necessarily mean each m/c is different. Several operators and helpers may perform the same operation. The objective is steady work flow through succeeding operations. If a style requires only one operator to hem the pockets and three operators to set pockets in order to keep work in process moving smoothly, then engineers will build that into the layout. Advantages of line layout may be less work in process than a skill center configuration and fewer handling between operations. This means faster throughput time and less buildup of parts between operations with high quality. Disadvantages of a line layout include potential bottlenecks (work buildup) and work load imbalance. Each operation depends on the previous one, and downtime, absenteeism, and slow operators may interrupt the workflow. To counteract these problems, some operators may need to cross-trained to perform more than one operation, and substitute machines must be readily available for immediate replacement if equipment breaks down. New trainees may be expected to meet production standards before being placed in a line position. Failure to meet production schedules for whatever reason may create a need to reroute work, shift personnel, or schedule to avoid further days [7, 10].

2.2.2 Progressive bundle system

The Progressive bundle system gets its name from the bundles of garment parts that are moved sequentially from operation to operation. This system often referred to as the traditional production system, has widely used by apparel manufacturers for several decades and still is used today. The technical advisory committee of AAMA (1993) reports that 80% of apparel manufacturers use bundle system. The committee also predicts that use of bundle systems would decrease as firms seeks more flexibility in their production systems. A progressive bundle system may require a high volume of work in process because of the number of units in the bundles and the large buffer of backup work that is needed to ensure a continuous workflow for all operators [7]. The

Progressive bundle system is driven by cost efficiency for individual operations. Operators perform the same operation on a continuing basis, which allows them to increase their speed and productivity. Operators who are compensated by piece rates become extremely efficient at one operation and may not be willing to learn a new operation because it reduces their efficiency and earnings. Individual operators that work in a progressive bundle system are independent of other operators and the final product [7].

Time study: At ANSI in 1982 Institute of Industrial Engineers state time study as, "A work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs." Time study is most popular and used method for line balancing and solving bottlenecks. One problem of time study is the Hawthorne Effect where it is found that employees change their behavior when they know that their being measured [11].

Cycle time: Total time taken to do all works to complete one operation, i.e. time from pick up part of first piece to next pick up of the next piece [12, 13].

SMV (Standard minute value): The amount of time required to complete a specific job or operation under existing condition, using the specified & standard method at a standard pace when there is plenty of repetitive work [14].

Standard time = (Average observed time x Rating %) + Allowance %. (2.1)

Allowance: Different types of allowances are allowed in apparel production floor. Such as personal time allowance, Delay allowances, Fatigue allowances etc.

2.2.3 Efficiency

Efficiency is the comparison of what is actually produced or performed with what can be achieved with the same consumption of resources [4].

Sewing line efficiency = Total Produce minute / Total available minute (2.2)

= (Production×SMV×100) /(number of operator × working minute) (2.3)

As for example, Efficiency has been evaluated by measuring the following times for the November, 2015 where total Produce minute = 21352252 minute and total available minute = 57711780 minutes.

By using equation (2.2), sewing line efficiency for November, 2015

= (21352252 / 57711780) *100% = 36.99%

Balance: Balance is an important factor. In traditional performance measurement approach, the most important goals of evaluation is performance measurement while modern approach has focused on evaluated growth and development capacity [15]. Peter Drucker in 1954 argued that one potential solution was to introduce ‘’balanced’’ sets of measures [16, 17]. Market standings, innovation, productivity, physical and financial resources, profitability, manager performance and development, worker performance and attitude, and public responsibility are appropriate performance criteria [18]. Modern evaluation system results in satisfaction improvement, efficiency improvement, and finally improvement in effectiveness of organizational activities [16].

Bottleneck: A constraint for smooth flow of operation, limits the flow of production rate, productivity, efficiency is usually termed as bottleneck.

Non-productive time: Time not directly associated with manufacturing operations or performance of a job or task.

2.2.4 Defect per hundred units (DHU)

It means number of defects found or detected per hundred unit of garments. This is also known as DPHU (Defects Per Hundred Units). DHU value is calculated using following formula –

Defects per hundred units = (Total defects found*100) /Total garments inspected (2.4)

As for example, DHU has been evaluated by measuring the following times for the November, 2015 where total inspected quantity = 2338615 parts and total defects found = 194393 parts.

By using equation (2.4), sewing line DHU for November, 2015

= (194393*100 / 2338615) = 8.31

2.2.5 Overall labor effectiveness (OLE)

OLE is a key performance indicator (KPI) that measures the utilization, performance, and quality of the workforce and its impact on productivity. OLE measures availability, performance, and quality.

Availability – the percentage of time employees spend making effective contributions.

= Time operators are working productively / Time scheduled (2.5)

= (Available minute – Non-productive time) / Available time (2.6)

As for example, Availability has been evaluated by measuring the following times for the November, 2015 where total available minute = 57711780 minutes and total Non-productive time = 1286321 minutes.

By using equation (2.6), sewing line availability for November, 2015

= {(57711780 – 1286321) / 57711780}*100% = 97.71 %

Performance = the amount of product delivered.

= Produce minute / (Available minute – Non-productive time) (2.7)

For example, Performance has been evaluated by measuring the following times for the November, 2015 where total produce minute = 21352252 minutes, total available minute = 57711780 minute and total Non-productive time = 1286321 minutes.

By using equation (2.7), sewing line performance for November, 2015

= {21352252 / (57711780 – 1286321)}*100% = 37.41 %

Quality – the percentage of perfect or saleable product produced.

= Total good part / Total parts produced (2.8)

For example, quality has been evaluated by measuring the following times for the November, 2015 where total parts produced = 2338615 pcs, total good parts = 2144222 pcs.

By using equation (2.8), sewing line quality for November, 2015

= (2144222 / 2338615)*100% = 91.69 %

OLE allows manufacturers to make operational decisions by giving them the ability to analyze the cumulative effect of these three workforce factors on productive output, while considering the impact of both direct and indirect labor [5].

2.2.6 Overall equipment effectiveness (OEE)

OEE quantifies how well a manufacturing unit performs relative to its designed capacity, during the periods when it is scheduled to run [6]. OEE breaks the performance of a manufacturing unit into three separate but measurable components: Availability, Performance, and Quality. Each component points to an aspect of the process that can be targeted for improvement.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology of this research work is a case study research. This case study is conducted in a selected garments company located in Gazipur, Bangladesh. The study gives an idea about the existing scenario of the sewing section of the garments company. However, this study is aimed towards the performance measurement and improvement of sewing section.

3.2. Outline of Methodology/ Experimental Design

The proposed research methodology is outlined by assessment of existing system of mentioned organization about performance measure and evaluation of current situation. Then an analysis will be carried based on the result of empirical information collected and a consolidated evaluation of mentioned theory in specific section of RMG sector.

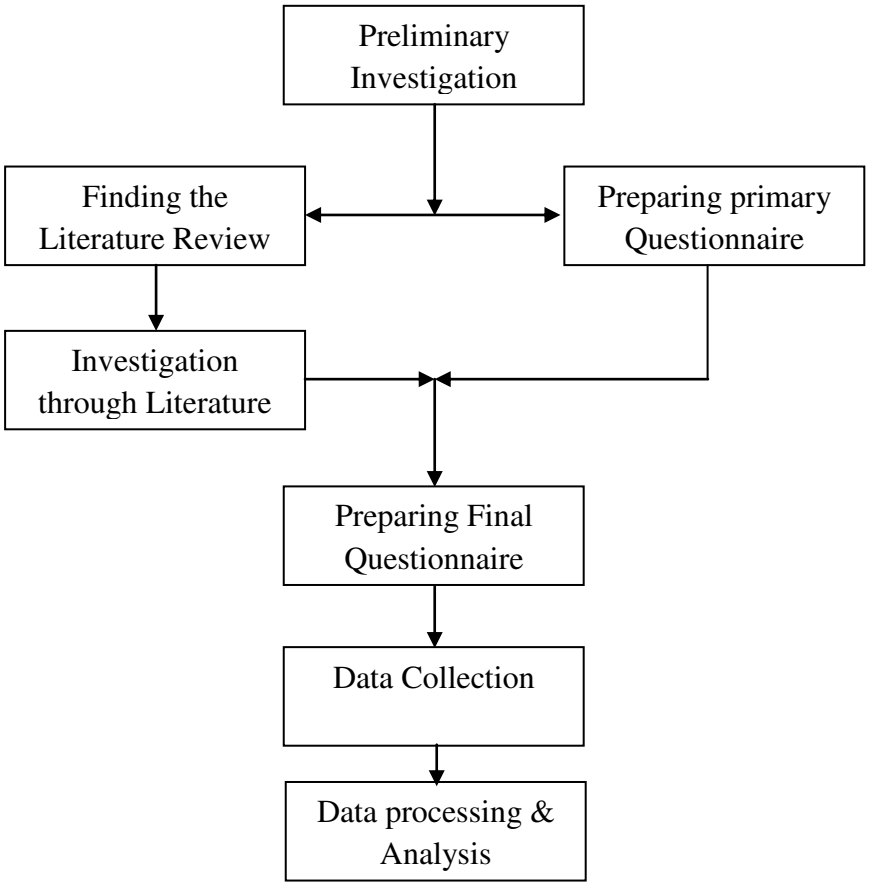

Fig. 3.1 Overall steps of the study

3.3. Data Collection

This study is aimed towards the measurement performance and improvement of sewing section in East West Industrial Park Limited located at National University, Gazipur, Bangladesh. This organization is one of the pioneers of the formal trousers and suits product from Bangladesh. This company believes in quality craftsmanship and development as their business goal. That philosophy, along with their central team, run various operations of the company including- Compliance & Safety, Production & Planning, Industrial Engineering, Merchandising & Product Development, Quality Assurance & Technical. These teams are always in the process of improvement to serve them as well as valuable customers.

Production area & capacity – Production area of this organization is 400,000 square feet. Production capacity is 225000 pcs, 350000 pcs and 100000 pcs per month for the item of blazer, trouser & waist coat respectively.

Production unit – Production unit means the name of sewing floor of this organization is given below –

- ✓ Aliza Blazer – 01
- ✓ Aliza Blazer – 02
- ✓ Aliza Trouser Limited
- ✓ Alvin Fashion Limited
- ✓ East West Dress Pant Limited
- ✓ European – Pantaloon Limited
- ✓ East West Fashion Trouser Limited
- ✓ Fashion Skirt Limited
- ✓ Fashion Suits Limited
- ✓ Fashion Trousers Limited
- ✓ Pantaloon Fashion Limited
- ✓ Rumana Fashion Limited
- ✓ United Fashion Trouser Limited.

To understand the organization current performance, taking monthly basis sewing related all data and to understand the production line efficiency, total process time, productivity and for design the optimum production system, process time is required.

The processing time exists simply because the process requires tasks and motion. Number of workers also must being identified to know where the place or machine that needed the worker. Total time and time collecting also will be observed and recorded. Total time is the amount of time that the assembly line finishes all task work in all workstation to make one product. Time collecting is the amount of time used to complete the task by one workstation.

For measuring the performance collected data for the month November, 2015 to identify the current performance which are shown in Table 4.8, 4.9, 4.15. After development collected data for the month July, 2016 and December, 2016 for performance evaluation which are shown in Table 4.10, 4.11, 4.12, 4.13 ,4.16, 4.17.

3.3.1 Preliminary Survey

To find out the causes of the problems and strength of the organization carried out survey to employee. The questionnaires are appended as Appendix 1 with this report.

3.4 Implementation Plan

It is the organization responsibility to work for continual improvements about productivity, efficiency & quality towards full and sustainable compliance with the customers / buyers quality requirements. The top management find out that, their sewing line overall labor effectiveness and efficiency are low. Now buyers are more concern about efficiency & quality during the capacity booking, costing stage, order placing and production stage. And also find out that expectation from owners didn't reach properly to the floor management as well as worker also. To fulfill owner expectation and buyers requirement need to improve process. For that case, the organization is suggested to work in two (2) different ways.

3.4.1 Goal set and training program

To reach the organization goal, the organization set below task –

- ✓ To set quality Policy / Mission / Vision as well as process improvement criteria for different section.

- ✓ To set department wise goal with respective Key Performance Indicator (KPI) Goal follow up based on data with analysis. & take corrective action plan based on goal follow up data.
- ✓ To set job responsibility for all designation for all respective department.
- ✓ Training plan to secure competence & execute the training based on plan.
- ✓ To keep the training record from top to floor management.

3.4.2 Sewing section line balancing

Work measurement applies different types of techniques to determine the required time to complete one operation and the total work that can be performed by one operator in a specific time. It provides a fair way of estimating the time to do a skillful operator with plentiful work supply & proper equipment. Different work measurement techniques used by sewing floor managers are stopwatch study or time study, historical time study, predetermined data, standard data, judgment, operator reporting & work sampling. For conducting time study visit at sewing floor had done for several times to muddle through the actual situation of sewing floor. For conducting time study here traditional stop watch method was used. Here 10 cycle time for each operation was recorded and at the same time the name of the operator or helper, attachment used and machine type was recorded in a time study template sheet. Before starting the time study, the breakdown of the progress of operation was done. After recording 10 cycle time; average cycle time was calculated from which normal time or cycle time was found. Average observed time = sum of the time recorded to perform each element/ Number of cycles observed [4].

From the line worker capacity balancing table, the bottlenecks & capacity variations between the workers were visible clearly. After finding the bottlenecks in layout and imbalance of worker capacity from the worker capacity and time study table, a change in layout and operation breakdown was done for effective flow of product. This changed breakdown shows better performance in case of work in progress and good through put time was achieved by solving the bottleneck points. For balancing the sewing line, here assistant was added or arrange training facility for the bottleneck creating worker or if the work load was too much; then load was divided within the higher capacity processing workers for maximum utilization of labor capacity & increase their productivity. By this way a more balanced & efficient line was found

with higher productivity. Here the bottleneck creating operators were provided training and also motivation was done for better performance. A change in the operation breakdown was also done. Finally, where work load is excess that was distributed among the higher capacity possessing workers considering the layout. Thus, the bottlenecks were solved and maximum capacity was utilized and most importantly productivity was improved.

CHAPTER 4

DATA ANALYSIS & RESULT

4.1 Introduction

The analysis of data and information gathered led to significant improvement carried out in process improvement. Comparison result before and after technique implementation was extensively reviewed. This data analysis chapter is constructed with coordination of some steps as data collection through time study, training & analysis the data through table and graphical representation. Finally, this chapter will show the existing line efficiency, DHU, productivity, OLE, OEE and later the increase efficiency & productivity after balancing the line & training the employees.

4.2 Training Program

Training is crucial for organizational development and success. It is fruitful to both employers and employees of an organization. An employee will become more efficient and productive if he is trained well. To enhance operational efficiency, the organization set the training program and provide the training to employees means top to line management and workers, where the training topics are selected quality policy, department wise goal & designation wise job responsibility, which can increase their efficiency and productivity in completing their daily work tasks. Training can also help your organization achieve greater consistency in process adherence, making it easier to project outcomes and meet organizational goals and targets.

Table 4.1: Example (1) of Training content

Training Content	:	**Quality Policy, Department wise Goal & Job Responsibility**
Date	:	19 – March – 2016
Time	:	11.00 am to 12.00 pm
Venue	:	Aliza Training Room (6th Floor)
Trainer Name	:	**Mr. Shamsul Alam (General Manager – Quality Assurance)**
Target Employee	:	Quality Manager, Quality Incharge, Quality Controller
Participant Number	:	**41 person**

Table 4.2: Example (2) of Training content

Training Content	:	**Department wise Goal & Job Responsibility**
Date	:	28 – March – 2016
Time	:	3.00 pm to 3.30 pm
Venue	:	Aliza Training Room (6th Floor)
Trainer Name	:	**Mr. Samsul Alam (General Manager – Quality), Mr. Babul Mia (General Manager – Production), Mr. Abdul Razzak (General Manager – Production)**
Target Person	:	Operator, Ironman & Floor Management
Participant Number	:	**58 persons**

To train up the work study & production team about process improvement, where the training module given below –

1. Single workstation/operator will process one bundle at a time.
2. Way to provide more balance combined processes.
3. Reduce operator handling time (Non-value added activities)
4. Improve line balancing during initial line layout set up & maturity stage of line.
5. Production gap should be zero during style changeover.
6. Prevent defective garment from going to finishing section.
7. Use traffic light system. If any yellow or red color card is shown, make the process to produce right product and show green card by working together Production, Quality, Work Study, Technical and Maintenance concerns.

4.2.1 Training summary

For process improvement, training need for all level of employees means top management to worker. Month wise training employees (persons) floor employees and workers summary is given in Table 4.3.

Table 4.3: Month wise training summary with respective department (Year: 2016)

Month	**Department wise – Number of Training Employee (Person)**				Total
	Production	Quality	Operation	Compliance	
Mar'16	71	44	1	0	116
Apr'16	284	48	0	0	332
May'16	85	33	0	1	119
Jun'16	0	0	0	0	0
July'16	0	0	0	0	0
Aug'16	299	13	0	0	312
Sept'16	506	9	0	0	515
Oct'16	468	3	0	0	471
Nov'16	328	26	10	0	364
Dec'16	171	3	0	0	174
Total	**2212**	**179**	**11**	**1**	**2403**

4.3 Calculation

Here by analyzing worker psychology and sewing line condition existing workers was motivated and trained to work more consciously and efficiently. In this case before balancing the serial no – 32, 77, 84, 100, 106, 118, 126 operation merged and serial no – 42, 50, 97, 136 was eliminated by distributing their work load within the worker who possesses higher capacity, similar machine or changed machine type.

Table 4.4: Time study chart before worker capacity balancing

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Front Part	1	Body Sewing Allowence mark	HW	0.5	0.60	0.69	87
Front Part	2	Dart Position mark & Panel matching	HW	0.49	0.56	0.65	93
Front Part	3	Dart Make	SNLS	0.46	0.55	0.63	95
Front Part	4	Panel Join	SNLS	0.9	1.39	1.60	37
Front Part	5	Panel Join	SNLS		1.35	1.55	39
Front Part	6	Body Press & Fusing Attach (L)	Press	0.68	0.60	0.69	87

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Front Part	7	Body Press & Fusing Attach (R)	Press		0.61	0.71	85
Front Part	8	Flap Make	SNLS	0.71	0.55	0.63	95
Front Part	9	Flap Cut & Turn Up	HW	0.53	0.54	0.62	97
Front Part	10	Flap Make Iron (Pattern)	IM	0.56	0.65	0.75	80
Front Part	11	Flap Matching With Body	HW	0.58	0.59	0.68	88
Front Part	12	Bone Join	APW	0.61	0.63	0.73	82
Front Part	13	Bone Cut & Turn Up	HW	1.02	1.32	1.52	40
Front Part	14	Bone Cut & Turn Up	HW		1.36	1.56	38
Front Part	15	Bone Tack	SNLS	0.53	0.62	0.71	85
Front Part	16	Bone Iron	IM	0.5	0.46	0.53	113
Front Part	17	Supporting Join	SNLS	0.28	0.32	0.36	165
Front Part	18	Pocketing Join	SNLS	0.59	0.73	0.84	72
Front Part	19	Mouth Close & Lapel Position Tack	SNLS	0.5	0.53	0.61	98
Front Part	20	Pocket Close	C/S	0.59	0.60	0.69	87
Front Part	21	Flap & Pocket Iron	IM	0.59	0.70	0.81	75
Front Part	22	Show Bone Position Mark& Body Matching	HW	0.53	0.57	0.65	92
Front Part	23	Show Bone Make (Pattern)	IM	0.55	0.57	0.66	91
Front Part	24	Show Bone Cut & Mark	HW	0.56	0.57	0.66	92
Front Part	25	Show Bone Join	SNLS	0.52	0.54	0.62	96
Front Part	26	Show Bone Cut	HW	0.53	0.54	0.62	96
Front Part	27	Show Bone Iron & Gum Attach	IM	0.55	0.57	0.66	92
Front Part	28	Show Bone Zig Zag	ZZ	0.44	0.52	0.59	101
Front Part	29	Show Bone Pocketing Attach	SNLS	0.4	0.48	0.56	108
Front Part	30	Show Bone Pocket 1/4 Top Stitch	C/S	0.39	0.51	0.58	103
Front Part	31	Arm Hole Tap Join/Back Part	A/H	0.46	0.34	0.39	152
Front Part	32	Chest Pad Position Mark	HW	0.38	0.61	0.70	86

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Front Part	33	Chest Pad Arrange (Initial Table)	HW	0.4	0.47	0.54	110
Front Part	34	Chest Pad Zig Zag	ZZ	0.58	0.69	0.80	75
Front Part	35	Chest Pad Attach With Body	IM	0.61	0.67	0.77	78
Front Part	36	Chest Pad & Body Press (L)	Press	1.18	0.61	0.70	86
Front Part	37	Chest Pad & Body Press (R)	Press		0.61	0.70	86
Front Part	38	Chest Pad Blind Stitch With Body	BD/S	0.49	0.53	0.61	98
Front Part	39	Arm Hole Dressing	K/M	0.51	0.66	0.76	79
Front Part	40	Arm Hole Edge Cut	HW	0.3	0.50	0.58	104
Sleeve Part	41	Cuff Folding With Iron	IM	0.47	0.53	0.61	98
Sleeve Part	42	Cuff Decoration Mark	HW	0.28	0.48	0.55	109
Sleeve Part	43	Cuff Decoration	D/H	0.3	0.47	0.54	112
Sleeve Part	44	Sleeve side panel matching	HW	0.47	0.46	0.53	113
Sleeve Part	45	Sleeve side seam Join	SNLS	0.58	0.68	0.78	77
Sleeve Part	46	Sleeve nose make	SNLS	0.59	0.65	0.75	80
Sleeve Part	47	Sleeve nose Cut & Turn Up	HW	0.46	0.57	0.66	91
Sleeve Part	48	Sleeve Nose Iron	IM	0.38	0.47	0.54	111
Sleeve Part	49	Nose Tack	SNLS	0.46	0.45	0.51	117
Sleeve Part	50	Button Position Mark	HW	0.35	0.39	0.45	134
Sleeve Part	51	Button Join (8 Button)	BN/S	0.39	0.48	0.55	109
Sleeve Part	52	Lining Side Join	C/S	0.47	0.56	0.65	93

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Sleeve Part	53	Lining side Iron	IM	0.39	0.49	0.56	106
Sleeve Part	54	Lining matching with Sleeve	HW	0.49	0.53	0.61	98
Sleeve Part	55	Lining join with Sleeve	SNLS	0.47	0.54	0.62	97
Sleeve Part	56	Sleeve side Iron	IM	0.47	0.54	0.62	97
Sleeve Part	57	Sleeve Inseam	SNLS	0.56	0.65	0.75	80
Sleeve Part	58	Sleeve Inseam Iron	IM	0.61	0.48	0.55	109
Sleeve Part	59	Lining Inseam	SNLS	0.61	0.73	0.84	71
Sleeve Part	60	Mouth Close/Safety Stitch	SNLS	0.51	0.38	0.44	136
Sleeve Part	61	Lining Tack With Sleeve	SNLS	0.69	0.54	0.62	97
Sleeve Part	62	Sleeve Turn Up	HW	0.36	0.39	0.45	133
Sleeve Part	63	Sleeve Head Padding Make	SNLS	0.56	0.65	0.75	80
Sleeve Part	64	Hade Pad Join	C/S	0.46	0.53	0.61	99
Sleeve Part	65	Cuff Iron	IM	0.44	0.52	0.60	100
Lining	66	Back Center Join	SNLS	0.38	0.48	0.55	109
Lining	67	Panel & Shoulder Lining Matching	HW	0.52	0.56	0.65	93
Lining	68	Panel Join	SNLS	0.61	0.81	0.93	65
Lining	69	Panel & Back Part Iron	IM	0.39	0.45	0.52	115
Lining	70	Shoulder Join	SNLS	0.44	0.52	0.60	100
Lining	71	Shoulder Iron	IM	0.36	0.43	0.49	122
Lining	72	Lining Body Matching With Facing(Collar)	HW	0.36	0.46	0.53	113

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Lining	73	Care Label & Piping Tack	SNLS	0.45	0.37	0.42	142
Lining	74	Facing Piping with Lining Body(Folder guide)	SNLS	0.7	0.97	1.11	54
Lining	75	Facing Piping with Lining Body(Folder guide)	SNLS		0.88	1.02	59
Lining	76	Facing & Collar Iron	IM	0.39	0.46	0.53	113
Lining	77	Bone Position Mark	HW	0.36	0.34	0.39	155
Lining	78	Bone tack With Fussing	SNLS	0.3	0.37	0.43	141
Lining	79	Bone Join	APW	0.49	0.57	0.65	92
Lining	80	Bone Cut	HW	0.61	1.49	1.72	35
Lining	81	Bone Cut	HW		1.49	1.72	35
Lining	82	Bone tack(Support from 1)	SNLS	0.5	0.62	0.71	85
Lining	83	Bone & Care Label Iron	IM	0.42	0.49	0.57	106
Lining	84	Main label position mark	HW	0.4	0.48	0.55	109
Lining	85	Main Label & Size label Join	SNLS	0.29	0.46	0.53	114
Lining	86	Pocketing Join	SNLS	0.58	0.67	0.77	77
Lining	87	Facing Close with Care label	SNLS	0.5	0.52	0.60	100
Lining	88	Pocketing Side Tack	SNLS	0.55	0.67	0.77	78
Lining	89	Pocketing Close	C/S	0.47	0.56	0.64	94
Lining	90	Pocket Gum Attach & Bone Iron	IM	0.58	0.67	0.77	78
Lining	91	Side Join (L)	SNLS	0.51	0.52	0.60	100
Lining	92	Side Join ®	SNLS		0.57	0.66	91
Lining	93	Lining Side Iron	IM	0.46	0.39	0.44	135
Lining	94	Pocket Bar Tack	B/T	0.39	0.41	0.48	126
Lining	95	Stopple Tap Join	S/T	0.48	0.46	0.53	113
Lining	96	Thread Cut	HW	0.58	0.36	0.42	144
Lining	97	Sticker Remove	HW	0.4	0.22	0.25	237
Back Part	98	Back Center join	SNLS	0.45	0.42	0.49	123
Back Part	99	Back part Iron	IM	0.3	0.28	0.32	189

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Back Part	100	Back Part Tap & Thread Cut	HW	0.25	0.36	0.42	144
Collar	101	Collar Band Position Mark	HW	0.5	0.55	0.63	95
Collar	102	Collar band Join	SNLS	0.56	0.33	0.38	158
Collar	103	Collar Band Zig Zag(Share Collar Band join)	ZZ	0.25	0.27	0.31	196
Collar	104	Collar Felt C/S(Share Lining Sleeve)	C/S	0.2	0.35	0.40	151
Collar	105	Collar make Tack	SNLS	0.35	0.39	0.45	133
Collar	106	Collar Edge cut	HW	0.3	0.22	0.25	237
Collar	107	Collar Iron	IM	0.45	0.55	0.63	95
Collar	108	Collar Gum & fussing attach	IM	0.36	0.46	0.53	113
Collar	109	Collar join with Facing	SNLS	0.35	0.53	0.61	98
Assembly	110	Back & front part Matching	HW	0.33	0.41	0.47	128
Assembly	111	Back part & front part Side Join	SNLS	0.86	1.02	1.18	51
Assembly	112	Back part & front part Side Join	SNLS		1.02	1.18	51
Assembly	113	Side Iron	IM	0.59	0.79	0.91	66
Assembly	114	Shoulder Join	SNLS	0.52	0.63	0.73	82
Assembly	115	Shoulder Iron	IM	0.41	0.53	0.61	98
Assembly	116	Shoulder Tack with Chest Pad	SNLS	0.36	0.33	0.38	157
Assembly	117	Sleeve Join Position Mark	HW	0.33	0.41	0.47	128
Assembly	118	Sleeve Matching	HW	0.4	0.55	0.63	95
Assembly	119	Sleeve Join	S/J	1.04	1.23	1.42	42
Assembly	120	Sleeve Join	S/J		1.12	1.28	47
Assembly	121	Sleeve Cut & Iron	IM	0.32	0.52	0.59	101
Assembly	122	Sleeve Pad Join	S/H	0.52	0.56	0.64	93
Assembly	123	Pad Bar Tack	PB/T	0.18	0.33	0.38	157
Assembly	124	Shoulder Press	IM	0.35	0.28	0.32	186
Assembly	125	Lining & Shell Body Matching	HW	0.46	0.36	0.41	146
Assembly	126	Lining & Body Sticker Remove	HW	0.41	0.49	0.56	106

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Assembly	127	Facing Join	SNLS	1.02	0.93	1.07	56
Assembly	128	DO	SNLS		1.58	1.82	33
Assembly	129	Do	SNLS		2.02	2.33	26
Assembly	130	Facing Edge Cut	HW	0.47	0.45	0.52	116
Assembly	131	Facing Press	IM	0.46	0.53	0.61	98
Assembly	132	Facing S.t Edge Cut	K/M	0.4	0.42	0.49	123
Assembly	133	Hem Iron	IM	0.48	0.61	0.71	85
Assembly	134	Facing Iron	IM	0.5	0.92	1.05	57
Assembly	135	Collar Position Mark	HW	0.46	0.56	0.64	94
Assembly	136	Trimming	HW	0.25	0.48	0.56	108
Output	137	Collar Join & Vent tack	SNLS	0.56	0.52	0.60	100
Output	138	Collar edge cutting & Body Turn Up	HW	0.48	0.53	0.61	99
Output	139	Vent & Hem Iron	IM	0.64	0.65	0.75	80
Output	140	Vent Position Mark	HW	0.29	0.43	0.50	120
Output	141	Collar Felt Join	SNLS	0.47	0.55	0.64	94
Output	142	Collar Zig Zag	ZZ	0.51	0.62	0.71	85
Output	143	Collar Iron & Gum Attach	IM	0.59	0.59	0.68	88
Output	144	Lining Sleeve Join (L)	SNLS	1.27	0.68	0.78	77
Output	145	Lining Sleeve Join ®	SNLS		0.70	0.81	75
Output	146	Sleeve Loop Tack with Lining	SNLS	0.36	0.45	0.52	115
Output	147	Vent Join	SNLS	0.96	0.55	0.63	95

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Output	148	Hem Join (L)	SNLS	1.23	0.56	0.65	93
Output	149	Hem Join (R)	SNLS		0.48	0.55	109
Output	150	Hem Side Lower psn Tack	SNLS	0.51	0.48	0.55	109
Output	151	Body Turn Up	HW	0.53	0.55	0.64	94
Output	152	Sticker Remove	HW	0.41	0.51	0.58	103
Output	153	Sleeve Tack	SNLS	0.53	0.54	0.62	96
Output	154	Arm Hole Safety Stitch	SNLS	0.58	0.66	0.76	79
Output	155	Vent Top Stitch	SNLS	0.5	0.55	0.64	94
Output	156	Arm Hole busting	B/M	0.64	0.66	0.76	79
Output	157	Final Body Turn Up	HW	0.43	0.55	0.63	95
Output	158	Hem Lining & Vent Iron	IM	0.47	0.45	0.52	116
Output	159	Collar & Nose Iron	IM	0.61	0.58	0.67	89
Output	160	Hanger Loop Join	SNLS	0.5	0.50	0.58	104
Output	161	Collar Top Stitch	SNLS	0.53	0.54	0.62	97
Output	162	Trimming	HW	0.8	0.83	0.95	63
Output	163	Trimming	HW		0.83	0.95	63
Output	164	Sleeve Mouth Close	SNLS	0.48	0.53	0.61	99
		Total		**75.6**		**112.24**	

4.3.1 Machine summary for sewing section of existing layout

Machine summary of existing layout with machine type, machine surname & number of machine used is given in Table 4.5.

Table 4.5: Machine summary of existing layout of sewing section

Machine Summary					
Machine Type	Machine Surname	Number of Machine	Machine Type	Machine Surname	Number of Machine
Auto Pocket Welting	APW	**2**	Press Machine	Press	**4**
Chain Stitch	C/S	**6**	Iron Machine	IM	**32**
Arm Hole Tap	A/H	**1**	Vertical Knife Machine	K/M	**2**
Bind Stitch	BD/S	**1**	Padding Bar Tack	PB/T	**1**
Decorated Hole	D/H	**1**	ZigZag	ZZ	**4**
Button Stitch	BN/S	**1**	Stopple Tap	S/T	**1**
Bar Tack	B/T	**1**	Sleeve Joint Machine	S/J	**2**
Busting Machine	B/M	**1**	Sleeve Head Machine	S/H	**1**
Hand Work	HW	**44**	Single Needle Lock Stitch	SNLS	**59**

Table 4.6: Time study chart after worker capacity balancing

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Front Part	1	Body Sewing Allowance mark	HW	0.5	0.60	0.69	87
Front Part	2	Dart Position mark & Panel matching	HW	0.49	0.56	0.65	93
Front Part	3	Dart Make	SNLS	0.46	0.55	0.63	95
Front Part	4	Panel Join	SNLS	0.9	1.13	1.30	46
Front Part	5	Panel Join	SNLS		1.00	1.15	52
Front Part	6	Body Press & Fusing Attach (L)	Press	0.68	0.60	0.69	87
Front Part	7	Body Press & Fusing Attach (R)	Press		0.61	0.71	85

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Front Part	8	Flap Make	SNLS	0.71	0.55	0.63	95
Front Part	9	Flap Cut & Turn Up	HW	0.53	0.54	0.62	97
Front Part	10	Flap Make Iron (Pattern)	IM	0.56	0.65	0.75	80
Front Part	11	Flap Matching With Body	HW	0.58	0.59	0.68	88
Front Part	12	Bone Join	APW	0.61	0.63	0.73	82
Front Part	13	Bone Cut & Turn Up	HW	1.02	1.20	1.38	43
Front Part	14	Bone Cut & Turn Up	HW		1.13	1.30	46
Front Part	15	Bone Tack	SNLS	0.53	0.62	0.71	85
Front Part	16	Bone Iron	IM	0.5	0.46	0.53	113
Front Part	17	Supporting Attach & Pocketing Join	SNLS	0.87	1.22	1.40	43
Front Part	18	Supporting Attach & Pocketing Join	SNLS		1.00	1.15	52
Front Part	19	Mouth Close & Lapel Position Tack	SNLS	0.5	0.53	0.61	98
Front Part	20	Pocket Close	C/S	0.59	0.60	0.69	87
Front Part	21	Flap & Pocket Iron	IM	0.59	0.67	0.77	78
Front Part	22	Show Bone Position Mark& Body Matching	HW	0.53	0.57	0.65	92
Front Part	23	Show Bone Make (Pattern)	IM	0.55	0.57	0.66	91
Front Part	24	Show Bone Cut & Mark	HW	0.56	0.57	0.66	92
Front Part	25	Show Bone Join	SNLS	0.52	0.54	0.62	96
Front Part	26	Show Bone Cut	HW	0.53	0.54	0.62	96
Front Part	27	Show Bone Iron & Gum Attach	IM	0.55	0.57	0.66	92
Front Part	28	Show Bone Zig Zag	ZZ	0.44	0.52	0.59	101

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Front Part	29	Show Bone Pocketing Attach	SNLS	0.4	0.48	0.56	108
Front Part	30	Show Bone Pocket 1/4 Top Stitch	C/S	0.39	0.51	0.58	103
Front Part	31	Arm Hole Tap Join/Back Part	A/H	0.46	0.34	0.39	152
Front Part	32	Chest Pad Arrange (Initial Table) & Position Mark	HW	0.52	0.58	0.67	89
Front Part	33	Chest Pad Zig Zag	ZZ	0.58	0.69	0.80	75
Front Part	34	Chest Pad Attach With Body	IM	0.61	0.67	0.77	78
Front Part	35	Chest Pad & Body Press (L)	Press	1.18	0.61	0.70	86
Front Part	36	Chest Pad & Body Press (R)	Press		0.61	0.70	86
Front Part	37	Chest Pad Blind Stitch With Body	BD/S	0.49	0.53	0.61	98
Front Part	38	Arm Hole Dressing	K/M	0.51	0.66	0.76	79
Front Part	39	Arm Hole Edge Cut	HW	0.3	0.50	0.58	104
Sleeve Part	40	Cuff Folding With Iron	IM	0.47	0.53	0.61	98
Sleeve Part	41	Cuff Decoration with Pattern	D/H	0.53	0.57	0.65	92
Sleeve Part	42	Sleeve side panel matching	HW	0.47	0.46	0.53	113
Sleeve Part	43	Sleeve side seam Join	SNLS	0.58	0.68	0.78	77
Sleeve Part	44	Sleeve nose make	SNLS	0.59	0.65	0.75	80
Sleeve Part	45	Sleeve nose Cut & Turn Up	HW	0.46	0.57	0.66	91
Sleeve Part	46	Sleeve Nose Iron	IM	0.38	0.47	0.54	111
Sleeve Part	47	Nose Tack	SNLS	0.46	0.45	0.51	117

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Sleeve Part	48	Button Join (8 Button) with table pattern	BN/S	0.47	0.58	0.67	89
Sleeve Part	49	Lining Side Join	C/S	0.47	0.56	0.65	93
Sleeve Part	50	Lining side Iron	IM	0.39	0.49	0.56	106
Sleeve Part	51	Lining matching with Sleeve	HW	0.49	0.53	0.61	98
Sleeve Part	52	Lining join with Sleeve	SNLS	0.47	0.54	0.62	97
Sleeve Part	53	Sleeve side Iron	IM	0.47	0.54	0.62	97
Sleeve Part	54	Sleeve Inseam	SNLS	0.56	0.65	0.75	80
Sleeve Part	55	Sleeve Inseam Iron	IM	0.61	0.48	0.55	109
Sleeve Part	56	Lining Inseam	SNLS	0.61	0.73	0.84	71
Sleeve Part	57	Mouth Close/Safety Stitch	SNLS	0.51	0.38	0.44	136
Sleeve Part	58	Lining Tack With Sleeve	SNLS	0.69	0.54	0.62	97
Sleeve Part	59	Sleeve Turn Up	HW	0.36	0.39	0.45	133
Sleeve Part	60	Sleeve Head Padding Make	SNLS	0.56	0.65	0.75	80
Sleeve Part	61	Hade Pad Join	C/S	0.46	0.53	0.61	99
Sleeve Part	62	Cuff Iron	IM	0.44	0.52	0.60	100
Lining	63	Back Center Join	SNLS	0.38	0.48	0.55	109
Lining	64	Panel & Shoulder Lining Matching	HW	0.52	0.56	0.65	93
Lining	65	Panel Join	SNLS	0.61	0.81	0.93	65

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Lining	66	Panel & Back Part Iron	IM	0.39	0.45	0.52	115
Lining	67	Shoulder Join	SNLS	0.44	0.52	0.60	100
Lining	68	Shoulder Iron	IM	0.36	0.43	0.49	122
Lining	69	Lining Body Matching With Facing(Collar)	HW	0.36	0.46	0.53	113
Lining	70	Care Label & Piping Tack	SNLS	0.45	0.37	0.42	142
Lining	71	Facing Piping with Lining Body(Folder guide)	SNLS	0.7	0.97	1.11	54
Lining	72	Facing Piping with Lining Body(Folder guide)	SNLS		0.88	1.02	59
Lining	73	Facing & Collar Iron	IM	0.39	0.46	0.53	113
Lining	74	Bone Position Mark & tack With Fussing	SNLS	0.52	0.63	0.73	82
Lining	75	Bone Join	APW	0.49	0.57	0.65	92
Lining	76	Bone Cut	HW	0.92	1.20	1.38	43
Lining	77	Bone Cut	HW		1.33	1.53	39
Lining	78	Bone tack (Support from 1)	SNLS	0.5	0.62	0.71	85
Lining	79	Bone & Care Label Iron	IM	0.42	0.49	0.57	106
Lining	80	Main & Size label Position Mark & Join	SNLS	0.43	0.58	0.67	89
Lining	81	Pocketing Join	SNLS	0.58	0.67	0.77	77
Lining	82	Facing Close with Care label	SNLS	0.5	0.52	0.60	100
Lining	83	Pocketing Side Tack	SNLS	0.55	0.67	0.77	78
Lining	84	Pocketing Close	C/S	0.47	0.56	0.64	94
Lining	85	Pocket Gum Attach & Bone Iron	IM	0.58	0.67	0.77	78

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Lining	86	Side Join (L)	SNLS	0.51	0.52	0.60	100
Lining	87	Side Join ®	SNLS		0.57	0.66	91
Lining	88	Lining Side Iron	IM	0.46	0.39	0.44	135
Lining	89	Pocket Bar Tack	B/T	0.39	0.41	0.48	126
Lining	90	Stopple Tap Join	S/T	0.48	0.46	0.53	113
Lining	91	Thread Cut	HW	0.58	0.36	0.42	144
Back Part	92	Back Center join	SNLS	0.38	0.42	0.49	123
Back Part	93	Back part Iron & Thread Cut	IM	0.4	0.55	0.63	95
Collar	94	Collar Band Position Mark	HW	0.5	0.55	0.63	95
Collar	95	Collar band Join	SNLS	0.56	0.33	0.38	158
Collar	96	Collar Band Zig Zag(Share Collar Band join)	ZZ	0.25	0.27	0.31	196
Collar	97	Collar Felt C/S(Share Lining Sleeve)	C/S	0.2	0.35	0.40	151
Collar	98	Collar make Tack & Edge cut	K/M	0.45	0.55	0.63	95
Collar	99	Collar Iron	IM	0.45	0.55	0.63	95
Collar	100	Collar Gum & fussing attach	IM	0.36	0.46	0.53	113
Collar	101	Collar join with Facing	SNLS	0.35	0.53	0.61	98
Assembly	102	Back & front part Matching	HW	0.33	0.41	0.47	128
Assembly	103	Back part & front part Side Join	SNLS	0.86	1.02	1.18	51
Assembly	104	Back part & front part Side Join	SNLS		1.02	1.18	51
Assembly	105	Side Iron	IM	0.59	0.79	0.91	66
Assembly	106	Shoulder Join	SNLS	0.52	0.63	0.73	82

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Assembly	107	Shoulder Iron	IM	0.41	0.53	0.61	98
Assembly	108	Shoulder Tack with Chest Pad & Sleeve Position Mark	SNLS	0.46	0.63	0.73	82
Assembly	109	Sleeve Matching	HW	0.4	0.31	0.36	167
Assembly	110	Sleeve Join	S/J	1.04	1.23	1.42	42
Assembly	111	Sleeve Join	S/J		1.12	1.28	47
Assembly	112	Sleeve Cut & Iron	IM	0.32	0.52	0.59	101
Assembly	113	Sleeve Pad Join	S/H	0.52	0.56	0.64	93
Assembly	114	Pad Bar Tack, Lining Body Sticker Remove	PB/T	0.43	0.55	0.63	95
Assembly	115	Shoulder Press	IM	0.35	0.28	0.32	186
Assembly	116	Lining & Shell Body Matching	HW	0.46	0.36	0.41	146
Assembly	117	Facing Join	SNLS	1.02	0.93	1.07	56
Assembly	118	Facing Join	SNLS		1.58	1.82	33
Assembly	119	Facing Join	SNLS		2.02	2.33	26
Assembly	120	Facing Edge Cut	HW	0.47	0.45	0.52	116
Assembly	121	Facing Press	IM	0.46	0.53	0.61	98
Assembly	122	Facing S.t Edge Cut	K/M	0.4	0.42	0.49	123
Assembly	123	Hem & Facing Iron	IM	0.98	1.22	1.40	43
Assembly	124	Hem & Facing Iron	IM		1.00	1.15	52
Assembly	125	Collar Position Mark	HW	0.46	0.56	0.64	94
Output	126	Collar Join & Vent tack	SNLS	0.56	0.52	0.60	100
Output	127	Collar edge cutting & Body Turn Up	HW	0.48	0.53	0.61	99

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Output	128	Vent & Hem Iron	IM	0.64	0.65	0.75	80
Output	129	Vent Position Mark	HW	0.29	0.43	0.50	120
Output	130	Collar Felt Join	SNLS	0.47	0.55	0.64	94
Output	131	Collar Zig Zag	ZZ	0.51	0.62	0.71	85
Output	132	Collar Iron & Gum Attach	IM	0.59	0.59	0.68	88
Output	133	Lining Sleeve Join (L)	SNLS	1.27	0.68	0.78	77
Output	134	Lining Sleeve Join ®	SNLS		0.70	0.81	75
Output	135	Sleeve Loop Tack with Lining	SNLS	0.36	0.45	0.52	115
Output	136	Vent Join	SNLS	0.96	0.55	0.63	95
Output	137	Hem Join (L)	SNLS	1.23	0.56	0.65	93
Output	138	Hem Join (R)	SNLS		0.48	0.55	109
Output	139	Hem Side Lower psn Tack	SNLS	0.51	0.48	0.55	109
Output	140	Body Turn Up	HW	0.53	0.55	0.64	94
Output	141	Sticker Remove	HW	0.41	0.51	0.58	103
Output	142	Sleeve Tack	SNLS	0.53	0.54	0.62	96
Output	143	Arm Hole Safety Stitch	SNLS	0.58	0.66	0.76	79
Output	144	Vent Top Stitch	SNLS	0.5	0.55	0.64	94
Output	145	Arm Hole busting	B/M	0.64	0.66	0.76	79
Output	146	Final Body Turn Up	HW	0.43	0.55	0.63	95
Output	147	Hem Lining & Vent Iron	IM	0.47	0.45	0.52	116
Output	148	Collar & Nose Iron	IM	0.61	0.58	0.67	89
Output	149	Hanger Loop Join	SNLS	0.5	0.50	0.58	104

Section	Sl no	Operation	M/c type	SMV	Observe time (min)	Capacity time (min)	Capacity (pcs) / hour
Output	150	Collar Top Stitch	SNLS	0.53	0.54	0.62	97
Output	151	Trimming	HW	0.8	0.90	1.04	58
Output	152	Trimming	HW		1.02	1.17	51
Output	153	Sleeve Mouth Close	SNLS	0.48	0.53	0.61	99
		Total		**73.5**		**109.51**	

4.3.2 Calculation of sewing line efficiency

For measuring the sewing line performance used efficiency parameter. Based on equation (2.3)

Sewing line efficiency = (Total production×SMV×100) / (Number of manpower × Working hour × 60)

Before balancing line efficiency: = (55×75.60×100)/ (164×1×60) = 42.3%

After balancing the line efficiency = (63.5×73.5×100) / (152×1×60) = 51.17 %

4.3.3 Calculation of sewing productivity per man

For measuring the sewing line performance used productivity parameter.

Where, Productivity / Man = (Production / Number of the Manpower) (4.1)

Before balancing productivity / Man = (55 pcs /164 person) = 0.34 pcs per person

After balancing productivity = (63.5 pcs /152 person) = 0.42 pcs per person

4.3.4 Calculation of sewing line performance

For measuring the sewing line performance used productivity parameter.

Where, Performance (%) = (SMV / Capacity total time) x 100 (4.2)

Before balancing line performance = (75.6 / 112.24) × 100 =67 %

After balancing line performance = (73.5 / 109.51) × 100 = 67 %

From the above discussion it is noticeable that by applying time study and balancing techniques here bottlenecks were solved as well as sewing line efficiency is increased from 42.3% to 51.17%. Before balancing the line, the SMV required to complete the

garment is 75.6 min whereas after balancing it requires 73.5 min. Manpower (both operator and helper) are reduced, production is increased through utilization of worker capacity that ultimately leads to increase the efficiency. Table 4.7 shows a comprehensible indication.

4.3.5 Effects of line balancing

Line balancing is important as it balances the line and increases line efficiency as well as productivity. In this research line efficiency was improved 8.87% and most importantly productivity per person was improved to 0.42 pcs per person from 0.34 pcs per person.

4.4 Reduction of SMV, Manpower, Productivity and Line efficiency

After sewing line balancing based on the worker capacity, few parameter statuses are changed. The comparison of SMV, manpower, production per hour, productivity per person, sewing line efficiency is give in Table 4.7.

Table 4.7: Comparison of SMV, Manpower before and after balancing the sewing line

Parameter	Before Balancing	After Balancing
Standard Minute Value (SMV)	75.6 min	73.5 min
Manpower (Operator + Helper + Ironman)	164 person	152 person
Production / Hour	55 pcs	63.5 pcs
Productivity / Person	0.34 pcs	0.42 pcs
Line Efficiency	42.3 %	51.17 %

4.5 Month wise organization efficiency & DHU

For measuring the sewing line performance collected the data and the summary sheet of working hour, average SMV, average manpower, production, total available minute and total earn minute for the month of November, 2015 is given in Table 4.8.

Table 4.8: Average Working Hour, Average SMV, Average Manpower and Total Production of Sewing Section (Year: November, 2015)

Production Unit	Average Working Hour /Day	Average of SMV /Line	Average Worker (Person) / Line	Total Production (Pcs) / Month	TTL Available minute	TTL Earn minute
ALIZA BLZ 1	9.29	72.73	147.68	21819	4603320	1543940
ALIZA BLZ 2	9.32	110.90	181.64	12434	5700420	1386082
ALIZA TR	8.93	39.11	64.39	26664	2926500	1004944
ALVIN	9.52	103.86	151.21	20585	4838340	2138640
DPL	8.80	31.81	57.21	93249	4273800	1844792
EURO	8.38	27.32	76.66	35326	2166840	945688
EW	8.79	34.99	56.99	43655	4208280	1488296
F SKIRT	9.52	42.39	58.59	39390	4689180	1662181
F SUIT	8.95	70.92	149.27	30513	5605740	2168785
FTL	8.49	33.54	112.17	64990	4788900	2134489
PFL	8.84	35.23	104.44	64533	4616040	1534205
RFL	9.43	73.50	146.89	24043	4653480	1742503
UFTL	8.88	35.68	62.20	50551	4640940	1757708
Overall	8.99	48.24	91.55	527752	57711780	21352252

*Number of working day – **28** and Number of working line – **42** (Year: Nov, 2015)

For measuring the sewing line performance collected the data and the summary sheet of defect quantity, inspected quantity, DHU for the month of November, 2015 is given in Table 4.9.

Table 4.9: Defects per hundreds units (DHU) of Sewing Section (Year: Nov, 2015)

Production Unit	Defect Quantity (Parts)	Inspected Quantity (Parts)	DHU	Quality (%)
ALIZA BLZ 1	10181	97134	10.48	89.52%
ALIZA BLZ 2	5972	71787	8.32	91.68%
ALIZA TR	7606	113784	6.68	93.32%
ALVIN	17841	161201	11.07	88.93%
DPL	22145	262803	8.43	91.57%
EURO	10774	158003	6.82	93.18%
EW	22588	238698	9.46	90.54%
F SKIRT	13799	171446	8.05	91.95%
F SUIT	14939	185409	8.06	91.94%
FTL	16919	283620	5.97	94.03%
PFL	13902	198296	7.01	92.99%
RFL	18744	173836	10.78	89.22%
UFTL	18983	222598	8.53	91.47%
Overall	**194393**	**2338615**	**8.31**	**91.69%**

For measuring the sewing line performance collected the data and the summary sheet of working hour, average SMV, average manpower, production, total available minute and total earn minute for the month of July, 2016 is given in Table 4.10.

Table 4.10: Average working hour, average SMV, average manpower and total production of sewing section (Year: July, 2016)

Production Unit	Average Working Hour /Day	Average of SMV /Line	Average Manpower (Person) / Line	Total Production (Pcs) / Month	TTL Available minute	TTL Produce minute / Month
ALIZA 1	10.69	88.77	165.55	17,054	4,252,920	1,471,127
ALIZA 2	9.68	112.30	161.98	10,120	3,768,120	1,137,460
ALIZA TRS	10.23	48.97	69.23	18,035	2,544,360	881,955
ALVIN	11.29	107.54	155.85	18,293	4,230,240	1,896,508
DPL	10.60	44.59	53.69	32,120	3,426,240	1,418,942
E/W	10.68	39.86	56.79	38,315	3,641,040	1,442,857

Production Unit	Average Working Hour /Day	Average of SMV /Line	Average Manpower (Person) / Line	Total Production (Pcs) / Month	TTL Available minute	TTL Produce minute / Month
EUROPEAN	9.59	32.13	70.55	25,717	2,435,520	819,502
F.SKIRT	10.92	44.10	59.82	31,716	3,927,840	1,391,343
F.SUIT	7.31	83.31	150.96	27,399	5,434,650	2,211,457
FTL	9.71	52.83	118.30	19,289	4,153,500	911,839
PTL	10.52	51.48	114.17	24,350	4,449,840	1,246,240
RFL	10.23	82.46	148.68	15,183	3,654,480	1,230,772
UFTL	10.90	38.32	61.49	47,989	4,028,280	1,783,233
Grand Total	**10.20**	**56.95**	**94.17**	**325,580**	**49,947,030**	**17,843,236**

*Number of working day – **19** and Number of working line – **46** (Year: July, 2015)

For measuring the sewing line performance collected the data and the summary sheet of defect quantity, inspected quantity, DHU for the month of November, 2015 is given in Table 4.11.

Table 4.11: Defects per hundreds units (DHU) of Sewing Section (Year: July, 2016)

Production Unit	Defect Qty (Parts)	Inspected Quantity (Parts)	Reject Qty (Parts)	DHU	Reject (%)	Quality (%)
ALIZA 1	1,393	59,695	90	2.33	0.15%	97.67%
ALIZA 2	1,213	50,055	392	2.42	0.78%	97.58%
ALIZA TRS	1,878	67,566	110	3.01	0.16%	97.22%
ALVIN	2,555	114,466	238	2.23	0.21%	97.77%
DPL	3,301	127,366	80	2.59	0.06%	97.41%
E/W	3,008	127,224	5	2.36	0.00%	97.64%
EUROPEAN	3,253	105,752	2	3.08	0.00%	96.92%
F.SKIRT	2,850	110,657	14	2.58	0.01%	97.42%
F.SUIT	4,336	173,665	377	2.50	0.22%	97.50%
FTL	2,112	69,847	49	3.02	0.07%	96.98%
PTL	2,071	82,493	22	2.51	0.03%	97.49%
RFL	2,050	78,510	64	2.61	0.08%	97.39%
UFTL	4,170	162,031	147	2.57	0.09%	97.43%
Grand Total	**34,190**	**1,329,327**	**1,590**	**2.57**	**0.12%**	**97.43%**

For measuring the sewing line performance collected the data and the summary sheet of working hour, average SMV, average manpower, production, total available minute and total earn minute for the month of December, 2016 is given in Table 4.12.

Table 4.12: Average Working Hour, Average SMV, Average Manpower and Total Production of Sewing Section (Year: December, 2016)

Production Unit	Average Working Hour /Day	Average of SMV /Line	Average Manpower (Person) /Line	Total Production (Pcs) / Month	TTL Available minute / Month	TTL Produce minute / Month
ALIZA 1	11.58	85.33	159.35	23653	5753160	1930094
ALIZA 2	11.85	116.00	166.77	23798	6163800	2760568
ALIZA TRS	10.92	43.58	69.68	36148	3570360	1484398
ALVIN	7.75	99.67	154.00	27832	7447440	2713391
DPL	10.61	39.25	81.96	59570	5434110	2325036
E/W	10.71	40.90	57.78	56797	4823670	2316307
EUROPEAN	10.65	37.96	80.72	51209	4011525	1957302
F.SKIRT	7.75	44.11	82.01	63011	7931970	2741809
F.SUIT	7.75	70.55	150.91	53102	7298175	3684752
FTL	10.12	55.93	118.74	49486	5532615	2852636
PTL	10.12	54.61	117.86	45418	5487690	2668428
RFL	10.59	89.20	149.17	21073	4930440	1810254
UFTL	10.72	33.55	75.65	86706	6325155	2755370
Overall	**9.73**	**56.67**	**103.80**	**597,803**	**74,710,110**	**32,000,344**

*Number of working day – **24** & Number of working line – **52** (Year: December, 2016)

For measuring the sewing line performance collected the data and the summary sheet of defect quantity, inspected quantity, DHU for the month of November, 2015 is given in Table 4.13.

Table 4.13: Defects per hundreds units (DHU) of Sewing Section (Year: Dec, 2016)

Production Unit	Defect Qty (Parts)	Inspected Quantity (Parts)	Reject Qty (Parts)	Defects per hundred unit (DHU)	Reject (%)	Quality (%)
ALIZA 1	3394	91120	526	3.72	0.58%	96.28%
ALIZA 2	2734	103776	526	2.63	0.51%	97.37%
ALIZA TRS	3714	123352	115	3.01	0.09%	96.99%
ALVIN	24538	191746	606	12.80	0.32%	87.20%
DPL	12090	248009	342	4.87	0.14%	95.13%
E/W	8083	238687	494	3.39	0.21%	96.61%
EUROPEAN	9557	150754	286	6.34	0.19%	93.66%
F.SKIRT	10070	102350	151	9.84	0.15%	90.16%
F.SUIT	11806	294726	1234	4.01	0.42%	95.99%
FTL	6488	149414	81	4.34	0.05%	95.66%
PTL	4801	157591	0	3.05	0.00%	96.95%
RFL	3481	108743	171	3.20	0.16%	96.80%
UFTL	7379	329133	289	2.24	0.09%	97.76%
Overall	**108,135**	**2,289,401**	**4821**	**4.72**	0.21%	**95.28%**

At a glance below show the Efficiency & DHU for this organization for different month, where the Efficiency (%) = (Earn minute / Available Minute) *100

Table 4.14: Month wise Efficiency & DHU of the sewing section (Year: 2015, 2016)

Month	Total Available Minute	Total Earn Minute	Efficiency (%) = (Earn Minute / Available Minute)*100	DHU
November, 2015	57,711,780	21,352,252	37.00%	8.31
July, 2016	49,947,030	17,843,236	35.72%	2.57
December, 2016	74,710,110	32,000,344	42.83%	4.72

4.6 Ranking of the different Non-Productive Time

To identify the most affecting and contributing Non-Productive Time in total Non-productive time, ranking of the Non-Productive time has been done. Ranking has been performed in based on percentage contribution.

Individual percentage of contribution calculation: To measure the individual contribution of every Non-productive time, the following formula has been used.

Individual percentage of contribution = (Individual Non-productive time / Total Non-productive time) *100%.

As for example, percentage contribution of machine setup in total Non-productive time has been evaluated by measuring the following times for the November, 2015 where machine setup = 79192 minutes and total Non-productive time = 1286321 minutes.

So, percentage contribution of machine setup = (79192 / 1286321) *100% = 6.16% of total Non-productive time.

Similarly percentage contribution of every Non-productive time for three different months has been measured and given in Table 13 for the November, 2015 in particular.

Ranking of downtimes based on percentage of individual contribution: According to hierarchical sequence of individual contribution, different Non-Productive Time have been ranked. To establish a chronological order of all Non-Productive Time according to their contribution and inter-dependability, ranking of all Non-Productive Time was performed for the November, 2015 and has been put in Table 13 below as scheduled contributed the most, this was ranked as First.

Table 4.15: Ranking based on NPT (%) of contribution (Year: November, 2015)

Non-Productive Time Types	Non Productive Time (min)	Percentage (%)	Rank
Housekeeping/ Cleaning Issue	512790	39.86%	1
Cutting Input Not available	419305	32.60%	2
Power Failure	119733	9.31%	3
Machine Setup	79192	6.16%	4
Machine Breakdown	40944	3.18%	5
Cutting Permission Delay	26400	2.05%	6
Stream, Compressor Problem	22982	1.79%	7

Non-Productive Time Types	Non Productive Time (min)	Percentage (%)	Rank
Machine not available	22860	1.78%	8
Re-work	16035	1.25%	9
Accessories Not available	12720	0.99%	10
Machine Waiting	9010	0.70%	11
Fabric Fault	2640	0.21%	12
Sewing problem	1420	0.11%	13
Decision Delay	290	0.02%	14

Table 4.16: Ranking based on NPT (%) of contribution (Year: July, 2016)

Non-Productive Time Types	Non Productive Time (min)	Percentage (%)	Rank
Stream problem	1,425,444	91.32%	1
Power off	54,640	3.50%	2
Input gap due to docket delay	25,950	1.66%	3
Electricity problem	23,870	1.53%	4
Air problem	7,800	0.50%	5
Apw m/c problem	5,400	0.35%	6
Decorative hole m/c problem	4,400	0.28%	7
Lining in put gap	4,200	0.27%	8
Button stitch m/c problem	2,880	0.18%	9
Vacuum problem	2,610	0.17%	10
Waiting for work	2,205	0.14%	11
Zipper making m/c problem	900	0.06%	12
Bar tack M/C PROBLEM	500	0.03%	13
Arm hole tap joint m/c problem	180	0.01%	14

Table 4.17: Ranking based on NPT (%) of contribution (Year: December, 2016)

Reason	Non Productive Time (min)	Percentage (%)	Rank
Stream, Compressor Problem	2783987	86.76%	1
Power Failure	176366	5.50%	2
Input gap	98810	3.08%	3
Machine Breakdown	82863	2.58%	4
Waiting for work	24761	0.77%	5
Rework	18399	0.57%	6
Accessories Not Available	15300	0.48%	7
Layout Change	8400	0.26%	8

4.7 Month wise Organization Overall Labor Effectiveness (OLE)

At a glance below show the OLE for this organization for different month.

Table 4.18: Different month wise OLE of sewing section

Month	**Availability (%)**	**Performance rate (%)**	**Quality (%)**	**OLE**
November, 2015	97.71%	37.84%	91.69%	33.90%
July, 2016	96.87%	36.88%	97.43%	34.81%
December, 2016	95.70%	44.75%	95.28%	40.81%

4.8 Month wise Organization Overall Equipment Effectiveness (OEE)

OEE is the ratio of actual equipment output to its theoretical maximum output. The aims of Total Productive Maintenance (TPM) is to achieve the ideal performance and the Zero loss which means no production scrap or defect, no breakdown, no accident, no waste in the process running or changeover. The quantification of these accumulations of waste in time and its comparison to the total available time can give the production and the maintenance management a general view of the actual performance of the plant. It can help them to focus the improvement on the bigger loss [19]. It is calculated using the following formula: -

$$\text{OEE} = \text{Availability} \times \text{Performance Rate} \times \text{Quality Rate} \quad (4.3)$$

Performance rate (%) for OEE - This factor indicates the ratio of the actual output and the targeted output. In other words, loss of production occurs due to under-utilization of the machinery. Losses are incurred when the equipment is not run with full speed due to rough running of the equipment; jams and equipment wear [19].
Performance rate (%) = (Actual Production / Target Output) x100 (4.4)

Table 4.19: Month wise Performance (%) of the sewing section (Year: 2015, 2016)

Month	Target Output (pcs) / Month	Total Production (Pcs) / Month	Performance rate (%)
November, 2015	553,910	527,752	95.28 %
July, 2016	389,618	325,580	83.56 %
December, 2016	634,303	597,803	95.25 %

Table 4.20: Different month wise Availability, Performance and Quality rate of the sewing section (Year: 2015, 2016)

Month	Availability (%)	Performance (%)	Quality (%)
November, 2015	97.71%	95.28 %	91.69%
July, 2016	96.87%	83.56 %	97.43%
December, 2016	95.70%	95.25 %	95.28%

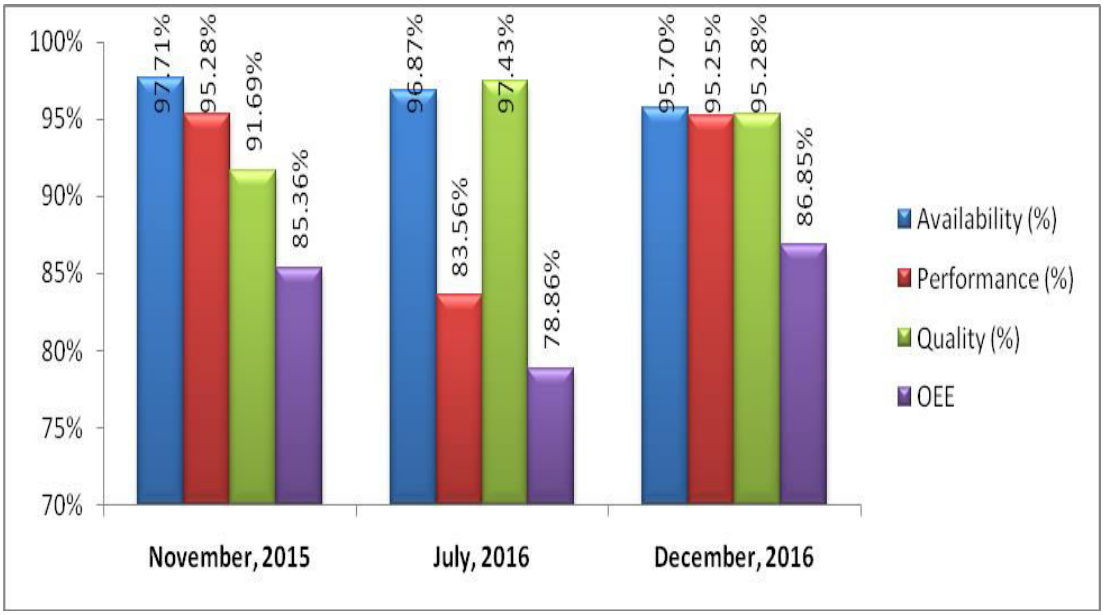

Fig 4.1 OEE comparison of November – 2015, July – 2016, December – 2016

CHAPTER 5

CONCLUSION

5.1 Conclusion

This case study research has extracted an overall scenario of the sewing section of the selected garments company in the context of productivity, quality, non-productive time, efficiency of sewing line. One of the main objectives of this case study is to increase sewing line efficiency, overall labor effectiveness (OLE) and overall equipment effectiveness (OEE) through the process improvement in sewing section. In this regard, this research has focused on a case-study work with the aim of evaluating current performance. In the month of November, 2015 found that organization sewing section efficiency – 37.0%, OLE – 33.90% and OEE – 85.36%. After providing training monthly basis and applying the worker capacity based on line balancing collected data for the month December, 2016 found that organization sewing section efficiency – 42.83%, OLE – 40.81% and OEE – 86.85%, that means improving. Findings of this research can be valuable and helpful to other similar garments factory of Bangladesh, those who expect for better productivity, efficiency through effective use of man, machines, materials and other resources.

5.2 Further work

The observations gained from this case study indicate some limitation as well as provide few scopes for future work. These are given below:

- To improve overall organization development, management can be more focus about Total Productive Maintenance (TPM) to reduce machine related non-productive time.
- Management can be more focus to develop multi-skill operator to improve productivity as well as efficiency.

REFERENCE

1. Adithan. M (2007), *Process Planning and Cost Estimation*, ISBN (13): 978-81-224-2655-7, New Age Publication, pdf.

2. Zairi, M. (1996). Benchmark for Best Practice: *Continuous learning through sustainable innovation.* Great Britain: Reed Educational &Professional Pub.

3. Schiemann, W, A. & Lingle, J. H. (1999). *Bullseye! Hitting your strategic targets through High* – Impact Measurement. USA: The Free press.

4. Source: [http://www.businessdictionary.com/definition/efficiency.html]: para. 1: [May 09, 2016]

5. RP news wires, Noria Corporation. "New KPI measures plants' overall labor effectiveness". (2011, Nov 30). Retrieved from https://en.wikipedia.org/ wiki/ Overall Labor_Effectiveness

6. Samuel H. Huang, John P. Dismukes, J.Shi, Qi Su, Ge Wang, (2002). "Manufacturing System Modeling for Productivity Improvement", *Journal of Manufacturing system*, vol.21, pp. 249-259.

7. G. E. Kunz, G. E. Ruth (2012). *Apparel manufacturing sewn product analysis*, 4th Edition. Pearson publication. ISBN 978-81-7758-076-1.

8. C. Harold, L. Barbara (1996). *The technology of clothing manufacture*, 2nd Edition. Blackwell Science. ISBN 0-632-03748-2.

9. M.R. H. Shumon, K. A. Zaman and A. Rahman. "Productivity Improvement through Line Balancing in Apparel Industries." Proceedings of the 2010 *International Conference on Industrial Engineering and Operations Management*, Dhaka, Bangladesh, January 9 – 10, 2010.

10. M.M. Islam, A. M. Khan and M. M. Islam. (2013), "Textiles Industries in Bangladesh and Challenges of Growth", *Research Journal of Management Science*, 2(6), 1-7.

11. S. Jannat, M. M. Hoque, N. Sultana, I. J. Chowdhury, "Time study of A Furniture industry: A case study at navana furniture industry". Proceeding of the

International Conference on Mechanical Engineering 2009 (ICME 2009), 26-28 December 2009, Dhaka, Bangladesh.

12. S. Bala, "Factors influencing costing of woven fabrics." *The Indian Textile Journal*, June, 2003.

13. D. P. Khanna, (2005) "Work study, time and motion study", Dhanpat Rai and sons, New Delhi (PP. 21).

14. M. M. Islam, A. M. Khan and M. M. Islam, (2013), "Application of Lean Manufacturing to Higher Productivity in the Apparel Industry in Bangladesh", *International Journal of Scientific & Engineering Research*, 4(2), 1-10.

15. P. Niknazar, (2009) "Application of integrated DEA-BSC model in strategic management", *6th international conference of management*.

16. D.P. Norton, (1999), "Use Strategy Maps to Communicate Your Strategy", Harvard Business Review, 1(2), November-December.

17. S. K. Bahadır, "Assembly line balancing in garment production by simulation." Retrieved from https//www.onlineclothing study.com (2014).

18. A.Neely, (2005), "The Evolution of performance measurement research", *International journal of operations and production management*, 25(12), 1264-1277.

19. Khairun Nahar, Md. Mohibul Islam, Md. Mostafizur Rahman, Md. Mosharraf Hossain, "Evaluation of OEE for Implementing Total Productive Maintenance (TPM) in Sewing Machine of a Knit Factory". Proceedings of the *Global Engineering, Science and Technology Conference*, 28-29 December 2012, Dhaka, Bangladesh.

Appendix 1

QUESTIONNAIRE FOR EMPLOYEE

Section-1: Company Profile

1. **Please indicate your core business areas in RMG industry-**

   □ Knitwear □ Woven □ Both

1. **Number of years that your organization has been operating**:

   □ Less than 3 years □ 3-5 years □ 6-10 years

   □ 11-15 years □ 16-20 years □ More than 20years

2. **How many people does this company employ (full-time)?**

   □ 1 to 500 □ 501 to 1000 □ 1001 to 2500

   □ 2501 to 5000 □ 5001 to 8000 □ 8001 or more

3. **The approximate annual sales revenue for this company(in BD Taka Core)**

   □ Less than 20 □ 20 to 40 □ 41 to 99

   □ 100 to 499 □ 500 or more

4. **Which of the following categories best describe your largest buyer?**

   □ Discount chains (e.g. ASDA, Kmart, Primark, Target, Tesco, Walmart)

   □ Mass merchandise retailers (e.g. JC Penny, Sears)

   □ Brand manufacturers (e.g. Zara)

   □ Brand marketers (e.g. Addidas, H & M, Liz Claiborne, Nautica, Nike, Puma)

   □ Apparel specialty stores (e.g. The Limited, The GAP)

   □Others (if possible please specify)

5. **How many years has your firm worked with the largest buyer (in terms of dollar value of exports)?**

   □ 1 - 3 □ 4 - 6 □ 7 - 9

   □ 10 - 12 □ 12 years and above

6. **How many buyers does your firm currently supply?**

   □ 1 - 3 □ 4 - 6 □ 7 and above

7. **Where is your largest buyer (in terms of dollar value of exports) located?**

   □ Africa □ Asia □ Australia □ Europe □North America

Section-2: Respondents profile

Name of Respondent person - ……

1. **Please tick the box that most closely corresponds to your occupation within the company –**

   □ Officer / Executive □ Assistant / Deputy Manager □ Manager

   □AGM / DGM □GM □Director/ CEO/COO

2. **What is your level of education?**

   □S.S.C □H.S.C/ Diploma □ Graduate/Bachelors □ Post-graduate/Masters □ PhD

Section-3: Operational Performance

1. **Are you familiar with the concept of 'Efficiency'?**

   □ Yes

   □ No

   If yes, what is your level of familiarity about efficiency?

   □ Very high

   □ Moderately high

   □ High

   □ Low

   □ Very low

2. **Are you familiar with the concept of 'Defects per hundred units (DHU)'?**

   □ Yes

   □ No

3. **Are you familiar with the concept of 'Standard Minute Value (SMV)'?**

   □ Yes

   □ No

4. **Are you familiar with the concept of 'Line Balancing & Bottleneck Analysis'?**

   □ Yes

   □ No

If yes, what is your level of familiarity about line balancing & bottleneck analysis?

- Very high
- Moderately high
- High
- Low
- Very low

5. **Have any facility for internal process and system that monitors production capacity and output?**
   - Yes
   - No
6. **Have any training program for manufacturing skill related work training?**
   - Yes
   - No
7. **Have any month wise training program for workers that received training on productivity?**
   - Yes
   - No
8. **Are you familiar with the concept of 'Lean Manufacturing'?**
   - Yes
   - No

   If yes, what is your level of familiarity about lean manufacturing?
   - Very high
   - Moderately high
   - High
   - Low
   - Very low
9. **Do you familiar with deadly "Wastes" (Overproduction, Excess Inventory, Waiting, Excess Motion, Excess Transportation, Rework, Over processing and Disconnectivity)?**
   - Yes
   - No

If yes, what is level of familiarity about Waste?

- Very high
- Moderately high
- High
- Low
- Very low

10. **Following are few lean tools. Please share your understanding level about Lean tools, Put "X" mark on appropriate cell.**

S/L	Lean Tools	Understanding Level				
		In-depth Knowledge	Workable Knowledge	Leaning about it	Heard about it	No Idea
1	5S (Sort, Set in Order, Shine, Standardize, Sustain)					
2	Visual Factory					
3	Standardize Work					
4	Bottleneck Analysis					
5	Takt Time					
6	VSM (Value Stream Mapping)					
7	Jidoka (Autonomation)					
8	Mistake Proofing (Poka Yoke)					
9	Andon					
10	Root Cause Analysis					
11	Gemba (The Real Place)					
12	Cellular Manufacturing layout					
13	PDCA (Plan, Do, Check, Act)					
14	Kanban (Pull System)					
15	Teamwork					
17	Total Productive Maintenance (TPM)					
18	Quick Machine Changeover					
19	Kaizen (Continuous Improvement)					
20	Hoshin Kanri (Policy Deployment)					

11. What are your suggestions for process improvement?

_____

_____

_____

_____

_____

_____

Thank you very much for giving your valuable time.