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Implementation of Industrial engineering in the Ready-Made garments industry

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

Keywords: work study, time study, method study, thread consumption, SMV, efficiency

1. Introduction

The RMG industry in Bangladesh primarily is an export-oriented industry. It is mainly compromised of knit and woven garments. In 2011, Bangladesh became the second largest garment exporter in the world, second only to china. Present techno economic scenario is marked by increasing competition in almost every sector of economy [1, 5]. The expectation of the customers are on the rise and manufacturers have to design, and produce well in as many variety as possible (concept of economics of scale is no more talked off) to cater to the demands of the customers. Thus there is a challenge before the industries to manufacture goods of right quality and quantity and at right time and at minimum cost for their survival and growth. This demands the increase in productive efficiency of the organization. Industrial Engineering is going to play a pivotal role in increasing productivity. Various industrial engineering techniques are used to analyze and improve the work method, to eliminate waste and proper allocation and utilization of resources.

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

Industrial engineering is a branch of engineering which is used to eliminate waste of time, money, materials, machine time, energy, person-hours, and other resources that do not generate value. As like other manufacturing industry, industrial engineering now widely used in textile and apparel industry. Textile and garment industry have to face heavy challenges due to various factors including global competition, production costs increase, less productivity/efficiency, labor attrition, etc. For overcoming those challenges industrial engineering knowledge and formulas are frequently used in apparel manufacturing industry [3, 7]. In this article I have given some important and popular terms and formulas of industrial engineering. I have also given some examples for which reader can easily understand.

Industrial engineering is an inter-disciplinary profession that is concerned with the optimization of complex processes, systems, or organizations by developing, improving and implementing integrated systems of people, money, knowledge, information, equipment, energy and materials [8, 11].

Industrial engineers use specialized knowledge and skills in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results obtained from systems and processes [1, 7]. From these results, they are able to create new systems, processes or situations for the useful coordination of labour, materials and machines and also improve the quality and productivity of systems, physical or social. Depending on the sub-specialties involved, industrial engineering may also overlap with, operations research, systems engineering, manufacturing engineering, production engineering, management science, management engineering, financial engineering, ergonomics or human factors engineering, safety engineering, or others, depending on the viewpoint or motives of the user [2, 4, 6].

Even though its underlying concepts overlap considerably with certain business-oriented disciplines, such as operations management, industrial engineering is a longstanding engineering discipline subject to (and eligible for) professional engineering licensure in most jurisdictions [9, 11].

The current interest in Human factors engineering arises from the fact that technological developments have focused attention on the need to consider human beings and their interaction with machines, materials, information, procedures and environments in such developments and in designing a technological system [15]. The aim is to ensure that human beings and technology work in complete harmony, with the equipment and tasks aligned to human characteristics. Industrial engineering involves the synthesis and application of scientific principles to analysis, design, installation and improvement of integrated systems of humans, materials, equipment and information to provide the most efficient and effective operating and work environment. In this concern, this analytical article explores the relevant information on details of human factors and the interdisciplinary nature of human factors as well as the implications of human factors in industrial engineering and design. Moreover, it presents the basic relationship between human factors engineering and industrial engineering and the importance of learning human factors for an industrial engineer since an industrial engineer with a background in human factors is ideal, as he can analyze different design alternatives for machinery and processes, make trade-offs in the selection of equipment, and arrive at a better solution [13] [14, 15].

A time and motion study (or time-motion study) is a business efficiency technique combining the Time Study work of Frederick Winslow Taylor with the Motion Study work of Frank and Lillian Gilbreth (the same couple as is best known through the biographical 1950 film and book *Cheaper by the Dozen*). It is a major part of scientific management (Taylorism). After its first introduction, time study developed in the direction of establishing standard times, while motion study evolved into a technique for improving work methods. The two techniques became integrated and refined into a widely accepted method applicable to the improvement and upgrading of work systems. This integrated approach to work system improvement is known as methods engineering and it is applied today to industrial as well as service organizations, including banks, schools and hospitals [17, 20].

Sewing is the craft of fastening or attaching objects using stitches made with a needle and thread. Sewing is one of the oldest of the textile arts, arising in the Paleolithic era. Before the invention of spinning yarn/weaving fabric, archaeologists believe Stone Age people across Europe and Asia sewed fur and skin clothing using bone, antler needles and "thread" made of various animal body parts including sinew, catgut, and veins [10, 12].

For thousands of years, all sewing was done by hand. The invention of the sewing machine in the 19th century and the rise of computerization in the 20th century led to mass production and export of sewn objects, but hand sewing is still practiced around the world. Fine hand sewing is a characteristic of high-quality tailoring, haute couture fashion, and custom dressmaking, and is pursued by both textile artists and hobbyists as a means of creative expression.

The first known use of the word "sewing" was in the 14th century [16, 19].

Productivity describes various measures of the efficiency of production. Often (yet not always), a productivity measure is expressed as the ratio of an aggregate output to a single input or an aggregate input used in a production process, i.e. output per unit of input. Most common example is the (aggregate) labour productivity measure, e.g., such as GDP per worker. There are many different definitions of productivity (including htose that are not defined as ratios of output to input) and the choice among them depends on the purpose of the productivity measurement and/or data availability. The key source of difference between various productivity measures is also usually related (directly or indirectly) to how the outputs and the inputs are aggregated into scalars to obtain such a ratio-type measure of productivity [18, 21].

Productivity is a crucial factor in production performance of firms and nations. Increasing national productivity can raise living standards because more real income improves people's ability to purchase goods and services, enjoy leisure, improve housing and education and contribute to social and environmental programs. Productivity growth can also help businesses to be more profitable.

2. Materials and Methods

A. Materials

Works study

1. Stopwatch
2. Calculator
3. Clipboard
4. Pen
5. Handy cam

Thread consumption

1. Measurement tape
2. Garment picture
3. Calculator

B. Methods

1. Line Labor Productivity:

$$\text{Line Labor Productivity} = \frac{\text{Total number of output per day per line}}{\text{Number of worker worked}}$$

2. Line Machine Productivity

$$\text{Line Machine Productivity} = \frac{\text{Total number of output per day per line}}{\text{Number of machines used}}$$

3. Line Efficiency

$$\text{Line Efficiency} = \frac{\text{Total output per day per line} * \text{SAM}}{\text{Total manpower per line} * \text{total working minutes per day}} * 100\%$$

4. Theoretical Manpower

$$\text{Theoretical Manpower} = \frac{\text{Target per houre}}{\text{Process capacity per houre}}$$

5. Standard Pitch Time (S.P.T) = Basic Pitch Time (B.P.T) + Allowances (%)
6. GSD
   GSD = (Man power * Work hour) / Target
7. SMV
   SMV = Basic time + (Basic time * Allowance)
8. Basic time Basic time = Observed time * Rating
9. Observed time Observed time = Total Cycle time / No of cycle
10. Rating
    Rating = (Observed Rating * Standard rating) / Standard rating
11. Earn minute Earn minute = No of Pc’s (Production) * Garments SMV
12. Available minute Available minute = Work hour * Manpower
13. Capacity

Capacity = 60 / Capacity time in minute

14. Cycle Time Cycle Time = 60 / Team target
15. Capacity Achievable Capacity Achievable = Capacity * Balance
16. Daily output Daily output = Work hour / SMV
17. Factory capacity Factory capacity = (Work hour / SMV) * Total worker * Working day * Efficiency
18. CPM CPM = (Total overhead cost of the month / No of SMV earners Work minutes) *Efficiency
19. Required no of operator required no of operator = Target daily output / Daily output per operator
20. Efficiency Efficiency = (Earn minute * Available minute) * 100

3. Result and Discussion

We have tried some method to improve the skill of the operators. We add some templates to work place; change the handling methods to improve the work of the operators. First at the starting time the operators are little bit confuse about the works but at the end we have ours targeted results. We have improved the working of the worker & also their working efficiency.

A. Attach elastic to tunnel waistband

Fig 1: Attaching elastic to tunnel waist band (before)

Fig 2: Attaching elastic to tunnel waist band (after)

From Figure 1, it is seen that the operator are not using any type of templates, she just use a measurement paper and mark the waistband for attaching the elastics. Now by this method she is taking 22 sec for each body.

And From Figure 2, we have attached a template with the machine body. Now the operator doesn't have to mark for elastic positioning now it's very much easy for the operator to complete the work. After this method the operator are taking only 18 sec.

Table 1

Before	**22 sec**
After	18 sec
Improved time	4 sec

Here we have improved the working time by 4 sec and also improved the quality of the work.

B. Press fuse to back darts

Fig 3: Press fuse to back darts (before)

Fig 4: Press fuse to back darts (after)

From Figure 3, here the operators are not using any type of template to adjust the position of the fuse on the darts. He just put the fuse on the dart & presses them. Here sometimes the quality of the work is get low because the operator is not using any measurement help he just putting them at his own assumptions. Here he is taking 34sec time for per body.

From Figure 4, we have attached a template with the pressing table. By this process the quality is improved very much. Now the positions of fuse are very much accurate and the time is also getting improved. It's taking 29 sec to do a body.

Table 2

Before	**34 sec**
After	29 sec
Improved time	5 sec

Here we have improved the working time by 05 sec and also improved the quality of the work.

C. Make welt pockets

Fig 5: Make welt pocket (before)

Fig 6: Welt pocket (after)

From Figure 5, here for this operation we are using Auto Welt Pocket (APW) machine. Here the operator is taking 25 sec to make two welt pockets. Now here for this operation the APW machines is done the work very fast but we just look the working process and think some improvements to improve this operation more.

Again from Figure 6, we have improved the placement of the parts. By this placement the operator can easily takes the parts and apply the operation. We have also improved the handling process of the operator. Now the operator is making 2 welt pockets in only 19 sec.

Table 3

Before	**25 sec**
After	19 sec
Improved time	6 sec

D. Attach facing to pocketing

Fig 7: Attaching facing to pocket (before)

Fig 8: Attaching facing to pocket (after)

Figure 7, Here the operation is very easy operation. For this operation we have to just work on the skill of the operators. Now the operator is taking 21 sec for this operation. Which is good but we see the process and thing that we can improved little more in this operation work. So we work on this.

Figure 8, Here after improving the skill of the operator. The operator is taking only 15 sec for one body.

Table 4

Before	**21 sec**
After	15 sec
Improved time	06 sec

After we covered all the operation area of improvement then we analyze the regular styles which are currently running on the factory. We have made a chart of Revised SMV which we have analyzed.

Table 5: Comparison between old SMV and reserved SMV.

SL	Operation	SMV	Revised SMV
1	Mark and Sew Darts	0.35	0.31
2	Press Darts	0.30	0.27
3	Attach welt facing to pocketing	0.38	0.30
4	Make Welt pocket	0.40	0.41
5	Invert and Press Welt Pocket	0.36	0.36

6	Tack Welt Pocket Ends	0.38	0.29
7	Close welt facings on pocketing	0.36	0.25
8	Close back pocket bags and Invert	0.82	0.80
9	Tack upper welt –hidden	0.54	0.46
10	Topstitch pocket bags	0.68	0.56
11	Stay stitch pocketing and tack waist line	0.23	0.24
12	Press and Fuse side pocket lining to front	0.34	0.44
13	make down fly	0.08	0.16
14	Invert and Press down fly	0.15	0.22
15	Over lock Front rise	0.26	0.21
16	Over lock Top Fly	0.10	0.12
17	Over lock down fly	0.08	0.10
18	Attach piping to front pocketing	0.26	0.11
19	Make front pleat and top tack	0.54	0.75
20	Attach side facings to front pocketing	0.45	0.44
21	Attach pocketing to front with top facings	0.54	0.51
22	Notch and Invert side pocket open	0.10	0.15
23	Topstitch top facing joints	0.50	0.57
24	Close top facings on pocketing	0.40	0.34
25	tack front to side facings - sides & waist	0.45	0.49
26	Close Front pocket bags	0.45	0.42
27	Invert and Topstitch front pocket bags	0.48	0.37
28	Attach and Edge Stitch Top fly to front	0.38	0.36
29	Tack front rise	0.36	0.32
30	Attach Zip to right front	0.30	0.21
31	Attach & Top Stitch Down fly to right front	0.30	0.40
33	Attach zip to top fly	0.45	0.34
34	Measure and Cut Under Waist band and elastic cut	0.40	0.18
35	Fold and Top Stitch to back under waist band ends	0.30	0.12
36	Press Front and back Under waistbands	0.40	0.40
36	Press Tunnel and extension	0.40	0.30
37	Press Front and back Top waist bands	0.50	0.77
38	Mark top Front waist band and elastic cut	0.40	0.37
39	Attach top and under front waist band	0.40	0.27
40	Attach top and under back waist band with tunnel patch	0.50	0.54
41	Mark Front and back Waist bands	0.55	0.51
42	Close Front Waist band extension	0.35	0.42
43	Invert Front wb extension	0.25	
44	Attach elastic and to front wb extn ends	0.28	0.40
45	Tack elastic to Tunnel patch ends	0.28	0.46
46	Over lock Front and back under ends	0.30	0.06
47	Join loop ends	0.09	0.16
48	Make loops	0.15	0.16
49	Press loops	0.08	0.22
50	Measure and Cut Loops	0.10	0.18
51	Match Front and Back	0.30	0.33
52	Close Inseam legs	0.65	0.49
53	Close Side seam legs	0.90	0.78
54	Close back rise through front	0.50	0.58
55	Mark for loop location and Wb positioning	0.50	0.96
56	Match Waistband and loops	0.30	0.29
57	Attach loops to waist line	0.56	0.45
58	Attach Front Waist band	0.58	0.56
59	Attach Back Waist band	0.50	0.40
60	Close Waist band ends	0.40	0.40
61	Trim Waistband ends and invert shape.	0.30	0.51
62	Bar tack Tunnel loops and lower loops	0.56	0.49
63	Close front wb ends alongside pocket opening	0.58	0.54
64	Attach Tunnel wb to down pocket facing	0.45	0.56
65	Mark and attach elastic to front under wb	0.20	0.35
66	Tack Front wb elastic to back waist band	0.40	0.44
67	Insert Elastic ends to tunnel and tack	0.30	0.46
68	Fold & Top Stitch inner Back wb ends	0.35	0.42
69	Attach label to waistband	0.38	0.39
70	Close Front waistband	0.52	0.27
71	Sew J stitch	0.45	0.56
72	Close Tunnel wb on down facing	0.44	0.44
73	Mark for Front WB Extended elastic position	0.30	0.30

74	Tack Front extended elastic to back wb	0.45	0.45
75	Close Back Waistband	0.50	0.36
76	Hem Bottom Legs	0.70	0.70
77	Fold and Tack upper loops	0.56	0.49
78	Bar tack Crotch	0.08	0.07
79	Bar tack Front pocket ends and Fly area	0.35	0.35
80	Bar tack back pocket ends	0.28	0.28
81	Sew eye hole on Back pockets and Center Front	0.45	0.40
82	Mark and attach buttons to back pocket and CF	0.30	0.40
83	Spot tack back with ends	0.44	0.28
84	Touch up Waistband press for appearance	0.30	0.30
85	Cut excess loops	0.40	0.42
86	Trim thread ends	1.00	0.44
	Total	33.73	32.71

Table 6: Improved SMV of a particular style.

Buyer	**Haggar**
Style	Hc00248
Description	Hidden expandable wb(with pleat)
Smv	32.71
Planned efficiency	76%

E. After over implement the result of 10 styles

Table 7: Result of 10 styles.

SL	Buyer	Program	Style	Old SMV	Revised SMV	Difference	Percentage
1	Haggar	COOL-18	HC00235	33.51	33.31	3.2	10%
2	Haggar	COOL-18	HC00248	33.73	32.71	1.02	3%
3	Haggar	COOL-18	HS10371	33.11	30.20	2.91	9%
4	Haggar	COOL-18	HC10555	28.77	26.48	2.29	85
5	Haggar	PNIK	HC00683	30.68	29.56	1.12	4%
6	Haggar	PNIK	HC00685	35.60	33.29	2.31	6%
7	Haggar	PNIK	HC11000	34.35	31.85	2.5	7%
8	Haggar	PNIK	HC71000	29.32	28.47	.85	3%
9	Perry Ellis	BEN HOGAN	BGBF7080	32.24	30.2	2.04	6%
10	Perry Ellis	PGA TOUR	PVBS90K5	33.31	33.1	2.21	7%
		Average		32.46	30.417	2.045	6%

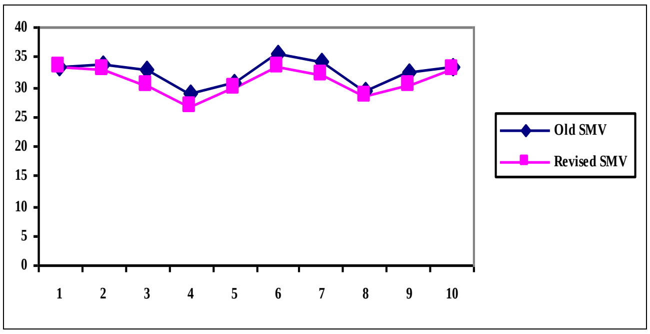

Fig 9: Comparison between old SMV and revised SMV.

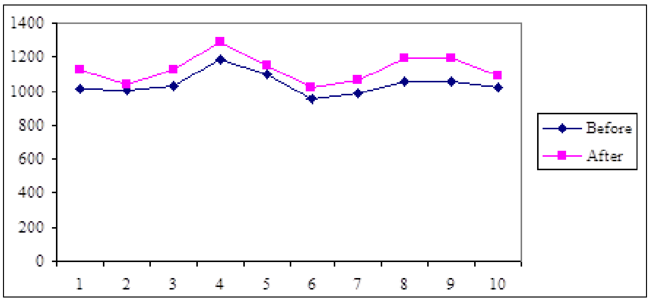

Fig 10: Before & after SMV.

F. Daily Production

Here we can see the effects of our project. When the SMV get tight the daily production will get increased. After our project we can get average 70pcs of extra production on daily basis. For current situation of our country RGM sector this is a very important study. Because by this we can save our lots of cost.

4. Conclusion

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

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