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Labour Productivity Improvement Using Line Balancing and Method Study Analysis: A Case of Indochine Apparel Factory

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Abstract

Labour productivity is one of the most essential performance indicators in garment manufacturing system. In the selected factory the planned production for one shift was 1200 pcs of trousers per line using 47 operators and the actual production was 718 pcs of trouser per shift. Due to this shipment delays were occurred frequently. So, this study aims to increase the labour productivity of a TCP type trouser sewing line through improving the method and balancing the line. Time study and method study techniques were used to get the required data. Using time study, the actual cycle time were recorded and using method study, value adding and non-value adding activities were identified according to the general sewing data (GSD system). Then these data were analysed using Ms. Excel, mathematical analysis and Arena software input analyser. Arena V14 full package software was used to represent the real system artificially and to analyse the queue of items, waiting time, daily output and work in progress (WIP). Scenarios were developed as shifting operators from one operation to other operation and method study analysis. Method study analysis gives a better improvement.

Key words: Labour productivity, Line balancing, Method Study, Garment production system

1. Introduction

Garment production system is one of the labour-intensive production systems with great economic advantage for the world. For such production system one of the key performance indicators is labour productivity that directly affect the overall productivity of the factory. Productivity is the relationship between the quantity of output and the quantity of input used to generate that output. It is basically a measure of the effectiveness and efficiency of your organization in generating output with the resources available. Most of the time, labour productivity in garment production system depends on the method that workers adopted and line balancing.

Islam discusses that there are various productivity techniques and performance measures with the aim of increasing manufacturing productivity (Islam *et al*., 2015). Some of the major techniques and methods are technology-based, employee-based, task-based, product-based techniques, and material-based techniques. Line balancing is one of the task-based techniques that can increase productivity. Line balancing in garment is usually undertaken to minimize imbalance between workers and workloads in order to achieve required run rate and productivity while meeting a required output from the line (Güner, 2008). Hence, this research is intended to identify critical bottlenecks using simulation analysis, balancing the line and avoiding unproper working method to enhance labour productivity for the case company. In garment industries, to examine the real production lines is very expensive and sometimes difficult due to many

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operations which done manually. A simulation model is an easier helpful way to build up models representing real production system. The model will assist to identify production line bottlenecks also to get insight in terms of production output, queues, resources utilization, etc. (Kitaw D. M., 2010).

1.1. Problem Statement

The factory's current export product is trouser, which has 19 workstations and 47 people per line. The export lines are designed to generate 1200 pieces per day, however current average output is just 718 pieces per day, which is less than the anticipated capacity. While the lines' average total efficiency is at 67 percent, productivity per operator is only about 16 pieces per operator compared to the average factory plan 24 pcs per operator. Shipment delays were common as a result of these challenges, and the manufacturer had to work overtime to fulfil the delivery deadline, resulting in higher manufacturing costs. On most workstations, there was also more work in progress (WIP). The objective of this research is therefore, to improve labour productivity using line balancing and method study.

1.2. Literature Review

Productivity can be defined as the application of the various inputs resources of an organization, industry, or country, in order to achieve certain planned and desired outputs (Baines, 1997). Higher productivity brings higher profit margin in a business and increment in productivity level reduces garment-manufacturing cost. Hence, factory can make more profit through productivity improvement (Naik, 2015). Productivity is a state of mind or an attitude that seeks the continuous improvement of what exists. It is a conviction that one can do better today than yesterday and that tomorrow will be better than today (Kitaw D. , 2011).

1.2.1. Line Balancing

Line Balancing is equalizing the workload across all operations in a line to remove bottlenecks and excess capacity. Line balancing helps to assign tasks to workstations, so that optimal assignment is achieved (Bappy, 2019). (Nabi, 2015) improves sewing section efficiency through utilization of worker capacity by time study techniques and enhances the line efficiency from 54.22% to 59.74% and productivity from 45.3% to 58% using line balancing of T-shirt producing line. Line balancing is a main part of a mass production.

1.2.2. Methodological Review

Method study is also called methods engineering or work design. Method engineering is used to describe collection of analysis techniques which focus on improving the effectiveness of men and machines (Suresh, 2008). Method study scope lies in improving work methods through process and operation analysis, such as manufacturing operations and their sequence, Workmen, Materials, tools and gauges, Layout of physical facilities and work station design, Movement of men and material handling, Work environment.

SAM or (Standard Allowed Minute) is used to measure task or work content of a garment. This term is widely used by industrial engineers and production people in the garment manufacturing industry. For the estimation of cost of making a garment SAM value plays a very important role (Korkut, 2009). General Sewing Data (GSD) has defined set of codes for motion data for SAM calculation. There are also other methods through which one can calculate SAM of a garment without using synthetic data or GSD. Predetermined Time Standard (PTS) code and direct time study methods are used to establish 'Standard Time' of a garment or other sewing products (Moktadir, 2017). Line balancing is performed by considering the SAM of each operation that performed to produce a particular garment.

Standard allowed minutes (SAM) = (Basic time + allowances) and it is always expressed in minutes.

2. Methodology

A production line was chosen for balancing, and the relevant data were gathered from the line. Stop watches, video cameras, and work study standard formats were used to record data for cycle time optimization, work method improvement, and job-sharing methods. Important documents such as monthly and annual reports, company profile, and inspection data were used in performing quantitative analysis. For this research primary from production line using stop watch techniques, interviewing and discussion with line managers, supervisors and secondary data collected from daily report, general sewing data (GSD) and production plan which are historical data were collected.

Primary data was obtained through continuous observation of operator movement, work station design, working environment, process flow. Time study was conducted to get cycle time of each sewing operation with the help of stop watch, time study sheet, pencils and time study board. The collected data was analysed using the formulas that are related to line balancing and standard time. During analysis of the data Microsoft Office Excel used to document the raw data. Also, it is used to present the result of the data through different charts; percentage share of sections, bar graph to show the status of each parameter and lean concept were used to identify non-value add activities and motion. Finally simulating the process was carried out using ARENA to show as-is and to-be process output.

Sampling Strategy

There are 19 Sewing lines operated for trousers manufacturing with comparable production efficiency. For this study TCP style trouser is selected by Company IE engineer since high demand in the market. The sample size is the number of readings that must be made for each element of work, given a predetermined confidence level and accuracy margin (Tanvir, 2013).

$$M = [40/\sum t \ \sqrt{N(\sum t^2) - (\sum t)^2}\ ]^2$$

Where: M - number of cycles should be observed

N - number of preliminary readings

t - cycle time of the task or observed time

Preliminary observation time 44, 43,40,52,48 second for sewing operation. Therefore N = 5

$\sum t = 44+43+40+52+48 = 227$

$M = [40/\sum t \ \sqrt{N(\sum t^2) - (\sum t)^2}\ ]^2$

$= [40/227\sqrt{5(\sum(44^2 + 43^2 + 40^2 + 52^2 + 48^2)) - (112)^2}\ ]^2$ =13.5~14 with 95.5% confidence interval.

Therefore, 14 cycles (observation) were taken for this research.

3. Analysis and Discussion

Indochine International, a subsidiary of the China-based Indochine Apparel Ltd., recently started the operations of its manufacturing unit in Ethiopia. Indochine have different types of products some of them are pocket Jeans, Chino Pants, Regular Pants, Skirts, T Shirts, Blouse. The production division of the factory consists different sections; Cutting, sewing (assembly), finishing and packing sections. the processing time for each operation was measured in seconds with 14 measurements for each operation recorded using stopwatch of TCP brand trouser.

Total observation time = $\sum_{t=1}^{14} Ot1 + Ot2 + Ot3 + \cdots + Ot14$

Average time = $\sum_{t=1}^{14} / N$

Normal time = average observed time * performance rating

PR = 100% Normal performance rating

Standard time = Normal time + (allowance factor * average time) for specific job

- Personal allowance (women) = 7%
- Fatigue allowance = 4%
- Machine allowance S/N =12.5%

Total allowance = 23.5%

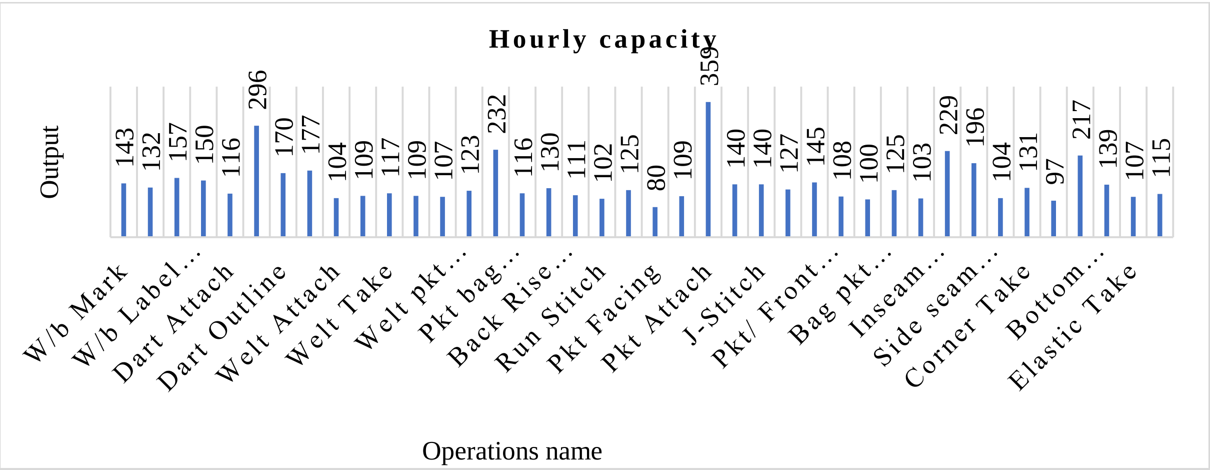

Figure 1. Output of each operation

The graph shows us there is unbalanced output since some operations have less output and others higher and it shows the line is not balanced.

Table 1. Data collection (cycle check)

INDOCHINE APPAREL PLC																				
Time Study Sheet		Observed Time (sec)														.				
S/No	Operation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	Avg.	Minute Value	MV with Allowance	O/P Per Hr	Total Hrly.
Waist Band Section																				
1	W/b Mark	21	23	18	17	19	22	24	17	18	20	22	24	21	20	20.4	0.34	0.42	143	143
2	W/b Button hole	21	24	22	22	23	23	23	22	21	20	21	22	22	24	22.1	0.37	0.46	132	132
3	W/b Label attach	15	24	21	16	18	18	20	17	16	17	20	16	22	20	18.6	0.31	0.38	157	157
4	W/b Button Att.	17	24	19	17	20	22	20	19	17	17	24	19	17	20	19.4	0.32	0.4	150	150
Back Section																				
5	Dart Attach	25	24	24	27	27	23	24	25	27	25	26	24	25	26	25.1	0.42	0.52	116	116
6	Dart Mark	10	9	9	11	10	12	11	8	9	10	9	9	11	10	9.86	0.16	0.2	296	296
7	Dart Outline	16	16	19	16	16	18	18	17	16	17	17	17	18	19	17.1	0.29	0.35	170	170
8	B/Pkt Facing	14	20	13	17	18	19	17	16	15	14	20	13	17	18	16.5	0.28	0.34	177	177
9	Welt Attach	28	29	28	29	29	27	28	29	25	27	29	28	29	28	28.1	0.47	0.58	104	104
10	Welt Iron	23	25	26	27	30	27	24	29	27	26	25	27	27	30	26.6	0.44	0.55	109	109
11	Welt Take	26	27	22	23	25	23	24	27	26	24	27	26	25	25	25	0.42	0.51	117	117
12	Welt button	24	26	27	29	27	27	26	25	25	26	27	28	29	27	26.6	0.44	0.55	109	109
13	Welt pkt Close	27	28	26	29	26	26	27	28	29	26	27	28	26	27	27.1	0.45	0.56	107	107
14	B/pocket over lock	24	24	23	23	24	24	23	24	25	23	24	23	23	24	23.6	0.39	0.49	123	123
15	Pkt bag topstitch1	25	22	23	23	24	23	22	23	24	24	25	23	24	22	23.4	0.39	0.48	125	232
16	Pkt bag topstitch2	23	29	27	29	27	26	25	27	27	28	27	27	29	28	27.1	0.45	0.56	108	
17	Back Rise OVL	19	25	30	25	25	24	24	25	26	27	27	26	26	24	25.2	0.42	0.52	116	116
18	Back Rise T/S	20	24	22	24	22	22	23	21	23	24	22	24	22	20	22.4	0.37	0.46	130	130
19	Welt Top T/S	27	26	26	28	25	26	27	25	26	28	27	25	26	25	26.2	0.44	0.54	111	111
20	Run Stitch	29	35	29	29	28	28	28	27	26	27	28	29	28	28	28.5	0.48	0.59	102	102
21	Back Bar tack	23	25	23	23	23	22	23	24	24	25	24	22	23	23	23.4	0.39	0.48	125	125
Front Section																				
22	Pkt Facing	37	36	37	37	37	37	36	35	34	37	37	36	36	37	36.4	0.61	0.75	80	80
23	Front Panel OVL	25	26	28	27	29	28	26	27	25	26	26	28	27	28	26.9	0.45	0.55	109	109

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24	Pkt Attach 1	16	17	18	15	15	16	17	18	15	15	16	16	17	18	16.4	0.27	0.34	178	359
25	Pkt Attach 2	16	17	16	18	13	16	17	18	16	17	18	14	15	14	16.1	0.27	0.33	181	
26	Zipper Close	19	20	20	22	21	22	21	20	22	23	20	21	20	21	20.9	0.35	0.43	140	140
27	J-Stitch	20	24	23	24	23	24	23	24	22	20	24	23	24	23	22.9	0.38	0.47	127	127
28	Fly Box	20	20	21	19	21	19	20	21	20	20	21	19	20	21	20.1	0.34	0.41	145	145
29	Pkt/ Front /Tack	25	24	30	27	28	25	29	30	27	25	24	30	27	28	27.1	0.45	0.56	108	108
30	Front /pkt OVL	24	28	28	24	26	25	28	27	28	26	27	28	29	28	26.9	0.45	0.55	109	109
31	Bag pkt outline	26	27	28	30	32	31	30	30	29	27	29	29	30	32	29.3	0.49	0.6	100	100
Assembly Section																				
32	Inseams OVL1	44	48	44	46	48	47	44	45	46	48	44	47	47	48	46.1	0.77	0.95	63	125
33	Inseam OVL2	43	47	45	47	48	46	43	46	47	49	51	46	47	49	46.7	0.78	0.96	62	
34	Inseam outline	26	25	27	30	32	27	26	26	27	28	29	30	32	30	28.2	0.47	0.58	103	103
35	Side seam OVL1	29	32	32	28	29	28	28	27	28	29	28	28	29	27	28.7	0.48	0.59	102	229
36	Side seam OVL2	24	22	21	24	25	21	22	22	24	24	22	21	24	25	22.9	0.38	0.47	127	
37	Side seam outline	30	29	31	30	32	30	32	31	29	30	29	30	31	29	30.2	0.5	0.62	96	196
38	Side seam outline	30	28	29	30	31	29	30	30	29	28	28	29	30	31	29.4	0.49	0.61	99	
39	W/b attach1	51	55	50	51	52	52	51	50	53	51	50	52	53	51	51.6	0.86	1.06	57	104
40	W/b attach2	65	60	62	60	64	60	62	60	64	62	60	62	60	64	61.8	1.03	1.27	47	
41	Corner Make	22	21	23	22	21	22	22	23	24	23	22	21	22	23	22.2	0.37	0.46	131	131
42	Front Bar Tack	28	30	31	30	32	30	31	30	29	28	29	31	30	32	30.1	0.5	0.62	97	97
43	Button Hole	15	14	13	14	12	12	12	13	14	15	14	13	14	13	13.4	0.22	0.28	217	217
44	Button attach	13	13	12	14	13	12	15	14	14	13	13	12	14	13	13.2	0.22	0.27	222	222
45	Bottom Hem1	44	42	43	44	42	42	44	43	42	44	42	40	41	42	42.5	0.71	0.87	69	139
46	Bottom Hem2	42	43	41	42	42	41	40	40	41	43	41	41	42	42	41.5	0.69	0.85	70	
47	Elastic Take	26	27	26	28	29	26	27	26	28	29	25	27	28	29	27.2	0.45	0.56	107	107
48	Loop Sitter attach	24	25	24	27	25	25	24	25	27	27	25	25	28	25	25.4	0.42	0.52	115	115

Data Analysis using Arena simulation

Cycle time distributions were analysed using the software's input analyser to obtain the optimal data distribution.

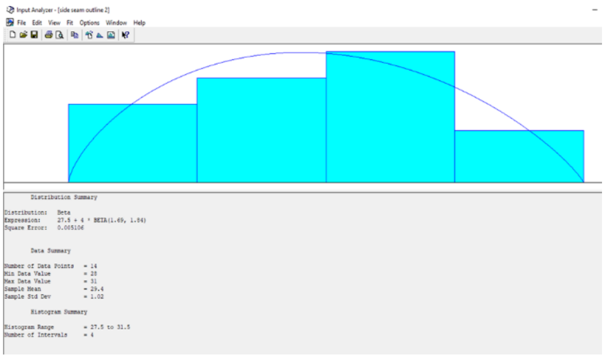

Figure 2. Input Analyser distribution function for bottom hemming operation (Example)

Table 2.Input Analyser data distribution function of each operation sewing section

No	Operation Name	Distribution
		Sewing Section
1	Waist Band Mark	Beta 16.5 + 8 * BETA (0.863, 0.894)
2	Waist Band Bottom Hole	19.5 + WEIB (2.97, 2.53)
3	Waist Band Label Attach	TRIA (14.5, 16, 24.5)
4	Waist Band Bottom Attach	POIS (19.4)
5	Dart Attach	22.5 + GAMM (0.721, 3.61)
6	Dart Mark	7.5 + ERLA (0.589, 4)
7	Dart Outline	15.5 + 4 * BETA (0.905,1.3)
8	Back Pkt Facing	12.5 + 8 * BETA (0.877, 0.877)
9	Welt Attach	24.5 + 5 * BETA (2.08, 0.834)
10	Welt Iron	TRIA (22.5, 26.9, 30.5)
11	Welt Take	21.5 + 6 * BETA (1.37, 0.977)
12	Welt Button	TRIA (23.5, 26.9, 29.5)
13	Welt Pkt Close	25.5 + 4 * BETA (0.905, 1.3)
14	Back Pkt Over look	22.5 + 3 * BETA (2.1, 3.36)
15	Pkt Bag T/S 1	21.5 + 4 * BETA (1.64, 1.87)
16	Pkt Bag T/S 2	NORM (27.1, 1.58)
17	Back Rise overlock	NORM (25.2, 2.3)
18	Back Rise T/S	19.5 + 5 * BETA (1.23, 0.924)
19	Welt Top T/S	24.5 + WEIB (1.93, 1.75)
20	Run Stitch	25.5 + ERLA (1, 3)
21	Back Bar tack	21.5 + ERLA (0.464, 4)
22	Pkt Facing	33.5 + 4 * BETA (1.99, 0.796)
23	Front Panel OVL	24.5 + 5 * BETA (1.72, 1.94)
24	Pkt Attach	UNIF (14.5,18.5)
25	Pkt Attach	12.5 + 6 * BETA (1.74, 1.23)
26	Zipper Close	18.5 + ERLA (0.589, 4)
27	J-Stitch	19.5 + 5 * BETA (1.24, 0.569)
28	Fly Boxer	18.5 + 3 * BETA (1.95, 1.64)
29	Pocket/ Front /Tack	23.5 + 7 * BETA (0.78, 0.749)
30	Front Pocket Overlook	TRIA (23.5, 28, 29.5)
31	Bag Pkt Outline	TRIA (25.5, 29.9, 32.5)
32	Inseam OVL 1	43.5 + 5 * BETA (0.67, 0.598)
33	Inseam OVL 2	NORM (46.7, 2.12)
34	Inseam Outline	24.5 + ERLA (1.86, 2)
35	Left Side Seam overlock	26.5 + LOGN (2.25, 1.71)
36	Right Side Seam Overlock	UNIF (20.5, 25.5)
37	Side Seam Outline 1	28.5+ WEIB (1.93, 1.75)

38	Side Seam Outline 2	27.5 + 4 * BETA (1.69, 1.84)
39	Waist Band Attach 1	49.5 + GAMM (0.908, 2.28)
40	Waist Band Attach 2	59.5 + 6 * BETA (0.567, 0.921)
41	Corner Make	20.5 + WEIB (1.94, 2.1)
42	Front Bar tack	NORM (30.1, 1.22)
43	Button Hole	11.5 + 4 * BETA (1.69, 1.84)
44	Button Attach	11.5 + WEIB (1.94, 2.1)
45	Bottom Hem 1	39.5 + 5 * BETA (1.8, 1.2)
46	Bottom Hem 2	39.5 + 4 * BETA (2.31, 2.26)
47	Elastic Take	18.5 + 3 * BETA (1.95, 1.64)
48	Loop Seater Later	TRIA (24, 25.2, 28)

Arena® version 14.0 full package simulation software was used to create the simulation model by verifying and validating for it.

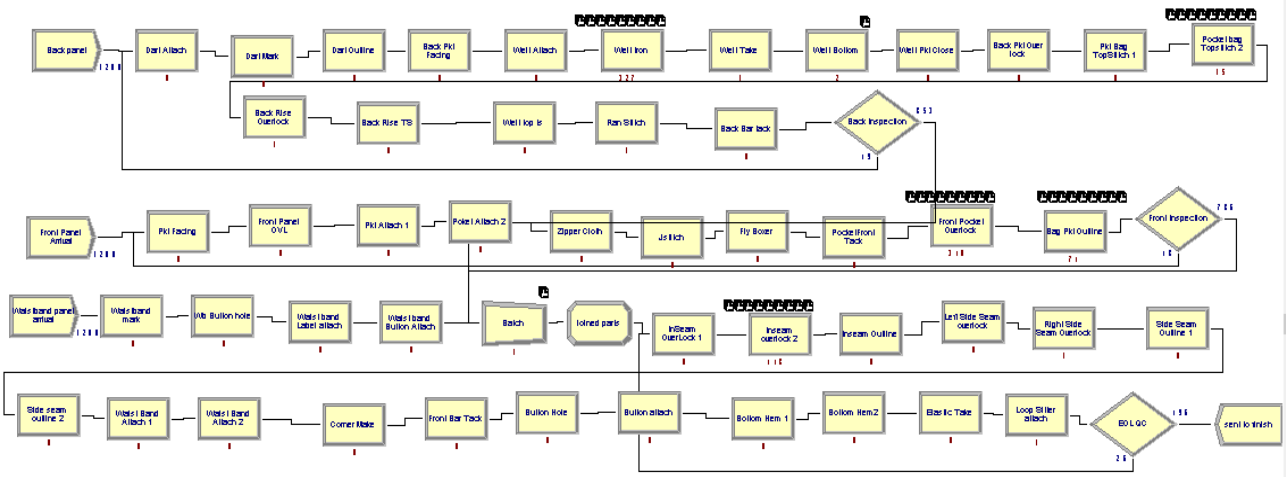

Figure 3.Existing Model for sewing section of TCP Style trouser

Based on the simulation result of 47 replications the average output, Work in Progress values, and number of operator/resources assigned for existing system is shown below.

Table 3.Output and WIP of existing system

S.No.	Section	Resource Assigned	Input	Average output/shift	WIP	Output per operator/shift
1	Back section	17	1,200	643	557	37.82
2	Front Section	10	1,200	596	604	59.6
3	Waistband section	4	1,200	948	252	237
4	Assembly section	17	1,185	729	456	42.88
	Total	48				

As shown in the above table the front section of trouser sewing has lower output (596 pcs per shift) and it has higher work in progress (604 pcs). The average output of back section and waistband section is 643 pcs/shift and 948 pcs/shift respectively and those are higher than front section's output. This informs us the production system is unbalanced and front section should get attention to improve the productivity of trouser sewing line. In the front section front pocket overlock operation has WIP of 228 pcs and pocket attach operation has WIP of 326 pcs. The resource utilization of front pocket overlock operator is 95.19% and utilization of pocket attach operator one is 58%. This informs us there is more burden on these operators and other operators' utilization is very low. Focusing on these operations leads to productivity improvement.

Alternatives to improve the productivity

Scenario 1. Shifting one pocket attach operator (operator with 2% capacity utilization) to front pocket overlock operation. Here, the production output of front section becomes 610 pcs per shift and the total production output becomes 742 pcs per shift. There is addition of 15 pieces in front section and 13 pieces in final output without adding extra resource for each section. Work in progress at pocket attach operation becomes null.

Scenario 2: Avoiding unnecessary activities while doing inseam overlock operation. General Sewing Data (GSD) is a PTS (Pre-determined Time Standards) based time measuring system. Here, the actual operation time is much higher than Standard minute value set by General sewing data (GSD) which results less hourly production output. The total non-value adding time found using video analysis was 9 seconds wasted by unnecessary motion while doing inseam overlock operation shown in the flow process chart below.

Table 4.Method study analysis for Inseam Overlock operation

Location: Sewing Line		Summary			
Activity: routine work		**Event**	**Present**	**Proposed**	**Saving**
Date:14/04/2021		Operation	9	8	1
Operator:	Analyst: Dadimos	Transportation	-		
Method and type: Method: Current		Delay	-		
		Inspection	1	0	1
Type: Material Operator Machine		Storing	3	2	1
Operation name: Inseam overlock		Time (sec)	44	35	9

Activity	Symbols					Time (sec)	Remark
Work piece on table	○	⇨	D	□	▼		
Picking some workpieces	●	⇨	D	□	▽	3	Value adding activity
Placing on knee	○	⇨	D	□	▼	2	Unnecessary
Picking a workpiece from knee	●	⇨	D	□	▽	3	Unnecessary
Align	●	⇨	D	□	▽	5	Necessary
Put on pressor foot	●	⇨	D	□	▽	1	Value adding
Sew	●	⇨	D	□	▽	6	Value adding
Align	●	⇨	D	□	▽	2	Necessary
Sew	●	⇨	D	□	▽	5	Value adding
Align	●	⇨	D	□	▽	4	Necessary
Sew	●	⇨	D	□	▽	7	Value adding
Inspect	○	⇨	D	■	▽	4	Unnecessary
Dispose to table	○	⇨	D	□	▼	2	Value adding

By subtracting nine seconds from the cycle time (cycle time reduced from 44 seconds to 35 seconds) of inseam overlock operation the simulation run has been done. The output from the improved model has positive result. Here, the production output of front section becomes 733 pcs per shift and the total production output becomes 906 pcs per shift. By merging Scenario one and three the production output of front section becomes 736 pcs per shift and the total production output becomes 905 pcs per shift as shown below. Therefore, incorporating method improvement with changing the level of resources at stations with higher number waiting has better results.

Table 5. Number of waiting items (scenarios comparison)

Section	Station	Existing System	Scenario 1	Scenario 2
		Number waiting	Number waiting	Number waiting
Front section	Front Pocket Overlock. Queue	228	516	526
	Pkt Attach Queue	326	0	0
Back section	Welt Iron. Queue	507.68	511	510
Assembly section	Inseam overlock 2. Queue	303.73	296	213
Total work in progress (WIP)		**1,365**	**1,323**	**1,249**

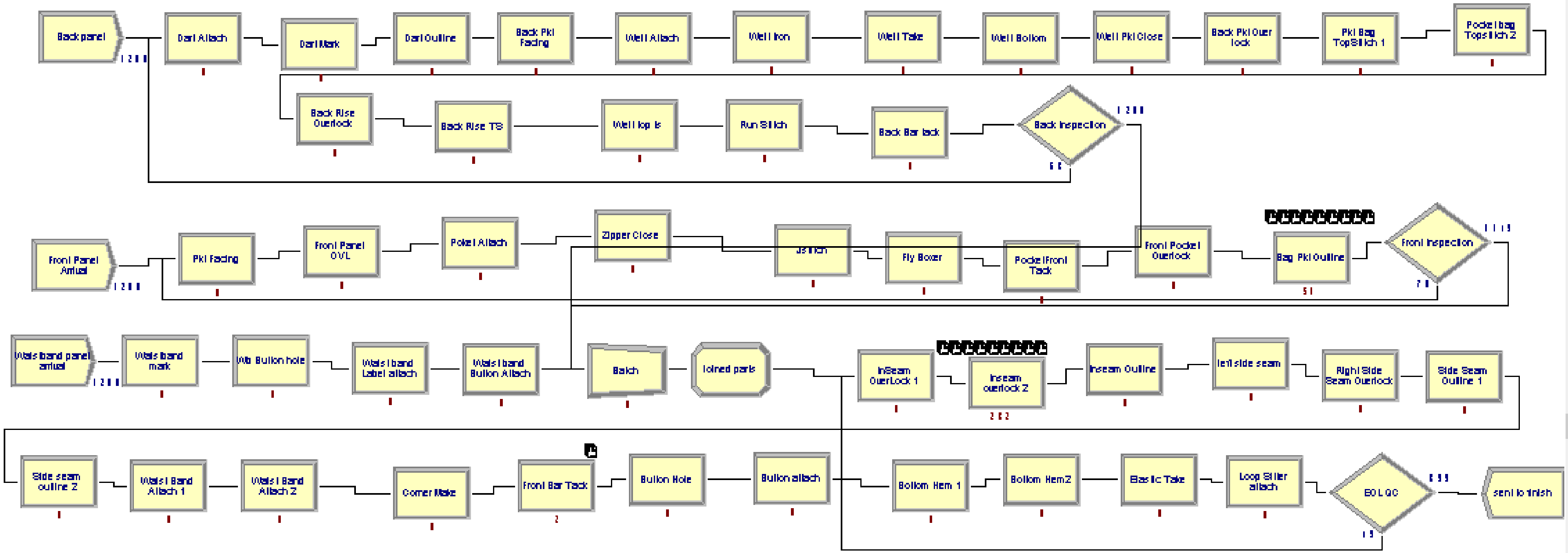

Figure 4. Improved Model

Table 6.Comparison of the existing system with developed scenarios

Scenarios	Parameters	Sections			Final Assembly
		Back section	Front Section	Waistband section	
Existing	Input	1,200	1,200	1,200	1,185
	Output	**643**	**596**	**948**	**729**
	Operators Assigned	17	10	4	17
	Output per operator	37.82	59.6	237	42.88
Scenario 1	Input	1,200	1,200	,1200	1,186
	Output	**649**	**610**	**967**	**742**
	Operators Assigned	17	10	4	17
	Output per operator	38.17	61	241.75	43.64
Scenario 2	Input	1,200	1,200	1,200	1,184
	Output	**801**	**736**	**1178**	**905**
	Operators Assigned	17	10	4	17
	Output per operator	47.1	73.6	294.5	53.23

4. Conclusion

This research focused with the labour productivity improvement of apparel sector through lean tools by minimizing bottleneck in production process approaches Indochine Apparel Factory in Hawassa Industrial Park. This was done by identifying sections that have less production. After simulating the existing system, the front section of trouser sewing line has lower output (596 pcs per shift) and it has higher work in progress (604 pcs) but the other sections produce more than the front section which shows the line has problem of line balancing. So, the research focuses on the front section to identify the problem. By analysing output of each operation in the front section, front pocket overlock operation and pocket attach operation affected by higher work in progress pieces. To improve the productivity of front section scenarios were developed as shifting underutilized operators to very tight operations and improving the method. By shifting one pocket attach operator (operator with 2% capacity utilization) to front pocket overlock operation production output of front section becomes 610 pcs per shift and the total production output becomes 742 pcs per shift, which has positive contribution to productivity. The other operation which is very critical was inseam overlock. By avoiding three unnecessary activities (motions) while doing inseam overlock operation as per General Sewing Data system nine seconds were saved and the shift production of front section becomes 733 pcs and the line production becomes 906 pcs. By merging those two scenarios the production output of front section becomes 736 pcs per shift and the total production output becomes 905 pcs per shift.

Therefore, this research gives us better practical understanding and knowledge about applications of Industrial Engineering tools for the productivity of garment manufacturing system. The method improvement gives us higher productivity and focusing on working method is better for the future research and for the company too.

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