International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

Analysis on the proper utilization of man and machine to improve the efficiency and a proper line balancing of a sewing line: A case study

Sharmin Akter[1], Kazi Rezwan Hossain[2]
[1]Lecturer, Department of Textile Engineering, Daffodil International University
[1]Email: sharmin.te@diu.edu.bd
[2]Lecturer, Department of Textile Engineering, Daffodil International University
[2]Email: rezwan.te@diu.edu.bd

Abstract— This study is based on proper utilization of man and machine to improve the efficiency and a proper line balancing of a sewing line. In industry sectors, it is important to manufacture the products which have good quality and meet customers' demand. This action could be conducted under existing resources such as employees, machines and other facilities. However, plant layout improvement, could be one of the tools to response to increase industrial productivity. Plant layout design has become a fundamental basis of today's industrial plants which can influence parts of work efficiency. To increase the efficiency detailed work and time study were performed along the line. In this paper we showed how an effective layout can be designed and efficiency can be increased by appropriate line balancing using time study technique.

Index Terms: balancing, efficiency, layout, output, SMV, target, workstation

1 Introduction

Today's highly competitive global market, manufacturers are faced with a constant pressure to reduce costs, offer greater product selection, and faster product delivery. The focus of efficiency in the apparel industry is to reduce the use of resources. Global trend of garments industry is majorly related to the intense laborious activities. A systematic synchronization of process and operational parameters are required to produce a one piece of complete set of product [1]. So by proper utilization of resources like, man machine by optimal layout can improve the efficiency of production. Layout determines the relative position of each unit (department/ process/ function/ machine centre) within the facility (plant/ shop). It also determines the workflow pattern (job/ material/ work) in the facility. Layout design has a significant impact on most operational performance measure, especially on material handling cost, production cost, production lead-time, inventory level, quality control [2].

In garment production, until garment components are gathered into a finished garment, they are assembled through a sub-assembly process. The production process includes a set of workstations, at each of which a specific task is carried out in a restricted sequence, with hundreds of employees and thousands of bundles of sub-assemblies producing different styles simultaneously (Chan et al, 1998) [3]. The joining together of components, known as the sewing process which is the most labor intensive part of garment manufacturing, makes the structure complex as the some works has a priority before being assembled (Cooklin, 1991)[4]. Furthermore, since sewing process is labor intensive; apart from material costs, the cost structure of the sewing process is also important. Therefore, this process is of critical importance and needs to be planned more carefully (Tyler, 1991) [5]. As a consequence, good line balancing with small stocks in the sewing line has to be drawn up to increase the efficiency and quality of production (Cooklin, 1991; Tyler, 1991; Chuter, 1988) [6]. Sharing a job of work between several people is called division of labor. Division of labor should be balanced equally by ensuring the time spent at each station approximately the same. Each individual step in the assembly of product has to be analyzed carefully, and allocated to stations in a balanced way over the available workstations. Each operator then carries out operations properly and the work flow is synchronized. In a detailed work flow, synchronized line includes short distances between stations, low volume of work in process, precise of planning of production times, and predictable production quantity (Eberle et al, 2004) [7]. Overall, the important criteria in garment production is whether assembly work will be finished on time for delivery, how machines and employees are being utilized, whether any station in the assembly line is lagging behind the schedule and how the assembly line is doing overall (Glock&Kutz, 1995; Hui& Ng, 1999) [8]. To achieve this approach, work-time study, assembly line balancing and simulation can be applied to apparel production line to find alternative solutions to increase the efficiency of the sewing line (Kursun&Kalaoglu, 2009) [9].

2 Literature Review

Line layout: Layout refers to the configuration of depart-

International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

ments, work centers and equipment with particular emphasis on movement of work (customers or materials) through the system. Layout decisions require substantial investments (money and effort), involve long-term commitments, impacts the cost and efficiency of short-term operations. The need for layout planning arises in the process of designing new facilities and redesigning existing facilities [10].

Line balancing: Assembly line balancing is the problem of assigning various tasks to workstations, while optimizing one or more objectives without violating any restrictions imposed on the line. ALBP has been an active field of research over the past decades due to its relevancy to diversified industries such as garment, footwear and electronics. Ghosh and Gagnon (1989) [11] as well as Erel and Sarin (1998) [12] provided detailed reviews on these topics. Configurations of assembly lines for single and multiple products could be divided by three product, and mixed-model assembles multiple products, whereas a multi-model produces a sequence of batches with intermediate setup operations (Becker & Scholl, 2006) [13]. This research solves single-model line balancing problem with real application. Boysen, Fliedner, and Scholl (2007, 2008) [14,15] classified line types, single-model, mixed-model and multi-model. Single-model assembles only one ALBPs and pointed out that there were less than 5% articles explicitly solving line balancing of real world assembly systems. As a result, for practical consideration, this research focuses on the real case of an assembly line in garment manufacturing.

Time Study:A work measurement technique for recording the times and rates of working for the elements within specific conditions, and for analyzing the data so as to determine the time necessary for carrying out a job at a defined level of performance (Glock and Kunz, 2009) [16].

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 [17].

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 [18, 19].

Balance: Balance is an important factor. Balance = (minimum output/target output)* 100%

1. Methodology

In garments production, at first a garment model need to be developed. Then according to model the garments part are being cut and sewn according to assembled order. (Mominul, Mohiuddin, Mehidi, Sakib. 2014)[20]. A sewing line consists of a set of work station in which specific task in a predefined sequence is processed. (James, chen, Ling, Heng, Cheng. 2012)[21] In this case study, to analyze sewing line efficiency and line balancing, a T-shirt sewing line was considered. This study was accomplished in a garments factory of Bangladesh. In this study three case was considered. In each case we recorded the time required to finish each task, required operator and helper, type of machine in order to calculating SMV, BPT, efficiency, target output and balancing of the sewing line. In this study we proposed a line which have maximum efficiency and a balanced line out of three case by proper utilization of man & machine. We compared the efficiency and balancing value and got a production layout which have maximum efficiency and most balanced line among the three.

Measurement of T-shirt used in our case study-

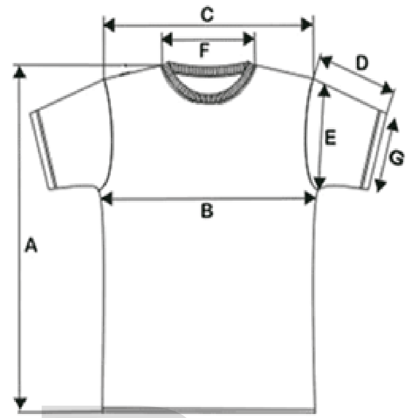


Figure 1: T -Shirt

	MEN'S T-SHIRTS SIZE CHART	S	M	L	XL	XXL
A	BODY LENGTH	68	70	72	74	76
B	CHEST 1 INCH BELOW FROM ARMHOLE	52	54	56	58	60
C	ACROSS SHOULDERS	44	46	48	50	52
D	SLEEVE LENGTH	20	20.5	21	22	23
E	ARMHOLE	25.5	26	26.5	27	27.5
F	NECK OPENING	16	16.5	17	17.5	18
G	SLEEVE OPENING	18	18.5	19	19.5	20

	WOMEN'S T-SHIRTS SIZE CHART	S	M	L	XL	XXL
A	BODY LENGTH	60	62	64	66	68
B	CHEST 1 INCH BELOW FROM ARMHOLE	38	40	42	44	46
C	ACROSS SHOULDERS	37	38	39	40	41
D	SLEEVE LENGTH	12	12	13	13	14
E	ARMHOLE	20	21	22	23	24
F	NECK OPENING	20	21	21.5	22	22.5
G	SLEEVE OPENING	13	14	14.5	15	15.5

Figure 2: Dimension of T-Shirt
Note: All the measurement in centimeters

3.1: Equation:
Standard Minute Value (SMV) = Basic time+ allowances

Basic Time= (Observed time X Observed rating)/ Standard rating

Basic pitch time= SMV/ No of workstation
Efficiency={ (per hour production X total SMV)/(man re-

International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

quired X working minute)} X 100%
Target= working minute/ BPT

Balancing= (Minimum out put/ target output) X 100%

3.2. Data Analysis and Calculations:

Before line balancing all the operations need to breakdown according to pursuant logical order. The breakdown is for better understanding and redact the sequential order of product processing steps. (Morshed&Palash. 2014)[22]. Taking the observed time for each operations manually and SMV is calculated by given equations. With the help of SMV, no of operations and man & minute value we can calculate BPT, efficiency, target production and balancing for each sewing line.

Scenario1:
Sewing line layout for scenario 1 is given below:

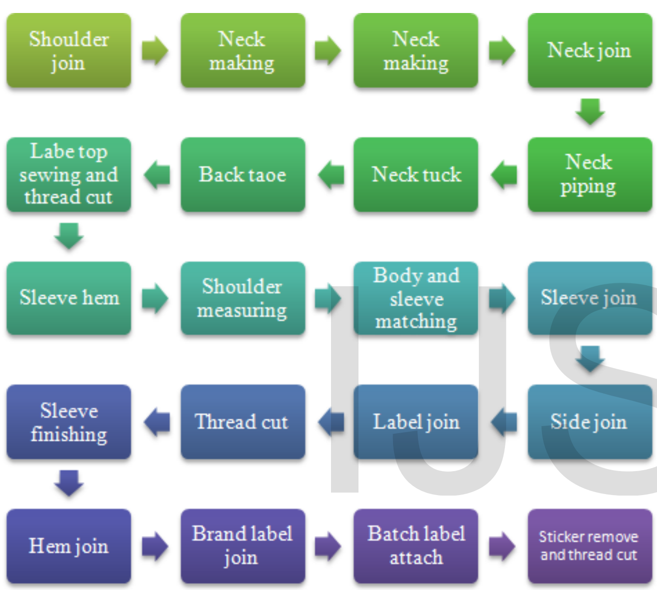


Figure 2: Layout of Sewing for a T-Shirt (Scenario 1)

The sewing operation starts form shoulder join and ends at sticker remove and thread cut. Total man power required for this operation is 20 and SMV is 6.65. In this line the production is 150 pcs per hour.

BPT= SMV/No. of workstation =6.65/20= 0.3325

Where, **BPT**= Basic Pitch Time

Table 1: Data for scenario 1 layout

SL. No	Operation Breakdown	Machine type	SMV	Target	Manning level
1	Shoulder join	OL	0.15	400	0.45
2	Neck making	SN	0.68	88	2.04
3	Neck making				
4	Neck join	OL	0.45	133	1.35
5	Neck piping	FL	0.25	240	0.75
6	Neck tuck	SN	0.15	400	0.45
7	Back tape	FL	0.35	171	1.05
8	Label top sewing and thread cut	SN	0.40	150	1.20
9	Sleeve hem	DNFL	0.45	133	1.35
10	Shoulder measuring	HP	0.20	300	0.60
11	Body and sleeve matching	HP	0.25	240	0.75
12	Sleeve join	OL	0.5	120	1.50
13	Side join	OL	0.6	100	1.80
14	Label join	FL	0.3	200	0.90
15	Thread cut	HP	0.2	300	0.60
16	Sleeve finishing	FL	0.3	200	0.90
17	Hem join	FL	0.45	133	1.35
18	Brand label join	FL	0.3	200	0.90
19	Batch label attach	SN	0.35	171	1.05
20	Sticker remove and thread cut	HP	0.35	171	1.05
		Total SMV	6.65		

Now,

Efficiency= {(per hour production X total SMV)/(man required X working minute)} X 100%

= ({150X 6.65)/(20X60)}X 100%

= 83.125%

Target output = working minute/ BPT

= 60/0.3325

= 180pcs

Balancing= (Minimum out put/ target output) X 100%

= (88/180)X 100%

= 48.89%

Scenario 2:
Sewing line layout for scenario 2 is given below:

International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

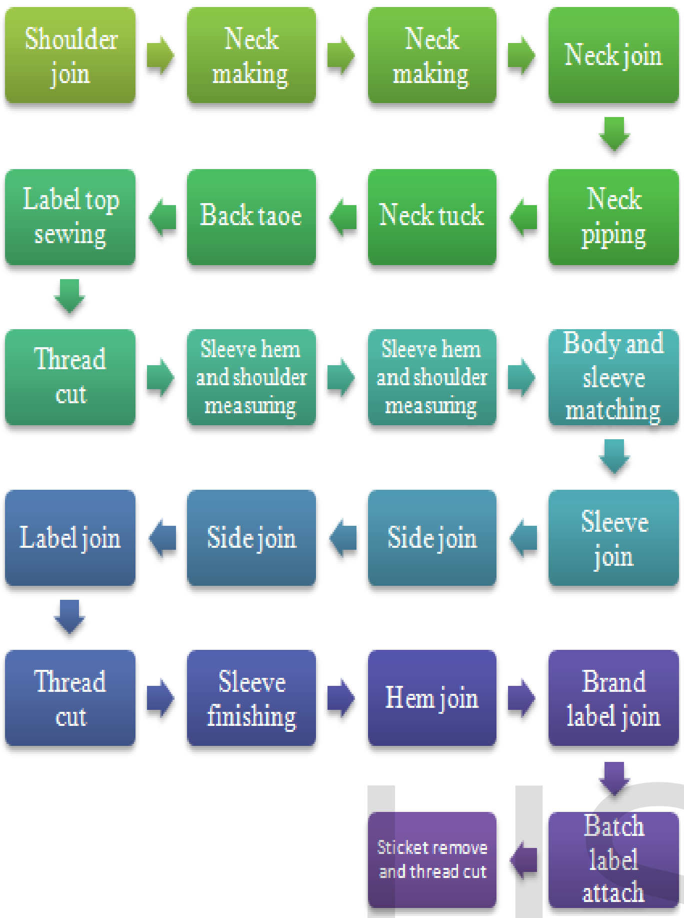


Figure 3: Layout of Sewing for a T-Shirt (Scenario 2)

The sewing operation starts form shoulder joining and ends at sticker remove and thread cut. Total man power required for this operation is 22 and SMV is 6.80. In this line the production is 150 pcs per hour.

BPT= SMV/No. of workstation = 6.80/22= 0.309

Where, **BPT**= Basic Pitch Time

Table 2: Data for scenario 2 layout

SL. No	Operation Breakdown	Machine type	SMV	Target	Manning level
1	Shoulder join	OL	0.15	400	0.49
2	Neck making	SN	0.75	80	2.43
3	Neck making				
4	Neck join	OL	0.45	133	1.45
5	Neck piping	FL	0.25	240	0.81
6	Neck tuck	SN	0.15	400	0.49
7	Back tape	FL	0.35	171	1.13
8	Label top sewing	SN	0.20	300	0.65
9	Thread cut	HP	0.20	300	0.65
10	Sleeve hem & Shoulder measuring	DNFL	0.70	85	2.27
11	Sleeve hem & Shoulder measuring				
12	Body & sleeve matching	HP	0.25	240	0.81
13	Sleeve join	OL	0.50	120	1.61
14	Side join	OL	0.60	100	1.94
15	Side join				
16	Label join	FL	0.30	200	0.97
17	Thread cut	HP	0.20	300	0.65
18	Sleeve finishing	FL	0.30	200	0.97
19	Hem join	FL	0.45	133	1.45
20	Brand label join	FL	0.30	200	0.97
21	Batch label attach	SN	0.35	171	1.13
22	Sticker remove and thread cut	HP	0.35	171	1.13
		Total SMV=	**6.80**		

Now,

Efficiency= { (per hour production X total SMV) X man requ-Ired X working minute)} X 100%

= {(150X 6.8)/ (22X 60)} X 100%

= 77.27%

Target output = working minute/ BPT

= 60/0.309

= 194pcs

Balancing= (Minimum out put/ target output) X 100%

= (80/194)X 100%

= 41.24%

Scenario 3:
Sewing line layout for scenario 3 is given below:

International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

Fig 4: Layout of sewing for a T-shirt (scenario 3)

The sewing operation starts form shoulder joining and ends at sticker remove and thread cut. Total man power required for this operation is 18 and SMV is 6.43. In this line the production is 150 pcs per hour.

BPT= SMV/No. of workstation **=** 6.43/18= 0.357

Where, **BPT**= Basic Pitch Time

Table 3: Data for scenario 3 layout

SL NO	Operation Description	Machine type	SMV	Target	Manning level
1	Shoulder join	OL	0.15	400	0.42
2	Neck making	SN	0.68	88	1.90
3	Neck join	OL	0.45	133	1.26
4	Neck piping	FL	0.25	240	0.70
5	Neck tuck	SN	0.15	400	0.42
6	Back tape	FL	0.35	171	0.98
7	Label top sewing & **Thread cut**	SN	0.3	200	0.84
8	Sleeve hem	DNFL	0.45	133	1.26
9	Shoulder measuring & Body & sleeve matching	HP	0.3	200	0.84
10	Sleeve join	OL	0.5	120	1.40
11	Side join	OL	0.6	100	1.68
12	Label join	FL	0.3	200	0.84
13	Thread cut	HP	0.2	300	0.56
14	Sleeve finishing	FL	0.3	200	0.84
15	Hem join	FL	0.45	133	1.26
16	Brand label join	FL	0.3	200	0.84
17	Batch label attach	SN	0.35	171	0.98
18	Sticker remove and thread cut	HP	0.35	171	0.98
		Total SMV	**6.43**		

Now,

Efficiency= { (per hour production X total SMV) X man requIred X working minute)} X 100%

= {(150X 6.63)/ (18X 60)} X 100%

= 89%

Target output = working minute/ BPT

= 60/0.357

= 168pcs

Balancing= (Minimum out put/ target output) X 100%

= (88/168)X 100%

= 52.38%

4 Result and Discussion

From these scenarios it can be easily seen that efficiency and balancing is increasing with the proper utilization of man and machine. In scenario 1, number of workstation (man, machine) was applied 22 but efficiency and balancing was 83.125% and 48.49% respectively. For the scenario 2, number of workstation was 20 but efficiency and balancing was 72.27% and 41.24% respectively. And for the scenarion3, number of workstation was 18 but efficiency and balancing was 89% and 53.38% respectively, which is the most in this study. And this is our proposed plan. In scenario 3, we merge some operation to reduce number of man and machine to operate the job. In our merging process we took proper care about the sequences of the operation. That is why balancing also increased.

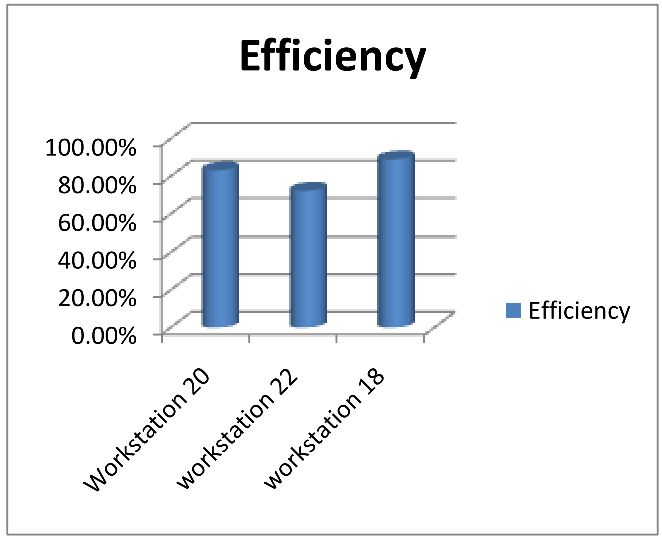
International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

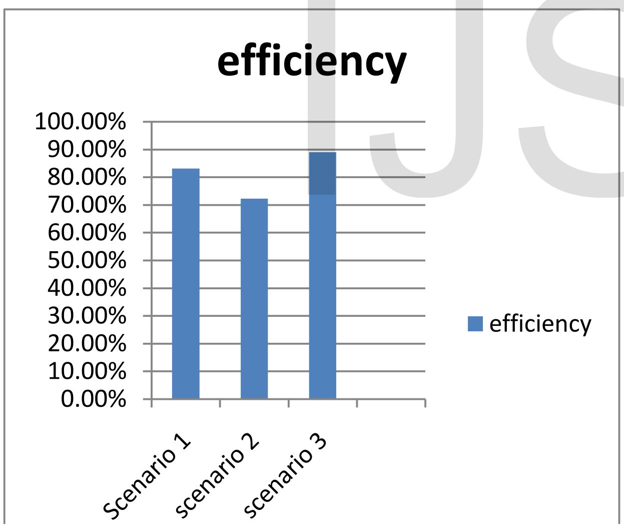
Comparative efficiency and balancing is given below:

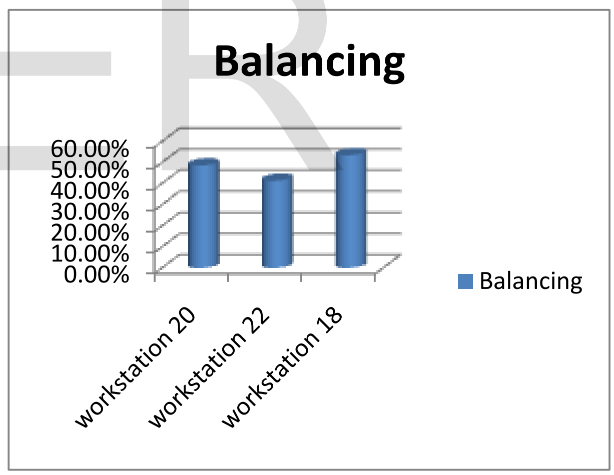
Table 4: comparative efficiency and balancing of the layout

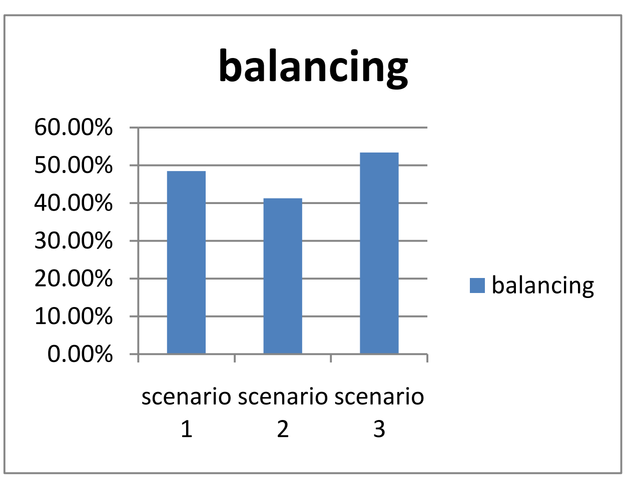
Name	SMV	Work-station(man + machine)	efficiency	Balancing
Scenario 1 (exist-ing one	6.65	20	83.125%	48.49%
Scenario (alterna-tive one	6.80	22	72.27%	41.24%
Scenario 3 (our proposed one)	6.43	18	89%	53.38%

With the decrease in number of workstation efficiency and balancing both are increased.









5 Conclusion

In garment industries sometimes it is difficult to identify the key areas and practices, which can be used to improve the current system & situation.Productivity in general is a ratio of output to input in the production of goods and services. Productivity is increased by lowering the amount of labor, capital, energy or materials that go into producing any given amount of economic goods and services. Increases in productivity are largely responsible for the increase inefficiency. Form our research we can easily say that with the decrease in workstation efficiency and balancing also increased. We believe that our findings also help others, those who expect better productivity with minimum workstation and better balancing within the worker.

International Journal of Scientific & Engineering Research, Volume 8, Issue 12, December-2017
ISSN 2229-5518

.

References

[1] Borse, S., Shrinivasan, V., Shivankar, V. S. 'Improving the garments productivity by using new design of folder'. International journal on textile engineering and process ISSN2395-3578.VOL 2.Issue 2.

[2] Das, A., 'facility design and line balancing'. May 26, 2013

[3] Chan, K.C.C, Hui, P.C.L., Yeung, K.W., Ng.F.S.F. (1998).Handling the assembly line balancing problem in the clothing industry using a genetic algorithm, International Journal of Clothing Science and Technology, Vol.10, pp. 21-37

[4] Cooklin, G. (1991). Introduction to Clothing Manufacturing, Blackwell Science, Oxford, p. 104.

[5] Tyler, D. J. (1991). Materials Management In Clothing Production, BSP Professional Books Press, London

[6] Chuter, A. J. (1988). Introduction to Clothing Production Management, Blackwell Science, Oxford, pp. 60-63.

[7] Eberle, H., Hermeling, H., Hornberger, M., Kilgus, R. ,Menzer, D., Ring, W., (2004). Clothing Technology, Beuth-Verlag GmbH, Berlin

[8] Glock, R. E. & Kunz, G. I. (1995). Apparel Manufacturing-Sewn Product Analysis, Prentice Hall, New Jersey, p:4

[9] Kursun, S. &Kalaoglu, F. (2009). Simulation of Production Line Balancing in Apparel Manufacturing, FIBRES & TEXTILES in Eastern Europe Vol. 17, No. 4 (75), pp.68-71

[10] Salonen, A. 'layout and line balancing'. Malardaneluniversity, Sweden.

[11] Ghosh, S., & Gagnon, R. J. (1989). A comprehensive literature review and analysis of the design, balancing and scheduling of assembly systems. Internal Journal of Production Research, 27, 637–670.

[12] Erel, E., &Sarin, S. C. (1998). A survey of the assembly line balancing procedures. Production Planning and Control, 9, 414–434.

[13] Becker, C., & Scholl, A. (2006). A survey on problems and methods in generalized assembly line balancing. European Journal of Operational Research, 168, 694–715.

[14] Boysen, N., Fliedner, M., & Scholl, A. (2007). A classification of assembly line balancing problems. European Journal of Operational Research, 183, 674–693.

[15] Boysen, N., Fliedner, M., & Scholl, A. (2008). Assembly line balancing: Which model to use when? International Journal of Production Economics, 111, 509–528.

[16] Glock, R. E. & Kunz, G. I. (1995). Apparel Manufacturing-Sewn Product Analysis, 4th edition

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

[18] Bala S., "Factors influencing costing of woven fabrics." The Indian Textile Journal, June, 2003.

[19] Khanna D. P., (2005) "Work study, time and motion study", DhanpatRai and sons, New Delhi (PP. 21).

[20] Islam M. M., Mohiuddin H.M., Mehidi S. H. &Sakib. N. "An Optimal Layout Design in an Apparel Industry by Appropriate Line Balancing: A Case Study". Global Journal of Research in engineering: G Industrial Engineering ISSN 2249-4596. VOL 14, Issue 5 Version 1.0 Year 2014

[21] James C. C. , Chun-Chieh C., Ling-Huey S., Han-Bin W., Cheng-Ju S. " Assembly line balancing in garment industry". Expert Systems with Applications 39 (2012) 10073-10081

[22] Morshed M. N. &Palash. K. S. "Assembly Line Balancing to Improve Productivity Using Work Sharing Method in Apparel Industry". Global Journal of Research in engineering: G Industrial Engineering ISSN 2249-4596. VOL 14, Issue 3 Version 1.0 Year 2014