A Statistically Significant Analysis of Dynamic Effect of Non-Production Time (NPT) on Apparel Manufacturing

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Abstract

Improvement of Non-Productive Time (NPT) plays a significant role to survive this highly competitive global market of Apparel Industries. At present, the average efficiency level of apparel Industries is 40% to 50%. One of the significant tools to pick up this efficiency level is analysis this NPT and resolve it as much as possible. In this research, we employ the Pareto chart, Root cause analysis, and the correlation to explore the NPT. We get the major causes of NPT in the Apparel sewing section are material not available, line layout setting, and machine maintenance, etc. From the cause-and-effect diagram, we locate the root of this NPT are fabric faults, lack of experience in supervision, wrong bundle numbering, wrong time action plan, etc. We also get a significant correlation between NPT and production.

Keywords: Non-productive time (NPT), Apparel, Line Setting, Correlation.

1. Introduction

Bangladesh generated $33.60 billion in the clothing exporting sector in 2019, putting it in second place among the world's top ten export processing countries [1]. The success of the apparel industry's global difficulties was largely dependent on various aspects, including manufacturing lead time, product quality, production cost, worker efficiency %, and reducing production defects or rework the system to reduce non-productive time (NPT), among others[2]. In the clothing business, rework is a routine task that eliminates bottlenecks in the production process and focuses on high-quality
products, which has an impact on the entire factory economy [3].

The garments company wants to improve the sewing section, which is the most problematic area in the industry. Low

productivity, extended production lead times, excessive rework, poor line balancing, operator attitude issues, absenteeism, and no standard style of working were among the issues. Their efficiency level is currently between 40% to 50 percent, and the reason for this is that they spend a significant amount of non-productive time (NPT)[4]. NPT in Industrial Engineering term is Non-Productive Time. Non-productive time, or asset uptime, is defined as time spent by an operator without creating any garment (standard minutes). Non-productive time is calculated in the garment industry to determine how much standard time is lost due to machine downtime[5]. The issue arises during the sewing section's initial processing. Due to problems with non-productive time (NPT) at each operational phase, the section's capacity utilization ranges from 40 to 65 percent. [6]. However, no core causes of low productivity

have been found as to why there is such a problem. In practically every sector of the economy, the current technological economic scenery is characterized by increased rivalry[7]. This necessitates an increase in the organization's productive efficiency. In order to boost productivity, Industrial Engineering will be critical. To examine and optimize the work method, minimize waste, and ensure optimum resource allocation and utilization, several industrial engineering techniques are applied. Industrial engineering is a profession in which judgment is used to design ways to employ materials, other natural resources[8]. It is a profession in which a knowledge of mathematical and natural sciences gained through study, experience, and practice is applied to develop ways to use economically the materials and other natural resources, and the focus of nature for the benefit of people in a cost-effective manner[9]. Here are a few examples of non-productive time (NPT) like i. Line setting ii. Machine Breakdown iii. Cutting materials unavailability iv. Sewing stitching Quality issue v. Cutting fabric quality problem vi. Electricity failure Problem vii. Change of Feeding Plan and viii. Basic Facility.

Choosing where to begin and when to begin is one of the most difficult jobs in the early stages of TQM implementation. One way to start is to assume that 20% of the company's processes are responsible for 80% of the company's problems (Pareto's Law)[10]. By identifying 20 percent of processes that are problematic, one can begin to focus on what needs to be addressed first. By focusing on these issues early, the company will reap greater benefits and gain momentum for the future[11]. The tools for quality control can be used to improve the manufacturing process. Thomas and Barton employed simple tools to focus on a cost-effective approach to Six Sigma project execution like the Pareto chart and the Cause& Effect diagram [12].

2. Materials and Methods

T-shirts, polo shirts, and long bottoms are the apparel product categories that have been investigated. 100% cotton knit, single jersey, pique fabric, and rib structure fabric with weights of 180, 240, and 280 grams per square meter (GSM) are used in this project. Each line should have a printed format in the factory. Assign one person to keep track of the lost time in total man minutes using the format (line feeder, work study officer, or line supervisor) whenever you detect operators sitting idle during production hours. Investigate the reasons for their lack of activity (or failure to complete the task) and record the start and stop times in the sample format. If more than one operator is idle for the same reason, multiply the lost time by the number of operators to get the total man-minutes lost, which you should record on our NPT format. We've also tallied production per line per day. The supervisor or authorized person must approve the lost time recorded under this category. Calculate total lost time in each category at the end of the day.
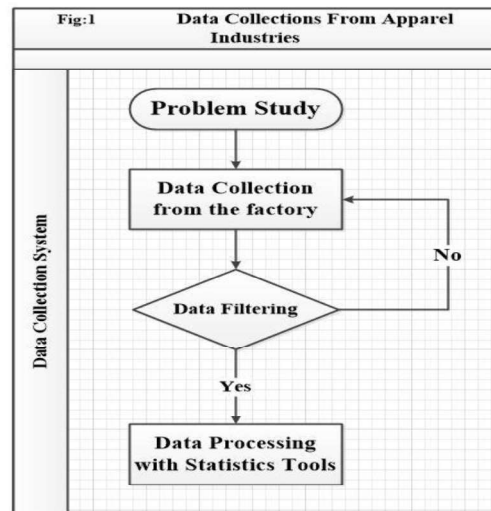

Figure 1: Data collections process from industries.

After collection, the data was filtered to this regard error and abnormal data. Then the process data by using statistics tools like Pareto chart, Root cause analysis, and correlation. The details of the data processing flow chart are shown in Fig no-1 and 2.
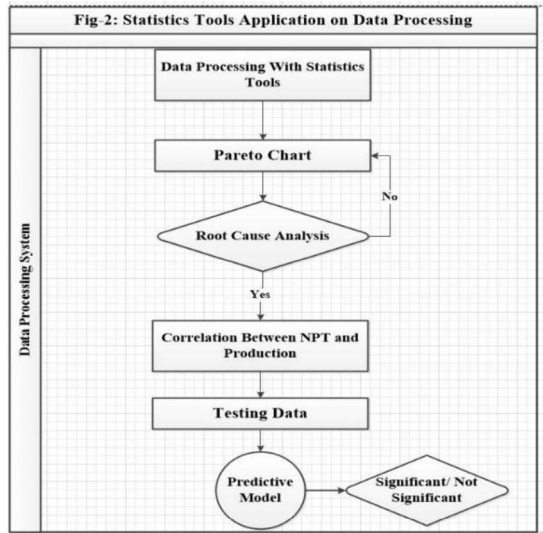

Figure 2: Statistics tools applications of TQM.

3. Results and Discussion

After filtering, we get the data of average non-productive time (Minute) per week due to various causes. This data is shown in table-1 and we design a Pareto chart according to this table.

Table 1: Different non-productive time percentage per week.

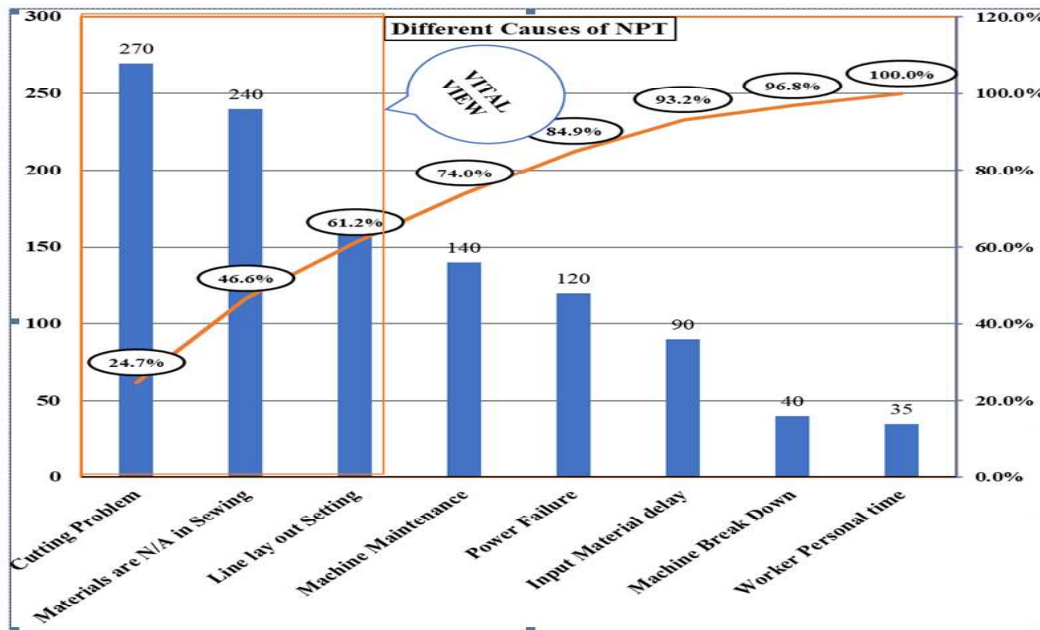| Causes	Average Minute per Week	Cumulative	Percent
Cutting Problem	270	270	24.66 %
Sewing Materials N/A	240	510	46.58 %
Line layout Setting	160	670	61.19 %
Machine Maintenance	140	810	73.97 %
Power Failure	120	930	84.93 %
Input Material delay	90	1020	93.15 %
Machine Break Down	40	1060	96.80 %
Worker Personal time	35	1095	100.00 %

Figure 3: Vital view of non-productive time.

From fig-3, we can say the vital causes of NPT are a total of 61.19% of genuine reasons. Where cutting problem was 24.66%, Sewing material not available was 21.92%, and line layout setting problems was 14.61%. The rest of the 38.81% problems are Machine maintenance, Power failure, Input material delay, machine break down, and worker personal time.

Cause and Effect Diagram

For the vital causes of NPT we have designed three cause and effect diagrams which are shown in Fig-4, 5, and 6.
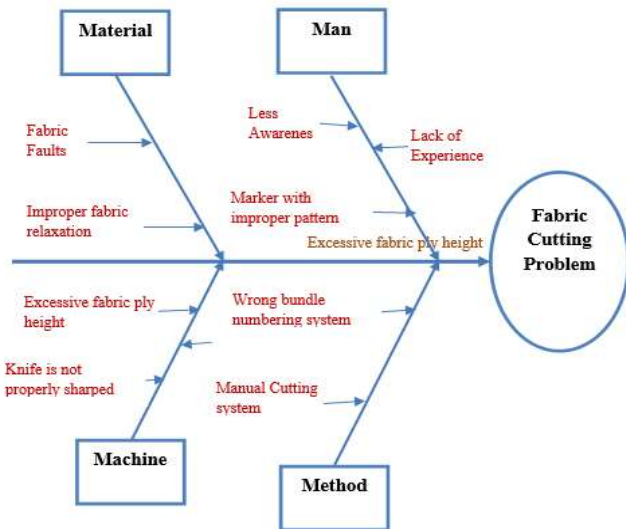

Figure 4: Major causes of fabric cutting problem.

From the fig-4, It is observed that the fabric cutting problem is one of the leading problems of NPT. Cutting problems mainly occur for the fabric faults, lack of experience of the operator, improper fabric relaxation, wrong bundle numbering system, and other causes which are shown in detail in the figure.

From the fig-5, It is shown that the Sewing Line layout problem is another vital problem of NPT which is mainly occur for the lack of experience, knowledge of management, Complex Garments style, number of sewing machine, and other causes which are shown in details in the figure.
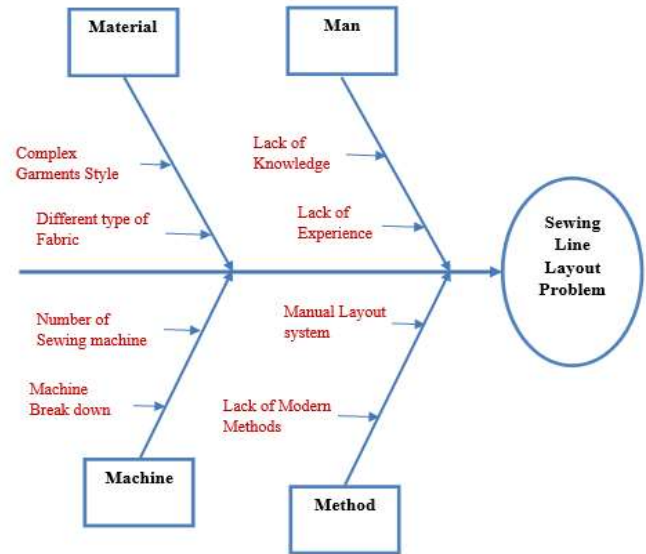

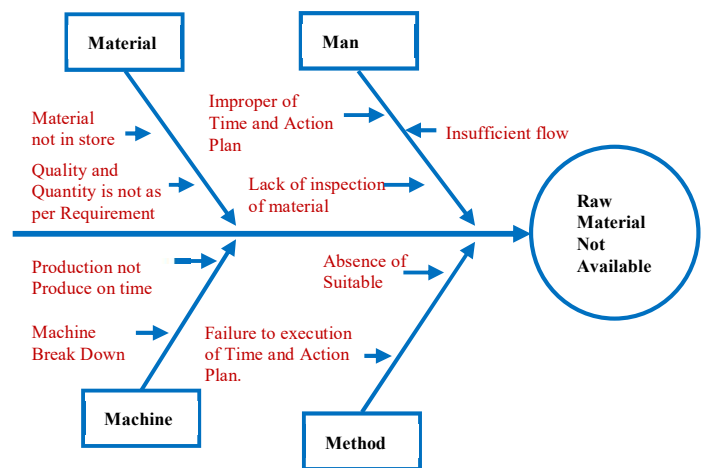**Figure 5:** Sewing Layout problem is another leading cause of NPT.

Figure 6: Raw material not available of n0n-productive time.

From the fig-6, It is observed that the material not available problem is also the leading problem of NPT. Raw material unavailable problems mainly occur for the Improper time action plan, absence of suitable supply chain, machine break down, failure to execution of Time and action plan and others causes shown in the figure. By data filtering, we get the average NPT and production per day per line which is shown in table no-2.

Table 2*:* Production output per line *Vs.* average NPT.

Days	Average NPT (Min) per day/per line	Average Production (pcs)per day per Line
1	130	750
2	120	900
3	119	905
4	115	910
5	112	915
6	110	925
7	90	1050
8	70	1100

From this table we design a correlation model (fig-7) between NPT and garments production.

4. Conclusion

From this research work, we have found that in the sewing section of apparel industries have non-productive time (NPT) is mainly due to cutting problems, Materials are not available in sewing, line layout setting, machine maintenance, and some other issues which are about 24.66%, 21.92%, 14.61%, and 12.78% respectively[13]. The cutting problem mainly happened for fabric faults, lack of experience, and wrong bundle numbering system, and materials unavailability is due to the incorrect time action plan and line setting problem mainly for lack of experience and knowledge of management[14]. This NPT has strongly affected the productivity of the apparel
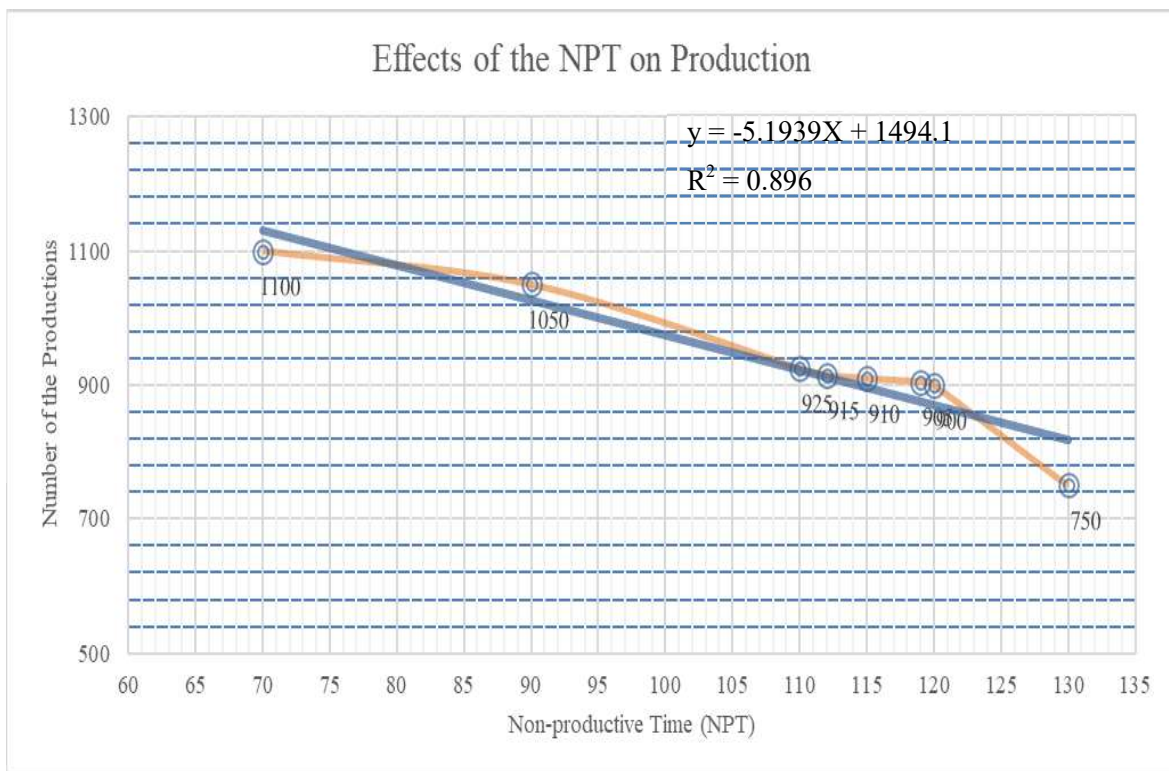

Figure 7: Effects of NPT on production.

From fig-**7** we found that the correlation value (R^2) between NPT and production is point 0.896 which is strongly significant.

industry. From this research work, we can say, if the NPT increase, then productivity goes down. So, to meet the global challenge of the

apparel sector, we should take all possible measures to minimize the NPT.

REFERENCES

[1] AKM Fariduddin Ahammad, "Monthly Export Summery Sheet-20-21," Dhaka. [Online]. Available: http://epb.gov.bd/site/epb_export_data/74b9bb75-54ec-4a66-8ff1-301e73393f47/2020-2021July-September

[2] S. M. M. Alam and M. N. Huda, "Critical Analyses of Sewing Defects and Minimization of," vol. 18, no. 1, 2018.

[3] R. Nayak and R. Padhye, *Introduction: The apparel industry. The apparel industry.* Elsevier Ltd, 2015.

[4] P. Chandurkar, S. Jain, and H. Upasani, "To Reduce Non-Productive Time in Garment Industry," vol. 1, no. 2, pp. 43–47, 2015.

[5] M. M. Islam, A. M. Khan, and M. Z. Uddin, "Elimination of Non Productive Activities is a Must in Cost and Time Savings in the Sewing Section of Apparel Industry," *Int. J. Eng.*, vol. 1, no. 4, pp. 2305–8269, 2013.

[6] A. Science, I. Management, A. Sciences, and S. Lanka, "Non-Productive Activities & Effectiveness o f the Methods to Minimize them on the Sewing Floor: A Case Study o f the Sri Lankan Apparel Industry Kothalawala KDPM* and Pallegedara A," 2016.

[7] M. N. S. Patil, S. S. Rajkumar, M. P. W. Chandurkar, and P. P. Kolte, "Minimization of Defects in Garment during Stitching," *Int. J. Text. Eng. Process.*, vol. 3, no. 1, pp. 24–29, 2017.

[8] N. Shrestha, "Proportion Defective Chart to Monitor Apparel Production Process," *Int. J. Eng. Bus. Manag.*, vol. 3, no. 2, pp. 55–59, 2021, doi: 10.22161/ijebm.3.2.3.

[9] V. Shivajee, R. K. Singh, and S. Rastogi, "Manufacturing conversion cost reduction using quality control tools and digitization of real-time data," *J. Clean. Prod.*, vol. 237, p. 117678, 2019, doi: 10.1016/j.jclepro.2019.117678

[10] C. N. Keist, *Quality control and quality assurance in the apparel industry*. Elsevier Ltd, 2015.

[11] R. Nupur, K. Gandhi, A. Solanki, and P. C. Jha, "Six Sigma Implementation in Cutting Process of Apparel Industry," pp. 279–295, 2018, doi: 10.1007/978-981-10-5577-5_22.

[12] J. Hossen, N. Ahmad, and S. M. Ali, "An application of Pareto analysis and cause-and-effect diagram (CED) to examine stoppage losses: a textile case from Bangladesh," *J. Text. Inst.*, vol. 108, no. 11, pp. 2013–2020, 2017, doi: 10.1080/00405000.2017.1308786.

[13] N. Aini, R. Kusumaningrum, Mustafid, and E. Hidayat, "Statistical process control systems in apparel production," *2017 Int. Conf. Inf. Technol. Syst. Innov. ICITSI 2017 - Proc.*, vol. 2018-Janua, pp. 134–138, 2017, doi: 10.1109/ICITSI.2017.8267931

[14] G. E. H. Wijewardhana, S. K. Weerabahu, J. L. D. Nanayakkara, and P. Samaranayake, "New product development process in apparel industry using Industry 4.0 technologies," *Int. J. Product. Perform. Manag.*, no. August, 2020, doi: 10.1108/IJPPM-02-2020-0058