Faculty of Engineering

Department of Textile Engineering

Impact of Non-Productive Time on Productivity of Basic, Semi-Critical and Critical Garments in Sewing Section

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A thesis submitted in partial fulfillment of the requirements for the degree of **Master of Science in Textile Engineering**

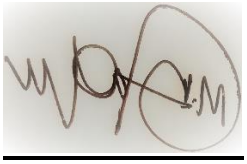
May, 2023

DECLARATION

I hereby declare that the work which is being presented in this thesis entitled, "**Impact of non-productive time on productivity of basic, semi-critical and critical garments in sewing section**" is done by myself, has not been presented for a degree of any other university and all the resources of collected information for this report has been duly acknowledged.

Submitted by	**Id no.**	**Signature**
Moshiur Rahman	**201-32-410**	

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.



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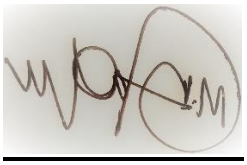
Approval Sheet

This research entitled **''Impact of non-productive time on productivity of basic, semi-critical and critical garments in sewing section''** at Daffodil International University, prepared and submitted by Moshiur Rahman (201-32-410), in partial fulfillment of the requirement for the degree of Master of Science in Textile Engineering has been examined and hereby recommended for approval and acceptance.

Supervisor



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My heartfelt thanks to my wife for her cordial co-operation, continuous inspirations and incredible support. Also, thanks to my sons, parents and family members for their unconditional love and support.

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DEDICATION

At first would like to express my gratitude to almighty ALLAH (SWT) for giving me chance to complete this work. I would like to dedicate this small piece of work to my family specially to my loving wife for her unconditional support, inspiration and assistance. I am very much pleased to her. I also dedicate my thesis to my sons, parents and other family members for their unconditional love and support.

ABSTRACT

Garments business is one of the most challenging businesses in the world. To survive in this competitive market, it is necessary to consider various techniques both before and during the start-up of the business. Product design, sampling, cutting, sewing, embellishment, finishing, and other processes are all part of the garment manufacturing process. To achieve the desired productivity, all of these activities must be performed in a synchronized, planned, and timely manner. Sewing is a crucial part of the manufacturing process. The purpose of this study was to investigate the effect of non-productive time (NPT) on sewing production at various efficiency levels (55, 65, and 75%). However, not only does efficiency influence NPT, but so does the complexity of the garment. Therefore, in this study, basic (T-shirts), semi-critical (hoodies), and critical (jackets) products were chosen to identify the NPT of a renowned garment factory, namely Oxford Knit Composite Ltd. (Pretty Group). The time study method, one of the most effective tools, was used in this study. This study reveals that at the highest efficiency level (75%), the production deviation due to NPT for T-shirts, hoodies, and jackets was 19.7, 8.8, and 6.3 pcs/h, respectively. However, if NPT is not controlled, output will not increase significantly. The NPT of T-shirt, hoodie, and jacket was about 0.4, 0.8, and 2.9 min, respectively. Additionally, NPT has a proportional relationship with SAM and product's complexity. It is worthy to mention an annual loss of 21465, 25927, and 29640 USD for T-shirts, hoodies, and jackets, respectively, that occurs at a 75% efficiency level. Therefore, it is recommended to reduce the NPT to maximize profit and productivity.

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List of Acronyms

OL- Overlock

FL- Flat Lock

SNL- Single Needle Lock

M- Man

FB- Flat Bad

CB- Cylinder Bad

BA- Button Attach

BH- Button Hole

BT-Bartack

NPT- Non-Productive Time

SAM- Standard Allowable Minutes

Chapter 1

Introduction

Joining of different parts together is the most important part of the garment industry. Apparel assembly is a time-consuming and complex process that has a significant impact on production performance and product quality (Ghosh and Gagnon, 1989). Again, because of the availability of cheap labor, garment industries in developing countries such as Bangladesh are more focused on sourcing raw materials and lowering manufacturing costs. Though labor costs are lower, the business is becoming more difficult to compete due to various types of non-productivity garments. To increase productivity in the sewing section, non-productive activities must be reduced. The majority of garment industries use a progressive bundle production system. This manufacturing system has numerous issues, one of which is a bottleneck (Nabi et al., 2015). Time study is a work measuring approach that records the durations of completing a certain task or its components under specific conditions and analyzes the results to determine how much time is required for an operator to complete the task at a specific rate of performance. In an industry, profit is typically given more attention. Finding wastes, avoiding, and rectifying poor work are only a few of the many difficulties involved in cost reduction that an industry must deal with internally to achieve significant cost savings (Feld, 2000). Although the garment sector in Bangladesh has an organizational framework, the problem lies with the mid-level management because the employees lack adequate job descriptions. The description of rules and responsibilities, as well as power and authority, is crucial for the smooth operation of any organization's production. In today's competitive world, manufacturers must be mindful of time, cost, quality, and delivery. To be a business champion, these four components, along with good management skills and innovative

technological aspects of modern development, should be prioritized. A systematic approach to identifying and eliminating waste through continuous improvement by delivering the product at the customer's request (Tandon et al., 2014). There are several factors that influence non-productive time (NPT), which influences a garment factory's financial losses. One of the most common causes of NPT is a problem with the sewing section layout. Furthermore, different types of garment products have a significant impact on the NPT. As a result, the focus of this study was on how different types of garment influence NPT as well as financial losses.

Aims and objectives:

The present study was aimed to complete the following objectives:

i. **Broad objectives**

The objective of the study was to investigate the relationship between non-productive time (NPT) in the sewing section and the financial outcome of the garment industry.

ii. **Specific objectives**

- To identify the NPT according to the types of garments (basic, semi-critical, and critical)
- To examine the sewing procedure for the aforementioned garments types
- To analyze product costs and determine the causes of low sewing line productivity
- To put the concept into practice, increase sewing inefficiency and reduce time and money spent on organizing

Chapter 2

Literature Review

2.1Factory Background

Pretty Group is one of the largest garment manufacturers in Bangladesh. In 2001, it has started its journey for operation. Corporate Head Office is situated at Gulshan. The sister concern of Oxford Knit Composite Ltd., Pretty Sweater Ltd., D&S Pretty Fashion Ltd., Pretty Composite Textile Ltd., S. Suhi Industrial Park Ltd., Oxford Colors Ltd., Oxford Shirt Ltd. and Oxford Knit Composite Ltd (OKCL).

Quality and on time delivery are the motto of the group. Total customer satisfaction is their aim and we never compromise it. They made diversified products and the category includes- Sweater, Shirt, Bottom, T-Shirt, Polo Shirt, Hoodie, Jeggings, Romper and more. OKCL has composite knit factory includes knitting, dyeing, finishing and stitching. Pretty can provide one stop apparel solution. It is highly specialized in Sweater Manufacturing. Nevertheless, they can also handle any kind of cotton, Twill, Canvas, Corduroy, Poplin, and any knitted stretch fabric. Their yearly capacity is 24 million pcs Sweaters, 8 million pcs of Shirts and 10 million Pcs T-shirts. Table 2.1 shows a short overview of OKCL.

Table 2.2: Pretty Group at a glance (source: http://www.prettygroupbd.com)

Establishment	**:**	2001
Aim	**:**	Quality and on time delivery with customer satisfaction
Logo	**:**	
Customers	**:**	Okaidi, Next, Lidl, Springfield, Pimkle, Jules, Auchan, JC Penny, Kohls, Walmart, Tesco, Target, Soriana, GU, Carter's, Celio, Akerman's, Brice, Cotton on, Debenhams, H & M, Mr. Price, Uniqlo, Zara, S.Oliver, C & A and so on.
Certificates:	**:**	ISO.9001-2008, C-TPAT, Wrap/ BSCI/ Sedex/ Accord/ BGMEA/ ALLIANCE/ BKMEA/ BDYEA/ DCCI
Production capacity:	**:**	42 million pcs per year
Total work force:	**:**	As on January 2022; 25,000 (Work Force)

2.2 What is non-productive time?

According to Jain et al., (2015), Non-Productive Time (NPT) is a term used in industrial engineering. Non-productive time is time spent by an operator without producing any garment (standard minutes), such as 'setup time'. Non-productive time is measured in garment manufacturing to determine how much standard time is lost due to machine downtime (Islam et al., 2013). Lost time is recorded to provide management with an explanation for low production on a particular day or lower line efficiency. Jain et al., (2015) gave some examples of lost time as follows:

1. Line setting
2. Machine Breakdown
3. Cutting not available
4. Stitching Quality issue
5. Cutting quality problem
6. Power failure
7. Change of Feeding Plan
8. Basic Amenity

Bangladesh, the third-largest clothing exporter in the world, earned $33.60 billion from the export of garments in 2019. (Monthly Export Summery Sheet, 20-21). The performance of the global apparel market is based on a number of factors, including manufacturing lead time, product quality, production cost, worker efficiency percentage, and eliminating production faults or reworking the system to reduce non-productive time (NPT), among others (Alam, 2018). Rework is a common task in the garment industry that removes production-process bottlenecks and concentrates on high-quality products, having an effect on the entire factory economics (Nayak & Padhye, 2015). The majority of unproductive time and activities are found in many areas, including sewing, fabric cutting, and others. However, the problem starts when the stitching piece is first processed. The section's capacity utilization ranges from 40 to 65 percent as a result of issues with non-productive time (NPT) at each operational phase (Kothalawala & Pallegedara, 2016). Industrial engineers are usually responsible for the task of recording and evaluating line-by-line NPT for the factory in garment manufacturing. The majority of printed forms are employed to track non-productive time.

2.3Non-productive activities

The garment industry is extremely competitive lately. Minimizing the lead time effectively is one of the finest methods to thrive in this cutthroat market (Haque, 2009). Due to a surplus of unproductive tasks, maintaining lead times might occasionally be challenging. Non-Productive Activities are those tasks that do not contribute to production and that cause process performance to be delayed. Line setting, machine breakdown, lack of cutting supplies, poor sewing stitch quality, poor fabric quality, electrical failure issue, and change in feeding plan are examples of non-productive operations (Kim & Mauborgne, 1999).

2.4Time study method to determine NPT

One of the most often employed methods of measuring work is the time study. In general, a time study analysis will involve taking a small sample of one worker's activity and using it to establish a standard for a task of that kind.

A time study is a process used to estimate how long it should take a well-trained, competent person working in a regular setting and following a certain procedure to complete a given task.

Time study is a branch of engineering that measures the productivity of a manufacturing process to determine where it can be improved. Time study explains the best way to do something, the time required to complete a task, and how to measure production rates in the manufacturing process (Khatun, 2013). Time study, according to ANSI (American National Standard Institute), is "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." When there is a lot of repetitive work, the amount of time required to complete a specific job or operation under existing conditions, using the specified & standard method in a standard space. Different types of allowance are permitted on the apparel production floor. Personal time allowance, Delay allowance, and fatigue allowance are examples (Shahidul and Akter, 2014).

According to Jain et al., (2015), time study is carried out using the following method. A printed format is given to each line. One person (line feeder, work study officer, or line supervisor) is allocated to be responsible for recording lost time in total man minutes in the format. During production hours, whenever it is seen operators sitting idle, the reasons for their lack of work (or failure to complete the task) is investigated and recorded the start and stop times in accordance with the sample format. If multiple operators are idle for the same reason, multiply the lost time by the number of operators to calculate the total number of man-minutes lost and record it on NPT format. Lost time recorded in this category must be approved by a supervisor or another authorized person. The total lost time is calculated in each category at the end of the day.

2.5Factors influencing non-productive time and activities

According to Alam and Sultan (2021), Figure 3.1, 3.2 and 3.3 show the factors influencing NPT on the productivity of a garment industry.

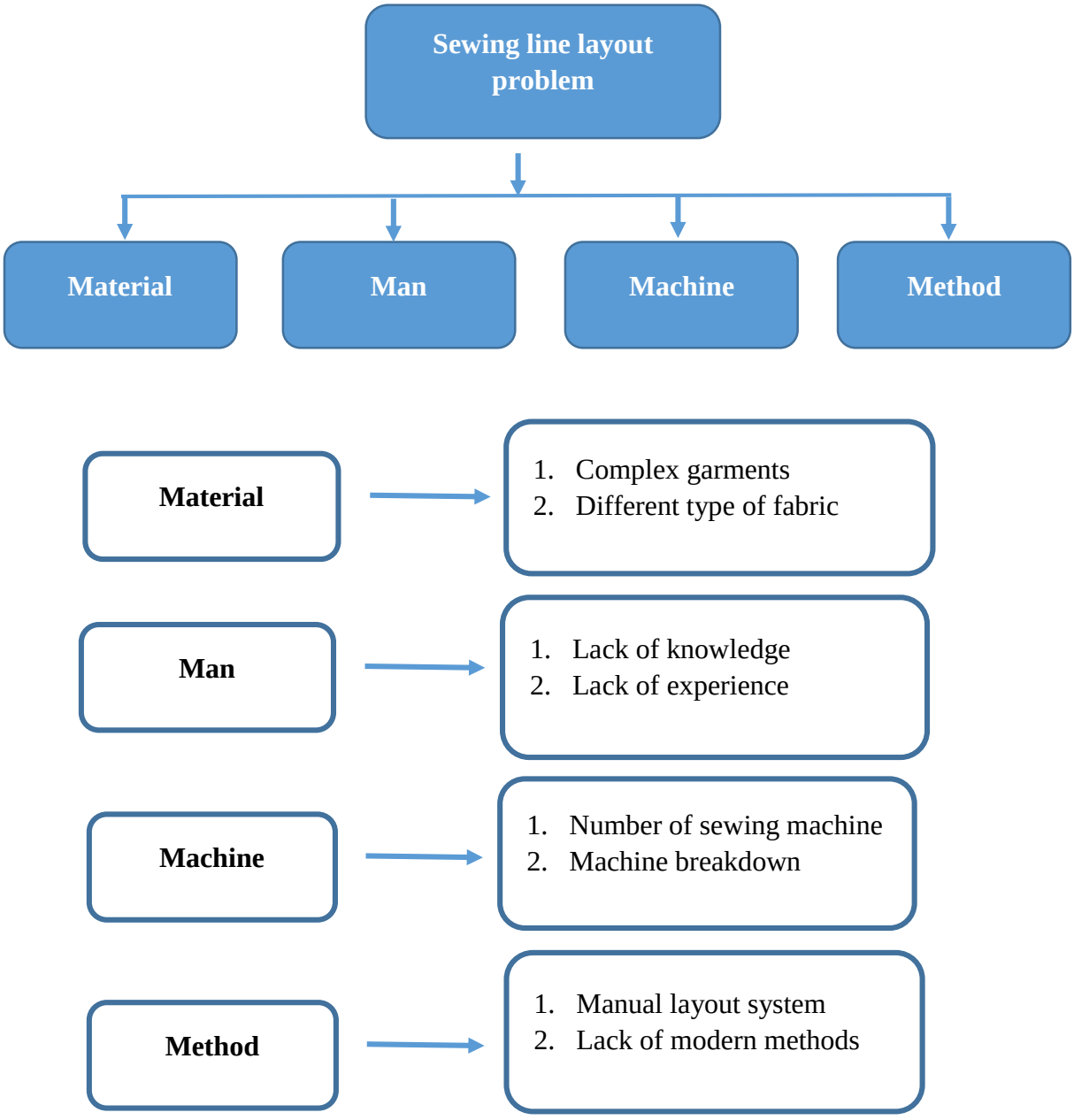


Figure 2.1. Factors affecting the NPT based on sewing layout problem

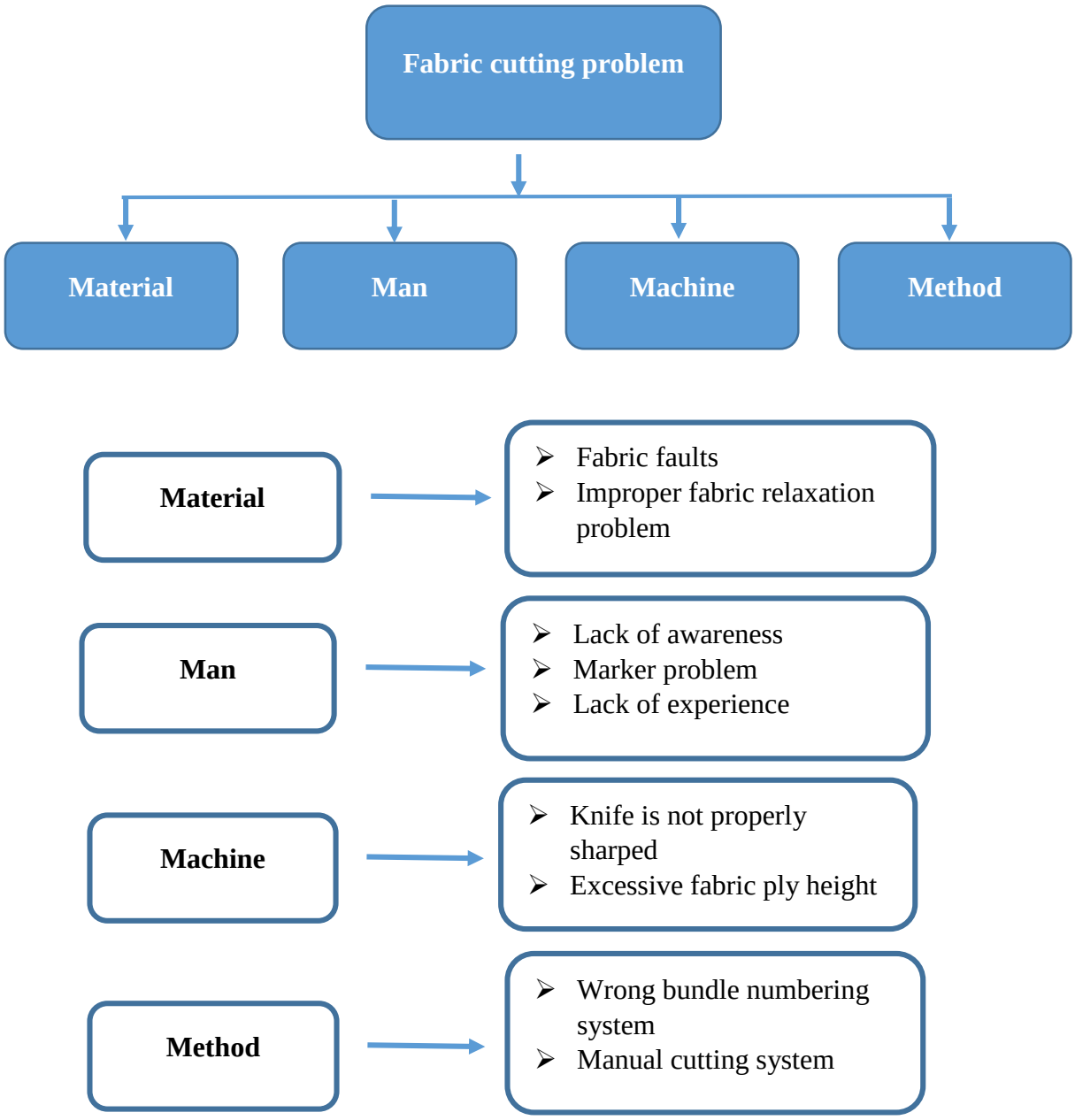


Figure 2.2. Factors affecting the NPT based on fabric cutting problem

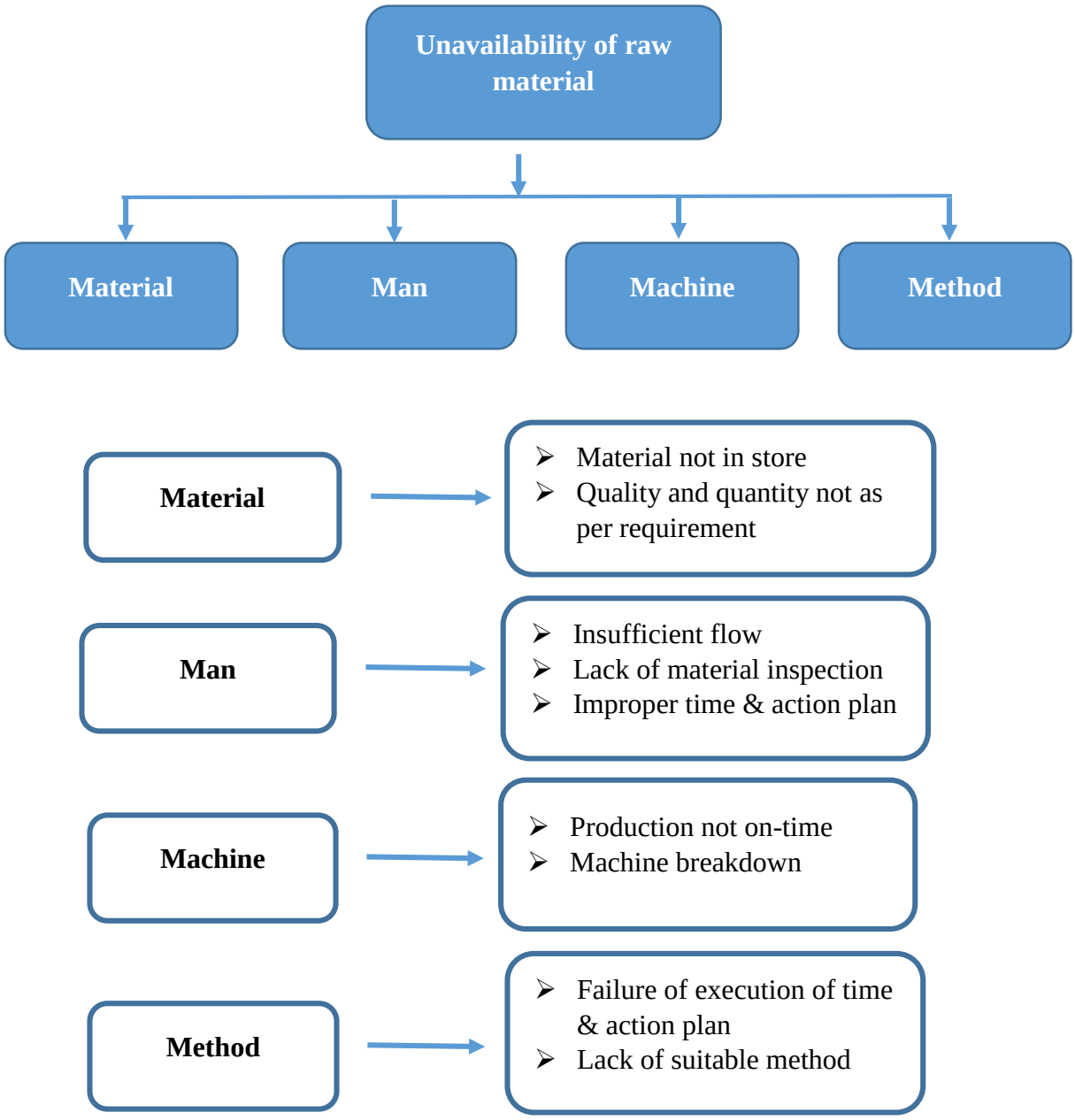


Figure 2.3. Factors affecting the NPT based on unavailability of raw material

2.6 How to reduce NPT

Jadhav et al. (2017) recommended several possible solutions to reduce the NPT from apparel garment industry and improve productivity as follows:

- Sufficient material should be provided to the operator before the process begins.
- A sufficient number of bones should be available near the operator table.
- The majority of the time spent for drinking water, so it is suggested that a water bottle be placed on the machine table to save time.
- The supervisor line noticed that after the sewing was finished, the operators were idling since there was no feed material available; therefore, attention must be given to ensure that there is enough stock material to keep the operators from idling and ensure correct time management is carried out.
- It was recommended that the operator follow a precise schedule for the time assigned to the task that he is working on so that, after the shift is over, he may evaluate the work he did. In the same way, management was advised to support and reward the operator for his achievements in the field.
- Preventive maintenance measures should be to decrease downtime and increase production.

Chapter 3

Materials and Methods

3.1. Materials

For this study, three sewing lines were chosen; one line was used to stitch men's T-shirt, one line was used to sew hoody and the third line was used to stitch jacket. T-shirt, hoody and jacket are considered as basic, semi-critical and critical type garments product. These outfits had the highest production in the Oxford Knit Composite Ltd. (Pretty Group) at the time of the study. Consequently, the improvement of the garment line's productivity was considered in these three stitching lines. Also, it was possible to carefully examine the sewing technique used to create these clothing.

3.2. Methods

A time study of garment sewing operation was conducted in production process at the Oxford Knit Composite Ltd. The average basic time, or Standard Allowable Minute (SAM), for each operation was calculated using the observed sewing time for each section, as follows:

3.2.1. Sewing process of garment

The sewing process of each product is different. The major processes of sewing of T-shirt, hoody and jacket are shown in the figure 3.1, 3.2 and 3.3.

Sewing flowchart of basic garments (T-shirt)

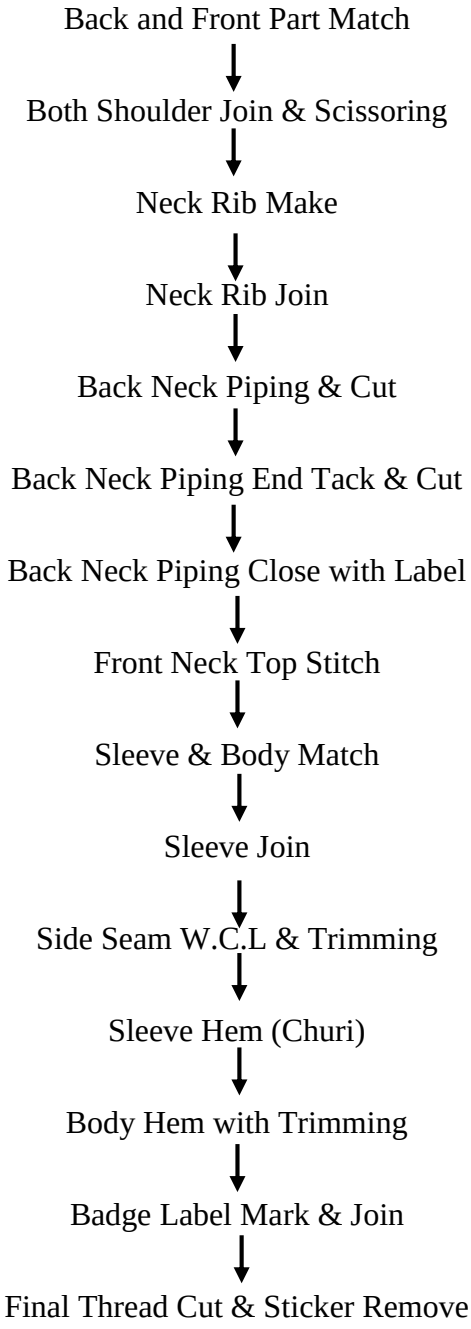
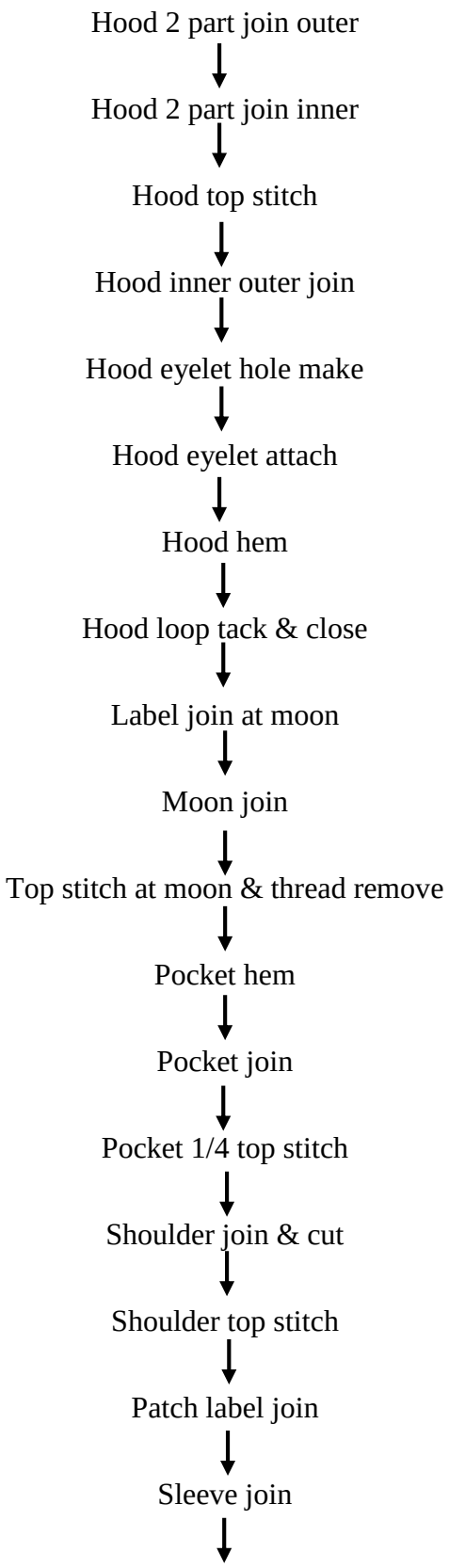


Figure 3.1. Flowchart of sewing process of basic garments (T-shirt)

Sewing flowchart of semi-critical garments (Hoody)



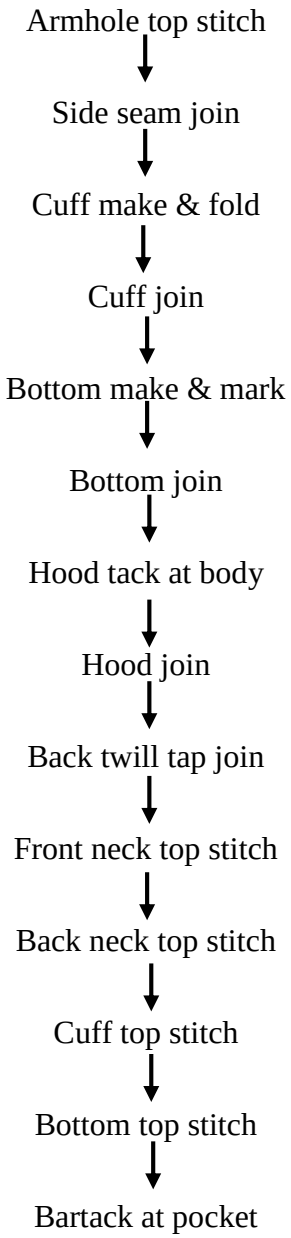
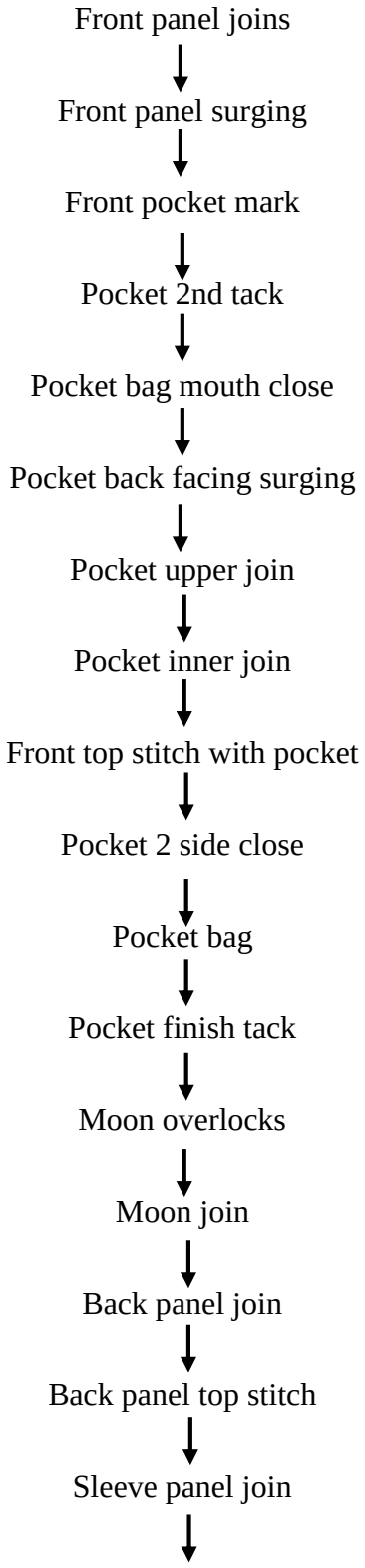
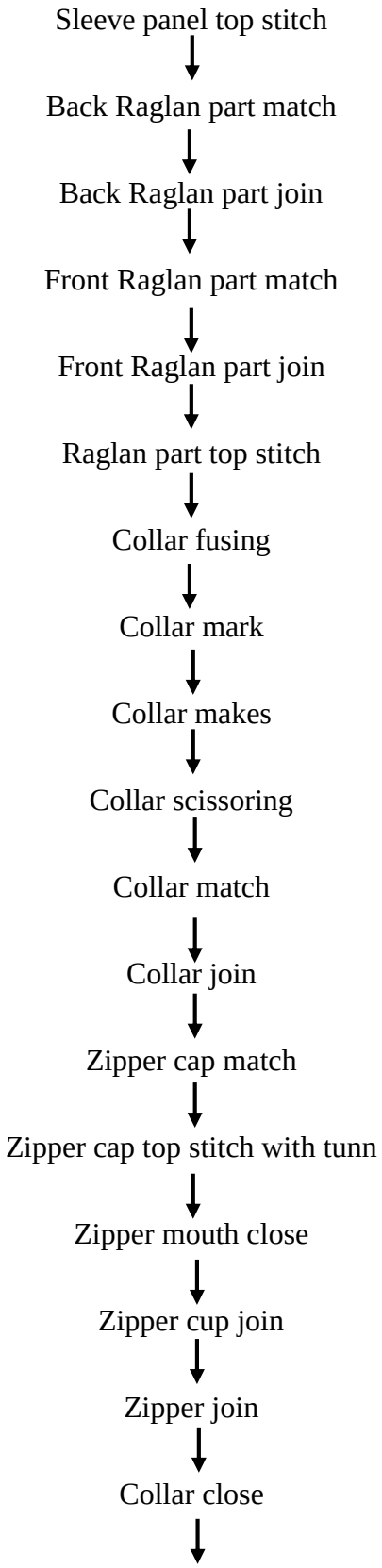


Figure 3.2. Flowchart of sewing process of semi-critical garments (Hoody)

Sewing flowchart of critical garments (Jacket)





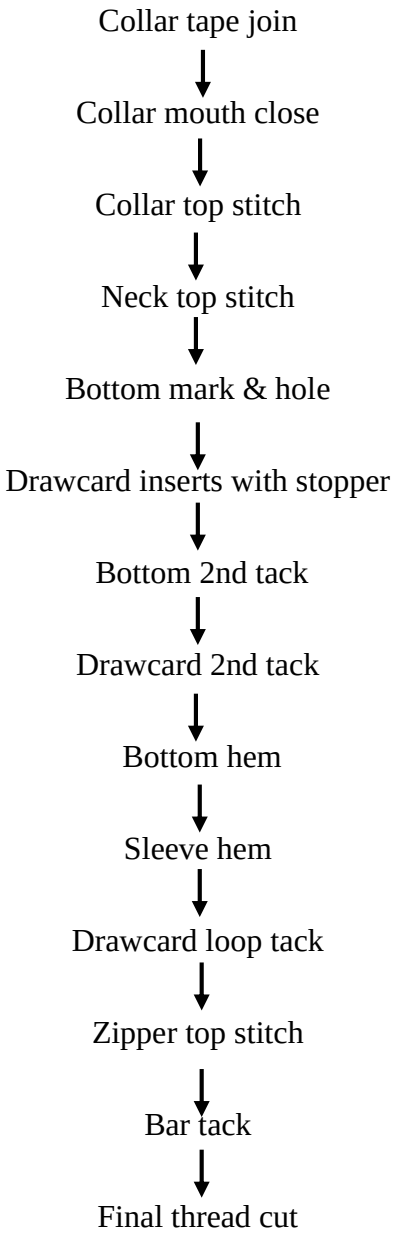


Figure 3.3. Flowchart of sewing process of critical garments (Jacket)

3.2.2. Data collection and calculation of SAM

Data collection and SAM calculation was conducted according to Vijayakumar & Maheswaran, (2016) by stop watch. The detailed procedure is shown in Figure 3.4. Data were collected three times for each garment type. Any abnormal or non-value-added time was discarded in each cycle completion.

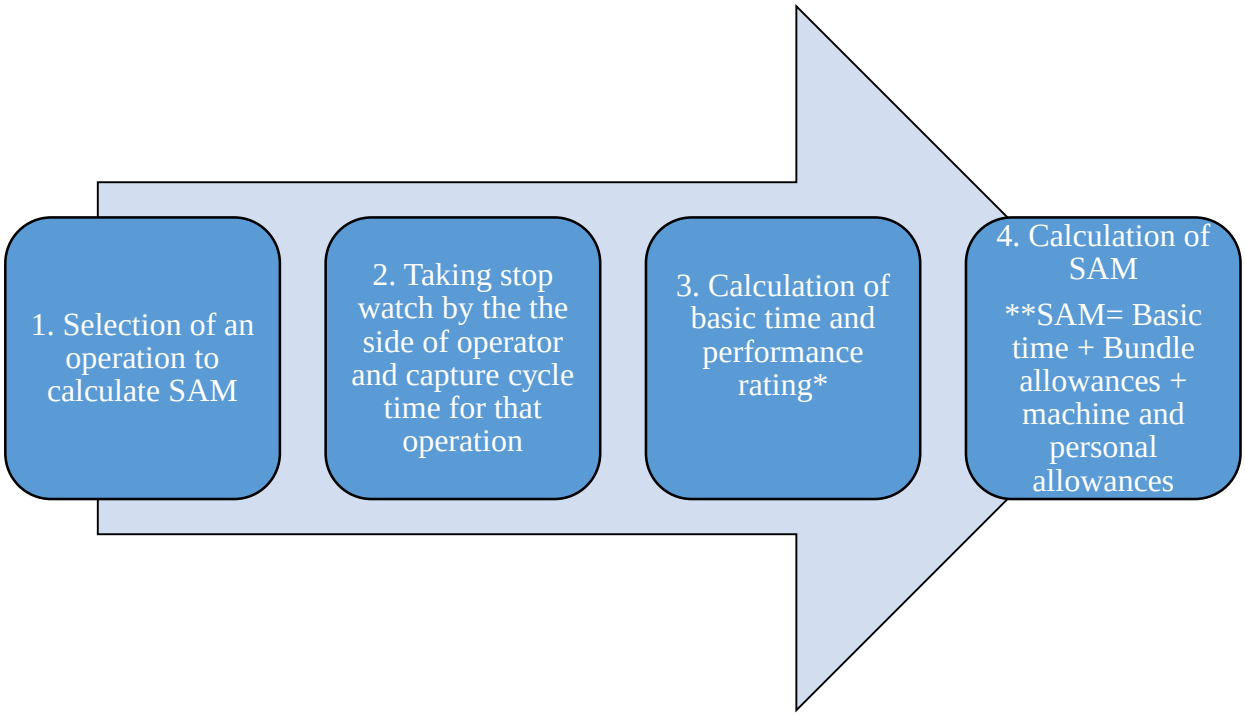


Figure 3.4. Data collection process and SAM calculation

Note:

*** Basic Time = Cycle Time × performance rating**

Where, Cycle time denotes the total amount of time required to complete one operation, i.e. time from picking up part of the first piece to picking up the next piece.

The performance rating of the operator is the rate at which he or she was doing the job based on his or her movement and work speed.

** Bundle allowances of 10% and machine and personal allowances of 20% were considered to basic time

3.2.3. Calculation of NPT and production deviation

The NPT and production output deviation were calculated as follows. The production deviation was depended on the worker efficiency level also.

NPT= SAM including NPT −SAM excluding NPT

Production deviation = Output/h without NPT − Output/h with NPT

3.2.4. Calculation of worker efficiency

Worker efficiency was calculated according to following equation:

Efficiency = Produced quantity*100/Target quantity

For example, in terms of T-shirt: worker produced 135, 164, 184 pcs respectively at efficiency 55%, 65% & 75% compare to targeted quantity 246 Pcs.

3.2.5. Analysis of financial loss

Financial losses were calculated using the following equation:

Financial loss/h = Product's making cost × production deviation/h

Financial loss/day = Financial loss/h × daily working hour (considering 10h/day)

Note:

Product's making cost for T-shirt, hoody and jacket at OKCL is 35, 95 and 150 BDT, respectively.

Chapter 4

Results and Discussion

4.1Findings and Analysis

Standard Allowable Minute (SAM) with and without non-productive (NP) activities for each operation of sewing of Oxford Knit Composite Ltd. are presented in the Table of next few pages. Table 4.1 to 4.3, Table 4.7 to 4.9, Table 4.13 to 4.15 show the collected data for basic, semi-critical and critical garment, respectively. The interpreted, and analyzed data are shown in the Tables Table 4.4 to 4.6, Table 4.10 to 4.12, Table 4.16 to 4.18 for basic, semi-critical and critical garment, respectively.

Table 4.1: Data collection for basic garments (T-Shirt) (Sample No.-04, Line No.-06)

Operation Process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	Machine
Back and Front Part Match	15.00	16.05	M
Both Shoulder Join & Scissoring	22.80	24.40	OL
Neck Rib Make	13.80	14.77	SNL
Neck Rib Join	14.40	15.41	OL
Back Neck Piping & Cut	15.00	16.05	FB
Back Neck Piping End Tack & Cut	18.00	19.26	SNL
Back Neck Piping Close with Label	19.20	20.54	SNL
Front Neck Top Stitch	16.20	17.01	CB
Sleeve & Body Match	15.00	15.75	M
Sleeve Join	30.00	32.10	OL
Side Seam W.C.L & Trimming	42.00	44.94	OL
Sleeve Hem (Churi)	33.00	35.31	CB
Body Hem with Trimming	15.60	16.69	CB
Badge Label Mark & Join	18.00	19.26	SNL

Final Thread Cut & Sticker Remove	24.00	25.68	M
Total in seconds	**312.00**	**333.22**	
Total in minutes	**5.20**	**5.55**	

Table 4.2: Data collection for basic garments (T-Shirt) (Sample No.-05, Line No.-06)

Operation Process	**SAM exclude NP activities in seconds**	**SAM include NP activities in seconds**	**Machine**
Back and Front Part Match	15.53	17.03	M
Both Shoulder Join & Scissoring	23.67	25.32	OL
Neck Rib Make	14.49	15.28	SNL
Neck Rib Join	14.95	15.99	OL
Back Neck Piping & Cut	15.60	16.69	FB
Back Neck Piping End Tack & Cut	18.90	19.93	SNL
Back Neck Piping Close with Label	19.93	21.26	SNL
Front Neck Top Stitch	16.69	17.66	CB
Sleeve & Body Match	15.68	16.46	M
Sleeve Join	31.20	33.38	OL
Side Seam W.C.L & Trimming	44.10	46.51	OL
Sleeve Hem (Churi)	34.25	36.55	CB
Body Hem with Trimming	16.07	17.33	CB
Badge Label Mark & Join	19.08	20.13	SNL
Final Thread Cut & Sticker Remove	24.96	26.71	M
Total in seconds	**325.08**	**346.23**	
Total in minutes	**5.42**	**5.77**	

Table 4.3: Data collection for basic garments (T-Shirt) (Sample No.-05, Line No.-06)

Operation Process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	Machine
Back and Front Part Match	14.34	16.07	M
Both Shoulder Join & Scissoring	22.53	24.13	OL
Neck Rib Make	13.32	14.51	SNL
Neck Rib Join	14.04	15.02	OL
Back Neck Piping & Cut	14.66	15.34	FB
Back Neck Piping End Tack & Cut	17.80	19.03	SNL
Back Neck Piping Close with Label	18.87	19.82	SNL
Front Neck Top Stitch	15.80	17.66	CB
Sleeve & Body Match	14.79	16.46	M
Sleeve Join	29.33	33.38	OL
Side Seam W.C.L & Trimming	40.15	43.93	OL
Sleeve Hem (Churi)	31.32	33.76	CB
Body Hem with Trimming	15.13	15.84	CB
Badge Label Mark & Join	17.78	18.68	SNL
Final Thread Cut & Sticker Remove	23.59	25.32	M
Total in seconds	**303.44**	**328.97**	
Total in minutes	**5.06**	**5.48**	

Table 4.4: Production Analysis through Estimated SAM Values excluding Non-Productive (NP) Time for basic garments (T-Shirt)

SL No.	SAM	Output/h @55% Efficiency	Output/h @65% Efficiency	Output/h @75% Efficiency
1	5.2	135	160	185
2	5.42	127	158	171
3	5.06	144	173	196
Total	**16**	**406**	**491**	**552**
AVG	**5.2**	**135**	**164**	**184**

Observation: The above observed SAM value includes non-productivity results say that for average 5.2 SAM and parallel production per hour for worker working at efficiency 55%, 65% & 75% will be 135, 164, 184 respectively.

Table 4.5: Production Analysis through Estimated SAM Values including Non-Productive (NP) Time for basic garments (T-Shirt)

SL No.	SAM	Output/h @55% Efficiency	Output/h @65% Efficiency	Output/h @75% Efficiency
1	5.55	123	150	163
2	5.77	118	143	156
3	5.48	115	137	174
Total	**16.80**	**356**	**430**	**493**
AVG	**5.6**	**119**	**143**	**164**

Observation: The above observed SAM value excludes non-productivity results say that for average 5.6 SAM and parallel production per hour for worker working at efficiency 55%, 65% & 75% will be 119, 143, 164 respectively.

Table 4.6: Production Analysis through Variable Chart for basic garments (T-Shirt)

SL No.	Efficiency	Production SAM exclude NPT	Production SAM include NPT	Production deviation on output/h
1	55%	135	119	17
2	65%	164	143	20
3	75%	184	164	20

Observation: The above production analysis variable result says that for an efficiency of 55%, 65% & 75% the production variation between include and exclude NPT output/h will be 17, 20 and 20 respectively

Table 4.7: Data collection for semi-critical garments (Hoody) (Sample No.-01, Line No.-01)

Operation process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	M/C
Hood 2 part join outer	24	26.9	OL
Hood 2 part join inner	37	40	OL
Hood top stitch	20	22.3	FL
Hood inner outer join	31	34	OL
Hood eyelet hole make	31	33.3	BH
Hood eyelet attach	25	27.3	BA
Hood hem	32	35	FL
Hood loop tack & close	33	36	SNL
Label join at moon	34	36.3	SNL
Moon join	35	37.3	SNL
Top stitch at moon	30	32.85	FL
Pocket hem	18	20.85	FL
Pocket join	30	33.4	SNL
Pocket 1/4 top stitch	32	35	SNL
Shoulder join & cut	32	33.9	OL
Shoulder top stitch	17	18.9	FL
Patch label join	30	33	SNL
Sleeve join	30	33	OL
Armhole top stitch	32	35.4	FL
Side seam join	37	40.4	OL
Cuff make & fold	32	35.4	SNL
Cuff join	30	33	OL
Bottom make & mark	32	34.85	SNL
Bottom join	36	38.85	OL
Hood tack at body	26	29	SNL
Hood join	26	29	OL
Back twill tap join	24	27	SNL
Front neck top stitch	28	31	FL
Back neck top stitch	28	29.9	SNL
Cuff top stitch	24	26.85	FL
Bottom top stitch	25	26.9	FL
Bartack at pocket	33	35.15	BT
Total Seconds	**934**	**1022**	
Total Minutes	**15.57**	**17.03**	

Table 4.8: Data collection for semi-critical garments (Hoody) (Sample No.-02, Line No.-01)

Operation process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	M/C
Hood 2 part join outer	25	27.9	OL
Hood 2 part join inner	35	38	OL
Hood top stitch	18	20.3	FL
Hood inner outer join	30	33	OL
Hood eyelet hole make	33	35.3	BH
Hood eyelet attach	28	30.3	BA
Hood hem	31	34	FL
Hood loop tack & close	36	39	SNL
label join at moon	30	32.3	SNL
Moon join	34	36.3	SNL
Top stitch at moon	31	33.85	FL
Pocket hem	16	18.85	FL
Pocket join	32	35.4	SNL
Pocket 1/4 top stitch	31	34	SNL
Shoulder join & cut	30	31.9	OL
Shoulder top stitch	18	19.9	FL
Patch label join	29	31.95	SNL
Sleeve join	31	34	OL
Armhole top stitch	31	34.4	FL
Side seam join	36	39	OL
Cuff make & fold	30	33.4	SNL
Cuff join	31	35	OL
Bottom make & mark	31	33.77	SNL
Bottom join	35	37.85	OL
Hood tack at body	28	31	SNL
Hood join	27	30	OL
Back twill tap join	27	30	SNL
Front neck top stitch	25	28	FL
Back neck top stitch	31	32.95	SNL
Cuff top stitch	27	29.75	FL
Bottom top stitch	26	27.9	FL
Bartack at pocket	38	40.15	BT
Total Seconds	**941**	**1029.42**	
Total Minutes	**15.68**	**17.16**	

Table 4.9: Data collection for semi critical garments (Hoody) (Sample No.-03, Line No.-01)

Operation process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	M/C
Hood 2 part join outer	22	24.9	OL
Hood 2 part join inner	35	38.27	OL
Hood top stitch	20	22.3	FL
Hood inner outer join	32	35	OL
Hood eyelet hole make	30	32.3	BH
Hood eyelet attach	26	28.3	BA
Hood hem	28	31	FL
Hood loop tack & close	35	38.25	SNL
label join at moon	32	34.3	SNL
Moon join	38	40.3	SNL
Top stitch at moon	32	34.85	FL
Pocket hem	17	19.85	FL
Pocket join	33	36.4	SNL
Pocket 1/4 top stitch	33	36	SNL
Shoulder join & cut	28	29.9	OL
Shoulder top stitch	21	22.9	FL
Patch label join	31	33.95	SNL
Sleeve join	32	35	OL
Armhole top stitch	32	35.4	FL
Side seam join	36	39.4	OL
Cuff make & fold	32	35.4	SNL
Cuff join	32	35	OL
Bottom make & mark	34	36.85	SNL
Bottom join	36	38.85	OL
Hood tack at body	26	28.55	SNL
Hood join	27	30	OL
Back twill tap join	25	27.87	SNL
Front neck top stitch	22	25	FL
Back neck top stitch	30	31.95	SNL
Cuff top stitch	25	27.75	FL
Bottom top stitch	25	26.9	FL
Bartack at pocket	33	35.15	BT
Total Seconds	**940**	**1027.84**	
Total Minutes	**15.67**	**17.13**	

Table 4.10: Production Analysis through Estimated SAM Values excluding Non-Productive (NP) Time for Line No.-01

SL No.	SAM	Output/h @55% Efficiency	Output/h @65% Efficiency	Output/h @75% Efficiency
1	15.57	98	113	128
2	15.68	97	112	127
3	15.67	97	112	127
Total	**47**	**292**	**337**	**382**
AVG	**16**	**97**	**112**	**127**

Observation: The above observed SAM value includes non-productivity results say that for average 16 SAM and parallel production per hour for worker working at efficiency 55%, 65% & 75% will be 97, 112, 127 respectively.

Table 4.11: Production Analysis through Estimated SAM Values including Non-Productive (NP) Time for Line No.-01

SL No.	SAM	Output/h @55% Efficiency	Output/h @65% Efficiency	Output/h @75% Efficiency
1	17.03	89	103	117
2	17.16	89	102	116
3	17.13	89	102	116
Total	**51.32**	**267**	**307**	**349**
AVG	**17**	**89**	**102**	**116**

Observation: The above observed SAM value includes non-productivity results say that for average 17 SAM and parallel production per hour for worker working at efficiency 55%, 65% & 75% will be 89, 102, 116 respectively.

Table 4.12: Production Analysis through Variable Chart for Line No.-01

SL No.	Efficiency	Production SAM exclude NPT	Production SAM include NPT	Production deviation on output/h
1	55%	98	89	8
2	65%	113	103	10
3	75%	128	117	11

Observation: The above production analysis variable result says that for an efficiency of 55%, 65% & 75% the production variation between include and exclude NP output/h will be 8, 10 and 11 respectively.

Table 4.13: Data collection for critical garments (Jacket) (Sample No.-01, Line No.-02)

Operation Process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	Machine
Front panel join	33.00	36.96	OL
Front panel surging	18.00	20.16	OL
Front pocket mark	13.20	14.78	M
Pocket 2nd tack	20.40	22.85	SNL
Pocket bag mouth close	15.00	16.80	OL
Pocket back facing surging	14.40	16.13	OL
Pocket upper join	26.40	29.57	SNL
Pocket inner join	26.40	29.57	SNL
Front top stitch with pocket	42.00	47.04	FL
Pocket 2 side close	26.40	29.57	SNL
Pocket bag	27.00	30.24	OL
Pocket finish tack	16.20	18.14	SNL
Moon overlock	12.00	13.44	OL
Moon join	27.60	30.91	SNL
Back panel join	25.80	28.90	OL
Back panel top stitch	24.00	26.88	FL
Sleeve panel join	36.00	40.32	OL
Sleeve panel top stitch	33.00	36.96	FL
Back Raglan part match	15.00	16.80	M
Back Raglan part join	25.80	28.90	OL
Front Raglan part match	15.00	16.80	M
Front Raglan part join	24.00	26.88	OL
Raglan part top stitch	39.00	43.68	FL
Collar fusing	19.80	22.77	IRON
Collar mark	15.00	17.25	M
Collar make	24.00	27.60	SNL
Collar scissoring	18.00	20.70	M
Collar match	13.80	15.87	M

Collar join	30.00	34.50	OL
Zipper cap match	12.00	13.44	SNL
Zipper cap top stitch with tunn	18.00	20.16	SNL
Zipper mouth close	18.00	20.16	SNL
Zipper cup join	18.00	20.16	SNL
Zipper join	60.00	67.20	SNL
Collar close	22.80	25.54	OL
Collar tape join	26.40	29.57	SNL
Collar mouth close	27.00	30.24	SNL
Collar top stitch	33.00	36.96	SNL
Neck top stitch	27.00	30.24	SNL
Btm mark & hole	18.00	20.16	BH
Drawcard insert with stopper	33.00	37.95	M
Btm 2nd tack	19.20	22.08	SNL
Drawcard 2nd tack	19.20	22.08	SNL
Btm hem	30.00	34.50	FL
Sleeve hem	30.00	34.50	FL
Drawcard loop tack	21.00	24.15	SNL
Zipper top stitch	66.00	75.90	SNL
Bar tack	24.00	27.60	BT
Final thread cut	24.00	27.60	M
Total Seconds	**1222.80**	**1381.15**	
Total in minutes	**20.38**	**23.02**	

Table 4.14: Data collection for critical garments (Jacket) (Sample No.-02, Line No.-02)

Operation Process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	Machine
Front panel join	34.55	38.40	OL
Front panel surging	18.61	20.99	OL
Front pocket mark	13.71	15.33	M
Pocket 2nd tack	21.24	23.92	SNL
Pocket bag mouth close	15.56	17.42	OL
Pocket back facing surging	14.89	16.89	OL
Pocket upper join	27.43	30.57	SNL
Pocket inner join	27.48	30.72	SNL
Front top stitch with pocket	43.55	48.97	FL
Pocket 2 side close	27.64	30.66	SNL
Pocket bag	28.00	31.27	OL
Pocket finish tack	16.96	18.85	SNL
Moon overlock	12.44	13.99	OL
Moon join	28.90	32.06	SNL
Back panel join	26.81	30.25	OL
Back panel top stitch	24.89	27.98	FL
Sleeve panel join	37.22	41.81	OL
Sleeve panel top stitch	34.29	38.70	FL
Back Raglan part match	15.62	17.42	M
Back Raglan part join	26.75	30.25	OL
Front Raglan part match	15.71	17.37	M
Front Raglan part join	24.89	27.93	OL
Raglan part top stitch	40.83	45.47	FL
Collar fusing	20.53	23.61	IRON
Collar mark	15.71	20.70	M
Collar make	24.94	15.87	SNL
Collar scissoring	18.67	34.50	M
Collar match	14.27	13.44	M

Collar join	31.17	20.16	OL
Zipper cap match	12.49	20.16	SNL
Zipper cap top stitch	18.85	20.16	SNL
Zipper mouth close	18.61	67.20	SNL
Zipper cup join	18.70	20.91	SNL
Zipper join	62.46	69.48	SNL
Collar close	23.64	26.53	OL
Collar tape join	27.30	30.78	SNL
Collar mouth close	28.05	31.36	SNL
Collar top stitch	34.35	38.70	SNL
Neck top stitch	28.00	31.48	SNL
Bottom mark & hole	18.52	20.91	BH
Drawcard insert with stopper	34.19	39.73	M
Bottom 2nd tack	19.76	22.90	SNL
Drawcard 2nd tack	19.93	22.90	SNL
Bottom hem	31.14	36.12	FL
Sleeve hem	31.14	35.67	FL
Drawcard loop tack	21.80	25.09	SNL
Zipper top stitch	68.71	79.01	SNL
Bar tack	24.89	28.62	BT
Final thread cut	24.70	28.54	M
Total Seconds	**1270.47**	**1471.76**	
Total in minutes	**21.17449**	**24.53**	

Table 4.15: Data collection for critical garments (Jacket) (Sample No.-03, Line No.-02)

Operation Process	SAM exclude NP activities in seconds	SAM include NP activities in seconds	Machine
Front panel join	33.69	37.88	OL
Front panel surging	18.50	20.76	OL
Front pocket mark	13.61	15.36	M
Pocket 2nd tack	21.42	23.33	SNL
Pocket bag mouth close	15.38	17.27	OL
Pocket back facing surging	14.83	16.63	OL
Pocket upper join	27.43	31.05	SNL
Pocket inner join	26.95	30.31	SNL
Front top stitch with pocket	43.18	48.45	FL
Pocket 2 side close	27.22	30.72	SNL
Pocket bag	28.35	31.42	OL
Pocket finish tack	16.61	19.05	SNL
Moon overlock	12.36	13.72	OL
Moon join	28.68	31.78	SNL
Back panel join	26.81	29.79	OL
Back panel top stitch	25.20	28.22	FL
Sleeve panel join	36.90	41.33	OL
Sleeve panel top stitch	33.99	38.07	FL
Back Raglan part match	15.59	17.46	M
Back Raglan part join	26.34	29.50	OL
Front Raglan part match	15.42	17.27	M
Front Raglan part join	24.94	27.71	OL
Raglan part top stitch	39.82	45.38	FL
Collar fusing	20.35	23.25	IRON
Collar mark	15.47	17.73	M
Collar make	25.20	28.46	SNL
Collar scissoring	18.45	21.74	M
Collar match	14.21	16.27	M
Collar join	31.17	35.54	OL
Zipper cap match	12.47	13.96	SNL
Zipper cap top stitch with tun	18.70	20.95	SNL
Zipper mouth close	18.90	21.17	SNL
Zipper cup join	18.45	20.66	SNL
Zipper join	61.80	69.22	SNL
Collar close	23.69	26.53	OL
Collar tape join	26.95	30.19	SNL

Collar mouth close	27.76	31.09	SNL
Collar top stitch	34.29	38.40	SNL
Neck top stitch	27.57	30.88	SNL
Btm mark & hole	18.50	20.91	BH
Drawcard insert with stopper	34.02	39.73	M
Btm 2nd tack	19.60	22.54	SNL
Drawcard 2nd tack	19.74	22.70	SNL
Btm hem	31.17	35.57	FL
Sleeve hem	30.63	36.23	FL
Drawcard loop tack	21.59	24.75	SNL
Zipper top stitch	68.05	78.18	SNL
Bar tack	24.53	28.37	BT
Final thread cut	24.65	28.68	M
Total Seconds	**1261.11**	**1426.14**	
Total in minutes	**21.02**	**23.77**	

Table 4.16: Production Analysis through Estimated SAM Values excluding Non-Productive (NP) Time for Line No.-06

SL No.	SAM	Output/h @55% Efficiency	Output/h @65% Efficiency	Output/h @75% Efficiency
1	20.38	76	89	97
2	21.17	70	81	90
3	21.02	72	84	93
Total	**62.6**	**218**	**254**	**280**
AVG	**20.9**	**73**	**85**	**93**

Observation: The above observed SAM value includes non-productivity results say that for average 20.9 SAM and parallel production per hour for worker working at efficiency 55%, 65% & 75% will be 73, 85, 93 respectively.

Table 4.17: Production Analysis through Estimated SAM Values including Non-Productive (NP) Time for Line No.-06

SL No.	SAM	Output/h @55% Efficiency	Output/h @65% Efficiency	Output/h @75% Efficiency
1	23.02	68	77	89
2	24.53	64	74	85
3	23.77	66	76	87
Total	**71.32**	**198**	**227**	**261**
AVG	**23.8**	**66**	**76**	**87**

Observation: The above observed SAM value excludes non-productivity results say that for average 23.8 SAM and parallel production per hour for worker working at efficiency 55%, 65% & 75% will be 66, 76, 87 respectively.

Table 4.18: Production Analysis through Variable Chart for Line No.-06

SL No.	Efficiency	Production SAM exclude NPT	Production SAM include NPT	Production deviation on output/h
1	55%	73	66	7
2	65%	85	76	9
3	75%	93	87	6

Observation: The above production analysis variable result says that for an efficiency of 55%, 65% & 75% the production variation between include and exclude NP output/h will be 7, 9 and 6 respectively.

4.2 Impact of NPT on production

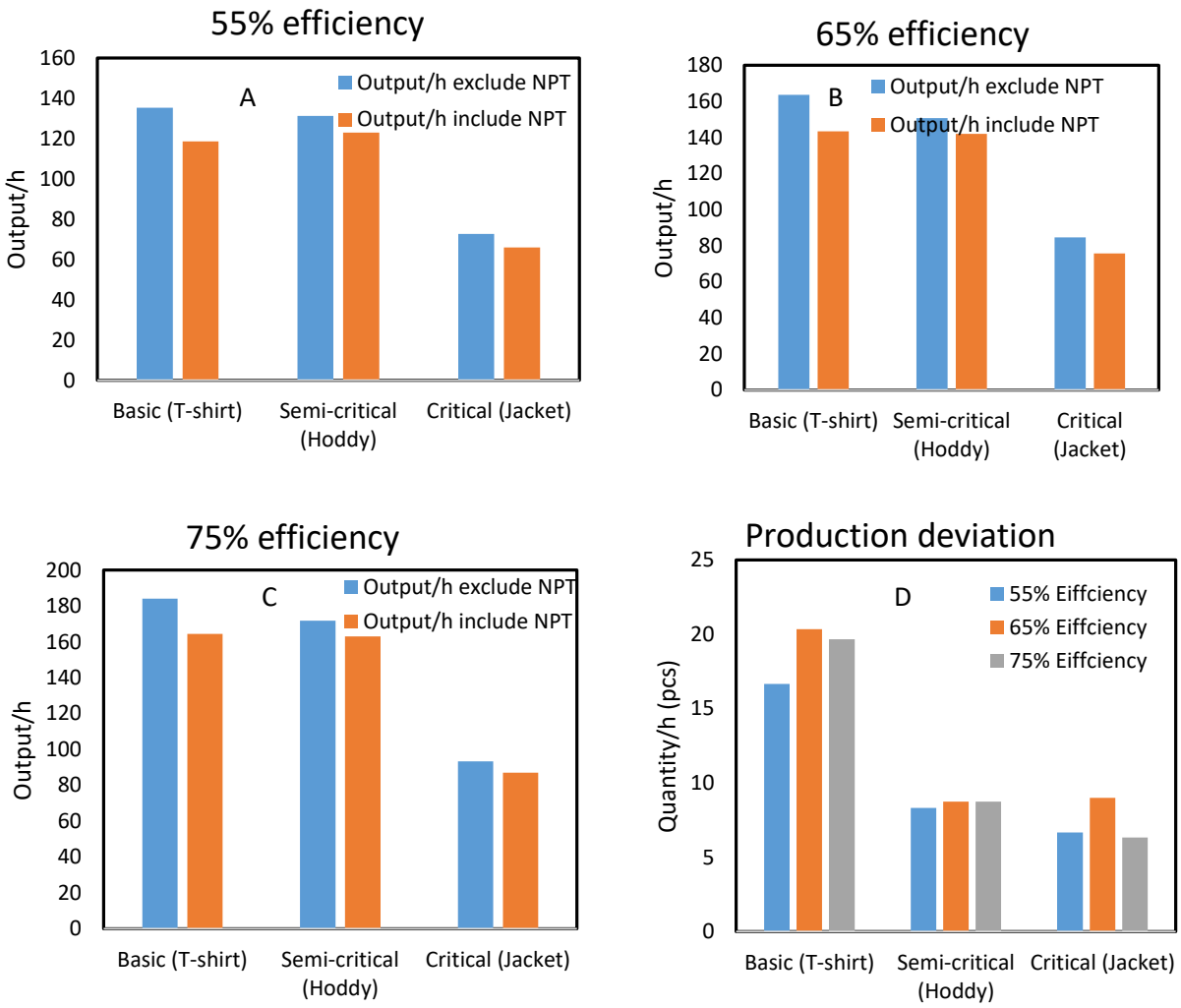


Figure 4.1. Impact of NPT in garment production on the basis of garments pattern

Figure 4.1 shows the effect of NPT on garment production at different efficiency level. Figure 4.1 (A-C) illustrate the output/h including and excluding NPT on the basis of different product for 55, 65 and 75% efficiency. From the above figures, it is seen that the output for critical product is less

that basic and semi-critical product with and without NPT at every efficiency level. Although the productivity increases with the production efficiency, however output will not that much increase if NPT is not controlled. Additionally, complex nature of garment product had the higher NPT and less output. The sewing line is significantly impacted by eight key factors on NPT, but loss time is significantly impacted by four important factors: line setting, machine breakdown, feeding loss, and basic amenity (Jain et., 2015). NPT is caused by a difficulty with the arrangement of the sewing line, which primarily happens due to insufficient management skills, familiarity with complex clothing styles, a lack of sewing machine variety, and other factors (Alam and Sultan, 2021).

4.3 Relationship between NPT and financial losses

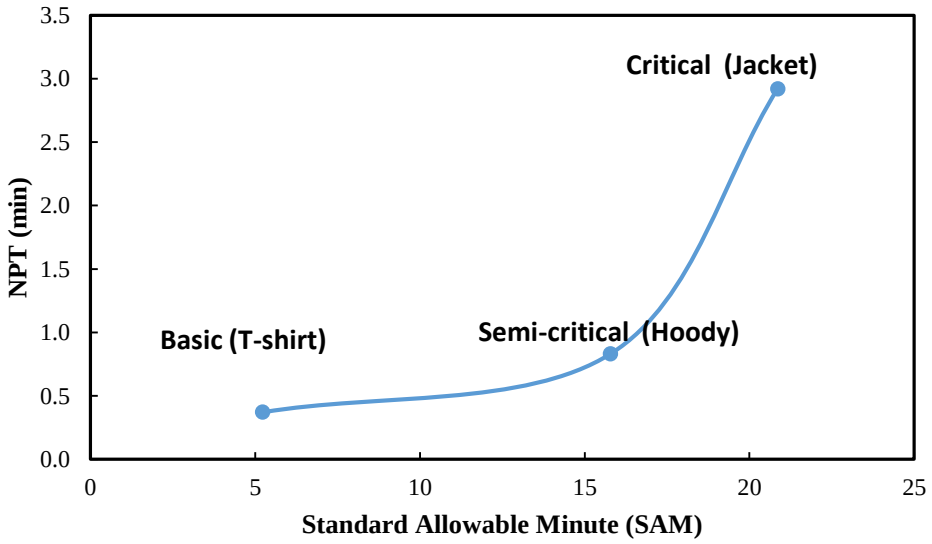


Figure 4.2. Relationship between SAM, NPT and complexity of garments

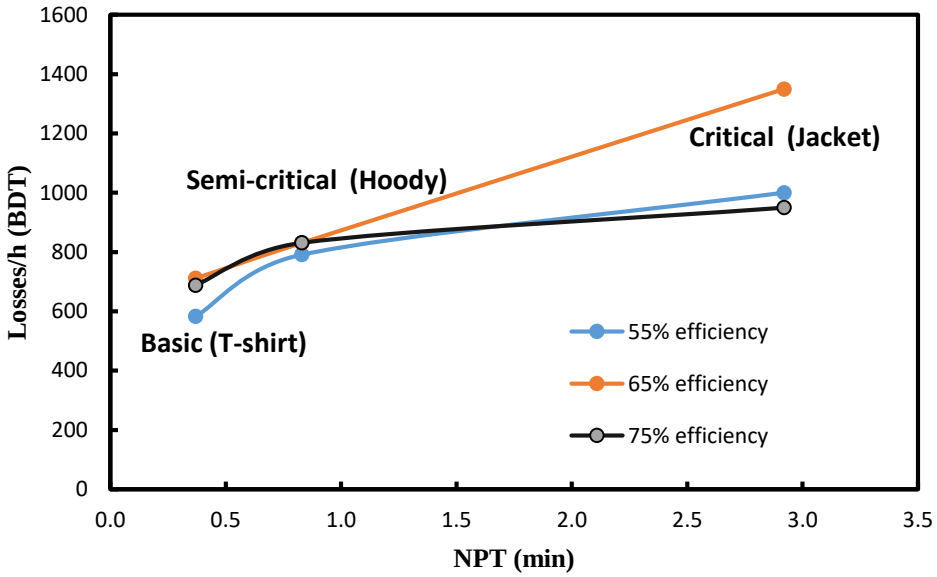


Figure 4.3. Financial losses related to NPT

Figure 4.2 indicate the relationship between NPT, SAM and complex nature of garment products. It is seen that SAM for basic (T-shirt), semi-critical (hoody) and critical product (jacket) were 5.2, 15.8 and 20.9, respectively. The NPT increases from about 0.4 min to 2.9 min for basic and critical product, respectively. Therefore, it can be said that NPT has a proportional relationship with SAM and product's complexity nature.

Figure 4.3 illustrate the summary of financial losses per hour in perspective to NPT at different efficiency level. After calculating financial losses, it is seen that NPT proportionally influences the losses of the company. For 55% efficiency, highest losses (around 1000 BDT) occur for critical product and lowest was for basic product (583 BDT). Although, 75% efficiency might have higher losses, but from the figure it is seen that 65% efficiency has the higher losses (around 1350 BDT) for critical product. This indicate that not only efficiency affects the NPT and losses, rather it depends on other factors mentioned as earlier.

It can be concluded that although the NPT for T-shirt, hoody and jacket is only 0.37, 0.8 and 2.9 min per piece, but the annual losses occur 21465, 25927 and 29640 USD, respectively at 75% efficiency level. This loss is calculated considering the 10 working hours per day, 26 working days per month and 1 USD= 100 BDT. It is worthy to mention that, the aforementioned annual losses are happening only from sewing section. Other department still have NPT and annual losses. Therefore, it is recommended to identify the root of NPT and minimize the NPT for maximizing the annual profit of a garment factory.

Chapter 5

Conclusion

By reducing non-productive activities in the sewing section of OKCL, we could save time and minimize the total cost. Higher-cost and time-consuming activities have a negative impact on a factory's economy. NPT is directly proportional to the economic losses of a factory. Additionally, NPT affects productivity. In this study, it is seen that critical products consume the most time for sewing, followed by semi-critical and basic products. Although the efficiency level has increased, productivity and profit still lag behind due to NPT. Production deviation at 55% efficiency was 17, 8, and 7 pcs/h for T-shirt, hoody and jacket, respectively. Whereas, for 65% efficiency, it was 20.3, 8.8, and 9 pcs/h, respectively, and 75% efficiency had the deviation of 19.7, 8.8, and 6.3 pcs/h, respectively. The SAM and NPT for T-shirt, hoody and jacket were 5.2, 15.8, and 20.9 min and 0.4, 0.8, and 2.9 min, respectively. This result clearly indicates that complex garments have a higher SAM than basic and semi-critical garments. Furthermore, NPT in critical garments rises compared to basic and semi-critical garments. NPT gradually reduces a garment factory's productivity and annual income, thereby influencing the country's income. Therefore, it is suggested to eliminate these non-productive activities to improve the financial condition of the company.

Recommendations

There are suggestions given to increase profitability by reducing non-productive time.

- Need to maintain proper production planning to feed the line timely,
- Supply chain management s/be very strong to minimize line idle time due to material,
- Industrial engineering s/be very effective,
- Well trained operator, proper layout, minimum rework, smooth running of sewing machine,
- Line balancing s/be proper,
- Ensuring quality production,
- Strong MIS,
- Correct fabric quality,
- Appropriate allocation of manpower is mandatory,
- Quality checking's be proper,
- Waiting and inspection times be least,
- Proper power supply

These recommendations were suggested to the sewing department at OKCL.

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