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Analysis of the Critical Path Methods Impacts on the Basic T-Shirt Manufacturing Process in the Apparel Industries

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Abstract:- Time and motion studies' effects on the apparel and textile industries increase their profitability and help to define the standard minute value (SMV), which is then used to clear traffic jams, reduce downtime, and increase production. The main goals of this research are the determination of the procedures which are appropriate for the garment production process. The second aim is to demonstrate the benefits and drawbacks of employing those tactics for the factory. The final option is to illustrate how the PERT and CPM affect the competitiveness of the entire garment sector. The Line balancing with CPM and PERT resulted in this work reduced the manpower from 17 to 11, an increase in line efficiency from 49 to 77.5 percent, and a reduction in production costs from 75 to 46 BDT for a basic T-shirt manufacturing process.

Keywords- *Critical Path Method (CPM), PERT, Textile Apparels, Industries, Manufacturing.*

I. INTRODUCTION

Today's textile production has short product life cycles, variable and unpredictable consumer demand, enormous product variety, and a protracted supply chain are all characteristics [1]. Suppliers in developing countries are under pressure due to several factors, including short product life cycles, high levels of impulsive buying, fashion influences across all product categories, increases in product diversity, ongoing in-season refreshments, and the need for prompt responses[2]. Cutting, stitching, finishing, and packing are just a few of the manufacturing steps that make up the overall manufacture of clothes. The predominant procedure is sewing. Up to a hundred machine hand, sewing operations may be used during the sewing process depending on the various clothing models [3]. The Critical Path Method, also known as CPM, is a technique for streamlining the order of planned activities, or tasks, in a project. A scientific method for analyzing a new manufacturing design is the CPM. By cutting down on time required by the conventional method, the critical route method generates the production flow chart as quickly as possible. This management tool makes sure a project is finished on schedule[4].The biggest problem in the fashion-oriented and order-based apparel businesses is the idle times and bottlenecks of the production process system. The CPM helps to identify idle time and reduce the bottlenecks problem[5]. The research work has three prime objectives. The first stage is to identify the suitable processes that the garment manufacturing process involves. The second step is to show both the advantages and the disadvantages that using those strategies might have for the factory. And, the last, shows how the CPM and the PERT impact the competitiveness of the overall apparel industry [6].

II. LITERATURE REVIEW

The classic methods for project scheduling are called program evaluation and review techniques (PERT). The PERT method uses probability theory to quantify the uncertainty surrounding the amount of production time needed to accomplish process tasks that is based on critical path analysis [7]. Also, themethod of labor measurement used to establish a baseline for future improvement is called time study. It calculates the amount of time required to finish a task using the most efficient methods which is the part of the critical path method [8]. The impact of time and motion studies on apparel and textile industries enhance the profitability to establish the standard minute value (SMV), which was then applied to remove bottleneck, cut down on idle time, and boost productivity [9].Planning, coordinating, and managing resources to achieve specific project goals and objectives is the subject of project management helps to discover the risk factors, productivity calculation [10]. Using planning methods like CPM and Pert to support project management has been usual policy for a long time. The use of simulation to support managerial decisions, notably those in the area of project management, has increased during the past few decades. One of the key benefits of employing simulation is that all the data from each project realization is available and can be utilized for additional analysis in addition to providing accurate statistics for the entire project. In real life, simulation findings could be utilized to establish the project's contractual completion date during the quoting process[11].

III. MATERIALS AND METHODOLOGY

The project work is carried out in the apparel industries at Gazipur. The product item was basic T-shirt and the fabric type was single jersey, weight of the cloth 180 gram per square meter (GSM). The goal of the study was to contrast the outcomes produced by using a traditional process planning technique with those acquired by creating and implementing a network diagram of CPM.The research data was collected by primary, secondary, and quantitative qualitative data source from the factory. We have observed, process sequence, time studies, and interviews with the managers of the basic T-Shirt sewing lines. The primary data were collected from the product model, the T-shirt

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sewing line, the processing times for each task, the production cycle times for each workstation, the number of operators, the number of taskstations, the production process flow, and the line balance circumstances at the moment. The company's organizational structure, a brief history, the company's production capacity, data on production planning, effective working hours, weekday schedules, table rating factors, publications, and research findings on the topic of line balancing were all considered secondary data Figure-1, shows the methodology of the research work.

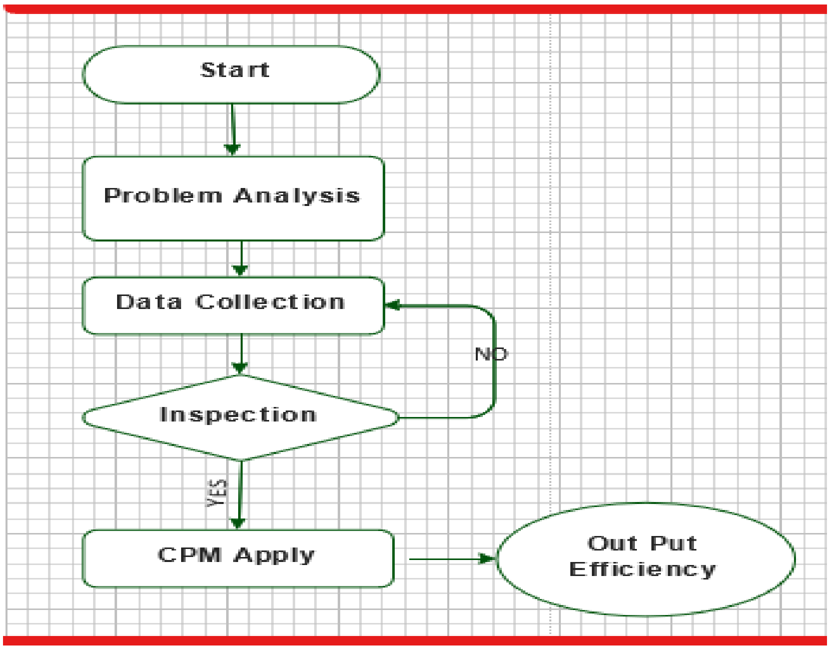

Fig. 1: Methodology diagram of research work

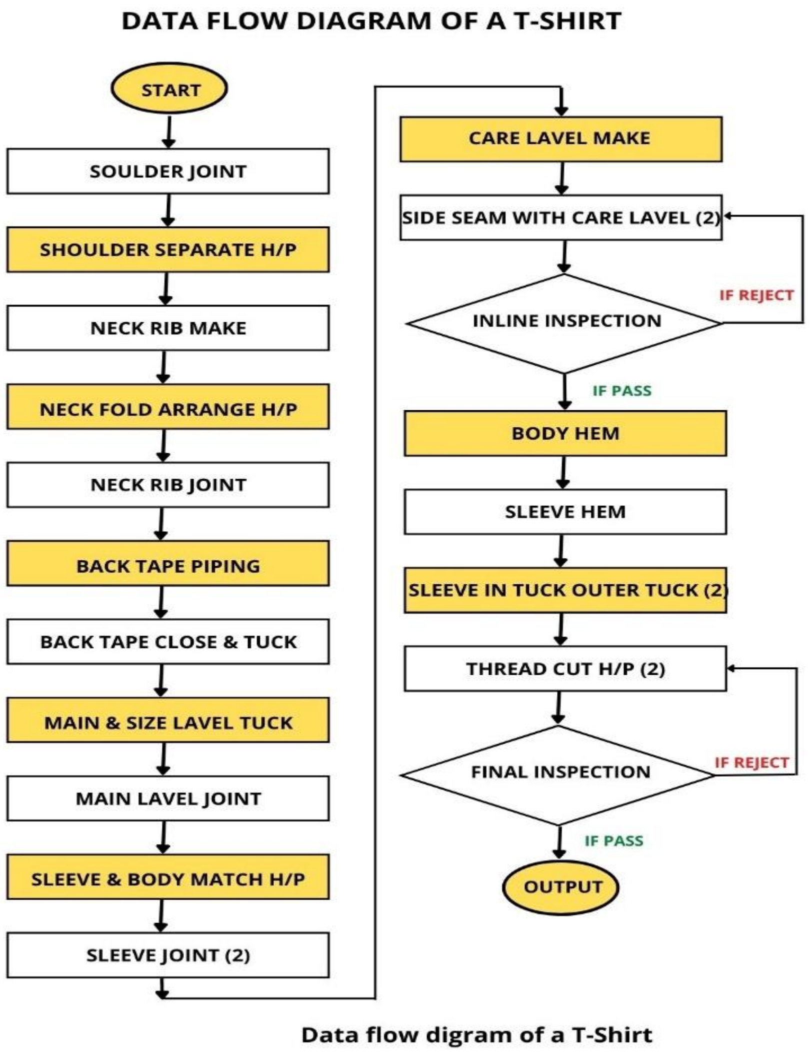

Fig. 2: Process Flow Chart of Basic T-Shirt

The typical T-shirt work process flow chart used by the garment industries is shown in Figure 2. There are 17 total workstations used in the conventional system, and the efficiency of the apparel line was 38%. The data has been analyzed as shown below.

- Cycle Time: The cycle time is the length of time a job is kept at a workstation. Equation 1 is used to calculate it as well as another definition, "time gap between the start time of any operation to next start time of same operation.

$$Cycle\ Time = \frac{Production\ Time\ Per\ Day}{Unit\ Required\ Per\ day}$$

- Standard Minute Value (SMV): Standard Minute Value is SMV in its complete form. It is described as the amount of time allotted to do a task successfully.
- $\text{Standard Minute Value} = \text{Basic Time} + \text{Basic Time} * \text{Allounce}\%$
- $\text{Production Target Per hour (Pcs)} = \frac{\text{Manpower}*\text{Production Time in Minute}*\text{Plan Effiency}\%}{\text{Standard Minute Value(SMV)}}$

- Line Efficiency%:

$$\text{Line Efficiency }\% = \frac{\text{Total Task Content} * 100}{\text{Number of Work Station} * \text{Cycle Time}}$$

- Cost of Making (CM): The entire spending of the factory, the total number of sewing machines needed to finish an item, the total number of sewing machines in use the factory, the number of working days month and hours per day, and the targeted production per hour of the sewing line are all important aspects of the cost of making in the garment business.

$$C.M = \frac{A * B}{C * D * E * F}$$

CM = Cost of Making, A =Factory Total Expenditure per month, B =Total number of Machine required an item, C =Total Number of Machine, D =Total working day per month, E =Total working hours per day, F =Target production per hour

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IV. RESULTS

The processing times for the T-shirt and its immediate predecessor are shown in Table 1. According to the conventional approach, the T-shirt's standard minute value was 3.41 minutes. To determine the longest path, we used the critical path approach. The longest path, as shown in Figure 3, is A+B+C+D+E+F+G+H+I+K+L+M+N+O+P = 3.23 minutes.

SL #	Task	SMV	Predecessors
A	Shoulder Join	0.18	
B	Shoulder Part Separate	0.22	A
C	Neck Rib Make	0.17	B
D	Neck Fold Arrange	0.17	C
E	Neck Rib Join	0.22	D
F	Back Tape Piping	0.23	E
G	Back Tape Close and Tuck	0.28	F
H	Main Label and Size Label Tuck	0.18	G
I	Main Label Join	0.21	H
J	Sleeve and Body Match	0.18	
K	Sleeve Join	0.21	I, J
L	Care Label folding	0.17	K
M	Side Seam and Care Label Join	0.18	L
N	Body Hem Stich	0.27	M
O	Sleeve Hem Stich	0.22	N
P	Sleeve In and Outer Side Tuck	0.14	O
Q	Thread Cut	0.18	P
	Total	**3.41**	

Table 1: Standard Minute Value and Immediate Predecessor of Basic T-Shirt

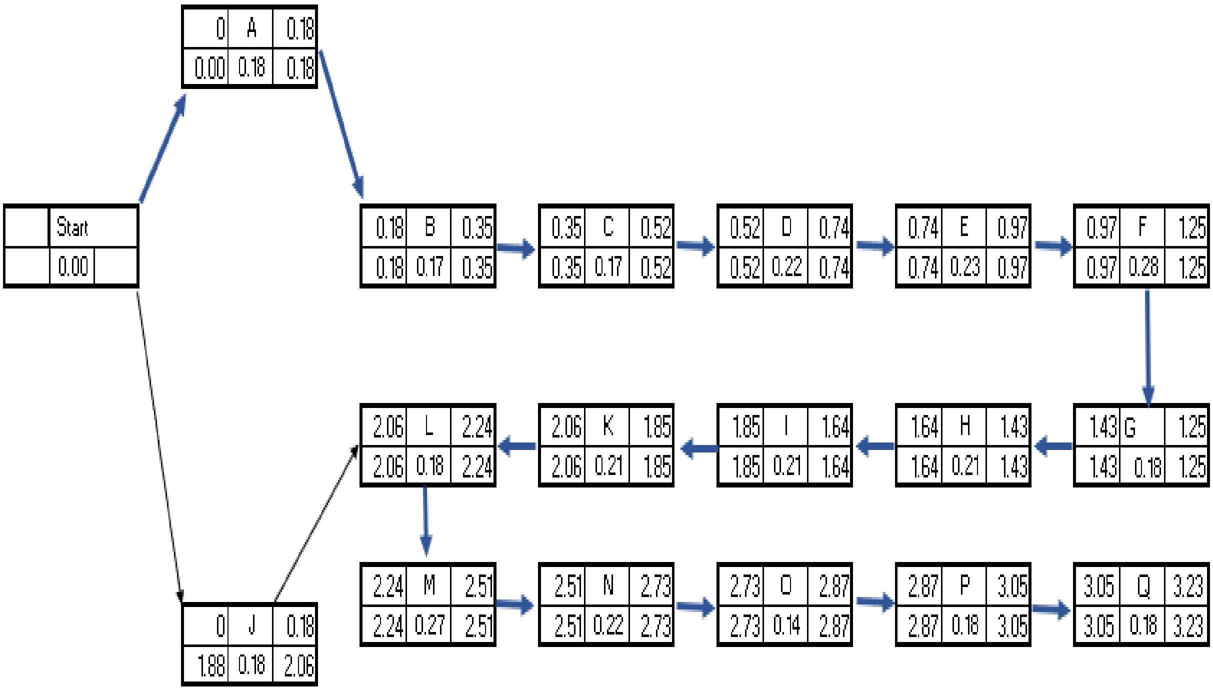

Fig. 3: Critical Path Method(CPM) of T-Shirt

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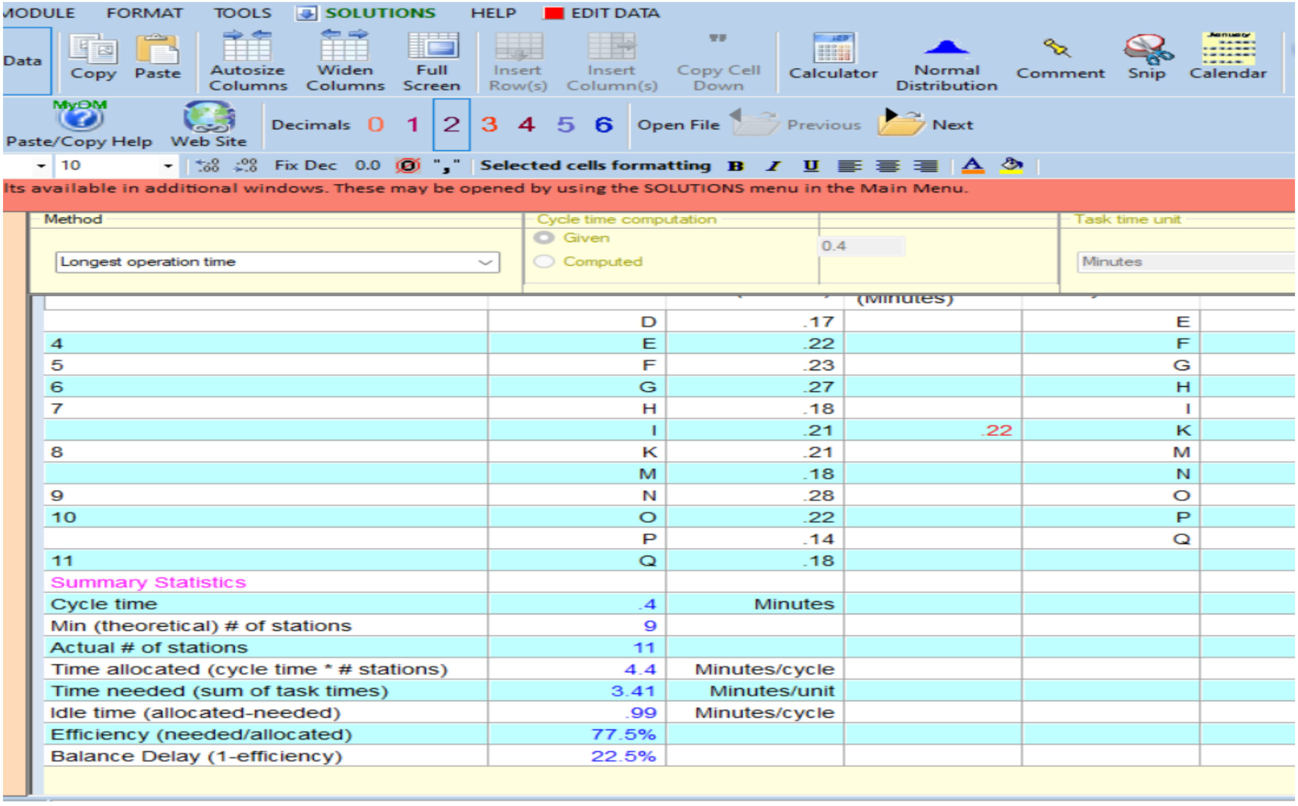

Fig. 4: The Line Balancing Summary of T-Shirt Process

With the help of the Quality Management (QM) software, we examined the T-shirt manufacturing process, with the results being summarized in Figure 4. The manufacturing process seemed to have a cycle time of 0.4 minutes and 9 hypothetical workstations but actually had 11.

The total allocated cycle time of 4.4 minutes for each workstation and total needed sum of the task time of 3.41 minutes. From the result of QM software idle time of 0.99 minutes and a line efficiency percentage show 77.5 where the rest of time was delay percentage 22.5 minutes.

Line Balance Activity	Manpower	SMV	Cycle time	Production Target	Line Efficiency %	Cost of Making Tk.
Before	17	3.41	0.41	1238	49	75
After	11	3.23	0.4	1855	77.5	46

Table 2: Performance between before and after Line Balance

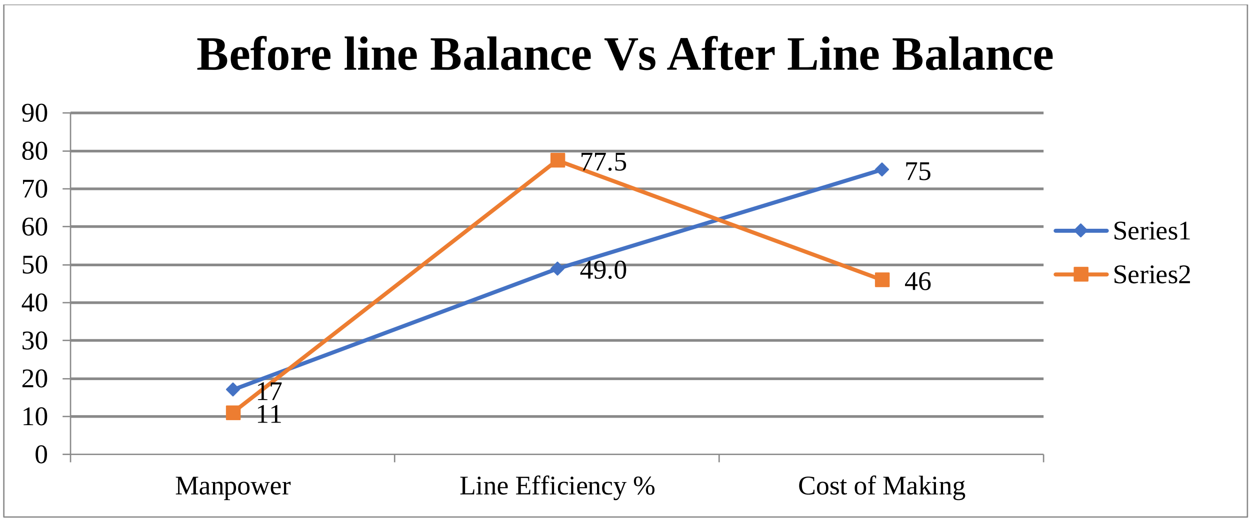

Fig. 5: The Performance of the Before and After Line Balancing of the T-shirt Manufacturing

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The effectiveness of line balancing in t-shirt production is displayed in table 2 below. We calculated the process characteristics prior to line balancing, which included cycle time of 0.41, standard minute value (SMV) of 3.41 minutes, manpower of 17 people, line efficiency of 49 percent, and cost of making BDT. 75 for each item. However, following line balancing with CPM and PERT, the workforce was decreased the manpower from 17 to 11, the efficiency of the line increased from 49 to 77.5 percent, and the cost of production was cut from 75 to 46 BDT, as shown in figure 5.

V. CONCLUSION

The research examined the likelihood that a project will be completed while using the critical path method (CPM), project evaluation, review techniques, and cost-benefit analysis. We calculated the probability that the job would be finished in the allotted period.This study sought to increase a Basic T-shirt assembly line's efficiency. by applying CPM PERT, and Quality management tools to determine the line balancing scenarios that would be appropriate for using them (without and with resource constraints). It was discovered that The prioritized positional weight technique works in a well-balanced assembly line with higher line efficiency when resource limitations in each task stations are really not taken into accountwith higher line efficiency. When resources are limited, it results in low line efficiency. This demonstrated the inefficiency of the ranked positional weight method for balancing complicated garment manufacturing lines, which typically involve multiple resource types and make line balancing in the absence of resource constraints all but impossible. Due to this, the concept of ranking positional weight for reachingthe larger increase in line effectiveness. However, using this method to increase efficiency is very simple. Specifically in the manufacturing of knitwear garments, of a garment assembly line with few identical equipment's.

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